An Explorative Study on Factors outside the Influence of the Entrepreneur that can explain the Commercialization Gap for Cleantech Innovation in Israel

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Delft University of Technology, Faculty of Technology Policy & Management
Master's Program: Management of Technology
Section: Economics of Technology and Innovation
Author: Thijs Schaap
Student number: 4317998
Graduation date: 29 September 2015

Commission Board:
Chairman: Prof. Dr. C.P. van Beers
First Supervisor: Dr. ing. Victor E. Scholten
Second Supervisor: Dr.ir. E.H.W.J. Eefje Cuppen

Placement:
Embassy of the Kingdom of the Netherlands to the State of Israel
Ramat Gan, Israel
Placement Supervisors:
Dhr. A. Kool – Head of Economic Section
Dhr. M. Nellen – Innovation Officer

TU Delft

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Thijs Schaap
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EXECUTIVE SUMMARY

Background

The research is executed as a master thesis for the MSc program Management of Technology at the TU Delft and is conducted in collaboration with the Embassy of the Kingdom of the Netherlands to the state of Israel in Tel Aviv. The researcher has spent six months in Israel to perform this research and was subsidized by Climate-KIC to execute this research.

Problem statement and research question

This research is an empirical exploration of the influence of external factors on the commercialization process for cleantech Technology Based New Ventures (TBNVs) in Israel after these ventures have received seed funding. External factors are defined as factors outside the influence of the entrepreneur.

Literature has described the progression of TBNVs in different stage-based models, although these mainly describe the organizational development. This thesis uses models of Kazanjian et al (1989) and Vohora et al (2004) to describe the growth process of cleantech TBNVs and zooms in on the processes which cleantech TBNVs have to execute after they passed the *credibility threshold* (Vohora et al, 2004). This milestone reflects in the research by only considering cleantech TBNVs which have received seed funding and where thus deemed credible enough by their investors.

Previous research has named Israel the most innovative country in cleantech, but showed that there is a lack of commercialization of this innovation. The purpose of this research is to explore explanations for this phenomenon and test whether the factors distilled from the literature study can be found in practice and explain the phenomenon. Ten factors were determined based upon a literature study and these were tested by conducting field interviews and studying research reports. The overall research question for this study is:

Which factors, outside the influence of cleantech TBNVs, have consequences for the progression of cleantech TBNVs to the sustainable returns phase after seed funding has been received?

Research Process

Three angles were chosen in the literature study to determine external factors – markets, resources and policy. These factors served in general as a good framework for the practical exploration of the influence of external factors on the commercialization process of cleantech technology based ventures in Israel. The studied factors are *accessibility of international markets, the need for high-paced growth, the need for an international network, availability of financial* and *human resources, risk tolerance of available financial resources*, *competition for financial resources with other fields of technology, the formal institutional regime for new innovations, the formal institutional regime for new sustainable innovations* and *perceived stability of the governmental policy by investors.*

Empirical research was done in the form of two rounds of data collection. The first data collection contained semi-structured interviews with ten respondents who were (in)directly involved with cleantech in Israel. These respondents were from four different areas – business development, government (policy), late stage finance and venture capitalists and were interviewed about the aforementioned factors. The results from these interviews prompted a second data collection in two specific topics that were thought to hold more explaining value about the observed commercialization gap. These two topics included the availability of financial resources and related factors, the policy for innovation in Israel in general and the policy

surrounding cleantech innovation. The second data collection contained another four semi-structured interviews on these specific topics and the study of reports on the topics.

Findings and conclusions

The results of the empirical research showed that all the proposed factors were relevant and influenced cleantech TBNVs in Israel, although the influence of some factors is more explicit than that of others. Especially the availability of financial resources which can be used to invest in technology development of cleantech TBNVs were found to be lacking. This can be explained by the high financial costs of technology development for cleantech TBNVs. The investment in such a project bears a lot of risk, which only a few types of investors can cope with – namely specialized, early-stage Venture Capitalists, business angels and the government.

Moreover, many cleantech TBNVs develop technologies related to the field of infrastructure which is a tough market for a start-up. Finally, the shift in policy relevant for cleantech TBNVs can be expected to offset investors, which also contributes to the lower amount of available financial resources.

Implications

Scientifically, this study contributes evidence to the validity of the applied theories in a specific setting – namely development of cleantech TBNVs in Israel. The conceptual model used in this study would be useful to explore similar research problems in other countries although a zoom into specific topics remains necessary. In this research the specific topics included policy relevant for cleantech TBNVs and the needs for funding for cleantech TBNVs.

Practically, this research has implications for entrepreneurs and investors in this field and for governments both in Israel and Europe. Entrepreneurs and investors in this field should realize themselves that they are in a precarious position due to factors like the high costs of technology development and instable policy that heighten the already high amounts of uncertainty that is currently surrounding the process of cleantech TBNV development. Risk reduction strategies should be high on the priority list of these actors.

Governments should realize that investors make investments with a five to ten year horizon and regulatory stability is therefore an important factor to take into account if one aims to increase in the sector. Especially the case which described the instability of the solar sector in Israel is an example of an increase in investment insecurity by governmental decisions.

Moreover, the financial resources necessary for most of the cleantech start-ups are momentarily simply not available. The Venture Capital investment model is only suitable for those start-ups that can achieve high growth rates, which can be difficult for cleantech start-ups. Making different financial resources available tailored to the needs of cleantech TBNVs, for instance via debt financing instead of equity financing should be a priority for the governments both in Israel and Europe. Previous research of EIM showed challenges in Europe to be similar to the challenges that have been found in this research.

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1 INTRODUCTION

"Cleantech" (or "sustainable innovation" or "eco-innovation") is now a widespread used concept, but it has a fuzzy meaning. Cleantech is an abbreviation of "clean technologies" and thereby comprises a whole range of technologies that, as the Cleantech group puts it, try to do "more (things) with less (pollution/resources)" (Parad, 2014).

Three discursive strands can be used to explain how the cleantech sector is currently described. These strands are the depiction of cleantech as the next paradigmatic technology revolution, the concept of cleantech as market-driven and the idea of cleantech as a 'technical fix' or solution to climate crisis (Capriotti, 2012). Within this thesis the concept of cleantech as market driven is explored. The core assumption that is made is that for cleantech to have a role as a 'technical fix' in the solution to the climate crisis[1], there is a need to scale up the new ventures that bring cleantech to the markets.

Bringing new products to the market is the lifeblood of new organizations, but it is also a hard and challenging task. It is hard to predict why some new products succeed, while most fail. Research in the area of new product innovation has attempted to specify those factors that can increase the number of project successes. After many studies, the notion of finding a single set of universal factors is now considered naïve (Souder, 1987).

Sustainable entrepreneurs can contribute to solving environmental problems by helping extant institutions in achieving their goals and by creating new, more environmentally sustainable products, services and institutions. (York & Venkataraman, 2010). An example of an initiative that attempts to push the sustainable transition forward through entrepreneurship is Climate-KIC, an initiative from the European Union which is also partially funding this research.

For cleantech to play some role as the aforementioned 'technical fix' and contribute to solving the climate crisis, the sustainable technology would need widespread implementation. One way to achieve this would be for an entrepreneur to build a successful venture that commercializes the sustainable technology. However, this is easier said than done. To achieve such a *commercialization process*, a technology based new venture (TBNV)[2] will follow a certain, undefined growth path from conceptual stage all the way to widespread commercialization. The TBNV will have to undergo a transformation in its design characteristics which enables it to face the new tasks or problems that growth elicits. Over time, a technology based new venture's management team faces a number of problems that emerge around the management of the new technologically based products. Such problems tend to follow a sequence and cluster together in such a way that it becomes possible to define stages that the new venture must pass through to become a viable business. In different models describing this transformation, growth stages tend to emerge in a well-defined sequence (Kazanjian & Drazin, 1989). In their model, Kazanjian & Drazin (1989) define four different stages; Conception and Development, Commercialization, Growth and Stability.

[1] The author does not want to make the claim that there is a sole 'technical fix' to the climate change problem, but technological advancement can play an important role in the fight against climate change.

[2] With technology based start-ups I refer to start-ups who develop a tangible technology. Many hi-tech in Israel is IT-based, thus non-tangible and therefore susceptible to different challenges (e.g. the creation of a physical new technology comes with different environmental influences than the creation of an application for a certain purpose).

This thesis focuses on the commercialization challenges for new clean technology based ventures in Israel. The research has a focus on the initial two phases described by Kazanjian et al (1989) because empirical data shows a difference between the amount of cleantech innovation in Israel and commercialized cleantech innovation[3]. This data shows that many cleantech start-ups are unable to move beyond the initial revenue stages (see also fig. 11, p. 43) which are captured by these two phases.

During the **Conception and Development** stage, the primary focus of the entrepreneur (and possibly several others) is on the invention and the development of a product and/or a technology, the securing of adequate financial backing, and the identification of market opportunities. Vohora, Wright and Lockett (2004) explain a stage-based growth model that could be perceived as deeper look into the Conception and Development stage of Kazanjian et al (1989). The *problems surrounding the TBNV management* are described by Vohora et al (2004) in four **critical junctures** which have to be overcome in order to progress to the next phase. An example of such a critical juncture is the *credibility threshold*, which means that the entrepreneurial team did not build up enough credibility (for instance due to flaws in the business model) to gain certain resources like seed finance (Vohora, Wright, & Lockett, 2004). This thesis focuses on TBNVs that have passed the credibility threshold and have to overcome the *sustainability threshold*. To do so, the TBNV team has to *generate the ability to continuously re-configure existing resource weaknesses, inadequate capabilities and social liabilities into resources strengths, distinctive capabilities and social capital that enables the venture to generate sustainable returns* (Vohora, Wright, & Lockett, 2004). In fact, the core challenge of TBNVs in this thesis is to **generate sustainable returns.** These models are further explored in section 2.1.1.1 and this aspect of the focus of the thesis is visualized in figure 1.

Theorists like Kazanjian et al. and Vohora et al. look at internal causes of inability to generate sustainable returns. In a recent study by van Geenhuizen et al. (2009) on academic spin-offs from the TU Delft, obstacles to growth were identified to be of both an internal (within the start-up – e.g. lack of certain technological skills) and external nature (outside the start-up – e.g. lack of available hires with certain technological skills). For example, the research of van Geenhuizen et al. into academic spinoffs confirmed that inadequate capabilities like the lack of marketing knowledge are the highest ranking obstacle to growth in academic spinoffs, combined with shortage of sales skills and a lack of cash flow (van Geenhuizen & Soetanto, 2009). If one considers these to be internal causes, the assumption is that there are plenty of resources in the external environment waiting to be captured by the entrepreneur to use for its purposes.

Figure 1 Stages of the ventures of interest in this thesis. The two stages of Kazanjian et al (1988) and the two critical junctures of interest are highlighted. This thesis looks at the external factors which are relevant at this particular point in time. It should be noted that this thesis does not make any claims about the relation between these two stage-based models.

Such an approach makes sense if one researches academic spin-offs like van Geenhuizen et al (2009), because such spin-offs can be assumed to be not very experienced in the act of determining and capturing the necessary resources from their environment. However, this may not be the case for the entrepreneurs within this thesis, because a differentiation between certain types of

[3] See section 1.1 for a broader description of the case Israel and empirical data.

entrepreneurship is not made. This thesis focuses on cleantech entrepreneurs in Israel, a country that is often named "Start-up Nation" and has the highest score in perceived entrepreneurship under managers (IMD, 2014). Section 1.1 explores the entrepreneurial cleantech roots of Israel.

In this thesis the aforementioned assumption is reversed – entrepreneurs are assumed to be able to capture resources from their environment, which allows the researcher to identify other obstacles to growth. An example of such an obstacle to growth could be that a very limited amount of suitable employees and financing possibilities are available within the environment of the start-up. In this case, one could say the **external factor** "specific available resources in the environment of the start-up are lacking" is the obstacle to growth. This angle of *external factors* is what this research is further investigating. External factors are defined as factors outside the influence of the cleantech TBNV.

To increase the plausibility of the assumption, the general units of analysis are the external factors that influence TBNVs *after the ventures have received seed funding*. Seed funding is the initial funding a venture receives from an investor, which has judged the venture to be credible enough for an initial investment. This is consistent with the theory of Vohora et al (2004), who hypothesize that after the credibility threshold, start-ups have to organize their venture to cope with the sustainable returns threshold. Other categories of external factors that will be considered besides the availability of resources, are policy (the government) and markets.

This research investigates the influence of these three categories of external factors (markets, resources and policy) on cleantech TBNVs' challenge to **generate sustainable returns** by performing a case study on the cleantech sector in Israel. The cleantech sector in Israel was labeled a "cleantech start-up generator" by recent research of the Cleantech Group and outperformed every other country in the world in terms of 'evidence of emerging cleantech innovation', which is measured in environmental patents, cleantech venture capital and entries in the annual rankings of the top 100 private cleantech companies globally. The report also notes that Israel has demonstrated the largest gaps between 'evidence of emerging cleantech innovation' and 'evidence of commercialized cleantech innovation' (Parad, 2014). These findings can interpreted as that there are challenges with regards to commercializing clean technology in Israel. This *commercialization gap* is an interesting case to research the external factors that influence the sustainable returns challenge because the data suggests that in Israel the worlds' largest amount of cleantech innovation is reduced to a far smaller amount of commercialized cleantech commercialization. The factors that cause this are unknown and identifying them will be the main topic of this research.

In their literature review of factors influencing new product innovation, Balachandra and Friar (1997) found that commercial R&D projects are more often found to be influenced by external factors than internal factors if the factor classification depends on the amount of influence the firm can exert on them (Balachandra & Friar, 1997). The factors that can explain the cleantech commercialization gap can have both an internal and an external nature, but this thesis will look at factors outside the limited influence of the firm. In combination with the notion on the goal of generating sustainable returns, which is considered the next step for TBNVs after they passed the credibility threshold, this leads to the following research question.

Which factors, outside the influence of cleantech TBNVs, have consequences for the progression of cleantech TBNVs to the sustainable returns phase after seed funding has been received?

The overall research question consists of two main components – the external factors within and/or outside Israel and the progress the cleantech start-ups have to make to progress to the sustainable returns phase, as defined by Vohora et al (2004).

This research consists of two steps. First, theoretical external factors are derived from several streams of literature in sections 2.1 and 2.2 to describe these two components. The external factors are categorized in markets, resources and policy. Secondly, fourteen field interviews within Israel are conducted with respondents who are involved in the cleantech sectors in different roles, for instance as venture capitalist or policy maker. In this way, empirical evidence for the theoretical factors can be generated

The commercialization process is theoretically described by the literature stream of growth paths like the aforementioned articles of Kazanjian et al (1989) and Vohora et al (2004). These streams of literature, combined with literature on entrepreneurship in Israel and entrepreneurship in cleantech, will be used to construe three groups of challenges that are described within the literature to generate sustainable returns. Therefore, the first sub research question for this thesis is:

1. How do cleantech TBNVs progress after seed funding has been obtained to the sustainable returns phase?

The already complex task of understanding the factors leading to success in new product development cannot be totally explained by one set of factors for all situations. Instead, depending on the situation, different factors become more or less important, and some may actually begin to hinder rather than aid in the already difficult task of New Product Development (Balachandra & Friar, 1997). Describing the ways for cleantech TBNVs to progress to the sustainable returns phase can be used as a selection mechanism to derive external factors from the literature the specifically influence these challenges. Moreover, it gives the research context for the mechanisms that are introduced in the results part of this thesis.

The external factors will be explored from three categories of factors – resources, markets and policy. The *resources* angle has already been briefly introduced. According to the resource based view (Barney, 1991), firms are collections of resources and capabilities that behave differently depending on the level of uniqueness of resources and difficulty to imitate them.

Obstacles to growth can be perceived as the *lack of availability* of resources or *accessibility* to resources (van Geenhuizen & Soetanto, 2009). These are two different concepts – availability of resources means whether the resource exists in a country (e.g. the education system educates many technologically skilled engineers) and the accessibility of resources means whether these resources are available for the TBNV to acquire (e.g. the willingness of engineers to work for TBNVs).

Markets play a specific role because of the small home market and the geographic isolation of Israel. Such a situation means that the start-up will not deploy his or her commercialization activities in Israel (Almor, Tarba, & Margalit, 2014).

The influence of the government on the external factors will be considered because the policy environment plays an important role in the creation of cleantech markets and the government can serve in a role to prevent market failures (Doganova & Karnoe, 2015; PBL, 2015).

2. What are the external factors in Israel that influence the progress which cleantech TBNVs within Israel have to make after these TBNVs have obtained seed funding?

2.1 Which external factors related to markets are described in the literature to influence growth of (cleantech) technology-based new ventures?

2.2 Which external factors related to resources are described in the literature to influence growth of (cleantech) technology-based new ventures?

2.3 Which external factors related to policy are described in the literature to influence growth of (cleantech) technology-based new ventures?

To connect the theoretical research of this thesis to the empirical aspects and to answer the main research question, a last research question is necessary. The question will be explored by conducting field interviews within Israel and by generating evidence from secondary sources.

3. Which of the external factors can be found to influence the cleantech TBNVs within Israel?

This research is based upon a conceptual framework which is derived from the aforementioned factors to explore the post seed-funding environmental factors of cleantech start-ups within Israel. The conceptual model is visualized within figure 2.

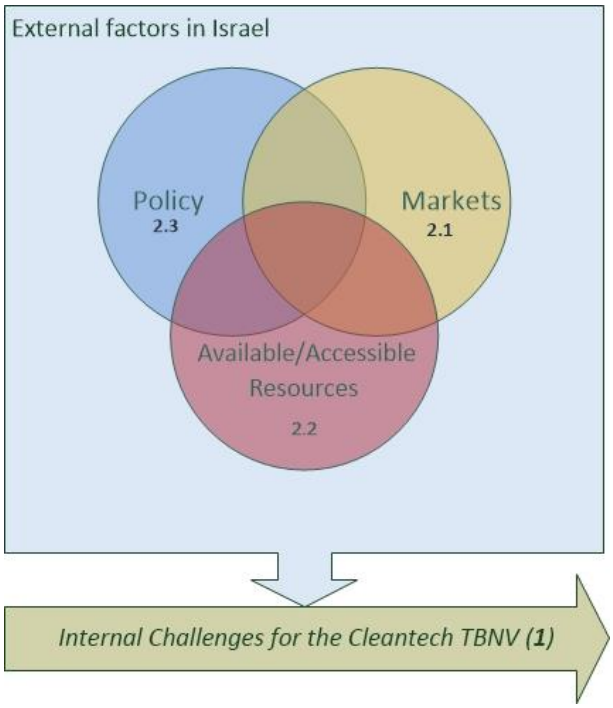

Figure 2 Conceptual model for this thesis. Specific factors based upon each category will be generated in the literature section.

In the following section, background information on Israel will be given to make the reader familiar with the choices of the researcher and to understand the uniqueness of the case Israel.

1.1 THE CASE ISRAEL

The external factors that are tested in this research will be evaluated in the state of Israel as a research project for the Dutch Embassy in Tel Aviv. The state of Israel is a small country in the Middle East with a very high percentage of well educated, technologically skilled citizens and a thriving start-up ecosystem. It has been given names like “the world’s most vital place for entrepreneurship” and “Start-up Nation”. The country is well known for its entrepreneurial culture, its strong technological capabilities and its dynamic startup intensive high tech cluster. The policy of the Israeli government certainly contributed to its current status. Some very successful start-ups that managed to commercialize the developed technology through sales of their technology to large corporate entities have emerged from Israel and almost all major Technology companies in the world (especially IT) have a research center or a subsidiary within Israel (Almor T. , 2014; Avnimelech & Teubal, 2006; Bresnahan, Gambardella, & Saxenian, 835-860; Senor & Singer, 2009).

Geopolitically, Israel is an isolated country although it is landlocked at three of its borders. Due to cultural, historical and religious reasons most countries of the Middle East were at war with Israel during a significant time of its existence. Although the relations with its direct neighbors Egypt and Jordan have improved since the peace treaties (1979 and 1994), most of Israel's neighbors are either hostile to its very existence or maintain minimal commercial relations with the country (Friedrich, 2014). Resources in Israel are naturally very limited and the Israeli have to be efficient with their resources to deal with this situation. The founding father of Israel, David Ben Gurion, already said in 1955:

> *"Israel requires the study of desalination, massive utilization of solar energy, preventing waste of useful rainwater and maximization of power from wind turbines."* (Gunther, 2013)

The water scarcity in Israel has led to the establishment of a successful water industry which has for instance produced drip irrigation. There is one resource which Israel actually has a lot of – brainpower (Avishai, 1991). Combine this with an exposure at early age to the hi-tech world and major responsibilities during the mandatory army service and one has found an explanation for the thriving start-up nation in Israel (Senor & Singer, 2009), in which cleantech plays an important role (Gunther, 2013).

According to government sources Israel has a booming cleantech sector - today it has more than 200 companies with renewable energy solutions and about the same number with clean water solutions. Exports of energy and water technologies from Israel are approaching $1 billion annually (Israel Export, 2011). The government is backed up by independent global research of Cleantech Group and WWF, who ranked Israel as the number one innovator in cleantech, being labeled a "cleantech start-up generator" (Parad, 2014).

1.1.1 The Commercialization Gap In Clean Technologies

The same research also mentioned the large gap between evidence of emerging cleantech innovation and the evidence of commercialized cleantech innovation in Israel. The Cleantech Group rapport ranks Israel eighth in cleantech commercialization based upon its own data on revenues of cleantech businesses within Israel and other factors like sustainable energy implementation (Parad, 2014).

Israel is known for the many successful exits that are achieved within the country (Almor T. , 2014). An exit occurs when the company is acquired by another company or makes an initial public offering (IPO), at this point the investors retrieve their money. While there have been some IPOs in cleantech in Israel in 2014, they form only 3% of the total value ($14,9B, (PwC, 2014)) generated by exits and form thus a marginal amount. One argument could be that most cleantech is tangible technology which is harder and more costly to create a company with. Indeed, the majority of exits have occurred in the Information and Communication Technology business (PwC, 2014), but also Life Sciences and Semiconductor companies have contributed a significant amount to the exit value in Israel. This means that there actually are possibilities for tangible, physical technology to reach advanced commercialization stages in Israel.

This thesis focuses on the difference between the evidence of emerging cleantech innovation and the evidence of commercialized cleantech innovation within Israel. The data on exits learns us that commercialization of technology based companies is possible within Israel and that the country is home to the most cleantech innovation worldwide. This makes Israel a very interesting place to research the environment of cleantech start-ups to deepen the knowledge on external factors that could hinder commercialization for (cleantech) start-ups.

1.2 RELEVANCE

This research has relevance in a few ways. Scientifically it is relevant to develop and test a framework of factors for the cleantech sector in Israel, thereby testing traditional theories on technology development and stage-based models. Furthermore, Climate-KIC has a project on cleantech start-up ecosystem research[4] at the University of Utrecht, to which this research could contribute in the future. For the Dutch and Israeli governments it is relevant to know which explanations there are for the commercialization gap in Israel to further develop support measures for start-ups in their respective countries. The recent PBL (Netherlands Environmental Assessment Agency) report on the valley of death for eco-innovations (explained in the Policy section, 2.2.2) and a bit older (2013) round table discussion[5] of the SER (Social economic council) show the actuality of this topic for the Dutch government.

1.3 STRUCTURE

This document will continue as follows.

Chapter 2 – Literature section. Within the literature section the first two research questions will be explored and ten factors are generated from the literature. In section 2.3 a more extensive conceptual model is generated from these factors.

Chapter 3 - Methodology: Within the methodology section the different methods that were used to gather and analyze the data are explained. Certain choices that have been made during this research are clarified. Furthermore, the validity and reliability of this research is discussed.

Chapter 4 – Data analysis: Within the data analysis section the results of the two rounds of data collection are presented. The first part consists of ten initial semi-structured interviews which are explained by generating several statements based upon the different stories from the respondents. The second part is presented to back up some of these statements and dive into two specific topics.

Chapter 5 – Painting the whole picture: The statements of chapter 4 are put into perspective by describing the whole story on the situation in Israel and presenting an empirical framework. Finally, this is compared to the conceptual model of section 2.3

Chapter 6 – Conclusion: Contains the answers to the main research question and the several sub-research questions. Also the implications and recommendations of the research are described within this part. Finally, a reflection upon the research process is given.

[4] http://www.startupinsights.org/

[5] http://www.energieakkoordser.nl/~/media/files/energieakkoord/werkdocumenten/werkdocument-tafel-3.ashx (PDF)

2 LITERATURE SECTION

The literature background chapter provides more in-depth information of the different theoretical streams described in the introduction, the reasons why these streams were chosen and the main results of previous studies. This in-depth literature background serves as a foundation for this research and explains why choices like the seed-funding cut-off point and the different theoretical streams have been made. Furthermore, this chapter connects the research to existing scientific knowledge with respect to TBNV growth paths and the connected theoretical streams on resources for entrepreneurship, the Israeli market and policy surrounding cleantech innovation.

This section will start with an overview of the growth path literature for general ventures and technology based academic spin-offs. Afterwards, the three theoretical streams that are used to describe the external factors are discussed.

Within the introduction the case was made that the environment for cleantech start-ups within Israel can be described from a resources, markets and policy point of view. Within the literature section, seven external factors that are derived from the literature will be determined to construct a theoretical framework for the environmental factors for cleantech start-ups within Israel.

2.1 CHALLENGES FOR THE TECHNOLOGY-BASED NEW VENTURE

This thesis is interested in the organizational development of the TBNV after it has passed the credibility threshold and before it has generated sustainable returns, because this is the phase that cleantech TBNVs are often stuck in. Section 2.1 of the thesis will describe the internal processes for TBNVs which are in this phase. The processes will be used to determine which external factors are relevant for the cleantech TBNV in Israel.

When describing the whole growth path, three phases are generally distinguished by several authors– the start-up phase, the growth phase and the maturity phase[6] (PBL, 2015). Within the start-up and growth phases, several sub phases can be distinguished, Vohora et al (2004) distinguish for instance the “pre-organization”, “re-orientation” and “sustainable returns” phase.

Several theories on venture growth with several venture types are described in the next section, to close in on the challenges for the *cleantech start-ups within Israel.* Within these theories, the notes on internal challenges will be highlighted.

2.1.1 THE INTERNAL PROCESSES OF A NEW VENTURE - GENERAL

The general theories on venture growth take high-growth ventures as their unit of analysis, regardless of the industry they belong to or their (academic or non-academic) origin. These theories are used as a foundation to determine internal challenges for the start-up. With other words, what challenges does the start-up theoretically have to cope with to reach a next step in commercialization? An initial view comes from Greiner (1998), who describes five growth phases of new ventures. In each of these phases management styles have to evolve and change to keep up with the pace of the company. Each phase *begins with a period of evolution, with steady growth and stability, and ends with a revolutionary period of*

[6] See PBL, 2015 for an extensive review of several articles which describe stage based development models.

substantial organizational turmoil and change (Greiner, 1998). Over the course of this section, the initial phase of the TBNV is described in more detail.

Five dimensions can be used to describe an organization – its age and size, its stages of evolution and revolution and the growth rate of the industry (Greiner, 1998). The latter shows that internal factors are not the only factors that play a role in company growth. Companies in a high-growth industry will advance through the phases of growth at a higher pace than companies in low-growth industry.

Because clean technology belongs to several industries and is not one industry as such, the influence of the industry is not anticipated within this research. The organizations (TBNVs) in this thesis are not uniform in their age or size, but they are uniform in their early stage of evolution/revolution – described in 2.1.2. An interesting theory to describe this early stage is the liability of newness theory.

The liability of newness

When the new venture has just been created, it is in a vulnerable state. This state is described by the liability of newness theory (Stinchcombe, 1965). First, there are new roles in the organizations that have to be learned and cannot be learned from former employees who performed the role. Skills of the owners or employees which are obtained outside the organization are thus important. Second, new roles have to be invented, which is a process of high costs. Stinchcombe (1965) notes that *standard social routines in the organizational culture clearly reduce the liability of newness* and *the degree of initiative – the sense of responsibility for getting the job done rather than doing as told*. Third, new organizations must rely heavily on social relations among strangers. Some kinds of social structure reduce the amount of difference in trustworthiness between strangers – one is more eager to trust a friend or a friend of a friend than a stranger.

On a side note, these theories fit well with the contribution of the army conscription for (almost) all Israeli citizens. The army is an experience which most Israeli have to go through at young age. In combination with the loose hierarchal standards, this has a lasting impact on the society. In *Start-Up Nation*, Senor and Singer explain:

> "*Indeed, the IDF's lack of hierarchy pervades civilian life. It can even break down civilian hierarchies*. *'The professor acquires respect for his student, the boss for his high-ranking clerk. Every Israeli has his friends 'from the reserves' with whom he might not otherwise have any kind of social contact'"* (Senor & Singer, 2009, p. 62)

The general point is that young firms have a dependence on the availability of human resources outside the organization. In Israel, the army contributes to the reduction of the liability of newness factors of learning new roles, obtaining skills outside the organization and the building of social structures among strangers[7] .

Finally, old organizations have a set of stable ties to those who use organizational services. New organizations will have to build these relations from the ground up. As Stinchcombe describes it: *There are generally two necessary adoption units for a new practice or product – the producer and the consumer, the politician and the voter, the teacher and the student. The stronger the ties between the old organizations and the people they serve, or the larger the component of personal loyalty in the consumer-producer relation, the tougher the job of establishing a new organization* (Stinchcombe, 1965). It are these ties that the new

[7] See Senor and Singer, pp 48-69 for more examples on the influence of the army on the between entrepreneurship and the army.

venture has to break and to convince the customer to use their product instead. This is the main challenge for every new venture.

The importance of managers

The liability of newness of the new firm is a challenge for managers of the start-up because they have the responsibility to deal with the weaknesses of the new venture. In the case of a Technology Based New Venture (TBNV), the TBNV is managed in its early stages by technically and entrepreneurially oriented managers (Vohora, Wright, & Lockett, 2004).

Greiner describes how the growth process comes with evolution during phases of growth and revolution during transitions between phases of growth. The first revolution that a growing firm faces is the *crisis of leadership.* Larger scale operations require higher levels of standardized procedures, which conflicts with the original leadership style of the entrepreneur. The leadership style is often informal and oriented on problem-solving instead of management activities that focus on efficiency. Conflicts between leaders emerge and the need for a strong manager becomes clear. The first critical choice in an organization's development is "*to locate and install a strong business manager who is acceptable to the founders and who can pull the organization together".* However, also in subsequent phases of development the leadership style changes which brings extra stress to the company (Greiner, 1998).

In the early stages, many interaction goes on with the marketplace. If customers give feedback, management will immediately respond (Greiner, 1998). Remote markets – as is the case in Israel, can thus prove specific challenges because the interaction with foreign-based customers will prove more difficult then interaction with customers which are based in the same country. This is a topic that is discussed in section 2.2.1.

2.1.2 Technology based new ventures (TBNVs)

Two general theories on venture growth and early challenges have been discussed. From the theory of Greiner (1998) we learn that venture growth can be described as the advancement of a venture between different phases, each phase having its own specific tasks and challenges. From the liability of newness theory we learn that these include 1) the building of a social structure within the firm and 2) the design of a strategy to disrupt the ties between incumbent companies and their customers. The latter point is further discussed for technology based ventures.

Three complementary theories are used to describe the growth of technology based ventures and their internal challenges. The first two (Kazanjian et al (1989) and Vohora et al (2004)) describe general principles on dominant problems that arise along the growth path of TBNVs, while the model of Almor et al (2014) focuses on the phenomenon *born-global, technology-based companies.* Israeli firms are often characterized as born-global companies (Almor, Tarba, & Margalit, 2014; Vohora, Wright, & Lockett, 2004; Kazanjian & Drazin, 1989).

Stage based models and start-up development

Technology based new ventures (TBNVs) are start-ups that try to market a technology based product. Often they originate in the academic world, but not necessarily so. Other sources might be incumbent, R&D oriented companies or serial entrepreneurs (Acs, Braunerhjelm, Audretsch, & Carlsson, 2009; Vohora, Wright, & Lockett, 2004). This thesis does not discriminate between the origins of TBNVs.

The theories of Kazanjian et al (1989) and Vohora et al (2004) discuss stage-based models which address start-up growth from conception until maturity. Based upon 9 case studies of university spinoffs, Vohora et al (2004) describe five distinct phases through which ventures develop, while Kazanjian et al (1989) validate a model that distinguishes four phases. Each phase can be characterized as an iterative process of development (Vohora, Wright, & Lockett, 2004; Kazanjian & Drazin, 1989). A selection of the relevant phases for this thesis is introduced below.

Conception and development

Within the first phase of the venture, the *conception and development* phase, the dominant problems of the TBNV are the invention and the development of a product and/or a technology, the securing of adequate financial backing and the identification of market opportunities (Kazanjian R. A., 1988). The milestone approach of Macmillan et al gives a more palpable approach of milestones that have to be achieved for TBNV development (Block & Macmillan, 1985). The milestones are combined in with the model of Kazanjian et al (1989) in figure 3.

Conception and Development stage

- Completion of Concept and Product Testing
- Completion of Prototype
- First Financing

Commercialization stage

- Completion of Initial plant tests
- Market Testing
- Production Start-up

Growth & Stability stages

- Bellwether Sale (first substantial sale to an expected major account)
- First Competitive Action
- First Redesign or Redirection
- First Significant Price Change

Figure 3 The stage based model of Kazanjian et al (1989) combined with the milestones model described by Block et al (1985). The initial two stages are the more relevant of the three stages, but the focus is especially on the conception and development stage.

In the conception and development phase, dominant problems of the organization include construction of a product prototype and selling of the product and business ideas to financial backers (Kazanjian & Drazin, 1989), roughly the first three milestones of Block and Macmillan (1985). During the following phase, *commercialization,* the venture has gained adequate financial backing and has demonstrated technical feasibility. The dominant problems at this stage include acquiring adequate facilities, establishing a network of reliable vendors and developing product support capability (Kazanjian & Drazin, 1989). The milestones need to achieved include milestone 4-6 of Block and Macmillan.

Vohora et al (2004) describe the start-up process of TBNVs with an academic origin in detail for the conception and development stage. The authors describe five stages of this process, which will be dubbed here *sub-stages*, for the sake of clarity. To progress between different *sub-stages*, a venture has to overcome a "critical juncture" in terms of resources and capabilities they need to acquire to progress to the next sub-stage. The

different sub-stages are critical, because a venture cannot develop into the next sub-stage without overcoming each of the junctures (Vohora, Wright, & Lockett, 2004).

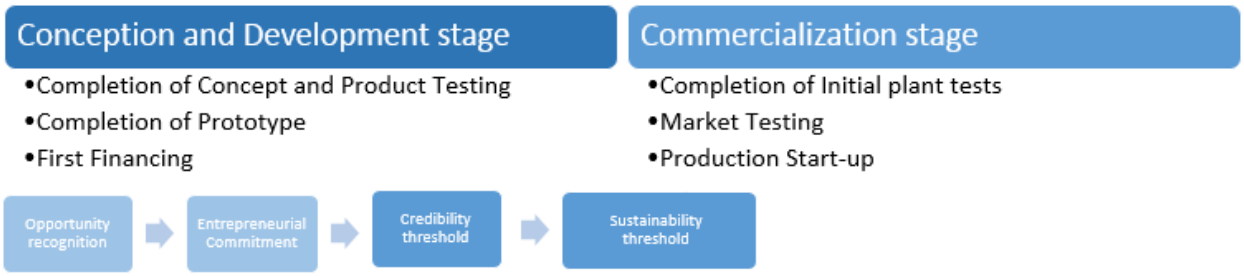

Figure 4 Integration of three theories. The conception and development and commercialization stages represent two of the stages of Kazanjian which represents the beginning of the growth process of the company. Within every stage the relevant milestones of Block and Macmillan are highlighted. Below this, the thresholds of Vohora et al are visualized. One should see this picture

Some similarities can be found between the (empirically observed) critical junctures of Vohora et al and the (theoretically grounded) milestones description of Block and Macmillan. The *opportunity recognition* juncture is defined as *recognizing the match between an unfulfilled market need and a solution that satisfies the need that most others have overlooked* (Vohora, Wright, & Lockett, 2004). In the *completion of concept and product testing* milestone, Block et al note that *At this point, planners consider whether a real market need exists for the product as they have conceived it or the model they have developed, or whether it has a potentially fatal flaw. At this milestone, entrepreneurs may have discovered a different opportunity as the result of testing their original concept and changing it* (Block & Macmillan, 1985).

This latter process of testing their original concept and changing it, is described by Vohora et al after the academic has committed itself to become an entrepreneur (entrepreneurial commitment). At this point the credibility threshold is the next critical juncture for the entrepreneur. The credibility threshold is defined as *a lack of credibility which constrains the entrepreneur's ability to access and acquire key resources: seed finance and human capital to form the entrepreneurial team*. Such a threshold occurs when the entrepreneur has understood an opportunity and committed himself to build a venture to pursue this opportunity. The entrepreneur is in search of initial resources to actually start his business. A key imperative is to raise sufficient financial resources (seed money), which can be used to acquire other important resources (like human capital) (Vohora, Wright, & Lockett, 2004). Credibility is build up by responsibly facing the start-up challenges, for instance by knowing which further resources are necessary to build the company and to present a strategy on acquiring the first customers (Vohora, Wright, & Lockett, 2004).

To build a strategy, entrepreneurs have to constantly test the assumptions in their models to come up with a plan to reach specific milestones (Block & Macmillan, 1985). One could derive that the initial milestone of Block and Macmillan covers stages of Vohora et al until the credibility threshold. The *credibility threshold* has similarities to the *first financing* milestone because both concepts consider the reception of initial seed finance.

It should be noticed that Block and Macmillan assume that a prototype has been finished at the point of receiving initial financial support. The topic *prototype building* is not explicitly discussed by Vohora et al but it is mentioned in the progress of some companies after they passed the credibility threshold. Although very important, prototype building is just one step in the development of technology. A commonly used way to

describe process of development of technology are 'Technology Readiness Levels', developed by the National Aeronautics and Space Administration (NASA). Figure 5 visualizes these levels.

When the venture has built up sufficient credibility to access financial resources for the first round of investment, the venture attempts to generate returns by offering value to customers. This is the beginning of the sub-stage (called "re-orientation phase" by Vohora et al) in which the entrepreneurial team needs to *identify, acquire and integrate resources and then subsequently integrate them.* Three key decisions influence this process – how the team created value from developing its existing technological resources, who the customers became and how the venture generates returns from the new customer (Vohora, Wright, & Lockett, 2004). This is an interesting overlap with the theory of Greiner who argues that the way key decisions have been made during the initial phases of the new venture, will eventually lead to the first revolution in the firm (Greiner, 1998).

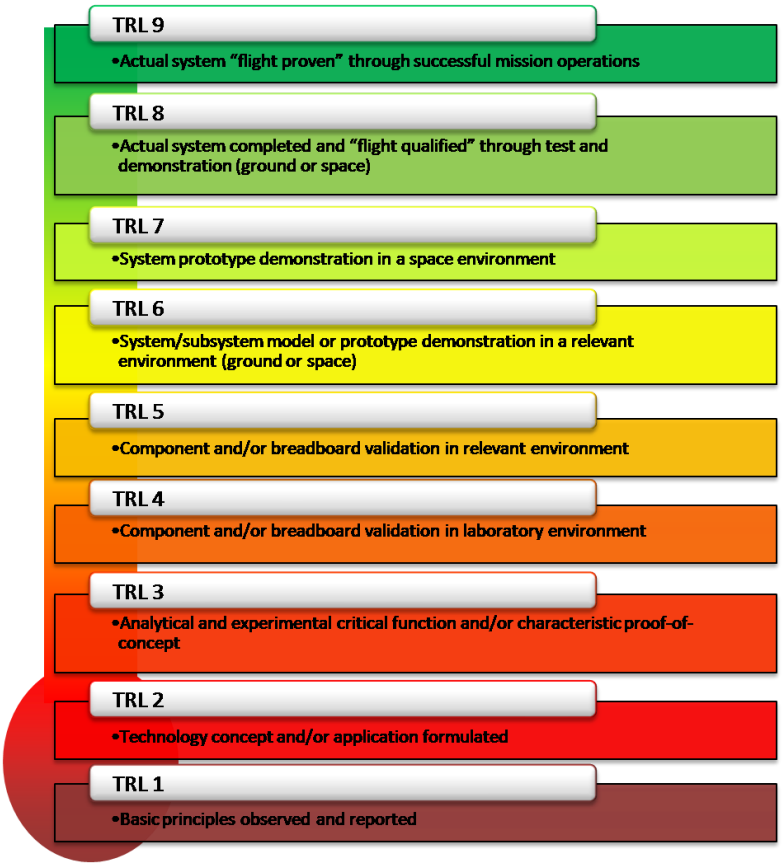

Figure 5 Technology readiness levels as developed by NASA.

A constraint on growth could origin from the lack of accessibility of the right resources for the venture because the network of the entrepreneur is not connected enough. The challenge for the entrepreneur lies in "repackaging" the available internal resources to connect with external customers and markets. If the entrepreneur fails to do so before the financial resources deplete, the venture is likely to stagnate (Brüderl & Schüssler, 1990).

Subsequently the final critical juncture is called *the sustainable returns threshold* by Vohora et al (2004). The acquired resources after seed funding need to be used to obtain new information, knowledge and resources. The imperative at this critical juncture is for the entrepreneurial team to acquire the ability to execute this reconfiguration by evaluating existing resources weaknesses, inadequate capabilities and social capital.

The organizational structure of the venture has to be developed to overcome this critical juncture. The entrepreneur and his team have to assemble an organizational structure, devise policies and routines that enable the allocation of scarce stocks of resources to be coordinated and the rate of their consumption to be controlled in order to achieve appropriate returns, which connects to aforementioned theory of Greiner (1998) on organizational development.

Before the credibility threshold is achieved, the main reason of the entrepreneur not being able to connect to resources is internal, e.g. due to a failure in constructing a feasible business plan. At this point, Venture Capitalists or other capital distributors do not consider the venture worthy of an investment. *Therefore, this research will consider the environment of start-ups after seed finance has been received.* At this stage, the venture has been reviewed by several instances who consider the venture credible enough to use seed finance. Such a credibility acknowledgement could also work facilitative for future partners who could work with the venture, because these will seek information that gauge the underlying potential of the venture (Hoang & Antoncic, 2003). Therefore, if resources in the 'outer environment' are not available or accessible for the start-up, there could be an external explanation for this constraint on growth[8].

2.1.3 THREE GROUPS OF INTERNAL PROCESSES

The goal of section 2.1 is to determine which internal processes there are on the agenda for cleantech TBNVs in Israel. From the theories that have been discussed, three groups of processes can be identified; *technological development of the product, business development* and *acquiring resources necessary for further development.*

Technological development of the product interweaves the technological development process with the other challenges with the aim of giving a holistic overview of the milestones for developing start-ups. Block and Macmillan describe for instance the milestones of 'developing a prototype' in the conception and development phase and the 'completion of initial plant tests' in the commercialization phase. The technological development is visualized in figure 5 with the Technology Readiness Levels.

The second group of challenges is the business development of the start-up. Examples of tasks and challenges in this category include 1) the building of a social structure within the firm and 2) the design of a strategy to disrupt the ties between incumbent companies and their customers, as argued by Stinchcombe (1965). Other processes that are grouped here could include the *three key decisions* highlighted by Vohora et al (2004) - *how the team created value from developing its existing technological resources, who the customers became and how the venture generates returns from the new customer.*

The third group of challenges include acquiring the resources necessary to drive forward the first two groups of challenges. For instance, the *first financing/credibility* threshold describe how the entrepreneur needs to proof himself credible to potential investors to be able to be worthy of their money. That money is necessary to finance the processes of technological development and business development. Finally, the start-up might also need to bring in external human resources to move forward these processes, for instance to bring in the external manager as discussed in the theory of Greiner (1998).

In the next section a further theoretical exploration is made and the theoretical context of cleantech start-ups in Israel is sketched. Theoretical influences of environment of the cleantech start-up on the group of challenges described here should arise and are captured in ten factors. In the empirical part, the influence of these factors is tested.

[8] One could argue that venture capitalists will not distribute money if there are no external resources available, but it turns out that there are three cleantech oriented VCs within Israel.

2.2 EXTERNAL FACTORS IN ISRAEL - ANGLES

The focus of this research is on factors within the institutional environment for cleantech start-ups within Israel. The topic is to research whether these factors influences (either negatively or positively) the in section 2.1 described groups of challenges of cleantech start-ups within Israel.

The literature analysis of Balachandra and Friar suggests that three contextual variables—nature of innovation, nature of market, and nature of technology—can encompass the range of pertinent contexts to be explored (Balachandra & Friar, 1997). The nature of innovation means that "The level of "newness" in a product innovation can vary broadly (Weelwright & Clark, 1992).

The nature of the market for a new product can be categorized into two types—existing and new. Whether a company is innovating in an existing market or trying to create a completely new market will cause differences in factors.

A useful classification for the nature of technology is high tech versus low tech. The uncertainties in market and technology are different for the two groups. Link (1987) found differences in factors depending on whether the setting was high tech. In the high-tech field, the technology is developing very rapidly, so new product introductions come quickly. The applications and customers may not yet be determined if the technologies are still emerging (Link, 1987). This turbulence would have an impact on the marketing and technology factors.

While cleantech has a fuzzy meaning and cannot be put into exact boxes with these contextual variables, it can serve as some guidance. Cleantech is more on the radical end of the innovation spectrum and can be considered high-tech. The market is most of the times an existing one – for instance with energy generation or transportation - but can be a new market too – for instance energy storage for renewable energy.

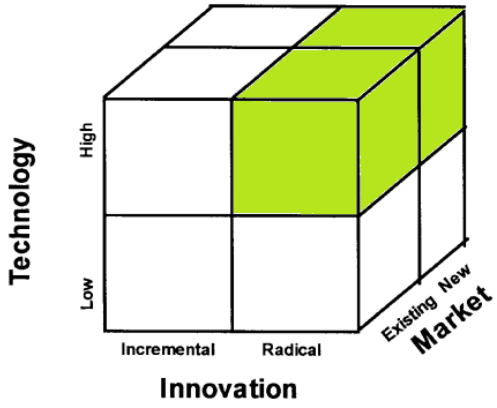

Figure 6 Visualizing Cleantech in the model of Balachandra & Friar. The green squares represent cleantech as radical high technology which aims both for new and existing markets.

Balachandra and Friar suggest that for these firms, technology factors and organization factors are very important, while market factors are important or less important[9]. In section 2.1 it was described how technology development, business development and acquiring resources for these two developments are the most important processes for TBNVs. The factors that influence these processes are categorized in three angles – resources, markets and policy.

Markets. There is universal agreement that there should be a strong market for the new product under consideration or for the outcome of the R&D project (Balachandra & Friar, 1997). The way ventures can connect to the market is a process which influences whether cleantech TBNVs can progress to the sustainable returns phase. The main contextual feature is whether the new product is entering an established market or is an innovative product for which there is no established market (Balachandra &

[9] This suggestion is made without supporting empirical evidence, but based upon their literature review.

Friar, 1997). If a market is unreachable or not interested, this forms a constraint on the development of the cleantech venture. This angle is related to the second group of challenges – business development.

Resources. Within this thesis, resources are considered external factors of the venture that can or cannot be captured by the venture to use for its business. Related to the group of challenges *acquiring the resources*, the concept is divided in Human and Financial resources, and the basic assumption is that resources accelerate the business if they are available and slow down if they are not available.

Policy. A product cannot succeed if the environment in which it is introduced is not supportive. The environment consists of a number of different aspects, such as political and social factors, public interest in the product, and social acceptability of the product. Previous studies that studied the environment for new product development used unique environmental factors and could not agree on which factors are important (Balachandra & Friar, 1997). The government shapes the institutional environment within Israel by the means of policy. Specific policies that affect cleantech entrepreneurship in Israel will be considered. The policy analysis is limited to policies that affect the cleantech TBNVs in Israel.

During section 2.2.1-3 the literature background and recent studies will be discussed. Specific elements that come up in markets and policy reflect in the resources section. In chapter 4 empirical evidence for these factors will be presented and in chapter 5 the empirical evidence is compared to the theoretical perspective.

2.2.1 MARKETS

Israel is a small country with a small market size. In such countries there have been several reports of small entrepreneurial companies that internationalize rapidly at the early stages of their existence (Zahra & Ireland, 2000; Autio, Sapienza, & Almedia, 2000) and such is also the case for Israel (Almor T. , 2013). These companies are dubbed *born-global companies* and are frequently characterized as *having the ability to create innovative, self-developed, technology-based products that are sold internationally from the start of their existence* (Almor, Tarba, & Margalit, 2014; Almor T. , 2013). The limited home market for the innovative venture drives it to international markets early in their organizational existence in order to exploit first mover advantages and monopolistic gains (McNaughton, 2000; Acs, Morck, & Shaver, 1997). Cleantech firms within Israel face a traditional and risk averse industry, especially in the field of renewable energy. The recent findings of great gas fields is called a *game changer* for the case for renewables (Fortuna, Freund-Koren, Liebes, & Raveh, 2014)[10]. Besides this, the most notorious Israeli cleantech start-up[11] tried Israel as its starting market and its quick rise and fall is named the '*most spectacularly failed technology startup of the 21st century*' by a popular business magazine (Chafkin, 2014). Thus, it is theorized that cleantech start-ups within Israel are forced to behave like born-globals.

[10] The report is in Hebrew, but an interview with the researchers clarified their main findings and results.

[11] Better Place was long seen as the company that was going to revolutionize the car industry by deploying their battery swap stations all over Israel in order to conquer the mileage limitation of electric cars. They had partnerships with large automobile companies in order to develop electric cars with swappable batteries. Hailed by Senor and Singer in 2009 in their famous novel "Start-up Nation" as a diamond of Israels start-up ecosystem, the company was declared bankrupt in May 2013, even though they had raised a staggering $1B in financing. The complete story is excellently written by Max Chafkin in Fast Company magazine.

F_M1 – Accessibility of international markets

With regards to research question 2.2 about markets[12], several factors will be important. The first factor, accessibility of international markets, relates to the fact that born-global companies have to connect to markets outside their home market. Factor F_M1 is studied to determine whether the relatively secluded position of Israel influences the business development group of challenges. To some extent, this means that it is also influenced by Israel's policy on a geopolitical level. However, for this study the current level of accessibility will be considered a constant and a potential change in the future will not be considered.

F_M2 – The need for high paced growth

The imminent international focus of such companies brings specific challenges. Technology driven companies need to stay in close contact with their customers for two reasons – protect their proprietary know-how and to receive feedback regarding their technology via the process of distribution and after-sale services (Hirsch, 1989). This is especially important in the early phases of the venture (Greiner, 1998). Moreover, financing of technology-based, born-global companies is frequently carried out through external capital, for instance via venture capital or private investments. Therefore they need to continue to grow in order to remain attractive to investors (Barrow, Burke, & Molian, 2005; Manigart, 1999). This leaves the company with two possibilities – either grow the company at a high pace or aim for an early exit (Almor, Tarba, & Margalit, 2014). The second factor is studied to find out whether this need for high paced growth influences the business development challenges.

F_M3 – The need for an international network

The constraints on the behavior of born-global companies, makes that their stages are slightly different than traditional stage based approaches like models of Kazanjian et al (1989) and Vohora (2004). The actions in initial stages of the venture directly focus on international markets, while market expansion activities take place in foreign countries too (Hashai & Almor, 2004).

This highlights important aspects of the necessity of cleantech start-ups within Israel to connect to global markets in order to commercialize their business. This could have an influence on the resources too - if the management of the start-ups has to travel every month this could strain the financial resources of the start-up significantly. Also, there is a need to connect with the international market for which certain mechanisms need to be in place, for instance an international network of the entrepreneur or the Venture Capitalist.

2.2.2 Resources

The firm is an organizational structure composed of collections of resources and capabilities which develops or acquires resources as input and converts the acquired resources into products for which revenue can be obtained (e.g. (Barney, 1991)). Following such a resource-based view, the start-up has a developing need for resources. This creates a dependency on the presence of suppliers of resources in their environment, such as investors. New firms need to access these resources and restructure them to connect with customers and suppliers.

[12] To retain the overview of the factors this study distinguishes, factors on resources will be distinguished with F_R, factors on markets with F_M and factors on policy with F_P.

F_R1 – Availability of Financial Resources
F_R2 - Availability of Human Resources

Within the *conception and development* phase of the venture, the primary focus of the venture is on the invention and the development of a product and/or a technology, the securing of adequate financial backing and the identification of market opportunities (Kazanjian & Drazin, 1989). Earlier the internal challenges for the TBNV were described and acquiring resources was one of the key group of challenges that the TBNV needs to accomplish. Resources are divided in financial and human capital for this thesis.

Obstacles to growth can be perceived as poor or non-availability of key resources at the time spin-offs need these resources. Obstacles may include shortage in management skills, shortage in market knowledge and marketing skills to access the market, and financial obstacles such as lack of cash flow and lack of investment capital (van Geenhuizen & Soetanto, 2009; van Geenhuizen & Soetanto, 2004). The next two factors are therefore defined as the availability and accessibility of financial and human resources. Hereby human resources also comprehend factors like marketing skills and market knowledge.

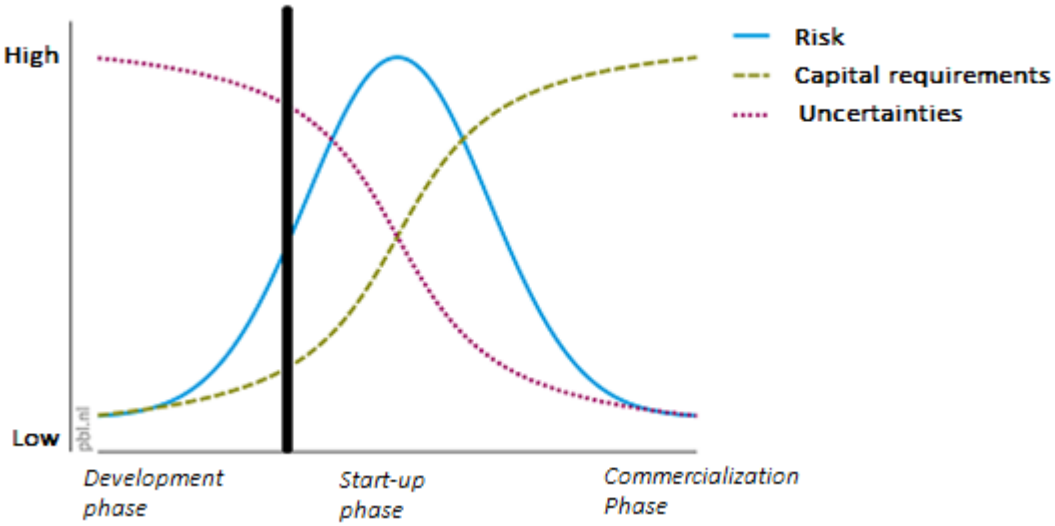

Figure 7 Risk profile, composed of capital requirements and uncertainty, over time. Adapted from PBL, 2015

First, financial resources are considered. In section 2.1, the different phases and challenges of technology development process have been described. The challenges within every phase of the technology represent is a certain amount of capital requirements and uncertainty, whereas risk is a function of these two parameters. Figure 7 visualizes a general overview how these three parameters evolve when the venture progresses through the different stages. The black line represents the credibility threshold. It can be seen that after the credibility threshold, investing has an increasingly high risk profile (PBL, 2015).

F_R3 - Risk tolerance of available financial resources

In figure 7, general financing sources that provide such investment are presented. Initially, the money comes from the government in the early development phase. When the technology is further developed and capital requirements increase, venture capital will take over and bear the high-risk investment. It can be seen that there is a need for several financial actors to be willing to invest in the venture before roll-out can be reached with asset (debt) finance. Each actor has a different rationale to invest in the venture with a corresponding risk tolerance (EIM & Oxford Research, 2011). This is considered the third factor and determines the *accessibility* of financial resources. If there is for instance a lot of money available via debt

financing from the banks, it will not help the technology based venture because such funds have a low risk tolerance. Figure 8 shows a simplified version of the technology development process (compared to the technology readiness levels of figure 5) and the corresponding possibilities for accessing financial resources. The risk tolerance of the governmental funds is the highest and the credit markets (banks) have the lowest risk tolerance.

F_R4 – Competition for financial resources with other fields of technology

Besides the risk level that plays a role, it is also hypothesized by others that eco-innovations are harder to finance because not all their positive externalities (e.g. CO_2-reductions) are not included in the price of the benefits of innovation (EIM & Oxford Research, 2011). Therefore, eco-innovation is unevenly competing with generic innovation. Cleantech ventures have a capital intensity (€20-50M, (SER, 2013)) that is in general higher than generic innovation and have a longer return on investment time (seven to ten years, (SER,

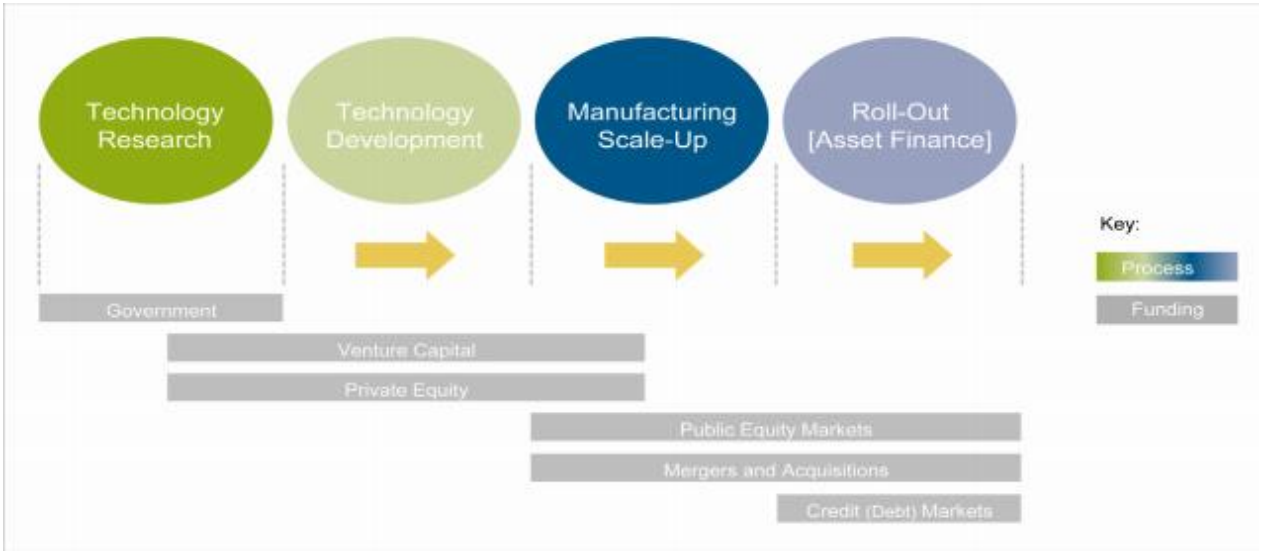

Figure 8 Hypothetical availability of money for development of technology based ventures. N.B. see section 4.4.1 for a nuance of this picture Source: (Frankfurt School-UNEP Centre/BNEF, 2014)

2013)). But eco-innovation is susceptible to the same financial constraints by private financing which were explained in the market section. Therefore, above average returns and growth expectations are necessary for eco-innovation start-ups. Another problem is the lack of knowledge from investors about the cleantech sector, which in itself can be explained by the heterogeneity of the sector. Cleantech is an umbrella term with many sub-sectors below it (EIM & Oxford Research, 2011). The challenge for sustainability transitions is to mobilize large sums of money. The availability of these types of finance is shaped by economic conditions, financial regulations, and investor confidence (Geels F. W., 2013).

Human resources

Secondly, human resources are considered. There is a need for both technological and business/management skilled human capital to fulfill the goals of prototype development and connecting to markets. Technological skills to develop the prototype are highly specific for each venture, depending on what kind of technology is developed by the venture. Business and management skills are better developed within the academic literature. The liability of newness theory highlights how the *experience* and the *network* of the venture helps the development of the TBNV (Stinchcombe, 1965). Networks play an

important role in the process of acquiring resources and supply the entrepreneur with information and advice. Differential network positioning has an important impact on resource flows, influencing both the amount and diversity of resources (Hoang & Antoncic, 2003).

The first revolution a growing firm faces according to Greiner (1998) follows from a *crisis of leadership*. At this point, an external manager is attracted *who is acceptable to the founders and who can pull the organization together* (Greiner, 1998). Such an external manager who is capable of a different management style needs to be available in the environment of the start-up and should be willing to work for the start-up. The points are discussed in the availability of human capital factor (F_R2).

2.2.3 POLICY

F_P1 - The formal institutional regime for new innovations

In the research and development phase, sustainable innovations (clean technologies) are often developed in sheltered niches created by the government (Geels F. W., 2013). When the take-off or commercialization phase begins, they face multi-dimensional struggles with incumbent regimes. Because formal institutions (North, 1990) have been accustomed to the needs of incumbent actors (Walker, 2000), the odds are often stacked against niche-innovations regarding policy. Such reflects in the 'mismatch' with existing institutions (Freeman & Perez, 1988) that niche innovations face. Thus for commercialization of cleantech, changes in policy and institutional frameworks are likely to be necessary. Because private actors have no immediate incentive to address sustainability problems, public authorities have to change economic frame conditions and formal institutions (regulations, subsidies, incentives, taxes). That is why many green growth reports not only call for more investment, but also for stronger policies (Geels F. W., 2013). The amount of stimulation of the formal institutional regime for new innovations in general is therefore considered as a factor.

F_P2 - The formal institutional regime for new sustainable innovations

In the resources section it was explained how the current financial system does not value the non-monetary benefits of clean technology, which asks for a correction of the system. Moreover, the high capital demand for cleantech development in combination with the associated risk with this investment (EIM & Oxford Research, 2011) means that without governmental intervention, many (clean) innovations will not be able to leave their sheltered niches. The amount of stimulation of the formal institutional regime for new clean innovations in is therefore also considered as a factor.

F_P3 – Perceived stability of the governmental policy by investors

It is uncertain whether a strong role for the government has a positive impact on the financing aspect of new ventures. The investor who makes an investment which benefits from a favorable policy creates a dependence for himself on the stability of governmental policy – the venture could lose profitability when policy changes. Such a dependency increases the risk for the investor, thus off-setting him to invest in the venture in the first place if he believes that the policy environment is unstable and the favorable policy might be changed in the future (EIM & Oxford Research, 2011). The role of policy within the cleantech environment is thus a double-edged sword – on the one end it can stimulate much needed investment within the cleantech sector but on the other end it creates a dependency on government intervention, which investors consider too risky.

2.3 CONCEPTUAL MODEL

Based upon sources from the academic literature and governmental rapports, this study has described ten factors that either negatively or positively influence the development of clean technology based new ventures in Israel. These factors are determined to find out why there is a gap in Israel between the amount of innovation and the amount of commercialization of cleantech ventures.

The gap is hypothesized to be caused by the theoretical institutional environment for cleantech start-ups in Israel which is the overall proposition of this study. The factors serve as a gateway to explore the institutional environment for cleantech start-ups in Israel and their individual influence on the commercialization gap for cleantech innovation within Israel. The institutional environment has been categorized in policy, markets and available/accessible resources (for the entrepreneur).

The factors are also grouped within these three categories, but this does not mean that there is no interplay between the different categories. For instance, the need to go to international markets is constraining the available resources of the venture. The need for a high paced growth is due to the nature of the resources (VC). Also an international network could be seen as a resource but is necessary to connect to the market (F_M3). On the other hand, factors like the availability of resources (F_R1 & 2) and the formal institutional regime for new (sustainable) innovations (F_P1 & 2) belong more clearly to one category. These factors and relationships are visualized within figure 8 which is the overall conceptual model for this study.

F_M1 - Accessibility of international markets
F_M2 - The need for high paced growth
F_M3 - The need for an international network
F_R1 - Availability of Financial Resources
F_R2 - Availability of Human Resources
F_R3 - Risk tolerance of available financial resources
F_R4 - Competition for financial resources with other fields of technology
F_P1 - The formal institutional regime for new innovations
F_P2 - The formal institutional regime for new sustainable innovations
F_P3 – Perceived stability of the governmental policy by investors

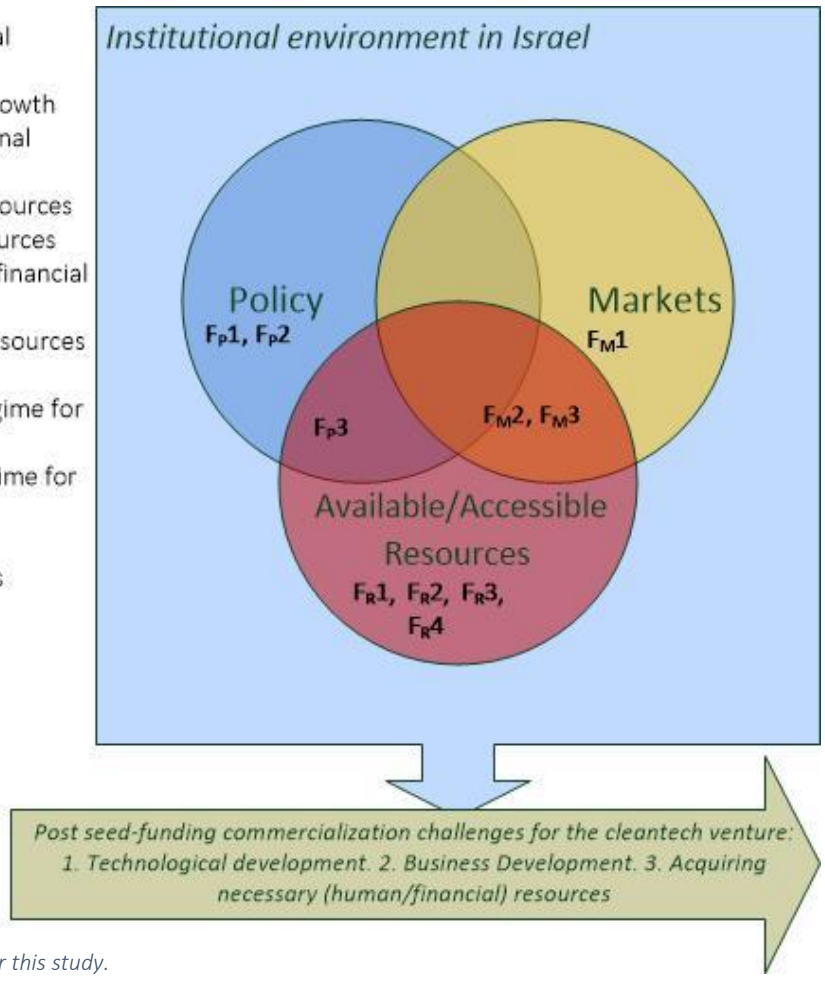

Figure 9 Overall conceptual model for this study.

3 METHODOLOGY

For the researcher, not much was known about the institutional situation for cleantech start-ups within Israel. Although the start-up ecosystem within Israel is well described in popular and (to a lesser extend) academic literature, the main focus lays on the hi-tech (IT) industry which is subject to different mechanisms than the cleantech industry, for instance because there is no need to develop a physical prototype. Thus, an exploratory research is the most suitable setting for this research. If such is the case, it is important to clearly describe the research objective.

Research objective. The objective of this exploratory research is to identify key issues of the institutional environment for cleantech start-ups within Israel, which could serve as an explanation for the observed commercialization gap.

To achieve this objective, a case study with a two-trapped research strategy has been used. First the institutional environment is described, using academic literature and reports on this problem in other countries as a source. The result of this exploration is the conceptual model in section 3.3 and the ten factors that come with it. The next step is to analyze to which extend these factors can actually be found in the institutional environment within Israel and to research whether they can be used to explain the commercialization gap.

The information for the second step was gathered by means of interviews and documentation, thereby using two out of the six sources Yin mentions for case study research (Yin, 2003). The interview was chosen because it is a targeted and insightful way to obtain empirical knowledge from day-to-day practitioners from a variety of fields within Israel. The interviews were semi-structured to guide the interviewee along the different propositions with targeted questions, allowing them to tell an elaborate story. Due to the variety of statements that were made and the sometimes limited support for some statements, documentation was used to cross-check whether assertions of the interviewees are corresponding with the documented evidence.

3.1 RESEARCH APPROACH

The research approach has been visualized in Figure 9. An inquisitive approach (Verschuren & Doorewaard, 2010) was used, because the researcher was unfamiliar with the situation in Israel that was going to be researched, nor had he been in the country before.

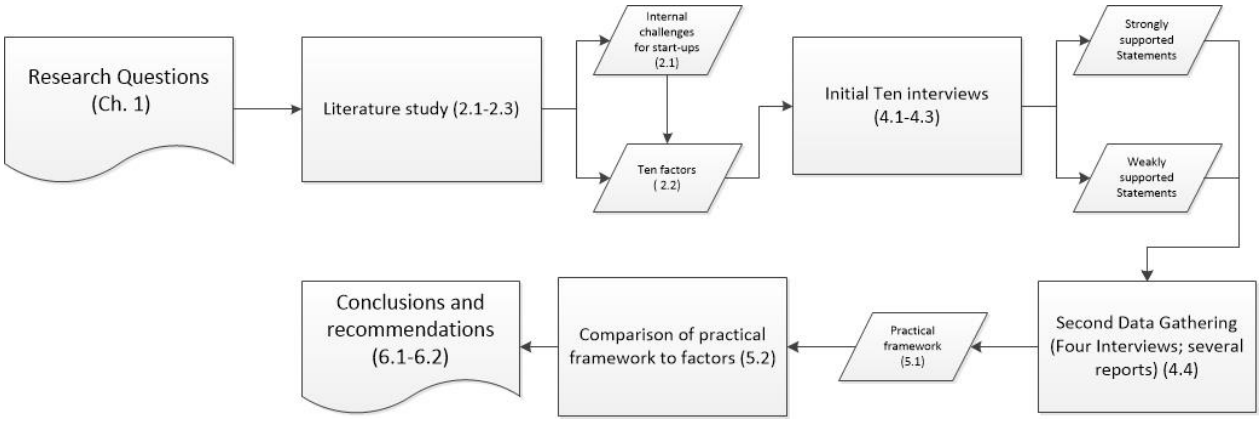

Figure 10 Visualization of the methodology of this research. Processes are visualized by squares and interim types of data are visualized by the parallelograms.

3.1.1 LITERATURE STUDY

Initially, theory was developed by gathering literature research and review of reports on themes within the topic in different countries. An example of such a report is the EIM Research report (2011) which granted many insights on the financing aspects of eco-innovations. Scopus was used as the main access point for academic research, combined with an informal meeting with an Israeli scholar (prof. T. Almor[13]) to guide the researcher through previous research that has been carried out on the topic of the market conditions within Israel. When leading articles were found, the "snowball method" (Verschuren & Doorewaard, 2010) was applied to retrieve more in-depth information on the applied theories, especially on the born-globals theory and the papers by Van Geenhuizen et al. (2009). In the meanwhile, respondents were selected following the criteria in section 4.2

3.1.2 INTERVIEWS

By leveraging the network of the Dutch embassy and the networks of the first two interviewees, 24 potential candidates were eventually contacted, out of which 14 agreed to participate in an interview (58,3% positive response rate). Hereby the first two interviews (BD2 and VC1) were used as pilot interviews to understand more of the practical aspects of the institutional environment within Israel. Their stories were combined with the following eight interviews to generate an initial set of results that tested the factors from section 2.3. Selection process of the interviewees is described below. The results can be found in section 4.1-4.

After the first ten interviews had been conducted and the reports had been written, the data was reduced, processed and analyzed. The analysis process has been described in section 3.3. An embedded single case design was used, in which the factors could be tested from multiple angles of professional experience, to get a holistic overview of the validity of the factors.

This analysis resulted in the description of many interesting *statements*. A statement (see section 3.4) is a combination of inputs from different respondents that represented the overall findings of the interviews. Because only ten respondents were interviewed, a limited amount of evidence for some statements was found (*weakly supported statements)* and there was a need to further confirm such statements before they could count as a reliable research result.

The final four interviews, together with other secondary data sources (see section 3.2.2), were conducted to confirm and test these statements. For instance, one of the respondents had just received series A funding[14] for his cleantech start-up and was interviewed to confirm the statements covering the factors of financial resources.

Interviews were conducted either face to face (12) or via telephone (2). The initial two interviews were recorded, but the following interviewees requested that the interview would not be recorded and asked for anonymity and to be paraphrased, except for the fellow researchers. Therefore anonymity has been granted to all respondents, except to the researchers from the Samuel Neaman Institute. The data collection process has been described in section 3.3.

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[13] Professor Tamar Almor lectures at the school of Business Administration, the College of Management, Rishon LeZion. She specializes in business strategy, international entrepreneurship, and international business, which she teaches to MBA students.

[14] After the start-up has raised seed funding, it needs to raise further financial resources which it does in "series" of investment rounds. The resulting investments are therefore called Series A, B, … funding.

The setting of this research was time constrained and in an environment where only a few connections to potential respondents was present. Therefore a compromise had to be found to access the right respondents within the time limits of the research.

The first two interviews conducted were "pilot respondents" with whom an easy introduction could be made because they were part of the personal network of embassy employees. While the anonymity promise means not too much can be revealed of these two respondents, it can be said that both were very well known, successful persons in the Israeli cleantech ecosystem. Because Israel is a small country with a very strong network through the army, these people were able to make a lot of introductions to the next respondents. Other respondents came through the network of the Dutch embassy.

To manage these introductions, a list of interesting professions was made out of which the propositions could be researched from several angles. Subsequently the pilot respondents were asked to made introductions to people who were experts on the field in their opinion. Following this process, four business development experts, two venture capitalists, two late stage finance and two actors from the government were interviewed. A criterion for respondents in the primary interviews was at least five years of experience in the technology based new ventures world and preferably (previous) involvement in the management of a cleantech oriented start-up. For policy respondents this rule was not applied because it turned out to be difficult to talk to senior policy officials who referred the researcher to less experienced policy officials and these were interviewed instead.

Business Development Experts – These respondents were either former or current entrepreneurs in cleantech or close areas in which Israel excelled (water, agriculture – these areas also counted in the Cleantech group research). It was expected that these respondents could particularly tell about the markets and resources propositions.

Venture Capitalists – Active in the area of cleantech or impact investment[15]. Two out of the three major funds active in this area were interviewed. It was expected that these respondents could tell about all the propositions, but be more specialized in the markets and resources propositions.

Late stage finance – To get a perspective from the investors that would need to finance the venture when its capital needs had exceeded the capabilities of venture capitalists. This included a private equity investor and a strategic investor from a large American technology company. It was expected that these respondents could particularly tell about the markets and resources propositions and confirm the perspective of the initial two groups of actors.

Policy makers/government – Government officials from the ministry of economy who were specifically involved in cleantech were interviewed. Additionally a representative from a government initiative to stimulate a specific, cleantech related industry (transportation), was interviewed. It was expected that these respondents could tell about the policy and markets propositions.

[15] Technologies that have a positive impact on society. These could be, besides cleantech, for instance be medical technologies or agricultural technologies.

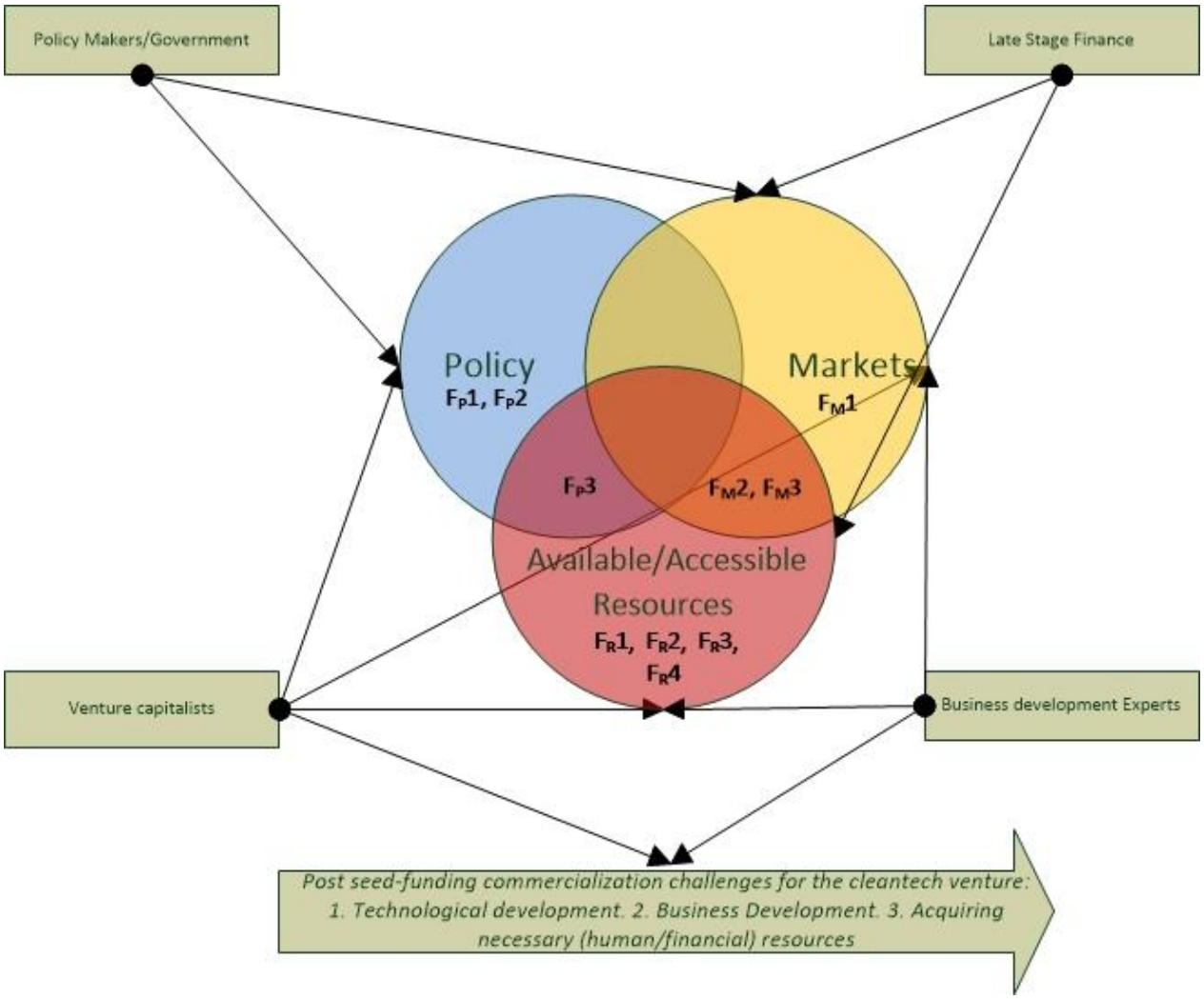

Figure 11 Expected knowledge of the different groups of respondents about the different topics.

When the initial results were collected and analyzed, the findings from this study were tested once more by performing another interview with a cleantech entrepreneur who had just received Series B funding (the round after seed funding) from a venture capitalist and by interviewing colleague researchers from the Samuel Neaman Institute at Technion, Haifa. Furthermore, the results are compared to results from researchers in Utrecht University who have also performed similar research, although the approach slightly varied. These connections were made through the initial 10 respondents.

3.2 DATA COLLECTION

3.2.1 DATA COLLECTION PART ONE - INTERVIEWS

The initial data inputs were collected via semi-structured interviews with open questions with the aforementioned experts. Seven questions were developed to get an idea of the institutional environment in Israel. The questions were categorized in Markets, Resources and Policy and can be found in the appendix and throughout section 4.1 - 4.3. The questions were not aimed specifically at the factors (e.g. Do the availability of human and financial resources influence the commercialization process?), but were phrased to find out how a certain topic influenced the commercialization process (e.g. Which resources does an

Israeli cleantech start-up need after it has obtained seed finance?). The open-ended nature of these questions allowed for conversations about the different topics to emerge.

The questions were sent beforehand to the respondent, along with an explanation of the research, to familiarize the respondent with the topic and to allow him or her to prepare for the interview. The phone interviews lasted on average around 30 minutes, while the face-to-face interviews lasted 1 – 2.5 hours. The reason for this variation was that it turned out that the open end questioning approach often triggered a conversation in which the respondent told his or her story about the experiences with the institutional environment. This did not follow the prepared line of questioning and it was up to the researcher to ensure as much topics as possible were covered. To aid in this task, some background information was prepared by each questions (e.g. [literature posits that] *Rapid international expansion is needed to establish global niche. Two necessary resources: financing and international network.*). This background information is also added to the interview protocol in the appendix. At the end of every interview it was checked whether all questions that the respondent knew about were answered.

After the interview was conducted, a report was immediately written out of the compiled notes. These reports are commonly 1 – 1,5 A4 of text for one hour of interview. During the interviews, the answers of the interviewees were repeated when notes were taken, to increase internal validity.

3.2.2 Data collection part Two – Interviews and Reports

A setback of the relatively low amount of interviews for such a broad topic was that many different statements were made but some were only made by a few respondents. Some of these statements were contrasted by none of the respondents (even after asking for it – they just were not aware of certain facts).

Secondary data was looked up to back up the statements that the respondents made. This data was searched via the internet and was only deemed acceptable if official governmental reports or independent research confirmed the facts – a newspaper article was not deemed credible enough as secondary proof for the claims[16].

The final four interviews were conducted in a similar fashion, with the difference that the statements from chapter 4.1-3 were used instead to generate the questions instead of the ones from section 3.3. These interviews had four different sets of interview questions which can also be found in the appendix. All these interviews were face to face interviews.

3.3 DATA ANALYSIS

Reduction and analysis

The first step in the data analysis was to reduce the data from the interview field notes to the aforementioned interview reports, which was done immediately after the interview took place. The first ten interview reports were analyzed on an individual level to see which information they contained about each of the questions that were asked and the topics that were linked to it.

For instance, one interview was initially mainly about the company the respondent worked for and their business plan. He explained to the researcher how they invested in the technology spectrum (see

[16] In one situation the English press announcement of a Hebrew report from the government was used as a source.

Technology readiness levels) from academic research until the development of commercial activities and how they collaborated with different actors for subsequent investment. Only after spending half an hour on these topics, other topics like markets and policy were addressed.

Merely a portion of this information was ultimately useful and could contribute to the topics of this thesis. The topics were used to group the information from the interviews. They were indirectly derived from the factors that came up in the literature review because the questions were used as an intermediary. The topics were used as guidance to select which information from the interview was useful. Topics were a bit broader then the factors to be able to tell the complete story about the studied environment in Israel.

These excerpts of interviews were combined under the different topics. The next step was to look for overlap between these excerpts of text. For instance, almost all respondents mentioned the abundance of technically skilled human capital, but they did so in different ways. One respondent mentioned his own company and highlighted their unique sets of human capital as an example of this statement. Another respondent said: *"You need people who are great with technology (which is not a problem at all in Israel)"* and there are many more examples. Ultimately, the different quotes were summarized into a generalized, strongly supported statement which is R2A (Topic R2 – availability and accessibility of resources, statement A).

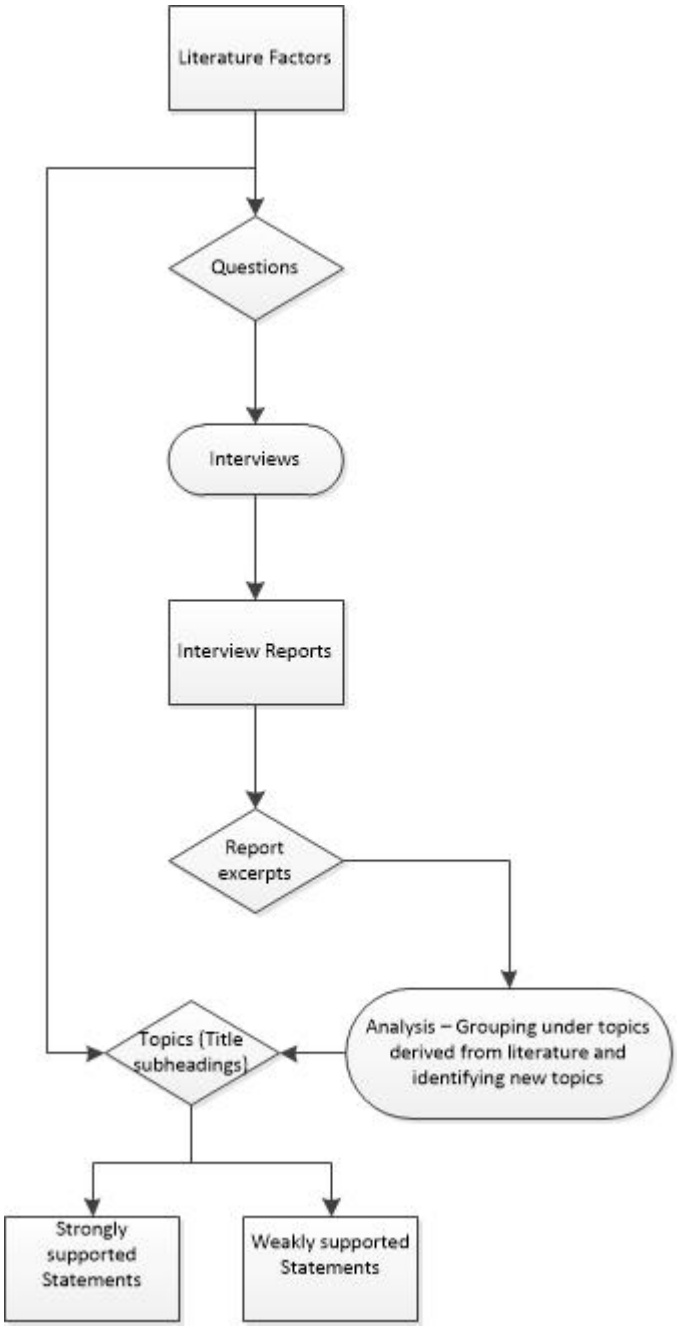

Figure 12 Visualization of the analysis process that led to the various statements. Title subheadings refers to the subheadings in 4.1-4.3

A. Technologically skilled employees, like engineers, scientists and programmers, are abundantly available.

Other questions, especially in the policy field, were not covered by the respondents because they were too specific – the respondents did not know about Israeli government interference to transform the societal value of cleantech start-ups to monetary value (question P1) or the answer to that question was simply no.

Therefore, the policy pool of answers were a bit more general than the questions would suggest. The main results of this step are explained in chapter 4.3.

Subsequently, the grouped pools of answers under each category (markets, resources, policy, others) were combined to write about the perceived reality from the respondents on each of the three research angels. In this process, patterns were distinguished and clusters of answers were made (Miles & Huberman, 1984). This was the process how the statements were created. The earlier example for instance ended up partially in the statement R1A together with responses from four other respondents.

Conclusion verification

After a process of qualitative data gathering and reduction, it is important to verify the conclusions drawn. "Real" conclusions are conclusions that would be found when another researcher repeated the same research (Miles & Huberman, 1984). It was this process where the secondary data collection became important because some statements seemed very plausible, but were not adequately backed up – these criteria are explained in section 3.4.1. The data that were not deemed valid were backed up with secondary sources as explained in section 3.2.2. Moreover, they were tested in practice by interviewing a cleantech entrepreneur, fellow researchers from the Samuel Neaman Institute and two more respondents.

After this process, the results about the perceived reality from the respondents, complemented (or contrasted) by secondary data have been compared to the initial factors in the conceptual model, to draw the final conclusions.

3.4 VALIDITY AND RELIABILITY

3.4.1 VALIDITY

To improve the construct validity of the research, the triangulation method was applied. Triangulation can be applied to many elements of research methods, including settings for data collection and sources of data (Verschuren & Doorewaard, 2010; Scandura & Williams, 2000). In practice this meant that a statement had to be supported by at least three respondents from at least two fields. If the statements were in accordance to theory, this was considered the third data collection point. The variety within the respondents within the categories was deemed broad enough (e.g. the business development experts belonged to three different industries within the cleantech industry) to justify such an approach. In the case that limited support was found for the statement, but there were also no contradictory statements, a secondary data source was searched to confirm or reject the statement.

Internal validity. The above procedures also improved the internal validity of this research. However, it has to be acknowledged that the policy category was not very well tested from the answers of the initial interviews. The two policy respondents did not give very comprehensive answers which discussed the factors in this field in satisfying way. Finally, the process of confirming the notes by the respondents also improved internal validity.

External validity refers to whether it is possible to generalize the gathered data to other cases. This research tries to describe the institutional environment of a very specific case and is therefore a good test of theory. The uniqueness of the case also brings several limitations – it would be possible to generalize the gathered data to other cases if there were other cases with exactly the same institutional parameters. This is not the case due to the uniqueness of Israel as a country. But, case studies rely on *analytical generalization* (Yin,

2003, p. 37), where the researcher tries to generalize the set of results into a broader theory. This will be done in the discussion part, by comparison with research on start-up ecosystems in Europe.

3.4.2 Reliability

The concept of **Reliability** is important for the research and it means that the research can be done by a different scholar at a different point in time and lead to the same results.

There are two negative influences on the reliability of this research. The first one is the point in time. Israel is under an ever changing geopolitical situation and the influence of *landscape developments* on this topic should not be underestimated – and is further discussed in section 5.1. When the research was conducted, the geopolitical situation was calm, but history proofs that calm situations in Israel seldom last long and such a change would alter the outcome of this research due to the impact on the Israel institutions in general. This point reflects also in the second influence due to the interview method. It turned out that most interviews turned into a conversation about the institutional environment where the interviewer was leading the conversation in a certain direction. Interviews are open to interviewer bias and this was very hard to prevent. Because all the respondents served in the army and some were still reserve, a different geopolitical situation that involved a war would probably affect the state of mind of the respondents and could generate different results of this research. A future researcher would have to follow the methodology of triangulation maybe even stricter to prevent such biases to influence the final results.

4 DATA ANALYSIS

This chapter will provide the main results of this research. Seven questions[17] were prepared for the interviews, which will be leading in the presentation of the data that have been found during this research. Each question covers a small topic within the three main categories of factors. How these topics were perceived by the respondents (Table 1) is captured in statements. A statement (see section 3.4) is a combination of inputs from different respondents that represented the overall findings of the interviews.

Table 1 Different respondents and their background. BD stands for business development, LSF for late stage finance, P for policy and VC for Venture Capital. Experience is defined as being involved in the world of new ventures. Between brackets is the amount of time the specialists have spent in cleantech. Management experience is defined as being involved in the management of a TBNV (not per se cleantech).

Code	Specialism	Years of Experience (Experience in cleantech)	Management experience
BD1	Agriculture	13 (6)	Yes
BD2	Frugal innovation, business to customer	6 (6)	Yes
BD3	Water & specialized in commercialization	10 (7)	Yes
BD4	Water treatment for water generation	19 (19)	Yes
LSF1	Private Growth Equity	6 (5)	No
LSF2	Corporate technology company - energy investment	10 (9)	Yes
P1	Policy Researcher	1 (1)	No
P2	Policy Manager	3 (3)	No
VC1	Impact Venture Capital	28 (10)	Yes
VC2	Renewables Venture Capital	18 (5)	Yes

Not all the statements that were made by the respondents were covered by the questions so it will be necessary to include "other" statements too – hence the topic approach. Also, the statements that are presented in this results are the *interpretation* of the researcher how the various answer elements came together within the different reports that were created after the interview. These individual reports will not be published because of the anonymity that was granted to the respondents. The explanation of the grouping of the respondents has been done in section 3.2. Table 1 provides basic information on their background including their specialism, years of experience in the new venture world and in cleantech, and management experience. The latter is defined as being involved in the management of a Technology Based New Venture (TBNV) – not per se cleantech. Table 2 shows the interaction between the respondents and the questions. Small excerpts of Table 2 will be provided when the individual questions are discussed.

The individual questions of the three categories (markets, resources, policy) will be discussed in what follows. The answers of the respondents have been rephrased and sometimes combined to create statements (see 3.4 for a description). These *statements* are distinguished as statement A – E, and it is reported which amount of *support* they received, from how many respondents and from how many

[17] The questions can be found at the start of each subsection of 4.1, 4.2 and 4.3. An overview can be found in the appendix.

different specialisms these responses came. Finally, it is reported if the amount of support is in line with the triangulation criterion of section 3.4 and the conformity with the conceptual model of this study is given. Table 2 presents an overview of all the results. For example, R1, statement C received two statements from one *specialism* and thus the triangulation criterion is not reached.

Table 2 Overview of the interview results and how the different respondents contributed to the different statements that were created based upon the interviews with the respondents. The M questions were about markets, R about resources and P about policy

	M1	M2	R1	R2	R3	P1	P2
BD1	A, B, C	A	A,C,D,E	A,B	A,B	B	
BD2	B,C	C	E	B,C		A,D	
BD3	A	C	A,C,D,E		B	A,B	A
BD4			B	C,D		A,C	A
LSF1			A,B	C			C
LSF2	C,D	B	A,B	A, B, C			
P1						C	B,D
P2	B,C	A		B,C		A,B	A
VC1	D (-)			B, C, D			A
VC2	A		A	A, B	B	D	

4.1 INTERVIEW RESULTS - MARKETS

The factors (F_M1-3) on markets focused on identifying the markets for cleantech ventures (discussed in 4.1.1) and how they can be reached (4.1.2). The first question, M1, focuses on where the markets are situated. The second question, M2, discusses strategy on company expansion, to see how the international expansion fits in the overall strategy of the cleantech venture. Table 3 gives an overview of how the different respondents contributed to the statements that were constructed out of the two questions.

Table 3. Construction of statements per actor for the Markets category.

	M1 – Customer segments	M2 – Motivations behind intl. expansion
BD1	A, B, C	A
BD2	B,C	C
BD3	A	C
BD4		
LSF1		
LSF2	C,D	B
P1		
P2	B,C	A
VC1	D (-)	
VC2	A	
Answers	7	5
Specialisms	4	3
Statements	4	4

4.1.1 CUSTOMER SEGMENTS

M1. On which customer segments are Israel cleantech start-ups focusing? How are these customer segments reached? How do cleantech start-ups connect with these customers?

This question was answered by six respondents from three different specialisms. Their answers could be combined to the five statements below. The respondents who contributed to statement A were in business to customer/business markets with high volumes, and they highlighted the importance of figuring out the right market, which was in general internationally located. The notion of that you have only one shot at picking a market seems inherent at being in a start-up.

> **M1A.** For the Israeli (cleantech) start-up it is important to figure out the right market. You have one shot at picking a market so you have to do it right.

M1B. Israel has a very small market so there is a necessity to go international.

Statement B was stressed by every single interviewee and can be exemplified with a quote from a late stage finance expert: *"If an entrepreneur is in Israel for one consecutive month, you know his business is not doing well."* The second part of question M1 discussed the way to connect to this market. The following statements could be derived from the answers of the respondents.

M1C. Direct interaction with customers is a great way to figure out the right market.

One entrepreneur said: *"You will have to prove your product in an international market immediately. Israeli firms are audacious enough to contact international customers before they even receive seed funding."*

M1D. Other ways of connecting to customers happens via government instances like the Fuel Choices Initiative (see section 4.3), networks of the investor and personal networks of the entrepreneurs.

Regarding C and D, one venture capitalist said that he just wanted to sell the entire company to a large corporate business, because this was the only way for the technology of the start-up to have significant impact.

Other comments that were made by the respondents included that some early adopters could be found in Israel despite the international focus, which was confirmed by most business development experts, who had found their initial customers for pilot projects often in Israel.

4.1.2 Motivations behind international expansion

M2. To expand the company, do cleantech companies focus on international expansion, product differentiation, or on early exits? Why are certain choices made?

When discussing this question, the respondents only focused on the latter part of the question – the motivations behind the choice for international expansion. This question was answered by four different respondents who made three different statements. Not much similarity could be found between the statements, but they do not contradict each other either. On itself this is not unexpected, because motivations for certain strategies can be highly specific.

M2A. The reason to choose internationalization is mainly the small market. For instance, in case of the automobile industry the OEM or OEM suppliers are abroad, this is often the case.

M2B. Local factors in Israel – traditional industry in general is said to be risk averse in Israel, real estate is very expensive and so is land, to build for instance a production plant.

These factors are focusing on the state of affairs in Israel and could be applied to any start-up. There were also more cleantech specific reasons though.

M2C. Cleantech is a different market and is mainly related to infrastructure and an infrastructure market is not a very good market for a start-up. [18]

[18] If one looks at how the world consumes its energy from "dirty" sources, this mainly comes down to Electricity generation (which is a lot of infrastructure), Heating (a lot of infrastructure), transportation (not only, but definitely a

4.1.3 RELIABILITY CRITERION

Statements are distinguished in strongly supported statements and weakly supported statements. A strongly supported statement has to be supported by at least three respondents from at least two fields. This was not the case for statements M1D, M2A, M2B and M2C. Statement M1D will be further substantiated as part of the policy of the Israeli government in section 4.4.2. M2A follows logically from the strongly supported statement M1A. Due to the conversational nature of the interviews there were no explicit statements who made this statement, but due to its strong link with M1A, M2A is accepted.

Evidence for M2B and M2C will be searched for in the secondary evidence results. The comparison to the factors of chapter 2.3 will be made in chapter 5.

Table 4 – evaluation of the reliability criterion for the markets section. The initial number is the amount of respondents who contributed to the statement. The second ms that he final ment is expanding on theory(+), similar to theory (=) or contradicting theory (-)

Table 5 Construction of statements per actor for the Resources category.

Respondent	R1 – Internal challenges	Statement	M1	M2
BD1	A,C,D,E	A,B	A,B	
BD2	E	B,C	3(2)=	2(2)+
BD3	A,C,D,E	B	3(2)=	1(1)+
BD4	B	C,D	4(3)=	2(1)+
LSF1	A,B	C		
LSF2	A,B	A, B, C	2(2)+	-
P1				
P2		B,C		
VC1		B, C, D		
VC2	A	A, B	B	
Answers	7	8	3	
Specialisms	3	4	2	
Statements	5	3	2	

4.2 INTERVIEW RESULTS – RESOURCES

The factors (F_R1-4) on resources focused on the importance of accessibility and availability of human and financial resources. Financial resources were discussed a bit more in depth and the risk tolerance of available resources was discussed. Finally, the competition of cleantech TBNVs with "other" TBNVs for resources was discussed. The questions within this category were rather broad, so the different statements cover an interesting range of resources necessary. Also, the internal challenges for cleantech ventures are discussed in this section.

4.2.1 INTERNAL CHALLENGES FOR THE START-UP AND THE NECESSARY RESOURCES

R1. Which resources does an Israeli cleantech start-up need after it has obtained seed finance?

This question was discussed by 7 out of 10 respondents from three different specialisms. Three different statements could be generalized out of the responses. The first two statements focus on the fundamental internal challenges for the start-up after the credibility threshold.

> **R1A.** Generally, there are two challenges for a start-up after seed funding has been received. The first challenge is understanding the market and how to reach it. The second challenge is to develop a prototype to lower technological risk and show technological capabilities.

large part is infrastructure) and industry (not per se – individual innovations stand a chance here). Source: Lawrence Livermore National Laboratory World Energy Flowchart, 2007.

R1B. The technology of the start-up should eventually cross the *technology* chasm. The above challenges are the first two challenges for the start-up after seed funding. The first step to reach "the masses", is that the technology needs to be demonstrated in a pilot project. Subsequently a venture needs to be able to develop on a large scale.

The other statements for this question discussed the need for resources after seed finance has been obtained.

R1C. The necessary resources necessary for these challenges are highly case-dependent, but can be generally be classified in both human and financial resources.

R1D. Human resources – the venture has a need for technologically skilled employees for prototype development and business skilled employees for business development.

R1E. Business skilled employees in particular need to be able to articulate the target market and develop sales channels, therefore particular knowledge of the specific market and a (international) network within this market is necessary.

Statement C, D and E can be exemplified by the following quote of a business development expert:

"So what I actually need, is someone in the USA who has highly specified knowledge of the corn market. Someone knows the relevant market players in this field, so he can start developing my international sales channels."

The first question was aimed at determining the necessary resources for the start-up. The second question was focused on whether these resources were available in the environment of start-up. And if they existed, whether these were accessible for the start-up at all.

4.2.2 Availability and accessibility of human and financial capital.

R2. Which resources needed for the development of cleantech start-ups are abundant and which are scarce? How do the entrepreneurs access them?

This question was discussed by 9 out of 10 respondents from four different specialisms. Three different statements could be generalized out of the responses. However, the statements turned out to be rather complex stories. Some examples are used to clear up the statements.

R2A. Technologically skilled employees, like engineers, scientists and programmers, are abundantly available.

This was said by all respondents who touched upon the subject. This statement can be subscribed by data from the world competitiveness report as explained in the introduction, but is contradicted by a recent report of the Israeli government on the state of affairs of the start-up ecosystem which will be discussed in the secondary data collection. The following quote, obtained from an entrepreneur that was interviewed as part of the secondary data collection, probably summarizes the complexity of the situation.

"For our prototype development, we need someone with specific knowledge of analogue electronics. Unfortunately those guys are very, very scarce. Don't get me wrong, there are tons of engineers around here. Hell, I believe I could build a space ship with the people within a five mile radius of me, but this specific knowledge is almost impossible to find!"

The next topic to cover is the availability of managers/business skilled employees. This topic was subject to very contradicting statements. Statement B is the consensus that was found within the statements and some notes are made below to clarify the statement.

> R2B. Managers and business skilled employees are available for the initial stages of the venture, but later stage managers are lacking.
>
> - However, the Israeli cleantech start-up SolarEdge grew towards a world class company with Israeli management for example. In other industries than Cleantech there are also good examples, for instance the company Checkpoint. The case that Israeli "cannot lead a big company", cannot be made.
> - A note from the Late Stage Finance perspective – as soon as the company relocates to the USA, these managers will be available. On this same note, the management could be replaced if a strategic partner comes in.

The definition of "initial stages", is a vague statement. The statement should not be interpreted as if there is some sort of "cut-off" point after which the management of the venture becomes a task that does not fit with the skillset of the entrepreneur anymore. A correct way to interpret the statement would be that it remains unsure whether (the lack of) business skilled employees can actually be used as an explanation for the commercialization gap. It should also be mentioned that such a statement was often started with *"I have a feeling that…",* so this qualitative approach is probably not very suitable to make a definite statement on this topic. Finally, the argument from the late stage finance respondent puts this discussion in perspective. While technological challenges will provide a true barrier for the venture development, the improper management for *initial stages* is likely to be filtered out by the Venture Capitalist who only invests in "*about 1 out of 300 companies with a very strong focus on the team".* Secondly, if the problem of *later stage management* occurs, alternative options for the management appear. The argument here is not that entrepreneurial management is *not* an issue, but it probably is not the missing piece within the resources that are needed for the cleantech start-up that has received seed funding (and was thus the chosen one of the Venture Capitalist).

Statement C & D discuss the accessibility and availability of financial resources in Israel for the cleantech venture.

> R2C. Financial (venture and late stage) capital in Israel is abundantly available, but the model is not suitable for the financing of cleantech.
>
> R2D. The capital needs for cleantech companies are much higher than the companies it has to compete with (IT industry).

An example of these statements was given by one of the business developers who was active within cleantech. *"For us, a cleantech company, 100% growth is amazing. For the Venture Capitalist [not specialized in Cleantech], 1000% growth is amazing. During the technology development phase, up to $500k per month could be burned on overhead and R&D costs. Commercialization costs for our particular company is estimated to be around $50M with a valuation of about $200M. "*

4.2.3 Ways and challenges in accessing human and financial resources

R3. How capable are entrepreneurs in accessing resources after they have obtained seed finance?

The necessary resources and the availability and accessibility of these resources have been discussed up to this point. Some respondents also covered ways to access the resources and specific challenges in accessing them. This topic was covered by 4 respondents and 2 statements could be derived.

Table 6 evaluation of the reliability criterion for the resources section. The initial number is the amount of respondents who contributed to the statement. The second number is the amount of specialisms that contributed to the statement and the final symbol means whether the statement is expanding on theory (+), similar to theory (=) or contradicting theory (-).

R3A. The challenge is that the venture has to access the right resources the first time. There is no room to make a bad hire or accept the wrong investment, experience is an important factor here.

R3B. A role of the VC is advising in this challenge and offering options via their network. They can also help to negotiate a better deal, based upon their previous experience. Still, the main job of the VC is to provide the financial capital.

4.2.4 RELIABILITY CRITERION

Statements are distinguished in strongly supported statements and weakly supported statements. A strongly supported statement has to be supported by at least three respondents from at least two fields. This was not the case for statements R1C, R1D, R2D and R3A.

Statement	R1	R2	R3
A	5(3)=	3(3)+	1(1)+
B	3(2)+	6(4)-+	3(2)+
C	2(1)=	6(3)=+	
D	2(1)=	2(2)+	
E	3(1)+		

Regarding R1C and R1D, these are rather logical statements which are in accordance with theory. The business development experts who contributed to these statements came from different industries (within cleantech). If one considers academic theory as the third source of evidence for the statements, they become triangular and can thus be accepted. During the secondary data collection these statements return as well and a third source of evidence becomes clear.

The statements of R2 are fundamental for this thesis and actually both R2B and R2C received sufficient back-up. For R2B, there was contradicting evidence. However, it was already discussed whether this qualitative approach is very suitable to approach this potential problem. When the situation with business human capital is compared to the situation with financial capital, one should notice that none of the respondents said that *Israeli do not want to work in cleantech*. In other areas of tech development, companies are very successful in commercializing their venture (to some extent), thus it seems illogical to view *lack of managers* as the fundamental issue for cleantech commercialization within Israel. If such was the case, cleantech would not perform worse than other industries.

Regarding R2C, the availability of financial resources, there were many "puzzle pieces" that demand further research. Actually, three independent respondents commented on the misfit between cleantech and the financial system, but they did so on different parts of the financing system. On the other hand, examples of cleantech companies can be found in almost every stage, from seed funding to a recent IPO[19]. R2D (and to some extend M2C – the view of cleantech as an "infrastructure industry") are connected to this story.

[19] SolarEdge raised $126M in their IPO in march. - http://news.nocamels.com/2015/03/29/solaredge-raises-126m-in-nasdaq-ipo/

Regarding R3A there is only a single source of evidence and it was only mentioned once. Since the statement is not a source of evidence to explain the commercialization gap in cleantech – such a challenge is there for every start-up company, it will not be followed up during the secondary part of data collection.

4.3 INTERVIEW RESULTS – POLICY

The factors (F_p1-3) on policy focused on the influence of the formal institutional regime within Israel and the link between investment and policy. It was argued that investors would not invest in a venture that has a complete dependency on policy for its business.

Table 7 Construction of statements per actor for the Policy category

	P1 – General government practices	P2 – Governmental policy to reduce investor uncertainty
BD1	B	
BD2	A,D	
BD3	A,B	A
BD4	A,C	A
LSF1		
LSF2		
P1	C	B
P2	A,B	A
VC1		A
VC2	D	
Answers	7	5
Specialisms	3	3
Statements	4	2

4.3.1 GENERAL GOVERNMENT PRACTICES AND INTERFERENCE

P1. Does the Israeli government interfere to transform the added societal value from cleantech start-ups in to monetary value?

It should be noted that the simple answer to question P1 is no. The question was too specifically aimed at a principle derived from the theoretical framework. Therefore, the influence of the governmental practices and government interference that was influencing cleantech start-ups were discussed within this paragraph. The main influence of the government is through the Office of the Chief Scientist, who have been hailed for their stimulation of the innovation processes. The OCS has a neutral stance towards all technologies. Their work has been extensively described and will be touched upon in section 4.4.2 (EY, 2015; Rozen, 2013; Almor T. , 2013). The question was discussed by seven respondents from three different specialisms.

> **P1A.** If the state of Israel has an interest in a specific technological field for geopolitical reasons (for instance, water or gas), the government will create a "buzz" surrounding this.

At this point, the geopolitical situation of Israel which was explained in the introduction becomes relevant. Recently, large gas discoveries have been made in front of the coast of Israel[20]. If this topic was discussed, respondents mentioned that it was *an absolute game changer* for the cleantech industry because it means Israel suddenly has energy resources (other than the sun) and a new way for the government to become energy independent from external countries in the Middle East.

Another large industry within Israel is the defense industry. If the defense industry has a specific technological need, the government will stimulate processes (either within the military or beyond) to develop such a technology. An example for cleantech could be energy storage and generation, which is very helpful for a military camp that does not want to rely on supply lines for its electricity. Evidence for the

[20] See for instance http://www.nobleenergyinc.com/operations/eastern-mediterranean-128.html. While there have been small gas operations since 2004 in Israel, the potential of the large *Tamar sands* was slowly discovered between 2009 and 2014.

interest of the defense industry in renewable energy can be found on the website of the main Israeli Venture Capitalist in renewables. Two of large Israeli defense companies are limited partners[21] within the venture capitalist (Capital Nature, 2015). However, the respondents noted that while the government can be very helpful, they also slow down the process which is reflected in statement B. In fact, the Fuel Choices Initiative (blue box) was partially founded to aid with this problem.

P1B. Israeli bureaucracy can slow down the process, especially if there is a need for standardization or if a claim has to go through multiple departments.

The aforementioned begs the question what the situation is if a venture is operating outside the interest field of the government? If there is no support of an initiative like the fuel choices initiative, the following does apply.

FUEL CHOICES INITIATIVE

Fuel choices initiative is a government program dedicated to reducing the world's dependency on oil for transport. Its three main goals are to achieve a 60% non-oil based fuels by 2025, turning Israel into a center of knowledge and industrial best practices in the field of fuel alternatives and to raise the world's awareness of alternative fuels. Based in Israel, an elite team of researchers, innovators and private sector collaborators all striving towards the same goal with different methods.

It tries to comprehensively support the development of alternative fuels for the transportation sector. It does so via financial and regulatory support, while it also tries to create a community surrounding alternative fuels. The initiative aims to create a business-supportive environment for the market through simplification of bureaucratic processes and a means to quickly respond to market changes and needs. It does not support specific start-ups – every start-up can contact the initiative for support, as long as there is an economically viable solution.

Sources: Fuel Choices Initiative leaflet (not available online) & Fuel Choices Initiative presentation - http://www.fuelchoicesinitiative.com/files/pics/Fuel_choices_Initiative.pdf

P1C. Specific policy on cleantech does not exist. The policy that is relevant for cleantech ventures is vague and ineffective.

It is mentioned though that the climate change summit in Paris could mean another *game changer* for the Israeli government. However, one respondent cleverly noticed the following:

P1D. Policy problems for cleantech companies might be less visible in this research setup, because the due diligence of VCs (credibility threshold) filters out most policy stress.

He is subscribed by another respondent who said. *"Look at their [VC's] website, they will [invest in] a quick solution that is easier to take to market. A solution that doesn't need infrastructure or regulations."* After the website of the specific venture capitalist was consulted this seems indeed to be the case and it actually makes sense. An investment in a company that is hold back by the law or infrastructure challenges must have an extreme high amount of potential before the investor makes an investment. In section 4.4 this topic will be further investigated.

[21] Investors who invest in the fund and are limited owners of the funds. See structure and background information at https://en.wikipedia.org/wiki/Venture_capital#Firms_and_funds

4.3.2 POLICIES TO REDUCE INVESTOR UNCERTAINTY

P2 Is there a clear policy from the Israel government that reduces uncertainty for investors in eco-innovations?

The main example for question P2 is the Fuel Choices Initiative – see the blue box. There is a clear link with the geopolitical interests of the previous section. In fact, the *Fuel Choices Initiative* was established to *free the world from a dependency on oil within transportation*. The focus is not completely on cleantech though - many projects focus on the application of gas in transportation.

P2A. The government reduces investor uncertainty with some programs.

There are quite a few other examples to reduce investor uncertainty, focused on sustainable transportation, renewable energy technology and related fields like energy storage or energy efficiency. Examples are the fund-matching practices, R&D and pilot grants of the Office of the Chief Scientist (see section 4.4 for a more in depth exploration of these programs) (Rozen, 2013; Almor T. , 2014) and the FCI support. Still, because *cleantech* is such a broad sector, many parts are not yet covered by legislation from the government. One respondent said:

Table 8 Evaluation of the reliability criterion for the Policy section. The initial number is the amount of respondents who contributed to the statement. The second number is the amount of specialisms that contributed to the statement and the final symbol means whether the statement is expanding on theory(+), similar to theory (=) or contradicting theory (-)

Statement	P1	P2
A	4(2)+	4(3)+
B	3(2)+	1(1)+
C	2(2)+ (~)	
D	2(2)+	

P2B. There is no clearly defined agenda to reach the goals for cleantech and renewable energy.

Whereas statement P2A lowers investor uncertainty, this is not the case for statement P2B which heightens investor uncertainty again.

4.3.3 RELIABILITY CRITERION

Statements are distinguished in strongly supported statements and weakly supported statements. A strongly supported statement has to be supported by at least three respondents from at least two fields. This was not the case for statements P1C, P1D and P2B. Policy is the only category in which more statements are rejected than accepted. This has to do with the fact that the respondents could not connect to the questions. Therefore, the policy of the Israeli government is explained from other sources in the next section.

4.4 DATA COLLECTION PART TWO

In the reliability criterion sections 4.1.3, 4.2.4 and 4.3.3 strongly the support of the statements was discussed. It was determined that some weakly supported statements needed extra attention. Moreover, the influence of some topics remained vague. The need for secondary data to back up the initial statements was analyzed. It was determined that further research in two main topics should be performed.

The main topic that was highlighted as an issue with a need for secondary evidence to back up its claims is the financing chain for cleantech in Israel and the mismatch between cleantech and the financing system. Secondly, the policy of the Israeli government will be evaluated on their influence on the cleantech industry.

Table 9 Different interviewees and their background. Experience is defined as being involved in the world of new ventures. Between brackets is the amount of time the specialists have spent in cleantech. The ~ sign for EX3 and EX4 means they were involved in cleantech on an irregular basis. Management experience is defined as being involved in the management of a TBNV (not per se cleantech).

Code	Specialism	Years of Experience (Experience in cleantech)	Management experience
EX1	Energy Storage	24 (3)	Yes
EX2	Energy sector Research	7 (3)	Yes
EX3	Strategic Consultancy & Expert on funding for SMEs	14 (~9)	Yes
EX4	Agro and Food VC	18 (~8)	Yes

Four further interviews have been performed to research these topics. Interviews were conducted with fellow researchers from the Samuel Neaman Institute who performed similar research, an entrepreneur who just received a Series B follow up seed funding for his company in energy storage, a consultant who specializes in funding on for SMEs and a venture capitalist in the field of Agriculture and Food. Further details on them are presented in Table 9. The information from these interviews is combined with excerpts from the other interviews which highlighted the financing challenges and secondary data. Moreover, some information from other reports on the topics are used to clarify the information.

4.4.1 THE FUNDING CHAIN OF CLEANTECH START-UPS

In section 2.2.2 general funding chains for cleantech start-ups within Europe were discussed, in this section the situation in Israel is clarified.

Investor Expectations

"Cleantech Investment" means something different for many of the actors involved in it, showed a study towards London-based cleantech investors. It was seen more as an investment theme, rather than a specific industry. Another important finding was that the motivations of the investors are financial, rather than environmentally oriented (Georgeson, Caprotti, & Bailey, 2014), which was also found by the EIM report (EIM & Oxford Research, 2011). Since cleantech development in Israel thrives on resource efficiency rather than environmental concerns (described in section 2.1), it seems fair to extrapolate this finding and make the assumption that the motivations in Israel will be similar. Thus, the return on investment is assumed to be the leading driver for cleantech investment, rather than environmental concerns.

One respondent from late stage finance explained the growth expectations of regular Venture Capitalists versus Growth Private Equity[22].

"The differences between Venture Capital and growth Private Equity (PE) lay within the technological risk. PE will not accept technological risk and only invests in companies with a final developed product that is already selling to the market. The PE will invest in a few companies that all get a 3 times return over 5 to 7 years. The Venture Capitalist will invest in companies with a technology risk. Maybe 3 out of 20 will generate returns but they should guarantee about 20-40 times their investment to cover for the other investments."

It has to be noted that this is a *general* rule for Venture Capitalists *from all sectors*. One of the two interviewed Venture Capitalists was willing to share the success rate of the companies they had invested in thus far. Six out of nine were still 'alive'. The venture capitalist contributed this to the 'filter' they applied – only 1 out of 300 companies was deemed suitable for *seed* investment. In this study, the 'filter' is the credibility threshold, so this study is concerned about the nine *venture-backed* companies.

Capital needs

These *venture-backed* companies have certain capital needs that are rather high due to various reasons. Two entrepreneurs (BD4 and EX1) shed their light on capital needs. After the technology-based company received seed funding, their job is first to build a prototype (financed by seed funding), start a pilot project (financed by follow-up funding from VC money) and then further develop implementation, for instance to start building a factory. This is in accordance with statement R1A about internal challenges for cleantech TBNVs who have received seed funding.

"*We managed the technology development chasm because we made a prototype plant[23] with the technology. During this process we faced technological problems we weren't aware of before. This took 3 years to solve. This makes technology development an important barrier. In this period, a lot of money is burned on overhead and R&D, around $500k/month."*

To put it simply, the company had spent $18M to build a *prototype.* They expected *commercialization costs* to be around $50M. If one returns to figure 5 on page 18 which describes technology readiness levels, these commercialization costs can be explained. The prototype could be considered either TRL4 or TRL5 (component and/or breadboard validation in laboratory/relevant environment), which is somewhere in the middle of the *technological development* process. Such amounts of money are not extraordinary. The other respondent expected to spend $3M to build a working prototype (they almost achieved this) and another $10M to develop a *commercially viable product*. The entrepreneur noted:

"*The turning point will be 'bankability'. For this, the technological risk needs to be removed and moreover, there needs to be a reasonable expectation that the technology will work for 20 years without failure."*

Thus – both private equity and banks in Israel expect technological risk to be removed before they consider investing in the cleantech company. But removing technological risk is very costly in the cleantech business,

[22] Which apparently doesn't exist in The Netherlands, where Private Equity companies have a reputation for buying large companies that are not being profitable (like Vroom and Dreesman recently), making those companies profitable and then selling them again.

[23] In the case of this company, their technology involved building an entire plant to function.

costs ranging somewhere between $10M – $50M from these two examples. The question is therefore – who is willing to finance these *technological development* costs?

One more note came up from the interviews. First of all, one entrepreneur noted that with the development of a prototype, only 20% of the technological risk is removed. On the other hand, the promise of the technology is declining much faster because it finds a niche to settle in or reaches the limits of its technological possibilities.

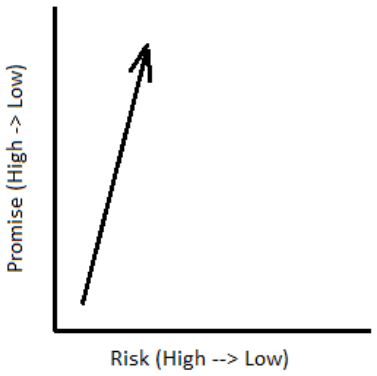

Figure 13 Risk versus promise over time. (Technological) Risk decreases much slower than the promise of the technology, because the technology is being developed towards a specific niche.

Comparison to other research

Researchers from the Samuel Neaman Institute made an extensive analysis of the stages different cleantech companies in Israel were in (Fortuna, Freund-Koren, Liebes, & Raveh, 2014). The results of this analysis are showed in figure 14. What can be seen is that there is indeed a large gap between the companies who are in the pilot phase (initial revenue) and those who surpassed it (revenue growth). Similar to the examples presented in this research, the conclusion was drawn that a market failure occurs within the Israel cleantech industry, because the development of the technology is too expensive for the venture capitalists and too risky for the banks. Interestingly, similar conclusions were drawn by the *Planbureau voor de Leefomgeving(PBL)* for the Netherlands about the Dutch situation (PBL, 2015). A difference between the conclusions was that the PBL concluded there was not enough venture capital for eco-innovations (cleantech) available in the Netherlands, while the Samuel Neaman Institute (SNI) concluded that the problem was that Venture Capital was not able to pay for the costs that the cleantech start-ups need to make to advance to the revenue growth stage (Fortuna, Freund-Koren, Liebes, & Raveh, 2014). None of the Israeli cleantech companies that made one of the five largest exits before 2014, were backed by venture capital (IVC, 2014).This story supports evidence for statements R2C and D. This difference could possibly be explained by Israels policy support for early-stage ventures, which will be highlighted in section 4.4.2.

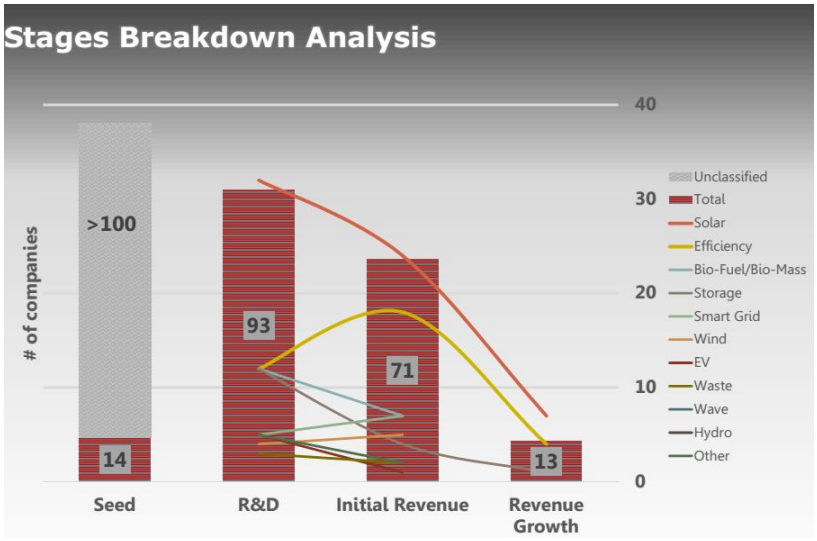

Figure 14 Cleantech companies in Israel broken down by stage. Source: (Fortuna, Freund-Koren, Liebes, & Raveh, 2014)

A final interview

In a final interview, these thoughts on a 'market failure' in Israel and the Netherlands were shared with a seasoned Venture Capitalist who has some experience in cleantech, but mainly focuses on agricultural technology – although there is some overlap between those fields. He made some interesting remarks about these conclusions.

First, alternative explanations for the data are discussed. The high amount of initial innovation could be that entrepreneurs in Israel are willing to cope with much more uncertainty compared to other countries like the Netherlands. An explanation for the large 'gap' was a rather practical one in his opinion and had to do with the amount of due diligence the VCs do before an investment. "*To simplify – you don't do a $5.000 due diligence process for a $100.000 investment because it is not worth the money. You will do this with a more expensive follow-up investment of say... $5M."* The assumption here is that the more extensive the due diligence process is, the higher the chance that something 'comes up' which prevents the investment from happening.

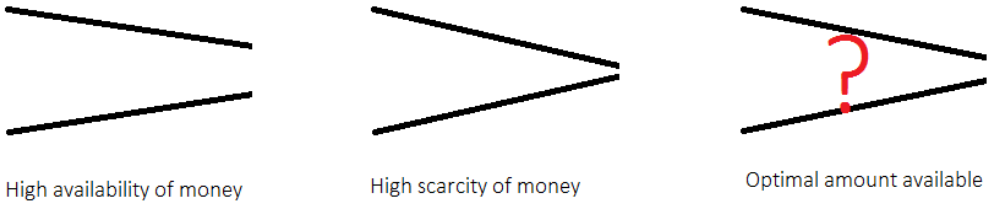

Figure 15 Availability of money as a natural filter for the amount of start-ups that can commercialize. The left tile represents the filter situation when there is a lot of money available - many start-ups will be funded to develop in the next stage. The middle tile represents the opposite situation. The right tile clarifies that it is very hard to know what the optimal situation is.

But what if a TBNV is good, great maybe, but others are better (in the eyes of the investor)? The respondent (and other VCs that were interviewed said the same) said that the amount of (investment) money available serves as some sort of funnel, as a filter mechanism. The higher the availability of investment money, the more technologies can be funded, while a scarcity of available money would constrain the amount of technologies that can be funded.

Whether there is scarcity of money or a lack of good ideas and technologies to be funded is difficult to say. If the current situation represents the 'optimal' filter cannot be found with this research setup because one needs to determine the optimal filter first. A final addition that can be mentioned is the ratio between emerging cleantech innovation and evidence of commercialized cleantech innovation, which was in Israel lower than in other countries, as noted by the report of the Cleantech group (Parad, 2014).

These are general principles and further research – for instance by comparing seed funding follow-up investment rates between different industries – could provide more insights. These principles and examples clarify the statements about the compatibility of the VC model with the financing of cleantech innovation (**R2C**) and the capital needs of cleantech TBNVs (**R2D**).

4.4.2 Governmental influence – Policy

When the VC respondent of the previous section turned to cleantech specific reasons, he mentioned that you are very dependent on the high levels of regulation if you invest in cleantech. This statement was illustrated by the example of the solar industry in Israel. In 2009, before the potency of the Tamar gas fields (p.44, footnote 20) was fully known, the Israeli government had its bets on the solar industry to fulfill the need for energy independency. As the Wall Street Journal writes it:

"In 2009, Israel embarked on an ambitious, renewable energy plan. As part of that, the government said it would issue landowners quotas to produce around 3,000 megawatts of power by 2020, about 10% of what they forecast energy demand to be. It would pay them subsidized tariffs for selling the power to the state-

run national grid. That triggered a rush of entrepreneurs and investors. Dozens of solar-power-focused companies sprung up. Arava Power Co. switched on Israel's first commercial solar field in 2011." (Stub Toth, 2015)

However, history proofs that the Israeli government tends to change their energy policy often. Lipstein and Tal show in an extensive historical overview of Israels renewable energy policy that initiatives for solar power deployment in Israel have been going on since 1955, but that they have been put on hold every time due to several reasons, including policy changes (Lipstein & Tal, 2013). And indeed, licenses for the subsidized tariffs (2.1NIS/kWh, about 0,50 €/kWh) for the sale of solar power to the grid have been stopped in 2012[24] (Stub Toth, 2015). As a result, many of the solar powered start-ups collapsed and went either bankrupt or were sold *"for far too less money" (Source: VC1)* to Chinese companies.

The story supports several statements. First, one can see that cleantech can indeed be dependent on government regulations. It also supports the part of statement M2C *which says that cleantech is mainly an infrastructure business and that the infrastructure market is not a very good market for start-ups*. Finally, statements P1A, P1B and P1C on respectively the creation of a buzz for specific technology, Israeli bureaucracy and the lack of specific policy for cleantech all receive further support by this story.

Financial Innovation stimulation programs of the Israeli government

If companies are not growing beyond their initial stages because they have high, risky capital demands to develop their technology towards a revenue growth stage, then why are VCs investing in Israeli cleantech the first place? One respondent mentioned that there are at least 700 cleantech companies in Israel, and that this amount has – despite the solar debacle - increased over the past years. A possible (though not complete) explanation for this trend comes from the government subsidy programs and the Angels' Law.

In 2011 the Israeli government decided to adopt a national "green growth" policy, which included the plan to turn Israel into a *major beta site for a wide range of environmental technologies.* Participants of the round table on eco-innovation (cleantech) identified means for overcoming regulatory hurdles and bureaucratic procedures, including greater government support for the establishment of essential infrastructure, division of risk, provision of favorable conditions and enabling regulations for beta sites, and verification and dissemination of locally developed best available techniques. The process initiated by the October 2011 government decision has led to policy and regulatory initiatives aimed at implementing the green growth strategy. Israel was aiming to move forward on a number of fronts: drafting a green licensing law, planning for a green growth knowledge center, advancing green taxes, designing training programs for green jobs, promoting green procurement, publishing anti-greenwash guidelines and launching a material and waste management research center (Israel Ministry of Economic Protection, 2014). Not all plans received budgetary approval from the Israeli parliament though (Israel Ministry of Economic Protection, 2012). Moreover, the recently newly elected government (March 2015) decided to merge the Ministry of Economic Protection with the Ministry of Economic Affairs. One respondent (a policy expert) called the cleantech policy of the government vague and ineffective and this points in the direction of evidence for that statement (P1C).

In practice it means that the government has several incentive programs running. Under the '*Tax Benefits for Individuals Investing in R&D Companies'* ('Angel's Law'), individuals who invest in start-ups who

[24] The Israeli government officially states that this is unrelated to the findings of the Tamar Gas Fields (Stub Toth, 2015).

commence an R&D project can deduct this investment of maximum ~$1.25M from their taxes if 75% of the investment is spend on R&D (EY, 2015). For a seed investment of $700.000 in a start-up, the government can provide a loan of $600.000 if selected venture capitalists invest the other $100.000 (Rozen, 2013). This loan only needs to be repaid when the company successfully commercialized the technology. Both interviewed VCs participated in this program. Other programs include 62,5% of the prototype development costs up to $180.000 (STARTERGY Program), 50% of the pilot plant costs up to $430.000 (Pilot and

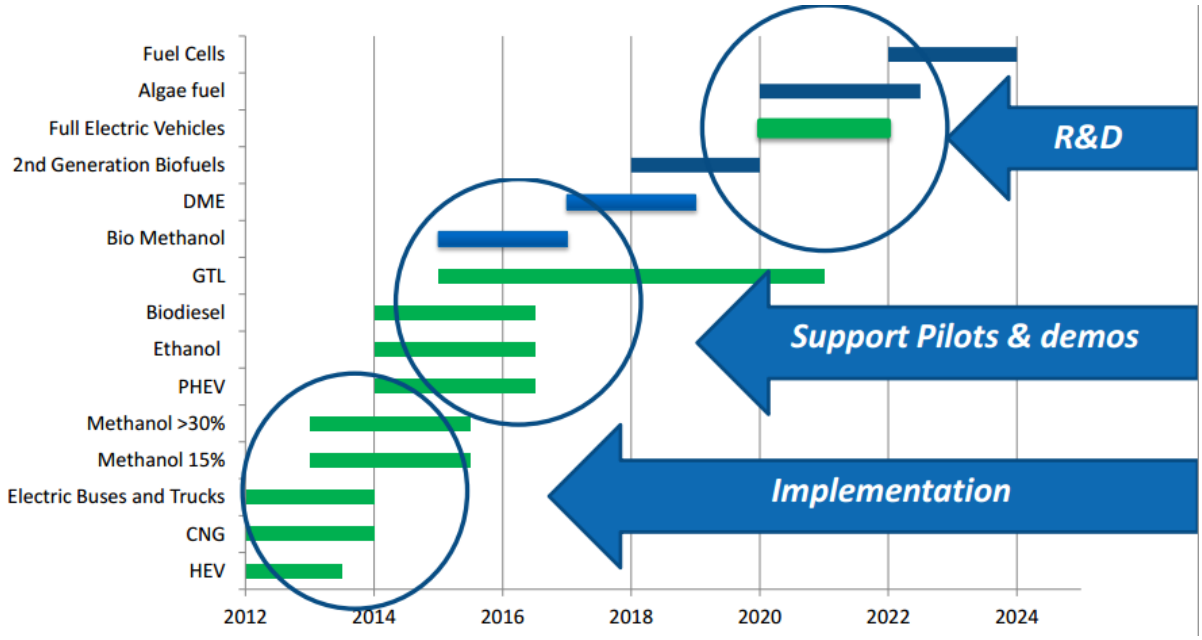

Figure 16 Overview of interference of FCI in the Israeli market. The X-axis represent the year when the alternative fuels on the Y-axis are economically viable. The graph shows that the initiative aids both in the research and development of new technologies, as well as the support of pilots in demos for technologies that have proven themselves in the laboratory and regulatory assistance in implementation of market ready products. Green indicates a developed technology, while blue means that the technology is still under development (Fuel Choices Initiative, 2014).

Demonstration fund) (The Chief Scientist Office, 2014). Figure 16 shows some examples of projects that are being funded by the Fuel Choices Initiative, which is involved in distributing these grants. Other sources of finance in which the Israeli Cleantech TBNVs could tap, are the Horizon 2020 (H2020) funds of the European Union. The H2020 program is an €80 bn program of the European Commission to stimulate innovation in Europe and partnered countries, including Israel.

To identify the influences of these H2020 grants, a consultant who specializes in advising start-ups about these grants (EX3) was interviewed. The H2020 grants consist of three different funds (action-specific grants, SME (small and medium enterprises) instrument and fast track to innovation grants), out of which the SME instrument the more interesting ones for Israeli start-ups. The SME instrument *helps high-potential SMEs to develop groundbreaking innovative ideas for products, services or processes that are ready to face global market competition* (European Commission, 2015) and aims to help start-ups overcome the valley of death (see section 2.2.2).

Typically, the grant is worth €0.5-2.5M and the chances of obtaining it are about 10-15% for Israeli start-ups, according to the respondent. He further said: *"Unfortunately you can't plan around the grants in such a way that you will definitely receive it, due to the low success rates. The nice thing is that you receive direct*

cash. Unfortunately, the governmental grants often cover for only about ~20% of the financing needs. The other 80% still has to be provided by Friends and Family, Angels and VCs."

The mismatch between the amount of money of the discussed grants and the aforementioned commercialization costs is clearly visible. While they are probably a good way to attract private investment – the OCS fund-matching programs have attracted $5 in follow-up investment for every dollar that was invested by the government (Rozen, 2013), the amount of money from these grants only covers a small part of the aforementioned amounts necessary to develop a prototype or a pilot program in cleantech. One of the driving ideas behind the H2020 grants is that they also have to attract private investment in the same projects. For the programs of the Israeli Office of the Chief Scientist (OCS), this is currently more difficult. The future privatization of the OCS is set to change this according to the respondent. In the future, more financial resources could become available due to these developments.

Not all cleantech start-ups within Israel are part of these programs – from 2011 – 2014, 30 pilot grants from the OCS were awarded, while the research of the Samuel Neaman Institute shows that there are at least 71 cleantech companies in this phase (H2020 started only in 2014 so it's unlikely that it has a lot of influence on these data).

Other programs and reflection on the start-up ecosystem by the Israeli government

To aid start-ups in Israel to connect to international markets, the Israeli government sponsors large conferences (for instance, WaTec[25]) on certain topics that are on their agenda. With regards to cleantech, this instance is NewTech[26], which focuses on the promotion of Israeli cleantech innovation in international markets. The Fuel Choices Initiative is another example.

In April this year, the Israeli government published the first annual report on the state of affairs of the Israeli start-up ecosystem. It indicated two major challenges for the start-up ecosystem (over all industries) (Israel Ministry of Foreign Affairs, 2015).

- The need for new funding sources for the industry
- Growing more hi-tech startups into major companies

In this sense, the data found by this research are not very controversial. Potential additional funding sources that are identified by the report of the government include strategic investments, corporate venture capital funds, micro funds and crowdfunding (Israel Ministry of Foreign Affairs, 2015).

4.4.3 CONCLUSIONS FOR THE DATA COLLECTION PART TWO

The purpose of the secondary data collection was to find evidence for statements that did not receive enough support in the first interviews and to clarify topics that appeared to be explanations for the commercialization gap between emerging cleantech innovation and commercialized cleantech innovations.

First, there are some statements that did not make it into secondary part of the data collection. Either because they were not considered important enough or because no support could be found for them. These statements are presented in table 10.

[25] http://watec-israel.com/
[26] http://israelnewtech.gov.il/English/Pages/default.aspx

Second, the majority of the unsupported statements fell under the two topics that were further scrutinized in the secondary data collection – financial resources and governmental policy. For most of these statements, further evidence was found and they can be considered reliable after this section. These statements are presented in table 11.

Overall, the secondary data have given insight in two major themes that can help to explain the commercialization gap. The first explanation is the combination of high need for financial resources of cleantech TBNVs for technology development and the lack of available financial resources that can be used to finance technology development (and therefore, lower technological risk).

Second, the influence of the supportive policy regime of Israel for innovation was highlighted. Two points stand out here, first the general amount of stimuli for innovation by the Israeli government. Highlights include the Fuel Choices Initiative which tries to flatten the way through Israeli bureaucracy and policy for innovative TBNVs and the Office of the Chief Scientist seed investment programs which helped attract almost $5 in follow-up investment for every dollar invested by the Israeli government. Secondly, the more specific stimuli for cleantech innovation were discussed. It was explained how energy policy of the Israeli government often changed and the influence of the Tamar gas fields were highlighted. Finally, it was shown that the available government investment programs from both the Office of the Chief Scientist and the Horizon 2020 programs are not matching the needs for financial resources of cleantech TBNVs.

Table 10 Overview of statements that were not further supported by part two of the data collection and remain weakly supported statements

Statement	Topic	Reason
M2B	Local factors in Israel	This topic was not further researched. Real estate prices in Israel are indeed very high, but start-ups from other industries face the same problems. Also, it was not one of the factors mentioned from the literature study.
R3A	One shot at accessing the right resources	This topic was not further researched. Indeed TBNVs have limited opportunities in accessing the right resources, but start-ups from other industries face the same problems. Also, it was not one of the factors mentioned from the literature study.
P1D	This setup filters out policy problems for cleantech companies	This topic was not further researched, but it seems to be true indeed, hence the approach with part two of the data collection.

Table 11 Overview of statements that were further supported by part two of the data collection and turn into strongly supported statements.

Statement	Topic	Support
M1D	Connecting to customers	The Israeli government plays an active role in presenting Israeli innovation to the rest of the world, for instance via the Fuel Choices Initiative, WaTec and Newtech.
M2C	Cleantech as an infrastructure business	Dependence on governmental regulation and energy policy is often changed in Israel.

R2C/R2D	Needs for financial resources of TBNVs and the availability of these resources	Based upon the evidence presented, cleantech TBNVs indeed have high capital needs in general[27], and there is a lack of capital available that can deal with the removal of technological risk[28]. There is a mismatch between the amount of financial capital needed and the availability of this capital.
P1C/P2B	Specific policy on cleantech does not exist /Lack of clearly defined agenda for cleantech	The green growth policy appears to be a clear agenda, but not all plans received budgetary approval and recently the ministry that should execute the plans has been fused with another ministry. If one combines this with the presented shift in energy policy, it appears that there is indeed a case for an unclear agenda on cleantech and the lack of a specific and clear policy.

[27] Future research is needed to substantiate this statement – this research did not go deep enough into this topic to make this claim definitive – also sources from other countries (SER, 2013) give similar results.
[28] This part of the conclusion is backed up by other research as well.

5 PAINTING THE WHOLE PICTURE - PRACTICAL FRAMEWORK AND DISCUSSION

In sections 4.1-4.4 the empirical results of the investigation towards several aspects of the institutional environment for Israeli cleantech start-ups have been presented. Twenty-four statements on the environment for cleantech start-ups within Israel and their challenges in commercialization were described by two rounds of data collection. Statements either described the situation for a certain institutional category or relations between different categories. Twenty-one out of twenty-four statements were strongly supported statements and can be combined with information from the introduction to *paint the whole picture*. The overall empirical findings of this study have been visualized in Figure 16.

5.1 CONCLUSIONS OF THE EMPIRICAL RESEARCH – EMPIRICAL FRAMEWORK

Internal challenges

The main internal challenges for the cleantech start-up were found to be 'identifying the right market' and to 'lower the technological risk of their venture' by developing a commercially viable product (R1A).

The technology of the TBNV should eventually cross the *technology* chasm. The aforementioned challenges are the first two challenges for the start-up after seed funding has been received. The first step to reach "the masses", is that the technology needs to be demonstrated in a pilot project. Subsequently a venture needs to be able to develop on a large scale (R1B).

Markets – Identifying the right market

Within the markets category, it was found that these markets are often outside Israel due to the lack of large industries and the small population (and thus a small market) within the country (M1B/M2A). Therefore the way to connect to these markets is an important topic for the Israeli government, which for instance is shown by the government-led activities of WaTec, NewTech and the Fuel Choices Initiative (M1D). Also the personal networks of the entrepreneur and the investors in the venture are important tools to connect to the intended market (R3B). Finally, cleantech was identified to be mainly related to infrastructure, which is considered not a very good market for a start-up (M2C).

Resources – Lower technological risk of the venture by product development

The resources category was concerned with the second challenge – lowering technological risk via product development of a commercially viable product. Both human and financial resources are necessary for the venture to execute this task (R1C). Human resources can be categorized in technical skills and business/management skills (R1D), where a note has to be made that Israeli entrepreneurs often possess a combination of such skills which they acquired in specialized units of the army – see section 1.1. This is a strong point, because as Lazear (2004) has observed, an entrepreneur has to be a 'generalist' and 'a jack of all trades' (Lazear, 2004). Four out of the five business development experts have served within Special Forces units of the Israeli army. Technical skills are abundantly available in Israel (R2A), while it was argued that a lack of business/management skills was neither sufficient to explain the commercialization gap (R2B) nor could it be proven with this research design.

The empirical results – especially part two of the data collection - further showed that technology development is very costly for cleantech ventures (R2D). Generally spoken, the results of this research showed that the VC system in collaboration with the government gives opportunities for cleantech TBNVs to receive seed funding. However, it also shows that that seed funding (often $700k in Israel due to governmental programs) only covers for a small portion of the money needed for successful development of the technology to commercialize it.

The costs of this latter process are highly product dependent but are estimated to be far higher than the seed funding money. Thus, the cleantech TBNVs have a need for follow-up investment after the seed money investment. The financial resources to back this technology development need to be available in large quantities and be risk tolerant for technology development. It are these financial resources that are currently lacking within Israel. It is therefore a possibility that the Venture Capital model is not very suitable for the development of cleantech TBNVs that have a high capital need for technological development (R2C).

This problem of adequate finance for product development is most likely not unique to cleantech companies and also not unique to Israel. Availability of adequate finance would not unequivocally solve the commercialization gap – many other factors can influence the commercialization (adaptation) of technology (e.g. (Ortt & Delgoshaie, 2008)), but from the results of this research it can be concluded that adequate finance is the most pressing factor for the cleantech ventures in Israel.

Policy – Both stimulating and frustrating investments

Finally, the policy of the government itself was further scrutinized. It was shown how policy functions in both a stimulating and a frustrating way for cleantech innovation in Israel and was driven by geopolitical interests (P1A).

The relationship with its neighboring countries, the scarcity in natural resources and the abundance of sun and brainpower made that cleantech was a very high priority for Israel. The water industry grew out of this scarcity and the solar industry seemed to be a natural follow-up.

The findings of large gas fields appears to have shifted this trend, because the original ambitious plans for solar development and national green growth policies are now being carried out in light versions or not at all. This means that there is an unclear agenda on cleantech and a lack of specific and clear policy (P1C/P2B) – although the Israeli government denies this.

The stimulating of investments refers to the general innovation programs in Israel by the office of the Chief Scientist (P2A) and Horizon 2020 programs. These programs are successful in that they offer a way to attract investment.

Finally, Israeli bureaucracy can slow down the process, especially if there is a need for standardization of a process or if a claim has to go through multiple governmental departments (P2B).

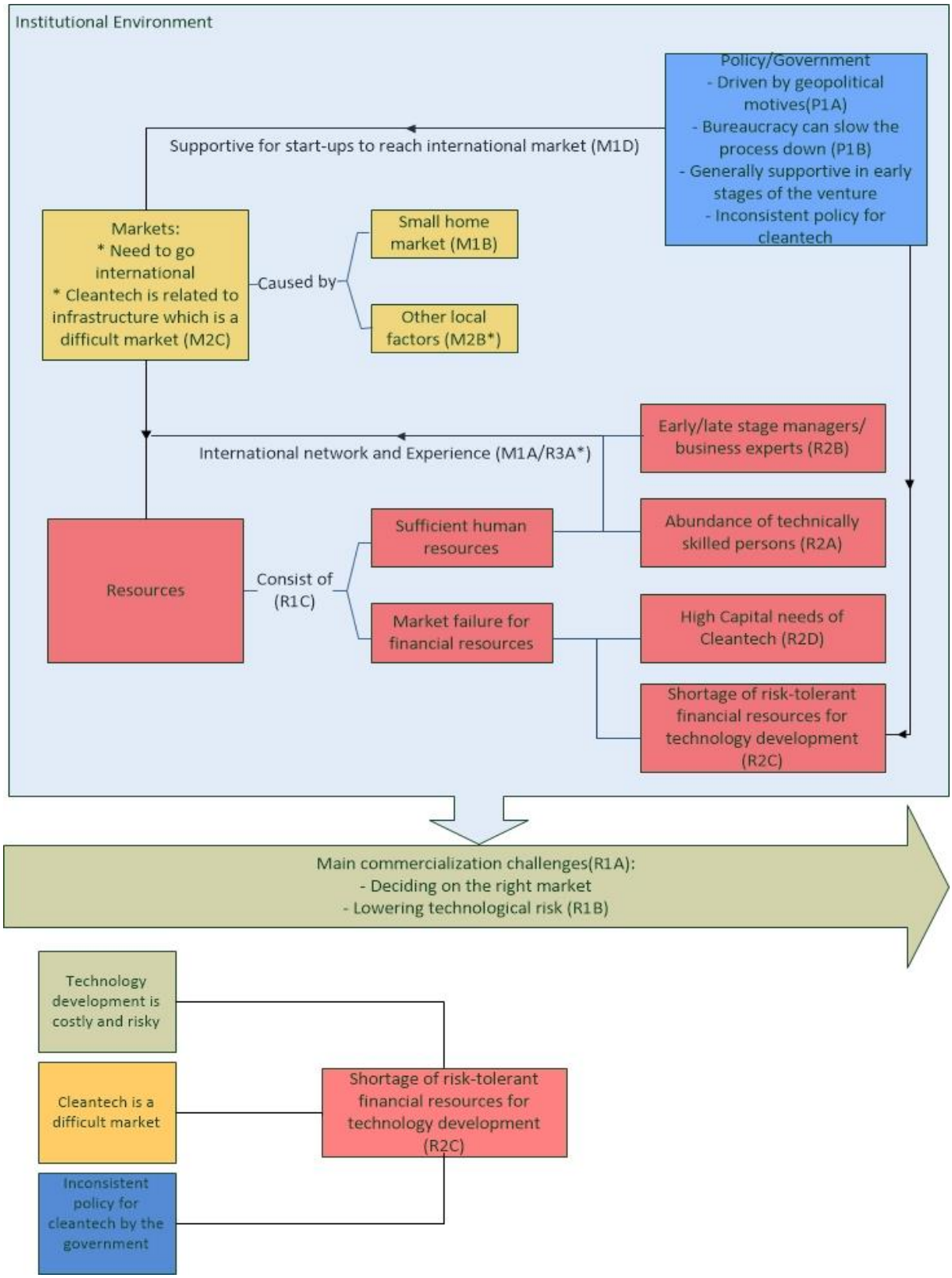

Figure 17 Visualization of the institutional parameters of this study that were found as result of the research. The blocks below highlight the findings of the second part of the data collection.

5.2 COMPARISON OF THE EMPIRICAL FRAMEWORK TO THE CONCEPTUAL MODEL

Figure 16 showed the main empirical findings, while Table 12-14 repeat the proposed factors from the conceptual model of this thesis and makes the comparison to the empirical framework. In this section, the comparison between these two results will be made.

5.2.1 INTERNAL CHALLENGES

The literature section of this study described the conceptual model of this study, wherein internal challenges for the TBNV play an important role. Several *stage based models* were introduced in which each phase can be characterized as an iterative process of development, with its own dominant problems (Kazanjian R. A., 1988). The dominant problems of the TBNV in the *conception and development phase* are the invention and the development of a product and/or a technology, the securing of adequate financial backing and the identification of market opportunities (Kazanjian & Drazin, 1989). This thesis merged the model of Kazanjian with the milestones approach of Block and Macmillan (1985) and proposed that important milestones in the conception and development phase include:

- Completion of Concept and Product Testing
- Completion of Prototype
- First Financing

It was described how this study focuses on cleantech TBNVs in Israel who just received seed funding and thereby passed the *credibility threshold* (Vohora, Wright, & Lockett, 2004). Thereby the assumption can be made that the entrepreneur has established sufficient credibility which does not withhold him to access and acquire key resources. At this point, this study proposes that there are three *internal challenges* that the cleantech (or any) TBNV has to focus on – acquiring resources, business development and technological development.

Acquiring resources

A key imperative for the company is to raise *sufficient* financial resources (seed money), which can be used to acquire other important resources (like human capital) and finance the technology development.

Business development

The liability of newness theory describes how incumbent organizations have a set of stable ties to those who use organizational services. New organizations like Cleantech TBNVs have to build these relations from the ground up and have two necessary adoption units who have to use their technology – the producer and the consumer (Stinchcombe, 1965). Statement M2C discussed that cleantech is often related to infrastructure, which fulfills a societal function (e.g. transportation, energy generation and distribution) and is not a very good market for a start-up.

Geels (2005) showed how societal functions are fulfilled by socio-technical systems which consist of a cluster of elements, including technology, regulation, user practices and markets, cultural meaning, infrastructure, maintenance networks and supply networks (Geels F. , 2005). Adoption units for many forms of clean technology are therefore seemingly endless and the business development challenge for Cleantech TBNVs might very well be how to fit in transitions between two socio-technical systems.

Companies in a high-growth industry will advance through the phases of growth at a higher pace than companies in low-growth industry (Greiner, 1998). Although clean technologies cannot be pinned down to one industry, if cleantech TBNVs are part of a socio-technical transition they are bound to the momentum

of this transition. This hypothesized aspect of cleantech TBNVs did not come forward as a major theme within this research although it can potentially be used to explain some of the outcomes.

Technology development

Technology development is an important topic which was explained by introducing the Technology Readiness Levels. Block and Macmillan assume that a prototype has been finished at the point of receiving initial financial support (Block & Macmillan, 1985). The empirical results of this study showed a different reality in Israel, where the initial financial resources (seed funding) were used to develop a prototype. Statement **R1A** explained how technology development is crucial to lower the technological risk of the venture, which makes it possible to attract other sources of finance. Development of a prototype was indeed one of the milestones, others being demonstration in a pilot project and to gain production capabilities on a large scale (**R1B**).

5.2.2 MARKETS

Three factors about markets were discussed in the conceptual model. Israeli TBNVs are being labeled as 'born-globals' and have the necessity to go to international markets right from the conception of the firm (Almor T. , 2013). *The accessibility of international markets* (F_M1) is thus important for Israeli cleantech TBNVs. Financing of technology-based, born-global companies is frequently carried out through external capital, for instance via venture capital or private investments. Therefore these companies need to continue to grow in order to remain attractive to investors. Hence the second factor – *the need for high-paced growth (F_M2)*. Technology driven companies need to stay in close contact with their customers for two reasons – protect their proprietary know-how and to receive feedback regarding their technology via the process of distribution and after-sale services (Hirsch, 1989). An international network (F_M3) is considered the tool to obtain and maintain this close contact. Each of the factors is discussed below and an overview of this discussion can be found in table 12.

Table 12 Overview of the factors from the conceptual model and the corresponding statements from the empirical framework which discuss it for Markets. The bold statements are statements that are well supported statements by the respondents in part one of the data collection and the italic statements are statements were found to be supported by the second part of the data collection.

Code	*Factor from conceptual model*	*Statement from empirical framework*
F_M1	Accessibility of International markets	**M1B** – The israeli market is too small *M1D* – Connecting to customers is actively supported by Israeli government
F_M2	The need for high paced growth	*M2C* – Cleantech as an infrastructure business VC quote of p.40
F_M3	The need for an international network	**M1A** – Identify the right market **M1B** – The israeli market is too small **M1C** – Preferably direct interaction with the target market *M1D* – See F_M1 **R3B** – Venture capitalists can offer options for the company via their network.

F_M1 & F_M3 - Accessibility of international markets and the need for an international network.

Israel is indeed a market that is too small for cleantech TBNVs which have to behave as born-globals and focus directly on international markets (**M1B**). The factor *F_M1 – Accessibility of international markets* is

therefore important, and this importance is acknowledged by actors in Israeli society. For instance, the Israeli government actively supports the connection of TBNVs to customers by organizing international conferences or creating Israeli innovation hotspots at foreign international conferences (M1D; additional data in section 4.4.2).

Connecting to these markets needs to happen via the international network of the TBNV. This network serves multiple purposes, it is important to identify the right market (M1A) and it is preferable to have direct interaction with the target market (M1C), to receive feedback about the market opportunities, as the argument of Hirsch predicted. Ways to reach the customers in these markets goes via the international network of the entrepreneur and the investor (R3B), while the government gives a platform to develop these networks (M1D).

F_M2 – The need for high-paced growth.

If born-globals are financed by external equity-based capital there is indeed a need for high-paced growth. In the business development section of 5.2.1 it was explained that high-paced growth is a real challenge for cleantech TBNVs. The business development challenge for cleantech TBNVs might very well be how to fit in transitions between two socio-technical systems. The quote from the entrepreneur of p.40 is self-explanatory.

"For us, a cleantech company, 100% growth is amazing. For the Venture Capitalist [not specialized in Cleantech], 1000% growth is amazing. "

This limits the options for obtaining financial resources to the investors who have realistic growth expectations of the cleantech TBNVs. In section 4.4.1 the argument was made though that the main driver of investors are financial gains. This means that if the cleantech TBNV can only grow at a slow rate, it has to grow to a large market to be interesting for an investor. See also the next section on financial resources.

5.2.3 Resources

Four factors related to resources were discussed in the conceptual model. Obstacles to growth can be perceived as poor or non-availability of key resources at the time spin-offs need these resources. Obstacles may include shortage in management skills, shortage in market knowledge and marketing skills to access the market, and financial obstacles such as lack of cash flow and lack of investment capital (van Geenhuizen & Soetanto, 2009; van Geenhuizen & Soetanto, 2004). The first two factors are therefore defined as the availability of financial (F_R1) and human (F_R2) resources.

The challenge for sustainability transitions is to mobilize large sums of money. The availability of these types of finance is shaped by economic conditions, financial regulations, and investor confidence (Geels F. W., 2013). The challenges within every phase of the TBNV development represent a certain amount of capital requirements and uncertainty which can be combined to estimate the risk of investing in the TBNV (PBL, 2015). Every investor has a certain tolerance for the amount of risk of the technology that can be invested in (Frankfurt School-UNEP Centre/BNEF, 2014; EIM & Oxford Research, 2011). The third resources factor is risk tolerance of available financial resources (F_R3). It was also hypothesized that eco-innovations are harder to finance because not all their positive externalities (e.g. CO_2-reductions) are included in the price of the benefits of innovation. Therefore, eco-innovation is unevenly competing with generic innovation. Cleantech ventures have a high capital intensity (€20-50M, (SER, 2013)) and have a longer return on investment time

(seven to ten years, (SER, 2013)). Another problem is the lack of knowledge from investors about the cleantech sector, which in itself can be explained by the heterogeneity of the sector. Cleantech is an umbrella term with many sub-sectors below it (EIM & Oxford Research, 2011). The last factor is therefore also related to the availability of financial resources - Competition for financial resources with other fields of technology (**F_R4**).

The necessary resources for cleantech TBNVs in this study were indeed identified in human and financial resources (**R1C**), whereas the latter was identified to be the more important factor. The availability of human resources will be discussed first before the financial resources are compared.

Table 13 Overview of the factors from the conceptual model and the corresponding statements from the empirical framework which discuss it for resources. The bold statements are statements that are well supported statements by the respondents in part one of the data collection and the italic statements are statements were found to be supported by the second part of the data collection.

Code	*Factor from conceptual model*	*Statement from empirical framework*
F_R1	Availability of Financial Resources	**R1C** – Necessary resources are case-dependent, but can be classified in human and financial resources ***R2C*** – Enough financial resources available in Israel, but see F_R3
F_R2	Availability of Human Resources	**R1C** – see F_R1 R1D – the venture has a need for technologically skilled employees for prototype development and business skilled employees for business development. **R1E** – Business skilled employees need to have particular knowledge of the specific target market **R2A** – Technological employees are abundantly available **R2B** – Early stage managers are available, late stage unsure. Uncertain which role this plays[29].
F_R3	Risk tolerance of available financial resources	***R2C*** – The amount of financial resources in Israel that is willing to invest to remove technological risk is too small to cover the need.
F_R4	Competition for financial resources with other fields of technology	*R2D* – The needs for financial resources of cleantech start-ups are much higher than the majority of start-ups in Israel which are IT-based.

F_R1, F_R3 & F_R4 – Availability and risk tolerance of financial resources and competition for financial resources

The availability of financial resources (**F_R1**) in general is abundant (**R2C**). Israel and in particular Tel Aviv are well-known start-up ecosystems which naturally attract Venture Capitalists (VCs) and other investors. Investor confidence is one of the factors Geels mentions for large sums of money to be mobilized (Geels F. W., 2013). Investor confidence reflects in the risk tolerance of financial resources (**F_R3**) and the competition for financial resources with other fields of technology (**F_R4**)[30] and it were these two factors that can explain

[29] The argument here is not that entrepreneurial management is not an issue, but it probably is not the missing piece within the resources that are needed for the cleantech start-up that has received seed funding.

[30] The assumption is that the investor will invest in the financially most attractive option (see 4.4.1) – this might be a small oversimplification because Venture Capitalists invest with the money of incumbent companies (limited partners)

the commercialization gap in the best way. The second part of statement **R2C** says that the VC financing model is not suitable for the financing of cleantech TBNVs. F_R3 and F_R4 can be used to explain this flaw.

Technology development is a very important process for the cleantech TBNV that is very costly (**R2D**; (SER, 2013; EIM & Oxford Research, 2011) SER estimates commercialization costs for eco-innovation to be between €20M-€50M, estimates that were shared by the entrepreneurs that were interviewed for section 4.4.1.

Only a few sorts of investors are willing to invest in TBNVs that have not developed their technology beyond a pilot project. These investors are the government, business angels and early stage venture capitalists (EIM & Oxford Research, 2011). The government programs are helpful but insufficient because they do not bear enough financial resources (see sections 4.4.2, 5.1 and 5.2.4), while business angels and early stage venture capitalists also cannot provide the amount of financial resources that are necessary for the cleantech TBNVs of Israel. Researchers in Israel from the Samuel Neaman institute found similar results for Israel and also in the Netherlands the *Planbureau voor de Leefomgeving* found similar results about the risk tolerance of available financial resources (**F_R3**) and the mismatch between the amount of financial capital needed for technology development and the availability of this capital (Fortuna, Freund-Koren, Liebes, & Raveh, 2014; PBL, 2015). Researchers from Utrecht University found in a study in the Netherlands that there is a need for an increase in financing sources that can finance technology development and are thus tolerant for technology risk, while also arguing that business angles are the most likely source of financial capital for this kind of investment (Altena, Tuinenburg, Eveleens, & van Rijnsoever, 2014).

Moreover, many Israeli TBNVs are active in the Information and Communication Technology industry which have significantly lower technology development costs. Such TBNVs are more compatible with the VC model and are more interesting to invest in (**R2D**).

F_R2 - Availability of Human Resources

Human resources can be characterized in technologically and business skilled employees (**R1D**). Comparable to the internal challenges discussed in section 5.2.1, the technologically skilled employees are necessary to develop the technology and the business skilled employees are necessary for business development. Although the entrepreneur has to be a 'jack of all trades' (Lazear, 2004), the respondents in this thesis still articulated a need for employees with highly case dependent skills. Technical skills are abundantly available in Israel (**R2A**), while it was argued that a lack of business/management skills was neither sufficient to explain the commercialization gap (**R2B**) nor can it be shown with this research design.

5.2.4 Policy

Sustainable innovations are often developed in sheltered niches created by the government (Geels F. W., 2013). When the take-off or commercialization phase begins they face multi-dimensional struggles with incumbent regimes. The amount of stimulation of the formal institutional regime for new innovations in general is therefore considered as a factor. Because formal institutions (North, 1990) have been adopted to the needs of incumbent actors (Walker, 2000), the odds are often stacked against niche-innovations regarding policy. Such reflects in the 'mismatch' with existing institutions (Freeman & Perez, 1988) that

who have a certain strategic interest for the technology to be developed. This is especially the case for strategic venture capital funds with one limited partner, its mother company.

niche innovations face. Institutions are a broad concept, and for this research it was chosen to research how current policy in Israel stimulates innovation (**F_P1**).

The current financial system does not value the non-monetary rewards of cleantech (like CO_2-reductions) and without governmental intervention, many clean innovations will not be able to leave their sheltered niches (EIM & Oxford Research, 2011). The formal institutional regime for new sustainable innovations (Cleantech) was the second factor (**F_P2**), where policy is the main topic of interest.

A strong role for the government does not have to be a positive impact on the development of cleantech innovation. The role of policy within the cleantech environment is a double-edged sword – on the one end it can stimulate much needed investment within the cleantech sector but on the other end it creates a dependency on government intervention, which investors consider too risky (EIM & Oxford Research, 2011). The third factor is the perceived stability of the governmental policy by investors (**F_P3**).

Table 14 Overview of the factors from the conceptual model and the corresponding statements from the empirical framework which discuss it for policy. The bold statements are statements that are well supported statements by the respondents in part one of the data collection and the italic statements are statements were found to be supported by the second part of the data collection.

Code	*Factor from conceptual model*	*Statement from empirical framework*
F_P1	The formal institutional regime for new innovations	**P1B** – Israeli bureaucracy can slow down new ventures **P2A** – Government has several successful innovation programs to (financially) support new ventures.
F_P2	The formal institutional regime for new sustainable innovations	**P1A** – Geopolitical reasons can motivate the government to create a buzz surrounding resources like solar or gas. *P1C* – The policy that is relevant for cleantech ventures is vague and ineffective *P2B* – The agenda of the government shifts away from support for sustainable innovations
F_P3	Perceived stability of the governmental policy by investors	**P2A** – The innovation programs collaborate with investors is part of their success. *P2B* – The shift in agenda, especially the solar policy example, makes the perceived stability of the governmental policy low.

The formal institutional regime for new innovations

The formal institutional regime for new innovations was studied in the second part of the data collection and described the very successful seed money investment policy by the government. Also the Fuel Choices initiative falls under this category (**P2A**). Less of a topic during the research, but mentioned several times throughout the thesis, is the obligatory army conscription which has a positive impact because it teaches management and technological skills to the population at a young age. Negative influences came from the Israeli bureaucracy (**P1B**) which can slow down new ventures significantly if there is a need for a permit to start building for example. In general though, the formal institutional regime for new innovations was, unsurprisingly, well organized in a country that is nicknamed as Start-up Nation.

The formal institutional regime for new sustainable innovations and perceived stability of the governmental policy by investors

The relationship with its neighboring countries, the scarcity in natural resources and the abundance of sun and brainpower turned cleantech into a high priority for Israel. Such geopolitical reasons can motivate the

Israeli government to create a 'buzz' surrounding a certain technological field which is necessary for the development of the state of Israel (P2A). The defense industry plays a large role in this too.

The Israeli water industry grew out of the natural water scarcity in Israel and the solar industry seemed to be a natural follow-up. The findings of large gas fields appears to have shifted this trend, because the original ambitious plans for solar development and national green growth policies are now being carried out in light versions or not at all. This means that there is an unclear agenda on cleantech and a lack of specific and clear policy (P1C/P2B) – although the Israeli government denies this. Investors have a need for stable policy though and the unstable policy surrounding cleantech can be expected to off-set investors, although this was not explicitly stated. Only three (out of 45, IVC-online) VCs in Israel specialize in cleantech though, which appears to be evidence for this statement too.

6 CONCLUSION

In the final chapter of this thesis the main findings are discussed and their implications are presented. Recommendations for future research are written and a reflection on the research process is given.

6.1 MAIN FINDINGS

In chapter 1 the problem of the commercialization gap for clean technologies in Israel was introduced. It was explained that data showed the manifestation of cleantech innovation in the country but that this innovation does not commercialize. The purpose of this study was to explain this gap between innovation and commercialized technology by looking at external factors in Israel that influence cleantech start-ups. Based on that observation the following main research question is proposed:

Which factors, outside the influence of cleantech TBNVs, have consequences for the progression of cleantech TBNVs to the sustainable returns phase after seed funding has been received?

External factors are defined as factors that the entrepreneur has limited or zero influence on. The fairly specific point of 'after they have received seed funding' in the development of the cleantech Technology Based New Ventures (TBNVs) was chosen to allow the researcher to look at external factors that influence the development of these TBNVs. The answer to the main research question can only be provided after the sub-questions supporting the main research question have been answered. These sub-questions are answered below.

1. How do cleantech TBNVs progress after seed funding has been obtained to the sustainable returns phase?

To determine which external factors are relevant for the development of cleantech TBNVs the internal challenges of these cleantech TBNVs are described first. "Internal challenges" basically refers to the "To-Do-List" after the TBNV has received seed funding. Based upon literature research, three large projects are identified to be on this "To-Do-List".

Technology development refers to the development of the technology of the TBNV. This process was explained by the concept of technology readiness levels (TRLs). It was determined that seed funding is often used to develop a prototype, around TRL 4 or 5 (out of 9). Other milestones in technology development are the demonstration of the technology in a pilot project (TRL 7) and to gain production capabilities on a large scale. Technology development is crucial to lower the *technological risk* of the venture, which makes it possible to attract other sources of finance.

Business development describes the task of identifying the right market for the TBNV and contacting this market. The liability of newness theory describes how incumbent organizations have a set of stable ties to those who use organizational services. New organizations like Cleantech TBNVs have to build these relations from the ground up and are required to have two necessary adoption units who must use their technology – the producer and the consumer. It was discussed that cleantech is often related to infrastructure, which fulfills a societal function (e.g. transportation, energy generation and distribution) and is not a very good market for a start-up because transitions in societal functions happen slowly and the growth rate of new ventures is related to the industry they belong to.

Acquiring resources refers to the acquisition of resources to develop the two aforementioned projects. Such resources can be divided into human and financial resources, whereas human resources can be divided into technologically skilled and business skilled employees.

2. What are the external factors in Israel that influence the progress which cleantech TBNVs within Israel have to make after these TBNVs have obtained seed funding?

The three aforementioned internal challenges served as guidance during the literature review which was performed to answer this sub-question. Ten external factors divided in three categories are identified which, together with the internal challenges, served as a conceptual framework for this study.

2.1 Which external factors related to markets are described in the literature that influence growth of (cleantech) technology-based new ventures?

Three factors about markets are discussed in the conceptual model. Israeli TBNVs are labeled as 'born-globals', which means they have the necessity to go to international markets right from the conception of the firm due to the limited size of the market in Israel. *The accessibility of international markets* (F_M1) is therefore an important factor for Israeli cleantech TBNVs. Financing of technology-based, born-global companies is frequently carried out through external capital, for instance via venture capital or private investments. Cleantech TBNVs need to continue growing in order to remain attractive to investors. Hence the second factor – *the need for high-paced growth (*F_M2*)*. Finally, technology driven companies need to stay in close contact with their customers for two reasons – in order to protect their proprietary know-how and to receive feedback regarding their technology. *An international network* (F_M3) is considered the tool to obtain and maintain this close contact.

2.2 Which external factors related to resources are described in the literature that influence growth of (cleantech) technology-based new ventures?

Four factors related to resources were discussed in the conceptual model. Obstacles to growth can be perceived as poor or non-availability of key resources at the time spin-offs need these resources. The first two factors are therefore defined as the availability of *financial* (F_R1) and *human* (F_R2) *resources*. The advancements in the internal challenges within every phase of the TBNV development represent a certain amount of capital requirements and uncertainty. These two elements can be combined to estimate the risk of investing in the TBNV. Every investor has a certain tolerance for the amount of technology risk that can be invested in so the third resources factor was identified as *risk tolerance of available financial resources* (F_R3). It was also hypothesized that eco-innovations are harder to finance because not all their positive externalities (e.g. CO_2-reductions) are included in the price of the benefits of innovation. Therefore, eco-innovation is unevenly competing with generic innovation. Cleantech ventures have a high capital intensity and have a long return on investment time. Another problem is the lack of knowledge from investors about the cleantech sector, which in itself can be explained by the heterogeneity of the sector. The last factor is therefore also related to the availability of financial resources - *Competition for financial resources with other fields of technology* (F_R4).

2.3 Which external factors related to policy are described in the literature that influence growth of (cleantech) technology based new ventures?

Sustainable innovations are often developed in sheltered niches created by the government. When the take-off or commercialization phase begins they face conflicts with the incumbent regimes which are stacked against them in multiple dimensions. The amount of stimulation of the formal institutional regime for new innovations in general is therefore considered as a factor. Institutions are a broad concept, and for this thesis it was chosen to research how current policy in Israel stimulates innovation (F_P1).

Without governmental intervention, many sustainable innovations will not be able to leave their sheltered niches. The formal institutional regime for new sustainable innovations (Cleantech) was the second factor (F_P2), in which policy is again the main topic of interest.

A strong role for the government does not have to be a positive impact on the development of cleantech innovation. The role of policy within the cleantech environment is a double-edged sword – on the one end it can stimulate much needed investment within the cleantech sector but on the other end it creates a dependency on government intervention, which investors consider too risky. The third factor is the perceived stability of the governmental policy by investors (F_P3).

3. Which of the external factors can be found to influence the cleantech TBNVs within Israel?

During the data collection that consisted of two rounds, it was researched to which extent these factors influence the development of the cleantech TBNVs after they have received seed funding. The first round of data collection consisted of ten interviews with experts from different fields surrounding cleantech – business development experts (often former entrepreneurs), late stage finance experts, policy experts and researchers and venture capitalists. From this round of data collection it could be concluded that all ten factors played a role to some extent (to which extent is described extensively in chapter 5), but that the availability of financial resources and its related factors held the most meaningful explanation for the commercialization gap. Furthermore, some haze remained concerning the role of the Israeli innovation policy and these two topics were discussed in the secondary data collection.

The secondary data collection consisted of four more interviews and the research of several reports on the topic. Combined, these sources provided a clearer image of the situation on financial resources and innovation policy.

The situation with financial resources

The factors that were identified surrounding financial resources included the availability, the risk tolerance and the competition for financial resources. To discuss the availability of financial resources, it is first necessary to determine what the financial resources will be used for by the cleantech TBNVs.

Earlier, technology development was introduced as an important internal challenge for cleantech TBNVs. Secondary sources and interviews with cleantech entrepreneurs from both rounds of data collection highlighted that technology development is often a very expensive project for cleantech start-ups. Most of the financial resources a cleantech TBNV obtains would flow to this development. Other internal challenges were identified as business development and acquiring resources.

The business development internal challenge prompted the researcher to look into the market prospects of cleantech TBNVs. The empirical results showed that many of the respondents thought that cleantech was indeed related to infrastructure – although this is not an overall rule -, which is seen as a tough market for a start-up. The need for high paced growth is a factor that can be expected to be difficult for cleantech start-ups.

Acquiring the resources to finance these two challenges will therefore prove difficult as well. Respondents explained how only several investors (business angels, early stage venture capitalists and the government) are willing to invest in TBNVs who still bear technology risk. The quantities of money that such investors are willing to invest to finance the development do not match the quantity that cleantech TBNVs need to develop their technology.

As long as the TBNV still bears technology risk, the *availability of financial resources* is limited. To *remove* the technology risk, the TBNV needs a lot of financial resources though. This mismatch in needs for financial resources that can finance technology development and availability of financial resources that can finance

technology development is the main explanation for the commercialization gap in Israel according to this study. This explanation fits in the results of other research that was executed by Israeli researchers.

The situation with innovation policy (for cleantech)

The other topic that was investigated and which to some extent influences the first topic, is the innovation policy in Israel in general and the innovation policy for cleantech. The first topic, innovation policy in Israel in general, was found to be successfully contributing to the high level of start-ups in Israel in all sorts of industries (although particularly in the ICT industry). This topic is covered more extensively in section 5.2.4.

Cleantech TBNVs benefit from the general innovation policy and the main strong points of this policy (variety of investment stimulating policies). Geopolitical reasons (like the relationship with its neighboring countries and the scarcity in natural resources in Israel) can motivate the Israeli government to create a 'buzz' surrounding a certain technological field which is necessary for the development of the state of Israel. The defense industry plays a large role in this too.

The Israeli water industry grew out of the natural water scarcity in Israel and the solar industry seemed to be a natural follow-up. However, the finding of large gas fields appears to have shifted this trend, because the original ambitious plans for solar development and national green growth policies are now being carried out in light versions or not at all. This means that there is an unclear agenda on cleantech and a lack of specific and clear policy – although the Israeli government denies this. The perceived stability of the governmental policy by investors can be expected to offset investors, although this was not explicitly stated by the interviewed investors.

Having answered the sub-questions, an answer to the main research question can be formulated:

Which factors, outside the influence of cleantech TBNVs, have consequences for the progression of cleantech TBNVs to the sustainable returns phase after seed funding has been received?

External factors from the literature that were found to be of influence on the cleantech TBNVs in Israel include *accessibility of international markets, the need for high-paced growth, an international network, financial* and *human resources, risk tolerance of available financial resources*, *competition for financial resources with other fields of technology, the formal institutional regime for new innovations, the formal institutional regime for new sustainable innovations* and *perceived stability of the governmental policy by investors.* Empirical research showed that all of these factors can be found in practice as well, although the influence of some factors is more explicit than that of others.

The results from this research suggest that the availability of financial resources is the most influential on the ability for cleantech TBNVs to generate sustainable returns. This can be explained by the high needs for financial resources by cleantech TBNVs to finance technological development which is considered an investment that bears a lot of risk and most investors in Israel are not willing to deal with this amount of risk. Moreover, many cleantech TBNVs develop technologies related to the field of infrastructure which is a tough market for a start-up. Finally, the lack of clear policy relevant for cleantech TBNVs can be expected to offset investors, which also contributes to the lower amount of available financial resources.

6.2 IMPLICATIONS

6.2.1 PRACTICAL IMPLICATIONS

The empirical evidence presented in this research points towards a specific challenge for governments and cleantech entrepreneurs. The factors representing the situation with the financial resources were to a large extent based upon previous empirical research in Europe. Developing new technology is a costly process and momentarily there are not enough financial resources available in both Israel and Europe which can finance this technological development.

Entrepreneurs and investors in this field should realize themselves that they are in a precarious position due to factors like the high costs of technology development and instable policy that heighten the already high amounts of uncertainty that is currently surrounding the process of cleantech TBNV development. Risk reduction strategies should be high on the priority list of these actors.

Empirical results from the European study on finance for eco-innovation show that 48% of cleantech TBNVs in Europe use debt financing to finance their growth (EIM & Oxford Research, 2011), a possibility that was only available for Israeli cleantech TBNVs if they successfully remove their technology risk. Two recommendations can be made to the Israeli government which can be interesting to some extent for European governments too.

First of all, investors make investments with a five to ten year horizon and regulatory stability is therefore an important factor to take into account to increase investments. Especially the case which described the instability of the solar sector in Israel is an example of an increase in investment insecurity by governmental decisions.

Second of all, after cleantech TBNVs have received seed finance, their capital needs could still be enormous. Although cleantech TBNVs differentiate in their exact capital needs, the financial resources necessary for most of them are momentarily simply not available. The Venture Capital investment model is only suitable for those start-ups that can achieve high growth rates, which can be difficult for cleantech start-ups. Making different financial resources available tailored to the needs of cleantech TBNVs, for instance via debt financing instead of equity financing could be an interesting job for the government. The Israeli government could reflect whether the Office of the Chief Scientist grants in collaboration with Venture Capitalists are effective in every innovation area. For areas which have lower growth expectations (like cleantech) it might be useful to design a (additional) program which facilitates debt financing. The reason for this is the high growth expectation that comes with equity financing. See also section 6.3.1.

6.2.2 SCIENTIFIC IMPLICATIONS

The aim of this study was to identify factors that are outside the influence of the entrepreneur and verifying to which extent there is empirical support for these factors. Previous literature studies have shown that critical success factors for New Product Development are dependent on the context of the process which was showed in this research as well. Specifically, the high degree of innovativeness and technology of cleantech (Balachandra & Friar, 1997) in combination with the challenging adoption units (Stinchcombe, 1965) that cleantech start-ups face served as context to identify the explaining factors for the commercialization gap. A final theory that gave the necessary context was the born global theory (Almor T. , 2013) which explained how Israeli TBNVs have a need for high growth due to their limited home market and their financing structure.

The conceptual model that was developed with the aid of these theories was helpful to explore the context of the research problem at hand and to identify problems in the development of cleantech TBNVs that prevent them to progress to the sustainable returns stage. Scientifically, this study contributes evidence to the validity of these theories in a specific setting – namely development of cleantech TBNVs in Israel

6.3 RECOMMENDATIONS FOR FUTURE RESEARCH

This section contains the recommendations for future research and a reflection upon the research process by the researcher. Learning points for the Embassy of the Netherlands and the Dutch government have also been presented to the embassy in a separate document in Dutch.

6.3.1 POTENTIAL SOURCES OF ADEQUATE FINANCE

The main conclusions of this research pointed at the lack of available financial resources for the technology development of Israeli cleantech TBNVs. Future research could evaluate how these resources could be made available anyway. Some suggestions to include in such research are mentioned below

A factor that has only briefly been touched upon by this research are the financing possibilities by strategic partners like large corporate companies or the army. Such a strategic partner would invest in specific technologies that fit their strategic agenda. It was shown that the defense industry in Israel has an interest in renewable energy through their limited partnership in one venture capitalist. The interview with a representative from a corporate company involved in strategic investments (LSF2) implied that they would consider investing in Israeli cleantech for both strategic and financial reasons.

The research from the Samuel Neaman Institute came with a solution of a large cleantech oriented, government led fund wherein the government, institutional investors (pension funds, banks) and (inter)national corporates could invest. The objectives of such a fund would be to finance the first commercial installations and the international aspirations of the company.

6.3.2 GENERALIZABILITY OF THE FACTORS

The factors studied in this research are based upon a literature study and empirically validated research. It can be expected that these serve as a good framework to explore this particular problem in other countries in which cleantech TBNVs have to behave like born-globals. The unique geopolitical situation of Israel did not influence the conceptual model to such an extent that it is not generalizable to other countries. This situation mainly reflected in the policy of Israel and these factors were articulated in a very minimalistic way (“The formal institutional regime for new (sustainable) innovations”)

6.3.3 REFLECTION UPON RESEARCH PROCESS

Problem statement and Theory

In retrospect the scope of the problem statement was too broad for the time designated to this research project and a more narrow statement could have resulted in a more accurate research process. The researcher tried to establish a theory that could explain the commercialization gap in Israel. To achieve this, two key assumptions had to be made in which the framework can stand its ground. The main assumptions in this research are that the entrepreneur cannot influence the described factors and the assumption that cleantech TBNVs are capable of extracting resources from their environment.

It is challenging to determine to which extent the first assumption can uphold outside this framework because to some extent the entrepreneur has influence on every factor by choosing his business model

wisely. If the entrepreneur knows that there are laws that forbid the implementation of his product, why would he start developing it in the first place? Despite this weakness, this assumption also allowed the researcher to look at the problem from a perspective that is not often taken. Nevertheless, the definition remains slightly vague and this vagueness in combination with the lack of known context in Israel made it especially challenging to define a suitable framework.

The second assumption might be oversimplified, because there is an interplay between the availability of resources and the status of the start-up. In the case of cleantech the status of the start-up is that it often tries to increase the sustainability of a process which fulfills a societal function – for instance energy generation. As Geels (2005) explained, there is much more necessary to change such a societal function than just the successful development of technology. Thereby the possibilities of fulfilling already challenging task of cleantech TBNVs to grow are slightly withered by the very nature of cleantech.

Despite these criticisms it was necessary to make these assumptions to be able to execute the research which has generated interesting results which could not have been retrieved in another way. Also, the two assumptions did probably not significantly influence the conclusions of this research.

Although the entrepreneur can indeed slightly steer the 'factors outside his influence' by choosing his business model wisely when he starts to develop his company, this flexibility is almost nonexistent for technology that has been developed by academics for instance. Therefore the development of such technologies will be influenced by factors beyond the influence of the entrepreneur, in a framework similar to the one proposed by this study but subjective to contextual changes. Such a statement contributes to some extent to the classic debate between determinism and constructivism and the Social Constructivism of Technology (SCOT) literature (e.g. (Rip, 1995)).

For the second assumption on the capability of entrepreneurs to extract resources from their environment is also valid that it did not significantly influence the conclusions of this research. The main implication it had was that the research was steered away from researching internal factors that could explain the commercialization gap. Hypothetical examples of such factors that could not come up within this research setting could be that Israeli entrepreneurs have a habit to evaluate their work often and are unwilling to engage in the high risks posed by cleantech entrepreneurship or that care for climate change is not a motivator within Israeli entrepreneurs.

Research Process and Results

The interviews were set up in a structured way although they turned out to be less structured in practice. However, due to the challenges with establishing a suitable and complete framework this lack of structure in the interviews is potentially a good aspect of the study. With this setup, the statements give a broad picture of the observed reality in Israel which allowed the researcher to dive deeper into specific topics which could explain the commercialization gap. Moreover, the conceptual model and the empirical framework were not connected very tightly in this setup which allowed the researcher to adjust the conceptual model and re-evaluate the way it reflects in the empirical framework.

The observed difficulties with financial resources were now only observed in a qualitative way via interviews and research reports, but should in future research also be validated with data on investments in Israel to be able to quantify the results. Due to time constraints it was not unfortunately not possible to gather

quantitative data on the topic of availability of financial data. If future studies try to quantify these results it would be recommended to read the final interview of this report (p.49) with a venture capitalist who is only distantly connected to the cleantech industry. His notions on the 'optimal filter' are interesting to determine in future research.

Finally it was not possible to differentiate the factors in matter of importance (e.g. F_M2 has more influence on the development of cleantech start-ups than F_M1) via this way of data gathering. The broad approach in combination with limited interviews (14) had the implication that factors could be identified, but not ranked in terms of importance. The interviews served an exploring function and it was only after the analysis of the first ten interviews that certain factors appeared to be more important than others. It has for instance been argued that it is very unlikely that the availability of human resources is probably not an explaining factor for the commercialization gap in Israel, but this does not mean that it is not an important factor in general. It is also difficult to say whether this factor is considered more important than for instance the need for an international network. The only distinction which has been made is the singling out of the financial resources and policy because the mechanisms at play for these factors remained rather vague from the initial round of interviews.

Despite these limitations, the research process allowed the researcher to obtain a detailed understanding of cleantech within Israel. The limited amount of respondents and interviews did not per se limit this research for two reasons. The first reason is the reliability criterion that was used in evaluating the statements. It turned out that this was a great tool to filter the need for further research into specific topics, because it appears to be a valid method to determine whether a topic is controversial. If three respondents in the same field but from different professions make a similar statement about a topic without knowing each other, this is good evidence that the statement is actually true. Secondly, by operating from the Dutch embassy in Tel Aviv, it was relatively easy to gain access to key actors in the Israeli cleantech ecosystem due to the reputation and the vast network of the embassy. Such a network proofs to be a true asset while conducting research in a foreign country unknown to the researcher. Nevertheless, more respondents would have given the research more reliability. A larger set of respondents could also increase the possibility to differentiate the factors in matter of importance.

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8 APPENDIX

8.1 APPENDIX I – INTERVIEW QUESTIONS AND BACKGROUND INFORMATION DATA COLLECTION PART I

Resources

1. Which resources does an Israeli cleantech start-up need after it has obtained seed finance?

- *Are factors like lack of marketing knowledge, sales skills and a customer base a problem for Israeli cleantech start-ups?*
- *Cash flow and knowledge problems are the largest problems for technology based start-ups. Acquiring the right management skills becomes more important over time.*
- *Rapid international expansion is needed to establish global niche. Two necessary resources: financing and international network.*

2. Which resources needed for the development of cleantech start-ups are abundant and which are scarce? How do the entrepreneurs access them?

- *Role network, role VC & Incubator.*
- *Eco-innovations have a capital intensity that is in general higher than with generic innovation and longer return on investment time. They are susceptible to the same financial constraints by private financing though. Therefore, above average returns and growth expectations are necessary for eco-innovation start-ups.*

3. How capable are entrepreneurs in accessing resources after they have obtained seed finance?

- *Role network, role VC & Incubator.*

Markets

1. On which customer segments are Israel cleantech start-ups focusing? How can they be reached? How do they connect with these customers?

2. To expand the company, do cleantech companies focus on international expansion, product differentiation, or on early exits? Why are certain choices made?

- *In which phase does this play a role?*

Policy

1. Does the Israeli government interfere to transform the added societal value from cleantech start-ups in to monetary value?

- Eco-innovations are harder to finance because positive externalities like CO2-reductions are not included in the price of the benefits of innovation. Therefore, eco-innovation is unevenly competing with generic innovation.

2. Is there a clear policy from the Israel government that reduces uncertainty for investors in eco-innovations? – How does the Initiative do this?

- *Due to the large role of the government in eco-innovation, the profitability of eco-innovations are partially determined by governmental interventions. This gives uncertainty to investors if governmental policy is unpredictable for the coming years*

8.2 APPENDIX II – INTERVIEW QUESTIONS DATA COLLECTION PART II

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Code	Specialism	Years of Experience (Experience in cleantech)	Management experience
EX1	Energy Storage	24 (3)	Yes
EX2	Energy sector Research	7 (3)	Yes
EX3	Strategic Consultancy & Expert on funding for SMEs	14 (~9)	Yes
EX4	Agro and Food VC	18 (~8)	Yes

EX1 – Energy storage

1. Could you explain a little bit on your story? I've looked at your website and linkedin profile. I understand that you are a seasoned CEO and that *[Company name]* has a new way of energy storage focused on both industrial and domestic applications.

2. In my research so far I've come across several challenges for cleantech start-ups. Could you comment whether these are relevant for you?

- Crossing the technology chasm – thus the challenge to reach large markets. It is considered a specific challenge for technology based start-ups due to the significant amount of resources that are necessary to overcome it.
- Which resources, in the form of money and human resources are most scarce in your experience?
    - Technologically skilled persons (yes/no? – I saw the job advertisements online)
    - Managers (yes/no/not relevant yet? – for which phases)
- Criteria for follow-up investment after the seed investment. Expectation of VC growth contrary to what's realistic.
- Would you be willing to share your strategy to overcome the chasm?

3. Markets

- You have to go to international markets, they all say. Right? Do you have the intention to grow towards an international company with branches all over the world. If no, why not?
- How would you connect to this exit strategy?

4. Policy

- To what extent is bureaucracy an issue?
- Have there been policy arrangements that specifically aided you in your growth path?

EX2. – No explicit questions prepared, the main purpose of this interview was to gain insights in their research. I also introduced the main results of this research and we discussed and compared the results.

EX3 - Strategic Consultancy & Expert on funding for SMEs

How are the EU H2020 grants financed? Only Tax money or also corporate investment?

And does the corporate investment influence the (rather specific) calls for technology. How are the actions of the grants determined?

How feasible would it be for an Israeli cleantech start-up to apply for such a grant?

EX4 - Agro and Food VC

How would you explain my findings with regards to the availability of financial resources?

What is the influence of the governmental policy in Israel for the availability of financial resources? How relevant are the H2020 grants for your portfolio?