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Venture Capital Financing of Cleantech Innovation

How Categorisation of Cleantech Innovation can reduce Investment Barriers: geographic focus on Sweden

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Abstract

The industrial development has during the last century caused a disturbance to the ecological system in the ecosphere, and many industrial processes are still systematically causing harm. In an increasing manner this is raising a demand for technology that reduce the burdens on the ecological system. The innovation of technology that responds to these demands is important, not just for human well being, but also for worldwide economic growth.

Even though there is a demand for such technology and a potential for financial returns for investors, the innovation area of environmental technology innovation attracts less financing than other technology innovation areas. In the innovation process, financial backing is an important component. Previous research has shown that investor backed ventures are more likely to perform well than those companies that have not attracted external funding.

To understand why environmental technology innovation is less attractive to investors, this paper provides a presentation of the process of innovation, the systems of innovation and equity financing of innovation, as well as an analysis of barriers to invest in environmental technology innovation and the use of investment sector categorisation. The research can help to understand the investment barriers of environmental technology innovation and how categorisation may help to reduce such barriers. Also, it contributes to the understanding of how a new sector for venture capital investments may emerge.

Executive Summary

In order to create a more sustainable way of production and consumption, the world needs to use the potential of technology innovation to meet the demands in society together with the demands of the ecosphere. Since the world community committed itself to the principles of sustainable development in Rio, 1992, it has become gradually clearer that the needed change to a more sustainable society is far away and the environmental threats are rising. It is a necessity to increase technological development to meet such new needs and efforts to reduce barriers for environmental technology innovations are essential to gain needed changes.

Technology innovations that improve the environment are referred to as Cleantech innovation and can be defined as development of technologies in physical, chemical, biological sciences that enable more efficient, productive and valuable use of, and greatly reduced impact on, natural and other scarce resources as compared to what is commercially available today. Even though there is a market demand for Cleantech innovation, it attracts less external financing than other types of technology innovation. As external financing is a key factor for successful innovation, it may create a barrier for the development of sustainable innovation.

The purpose of this thesis is to increase the understanding of the investment barriers of Cleantech innovation and analyse how categorisation may help to reduce such barriers in the context of Sweden and to highlight issues of importance for attracting financing to the investment sector of Cleantech. The research question is: *How can barriers to investing in Cleantech innovation be reduced by categorization?*

Research Methods

The research was initiated through a literature review. It served to establish a theoretical framework of the nature of innovation, innovation systems and venture capital financing. To collect primary data as a basis for the analysis, qualitative and semi-structured interviews were held with venture capitalists and financial analysts. Thereafter, to test the findings of the analysis two case studies were performed, where primary data was collected through qualitative and semi-structured interviews.

Major Findings

Four systemic investment barriers were identified in the research. First, the externality effects which create non-paid public benefits, which decrease the ROI for an investor. This is known by investors and is a concern when assessing Cleantech. The concern is two-fold. There are benefit takers that are non-paying customers, and also, it is difficult to assess the amount of externalities of a product or service.

Second, the outcome of the externality effects causes a regulatory risk. It is mentioned by a majority of the interviewees as a major concern in the assessment process of a potential investment. The risk based on demand from regulations is seen as an unstable customer demand. Two findings of the research relate to the regulatory risk. As the regulatory risk is a systemic risk, it may also affect other risks for the investor. For example, it may indirectly be reflected in exit risks as the possible takers of an investment will assess the regulatory risk and therefore may have a less interest in the venture. Also, as both the risks arising from externality and regulatory effects are difficult to quantify, the level of risk may be assessed higher than the actual level of the underlying risk. That is, uncertainty is in itself a source of risk.

Third, there may be regulations and political ambitions that may be in conflict with the regulation steering towards sustainability. It can be seen as a double regulatory risk, as there is a regulatory risk, as described above, and a risk that the regulation may be in conflict with other regulations.

Fourth, the information flow in the financial industry follows the categorisation, or indexes, made by larger institutions, often suppliers of information themselves. Credit institutions and corporate financial service providers have a large influence as these organizations provide indexes that are used worldwide by many actors. The indexes provide an industrial categorization, with accompanying sector reports of industry performance. The venture capital industry, as information taker and potential customers of the larger financial institutions, follow these indexes mainly for three reasons. First, it creates a common language in the financial industry. Second, it is a good source of industry specific financial information, and third, it follows the structure of the publicly traded industry. The latter reason reduces the exit risk for the venture capitalists as the major exit strategies all benefit from complying with exciting structures in the financial industry. Therefore, the larger financial service providers influence in what degree and in what speed an industry sector is treated as an investment sector.

The specific barriers to investments in Cleantech are based on the perception of investors, reflecting the assessed financial returns in Cleantech and the maturity of the industry. Based on the report by Steen and Frankel (2003), five perceptions were researched. The first perception reflects the view that investors invest in ventures and entrepreneurs with which they are familiar. The deeper the industry experience and expertise the more risk can be mitigated. This is something the investors of venture capital funds (in-direct investors) want to see before entrusting the venture capitalist, and is therefore reflected in the selection of target investment sectors of the venture capital fund. As the venture capital industry of Sweden had a strong growth phase during the rapid growth of the ICT industry, this expertise is often reflected among the investment professionals. The primary source of high quality deal flow comes from an investment professionals' contact network. Therefore, the professional background of an investment manager influences the selection of ventures that are assessed by a venture capital company.

The second perception reflects a view of low ROI in the Cleantech sector. The most important notion was that there is a perception that there are no clear trade sale exit routes in the Cleantech industry. No established companies are probable takers for small companies with innovative ideas. For IPO as exit route, it is difficult to assess the public interest in Cleantech companies. Therefore, the exit risk is assessed by the investors to be one of the larger risks for investments in Cleantech. Also, compared to other types of innovative technology Cleantech was mentioned to have a larger degree of a replacement customer market. Customers have technology in place that is replaced by more environmentally friendly substitutes. For innovative Cleantech companies this means that barriers as established customer markets and rigid industry supply chain relations must be overcome.

The third perception reflects the Cleantech sector as highly regulated with an accompanying high regulatory investment risk. The perception of such risk, which is difficult to assess, creates an uncertainty for the investors and is seen as a main barrier.

The fourth perception is that many of the ventures in the Cleantech sector are seen to be at a premature stage. The opinion is that the technologies are too far away from a commercialisation stage to be viable investments. Based on the Swedish export market for the Cleantech sector, this perception is less supported by reality.

The fifth perception among the interviewees is that the entrepreneurs in the Cleantech sector have a lack of commercial experience, with a tendency to focus more on the environmental benefits than the commercial gains. The perception brings out a contradiction for the venture capitalists. One of the offerings of venture capitalists is to support the venture with management advice. If ventures are weak in business expertise, one could see it as an opportunity for the venture capitalists. Findings in the research show that what is required is not always the business expertise itself, but a mind-set that is open and committed to a commercial way of running the operations. This mind-set of entrepreneurs is essential for venture capitalists, to be able to align the commercial strategies of the operation and to be able to contribute with business expertise.

Based on the notion that categorisation can help to address many of these systemic and specific barriers, the research uses an analytical framework for the purpose of exploring how categorisation of Cleantech may help address some of the above discussed barriers.

The analytical framework consists of the Descriptive Model, the Staircase Model and the Market Positioning Model. The Descriptive Model provides a way to categorize sustainable innovation based on four system principles of the ecosphere and 12 sustainability categories, the Staircase Model presents a picture of the sustainable development in society and the Market Positioning Model presents a view of innovative strategies based on two parameters: the level of customer benefit of the environmental innovation and the level of innovativeness.

For the Descriptive Model, a need for investors to relate the model to customer investment segments was identified. Therefore, an Adapted Descriptive Model is suggested in this research. It supplies a connection between the underlying demand from the ecosphere, with a clarification of Cleantech innovation by 12 sustainability classifications, and a reflection of the customer demands from the target industry segments. The model also provides an opportunity for investors to view possible investment focuses within the sector of Cleantech. The investment focuses could either be directed towards a sustainability class, towards an investment segment of customers, or even more specific, the crossover between the two.

The staircase model mainly contributes in three ways. First, it provides a general understanding of the evolutionary development in society towards sustainability. The model is as such a pedagogic model for investors to gain insight in the process of change towards a more sustainable industry production. Second, it is an instrument for investors to assess where in this process of sustainable development a specific geographic region can be positioned. Industry sectors in a geographic region may be in various development stages. Therefore, the relevance for investors increases with the possibility to target the stage of development for industry segments that are chosen as an investment focus (e.g. selected in the adapted descriptive model). Third, the technology of a portfolio company or a possible investment can be positioned in the staircase model. If this outcome is compared to the outcome in point two, it provides a possibility to assess the time gap for the market demand to evolve. Therefore, the model provides value to investors in the assessment of income streams and market risks of a potential investment. Also, it contributes in the evaluation of possible market strategies for portfolio companies.

Based on accounts from the interview data, one of the problems for investors in Cleantech is the lack of mature reference-companies of the sector. The Cleantech innovation scope is seen as a wide area and it is difficult to draw experience from other ventures and companies. As one of the three major methods of assessing the value of a venture is to compare to other reference objects, it is a concern in the valuation process. The Market Positioning Model is relevant here in the way it describes areas of innovation strategies. The model contributes by

providing a more specific reference area for comparable studies, especially for an investor in the process of assessing the value of a potential investment. At the same time, one can ask if a ratio between environmental customer benefit and customer benefit, together with the level of innovativeness is a good way to describe the three strategies. Comparable studies could be achieved based on a description of the characteristics of each innovation strategy area. Such description may be portrayed in connection to the staircase model.

It is this research recommendation to use the adapted descriptive model and the staircase model to categorise Cleantech innovation. The models are well suited for the characteristics of the sector of Cleantech innovation and the use of the models can reduce assessed investment risk levels. The market positioning model is not recommended for three reasons. First, the benefit it provides is of less significance for investors. Second, the value it may provide for comparative valuations can be provided in the staircase model, and third, the model is difficult to understand and use.

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1 Introduction

1.1 Background and Statement of the Problem

Technology is an important engine of economic and human development. It has brought remarkable ways to marshal the physical needs of humans and has brought great human benefit. Innovation, where we in general terms mean the successful implementation of new developments and ideas, depends upon much more than technology advance, but technology has consistently provided the opportunity of meeting human needs. But the diffusion of technical innovations has also created an increasingly less sustainable society.

These negative effects on the environment have during the past decades come into focus and have created a need for innovation of technology that ensures a more sustainable development, where the industry today is far from meeting the requirements of sustainability (Dearing, 2000). The next 50 years could see a fourfold increase in the size of the global economy but only if there is an action to avert the growing risk of severe damage to the environment (Dearing, 2000; The World Bank, 2004).

Cleantech innovation is an area of technological innovation that contains the preservation of the ecosphere among its attributes. It can be defined as development of technologies in physical, chemical, biological sciences that enable more efficient, productive and valuable use of, and greatly reduced impact on, natural and other scarce resources as compared to what is commercially available today.

This area of technology is important for the development in society and its potential for the industry is large (Klaus Rennings, 2000). It has been assessed to become one of the fastest growing industry sectors with a growth rate of five to twenty percent annually. The world-market for Cleantech is assessed to be SEK 6,000 billion by year 2010 (Swedish Trade Council, 2004). OECD (2004) points out that the renewable energy sector is currently the fastest growing energy sector worldwide. In just two decades the wind energy industry has evolved from being a less recognized technology to a multi-billion dollar industry currently experiencing a thirty percent annual growth rate with an average growth rate of twenty percent over the last decade. The solar cell market has also experiences substantial growth, increasing by an average of fifteen percent annually from 1990 to 2000. This growth has been achieved by two complimentary factors: rapid technological progress and new market regulations promoting cleaner forms of energy (OECD, 2004).

There are two lessons that can be learned from the development in renewable energy. First, that rapid change towards sustainable development can take place when there is a market need with an opportunity for the industry. The mechanisms of the market economy invite the industry to indulge such a demand for change and profit from it. Second, it also reminds about that there may be special conditions that influence the development process of Cleantech compared to other types of technology. These special conditions can create barriers for an industry. One is the close connection to regulations.

Access to external capital is an essential factor for innovation in early stages and a shortage of risk capital is one of the greatest hurdles for entrepreneurs when staring up a new company. There is a need for capital investors that are willing to take on a high business risk in return for potential high financial returns. Grasping that opportunity, the venture capital market has grown in the past years. Though, the larger part of the venture capitalist invest in companies once the ventures have accelerated past the more riskier parts of their lifecycles. The private

venture capitalist typically come in after being convinced that the business model to some extent has proven successfully, often by showing a market demand or even a positive sales and earnings. This creates a funding gap in the earlier stages of the innovation lifecycle and a need for the government to support innovation, through policy systems and public financial investments (Gullander & Napier, 2003; Neergaard, 2004).

Though the market opportunities for the industry in Cleantech innovation has been assessed to be large, it receives less venture capital financing than other technology innovation sectors (Dealflower, 2003; Steen & Frankel, 2003). This can partly be explained by the perception of investors of Cleantech as an emerging investment sector with higher or less assessable risks. Very little work has been done to understand how new sectors for venture capital investment emerge, which is necessary to understand the development of environmental innovation (Wüstenhagen & Teppo, 2004). Such understanding is based on how investor's perceive risks and benefits in an investment sector.

1.2 Research Purpose and Objective

The thesis researches two elements that may restrict innovation from meeting the demands in society, namely the investment barriers of Cleantech innovation and how categorisation may help to reduce such barriers. The aim is to increase the understanding of Cleantech innovation as an investment sector and thereby to reduce the barriers for investments.

The research can help to point out how a new sector for venture capital investments emerge and how the sector of Cleantech is assesses by external investors, and thereby help policy makers attract more external financing to the sector. For investors, the research can help in the understanding of investment barriers of Cleantech innovation and how categorisation may help to reduce such barriers. Also, it may contribute in the understanding of how innovative Cleantech ventures may present themselves to facilitate for investors to assess their operations.

1.3 Research questions

This purpose and objective leads to the formulation of the following research question:

How can barriers to investing in Cleantech innovation be reduced by categorization?

The following sub-questions aims to clarify the area of exploration:

1. Does Cleantech innovation attract less venture capital financing than other types of technology innovation?

2. What barriers are perceived among venture capitalists for investments in Cleantech innovation?

3. How can three models of categorisation help in reducing the investment risk for venture capitalists?

1.4 Scope

The research is focused around main agents in the venture capital industry. It is a highly international industry that involves many stakeholders and operates in various investment stages in different investment stages. Therefore, the following boundaries of the research were set.

1.4.1 Geographic and time boundaries

Geographic boundaries: The geographic boundary of this research is Sweden. However, the literature review was performed without any geographic concerns. As the U.S. has had the leading venture capital industry for the last decades, research from the U.S. came into focus. As the aim of the thesis is to increase the understanding of the conditions in Sweden, the research from the U.S. was compared to research material relevant for the Swedish market.

Time boundaries: As venture capital is a fairly new concept with a history of a few decades, and sustainable innovation is even newer, the literature reviews in this area were mainly made based on articles less than six years old. Much of the experience in venture capital is collected from the ICT sector, which grew to be a strong investment sector just about eight years ago. The innovation research and innovation system is an older research area, therefore literature review date back to about fifteen years ago.

Furthermore, the research was performed within the time constraints of the curriculum of a postgraduate programme.

1.4.2 Subject and stakeholder boundaries

Stakeholder boundaries: There is a broad range of actors involved in the process of financing of innovation, especially when innovation is seen from a sustainability perspective. The thesis provides a general perspective of the main areas of innovation and sustainable innovation financing, were three main parties are in focus: the investor, the policymaker and the innovating party. It is important to include all these actors, to provide for the setting in which the investors operate. The study is limited to the main actors involved and the major processes that are part of financing of innovation. No complete description or analysis of the different characteristics of the various parties was intended or has been achieved.

Innovation area boundaries: This research is focused on Cleantech innovation, a subset of sustainable innovation. Previous research indicates the necessity to view sustainable innovation with all its needs of change, to gain sustainability in society. Though, as the research has the perspective of the investors and as the interest of investors is ventures that they can invest in, the perspective of Cleantech innovation was chosen.

Investment boundaries: The thesis is concentrated on early stage financing of ventures. External equity investments apply to different stages of development of the ventures. However, there is a lack of financing in the early development of a company and external financing of this development stage has therefore a crucial part in bringing innovations to commercial success. As Cleantech innovation is an evolving industry, the focus on the early stages of development provides a strong possibility to create environmental, social and economic benefits.

As the geographic target of the thesis is Sweden, the research is not considering venture capital investments in Cleantech innovation in developing countries. The issue of venture capital financing in the developing world is also significant, but varies considerably in the degree of development to the developed countries. Hopefully, some outcomes of this research may be useful for the financing schemes of Cleantech innovation in the developing countries.

Investor boundaries: This research is concentrated on formal venture capital and its perception of Cleantech innovation. In the early stages of a ventures development, also informal or "angel investors" are important stakeholders in the process. However, the formal venture capital has a higher degree of influence on how an investment sector is perceived and analysed, as more capital is invested and larger organizations are built.

Case study: The relevance of the research for the region of Scania is based on the analysis of two case studies, where the cases are compared to the over-all findings of the research. These two cases are selected as two typical Cleantech innovation companies in the geographic area. Due to time constraints of the research only two case studies in the same industry sector were chosen.

1.5 Limitations

The main limitation of the research is the information sensitivity of the business sector of venture capital. Some presented information was assessed confidential and could not be included in the thesis and the interviewees could not present some information due to confidentiality. Also, some interviewees required staying anonymous. In order to ensure open dialog in a closed community, as the financial industry is, the author agreed not to personally attribute quotes. All confidentiality aspects were strictly respected.

All the interviews were performed in Swedish, which creates a limitation of translation. The author carried out the translation of the material from the interviews as well as secondary data in other languages than in English.

1.6 Research Approach and Methodology

1.6.1 Data Collection

The research is explorative in nature, as its purpose is to contribute to the understanding of how investors perceive benefits and risks and how such perception influences their decisions to invest or not. To gain such understating, mainly a qualitative research approach is used. The findings of this research are then tested against two case studies in Scania. In line with the scope of the research, the data was collected to provide understanding about the situation in Sweden.

The research was conducted in sequences. The approach provided an opportunity to gain insights from the various parts of the research in an iterative manner. The research phases, sources, objectives and outcomes with relationships are presented in figure 1-1.

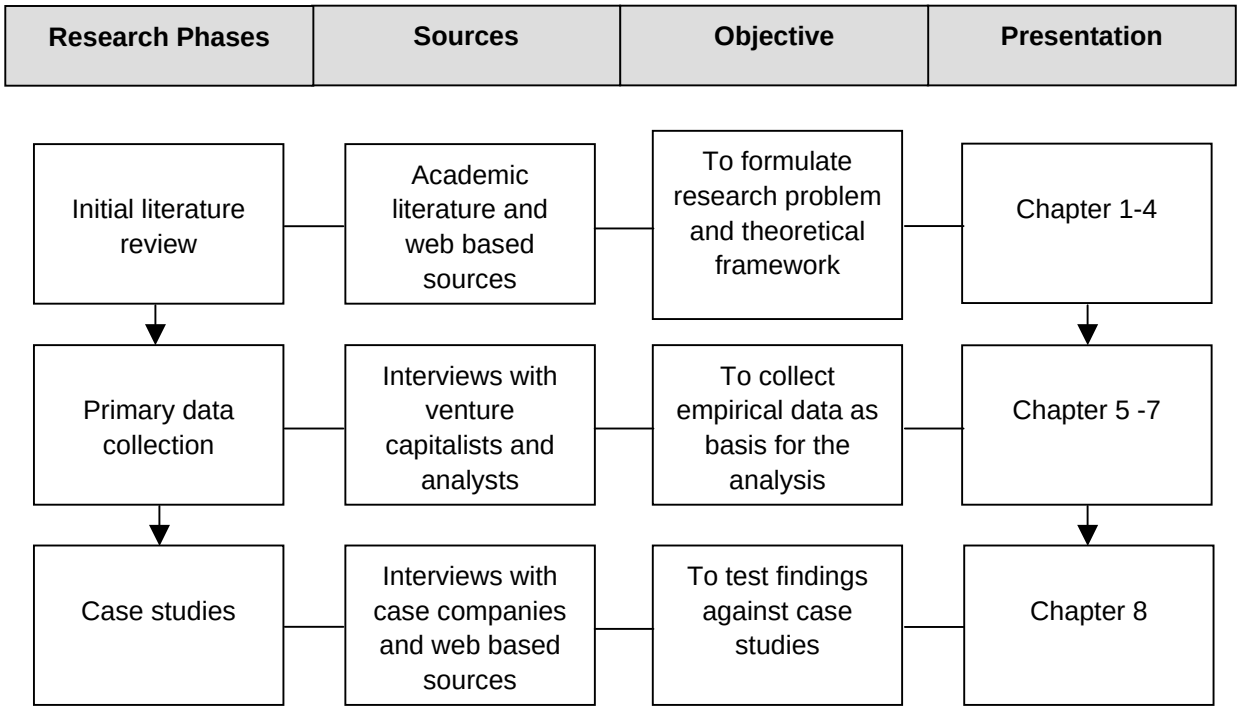

Figure 1-1 Approach of the research

1.6.1.1 Initial Literature review

A fundamental literature review was carried out before the core subject research started. The pre-research literature review served to gain knowledge about a theoretical background about the subject, mainly innovation, innovation systems, financing of sustainable innovation, and research methodology. The objective with the review was to realize the research gap and define the research problem presented in chapter one.

After defining the research problem, a more thorough literature review followed. The review was carried out with the purpose of establishing a theoretical framework, with guidelines in sub research question one, which was presented in chapter two, three and four. The reviewed literature consists of secondary data from academic literature and other secondary data collected from web based sources, as studies from different organizations and associations, archival records and together with data extracted from company web sites. The theoretical framework served to establish a basis for the interviews, the analysis and the two selected case studies.

1.6.1.2 Primary Data Collection: Interviews

Interviews held were qualitative and semi-structured. Therefore, although specific questions were asked, the interviews often revealed information that were followed up with more questions in the course of the interview. When it was possible telephone or email was used.

The objectives were mainly achieved by asking "why" and "how" questions. The study does not aim to manipulate events, nor does it intend to research outdated policies or methods of operation. Therefore, the method of qualitative interviews seems to be more appropriate than other methods (Yin, 1994).

The following characteristics were applied when choosing interviewees. The formal venture capitalists and financial analysts were selected from the listing of SVCA[1].

The selection criteria for formal venture capitalists are: (1) the investors are active members of SVCA, (2) the size of the investment fund is minimum SEK 100 million, (3) the investors have a wide industry sector focus (more than seven mentioned industry sectors or a general focus), (4) the development phase of investment is seed and start-up, and (5) the geographic focus for investments is Sweden (or larger geographic area).

The selection criteria for financial analysts are: (1) the organisations are active members of SVCA; (2) the size of the investment fund is minimum SEK 1,000 million; (3) they have a wide industry sector focus (more than seven mentioned industry sectors or a general focus); (4) the development phase of investment is seed, start-up, expansion and/or buy-out; (5) the geographic focus for investments is Sweden (or larger geographic area).

The objective of the selection of universe of venture capitalists was to interview established venture capital firms with relevant focus of investment for Cleantech innovation. For the financial analysts, it was to interview analysts that participate in a larger analyst team and therefore work in a context of industry sector categorised analysis.

The selection was made from the listing of SVCA, as the membership of SVCA implies that venture capitalists or financial analysts are a corporate association that directly or indirectly invest in private equity with active ownership participation. The size of investment fund was selected with an aim to target investors with a multi-role professional organization. The size of the funds, where the financial analysts are active, was selected larger than for venture capitalists to ensure that the interviewees work in a context of industry sector analysis. The development focus and the geographic focus were set in keeping with the scope of the research.

Primary data was collected in 16 interviews, where the interviewees had various positions and responsibilities. Every interview had its own objective depending on the responsibility and position of the interviewee. Secondary data was collected from various documents obtained from the interviewees, as well as from the companies web sites. Some information gathered remains confidential.

1.6.1.3 Review of Selected Case Studies in Scania

The case study of two companies in Scania was performed to test the findings of the research towards the case companies' perception of, and experience from, communications with venture capitalists and financial analysts. The method of case study was considered as the most appropriate research technique for the objective to test findings of previous research (Yin, 1994).

The selection of the two companies was made in co-operation with the CEO of the organisation Sustainable Business Hub[2]. The selection aimed at testing the findings in one industry segment of Cleantech innovation and in one region in Sweden. The two companies selected were Anox AB and KMI Kemimäklarna AB, both with their operations based in the region of Scania.

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[1] Swedish Venture Capital Association, http://www.svca.se

[2] Sustainable Business Hub, http://www.sbhub.nu

Interviews held were qualitative and semi-structured. Primary data was collected in interviews with the CEOs of each company. Secondary data was collected from various documents obtained from the companies web sites.

1.6.2 Data Analysis and Analytical Methodology

To answer the research question on how barriers to invest in Cleantech innovation can be reduced by categorization, three models on characteristics of Cleantech innovation were selected as analytical framework. The models view innovation from a systemic, development and market perspective. The analytical framework is presented in chapter five.

Since the research question requires understanding of the investment barriers as a basis for the analysis of the contribution of the categorisation, the collected data was clustered in relation to the terms "barriers" and "categorisation". The clusters revealed information about each of the two areas and possible inter linkage between the areas. The collected data was analysed in three steps:

The first step in the analysis of the data was to understand the barriers as perceived by the venture capitalists and financial analysts. Such understanding was gained in two parts. First, the data in relation to "barriers" were assessed towards the theoretical framework of financial risks (mainly chapter four) to view the systemic barriers. Second, for specific barriers, the research of Steen and Frankel (2003) on U.S. venture capital investors' perceptions of Cleantech innovation was compared to Swedish perceptions, with purpose to improve the understanding of investment barriers. The analysis on barriers of Cleantech innovation was guided by sub research question two and is presented in chapter six.

As a second step, based on the understanding of the barriers, the data clustered around "categorisation" was used to test the usefulness of the analytical framework. The models were assessed to elucidate their contribution to the understanding of Cleantech as an investment sector. The analysis was guided by sub research question three and presented in chapter seven.

As a third step, the prior findings in the analysis were tested towards the collected data from two selected case studies. The two case studies were positioned in the analytical framework, to view the usefulness of the analytical framework from the perspective of two innovative companies. It provided an opportunity to test the findings of the research. This step is presented in chapter eight.

1.7 Outline of the Thesis

The structure of each section of the thesis is given below.

Chapter 1: Introduction

This chapter provides the reader with a background to the researched area. Based on the background it provides a research problem and presents the research objective and question. It also describes the scope and limitations of the research. The methodology for the research and the data collection is presented.

Chapter 2: Innovation and Sustainable Development

The chapter provides a literature review of innovation theory. It presents and defines innovation in relation to sustainable innovation, with a focus on Cleantech innovation. Issues like the attributes of innovation, the role of innovation, determinants of innovation and the

innovation process are presented. Finally, the role of policy in relation to sustainable innovation is described. The chapter aims to provide a better understanding of innovation and the process of innovation.

Chapter 3: National and Regional Context of Innovation

The chapter explores the role of innovation systems based on literature. It presents the characteristics of national and regional innovations systems, together with an overview of the Swedish ambitions for Cleantech innovation. The purpose of the chapter is to increase the understanding of innovation systems, with focus on financing of sustainable innovation in Sweden.

Chapter 4: External Financing of Innovation

The chapter provides an over-view of financing of innovation, based on literature. It offers a presentation of venture capital and the operations of a venture capitalist's. Also, it provides the relation between venture capital and Cleantech innovation. After reading the chapter, the reader should have an understanding of how a venture capitalist operate, how the investment process is performed and what risks are considered when assessing investments.

Chapter 5: The Need to Categorise: Introduction to the Analytical Framework

This chapter presents research findings on why investors see a need to categorise innovation and an analytical framework of three models. The analytical framework is used in chapter seven and eight.

Chapter 6: Investment Barriers of Cleantech Innovation: Research Findings

The chapter provides an analysis of the data collected on the perceived investment barriers. The data is analysed into groupings of systemic and specific barriers. After reading the chapter, the reader should have an understanding of the barriers of investment in the Cleantech sector.

Chapter 7: Categorisation in the Analytical Framework: Research Findings

This chapter presents an analysis of the data collected on the issue of categorisation. The data is used to assess the usefulness of the analytical framework to categorise Cleantech as an investment sector, and thereby reduce investment risks. The chapter provides the reader with an understanding of what benefits categorisation brings to investors and an assessment of the level of benefit the analytical framework provides for the investors.

Chapter 8: Case Studies: Innovation and its Financing

The chapter presents two case studies of innovative ventures in the Swedish region of Scania. The cases are used to test the findings of chapter seven. This chapter contributes to the understanding of how a communication gap between investors and innovators can be reduced.

Chapter 9: Conclusions, Recommendations and Further Research

This chapter concludes the findings of the research and gives the author's view on how barriers to invest in Cleantech Innovation can be reduced by categorisation. It also provides the author's recommendation on future research.

2 Innovation and Sustainable Development

To be able to understand the process of innovation and its determinants and success factors, one must understand the nature of innovation itself. This section aims to view innovation from various perspectives and to provide an understanding of the process of innovation and its determinants.

2.1 Attributes of Innovation

2.1.1 Innovation as Perceived by Individuals

The rate and time to bring an innovation to the market and the rate of adoption vary extensively. The characteristics of innovation, as perceived by the individuals, help to explain their different rates of adoption. There are five characteristics that describe the perception of individuals.

First, the relative advantage is the degree to which an innovation is perceived as better than the idea it supersedes. The degree of relative advantage may be measured in terms as economic value, social prestige factor, convenience and satisfaction. What matters to an innovation is the whether an individual perceives the innovation as advantageous.

Second, the compatibility is the degree to which an innovation is perceived as being consistent with the exciting values, past experiences and experienced needs of potential adopters. The values and norms of a social system are strong influencers of its adoption. The adoption of an incompatible innovation often requires the prior adoption of a new value system. Such changes in beliefs are often slow processes.

Third, complexity is the degree of which an innovation is perceived as difficult to understand and use. Some innovations are easily understood and others are more complicated and adopted more slowly.

Fourth, trialability is the degree to which an innovation can be tried with a limited risk of damage. An innovation that is trialable represents less uncertainty to the individuals who are considering it for adoption, as the value of a mistake can be limited.

Fifth, observability is the degree to which the results of an innovation are visible to others. The easier it is for individuals to see the close-by results of an innovation, the more likely they are to adopt themselves. The visibility stimulates a discussion and an evaluation of the new idea, which reduces the risk for the potential adopter.

Innovations that are perceived by individuals to have greater relative advantage, compatibility, trialability and observability and less complexity will be adopted more rapidly than other innovations. These five perceived qualities are the most important characteristics of innovation in explaining the rate of adoption (Rogers, 2003).

2.1.2 Innovation from the Business Perspective

The unpredictability of innovation can be compared to recent development in the total quality movement (TQM) of business. The factors steering the quality were seen as something one could not predict, and that a randomised outcome of production was the nature of production. The quality movement developed methods for identifying those additional

factors. If one could account for all of them, it would give a predictable result that had no need for end-of-line inspections.

In an attempt to increase the predictability of innovation in the same manner as for TQM, Christensen (2002) describes four sets of factors that influence the variability and thereby the probability to succeed with innovations. These four factors give a view of innovation from a business perspective. Christensen describes these as; taking root in disruption, the necessary scope to succeed, levering the capabilities and disrupting competitors, not customers (C. M. Christensen, 2002).

2.1.2.1 Taking Root in the Disruptive

All companies have asymmetric motivations in that they focus on markets that promise higher profit margins and the most substantial and immediate growth. They leave out the markets that are less favourable, which opens up for new entrants. The entrants are safe, because the incumbents are motivated to ignore or even exit the market that the entrants are motivated to enter. Taking root in disruption, therefore, is the first condition that innovators need to meet to improve the profitability of successfully creating a new growth business.

2.1.2.2 The Necessary Scope to Succeed

The second set of variables that affect the probability if a new invention and a new business project will succeed or not, relates to its degree of integration. Integrated companies make and sell their own proprietary components and products across a wide range of product lines. Non-integrated companies outsource as much as possible to suppliers and partners and use modular, open systems of production, to facilitate for partnering companies to add value. In markets where product functionality is not yet enough fulfilling customer preferences, companies compete by making better products. This often means producing proprietary technology and setting up integrated systems along the supply chain. When functionality of products has overshot what the mainstream customer can use, successful companies should compete through improvement (innovation) in preference areas as speed to market, simplicity and convenience.

2.1.2.3 Leverage the Capabilities

Innovations fail when managers attempt to implement them in organizations that are incapable of succeeding. Three questions could be asked, according to Christensen (2002), to assess the innovation potential and limits of the organisation itself: Do I have the resources to succeed? Will my organization processes facilitate success in this new effort? Will my organisation's values allow employee to prioritise this innovation, given their other responsibilities? While the first two questions aim to assess the organisations resource to bring an innovation to the market, the latter aim to assess if the invention process can be accomplished in the company or better is spun off into a new organisational body.

2.1.2.4 Disrupting the Competitors, not the Customers

Successful innovation minimizes the need for customers to reorder their lives. If an innovation helps customers to do things that they are already trying to do, at all or in a better way, it has a better possibility to succeed. On the other hand, if it makes it easier for customers to do what they weren't trying to do, the probability of success is decreased. The point is that inventions must be based on sound assessments of behavioural patterns.

2.2 Definitions and Elements of Innovation

The strictest and most conventional understanding of innovation can be defined as "the process by which firms master and put into practice product designs and manufacturing processes that are new to them" (Cooke, Uranga, & Etxebarria, 1997). OECD (2002) proposes an alternative, and somewhat wider definition, where innovation is defined as "new goods and services, new business models or markets, new processes or organization of production, new competences and input sources" (OECD, 2002). It distinguishes mainly between process, product and organizational innovation. Process innovation occurs when a given amount of output (product, services) can be produced with less input. That is, an increase of efficiency. Product innovation is improvements to exciting goods or services or the development of new goods or services. Organizational innovation includes new forms of management, e.g. quality management (Klaus Rennings, 2000).

From an operational perspective, Kuczmarski reminds about the view of innovation as "a mindset that permeates every aspect of its business". Innovation is an attitude to and an ongoing commitment to change (Kuczmarski, 2003).

2.2.1 Defining Sustainable Innovation

A weakness of the OECD definition is that it does not distinguish between environmental and non-environmental innovation. The general definition of innovation is neutral concerning the content of change, which give a process of change that is open in all direction. The addition of sustainability concerns, that is, innovation with regards to challenges of sustainable development, raise a need for a new description. The interdisciplinary project "Innovation impacts of environmental policy instruments" has introduced the following definition: "Sustainable innovations are all measures of relevant actors that develop new ideas, behaviour, products, processes, apply or introduce them and which contribute to a reduction of the environmental burdens or to ecologically specified targets" (Klaus Rennings, 2000). The definition implies that a broad range of actors as private households, politicians, unions and associations can be actors in the innovation process, and that innovation is a process that can take place in many settings. Categories of sustainable innovation are technological (Cleantech), organisational, social and institutional innovation.

Cleantech measures can be differentiated into curative (e.g. cleaning of oil-contaminated soil) and preventative measures. As figure 2-1 illustrates, the latter can be further subdivided into integrated and additive (or end-of-pipe) technology protection. Integrated technology includes both product, service and process integrated measures.

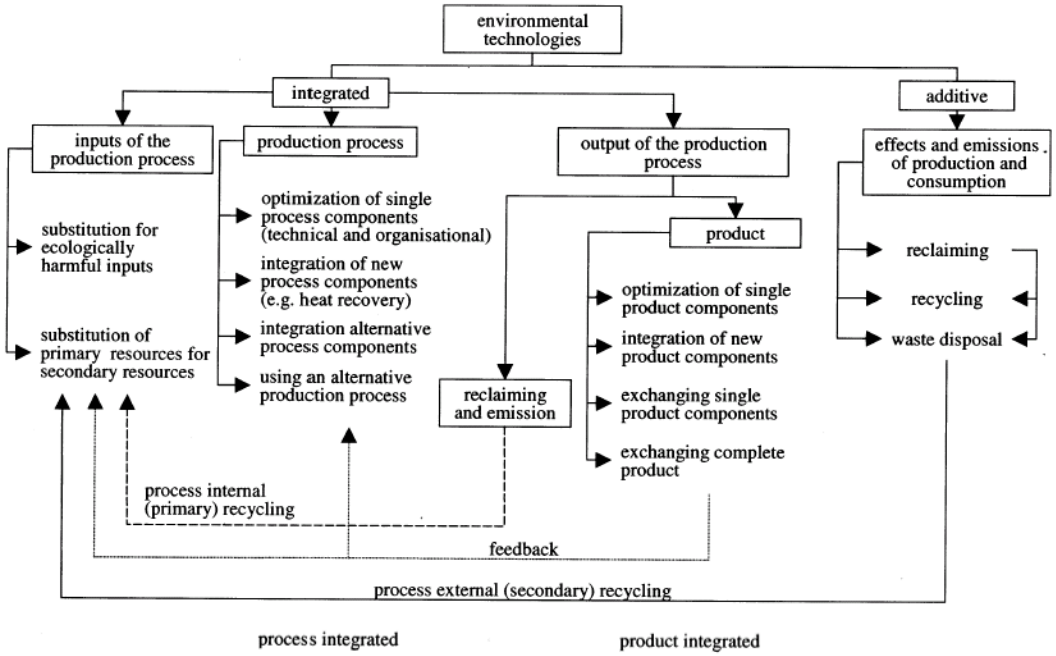


Figure 2-1 Preventative environmental technologies

Source: Rennings (2000); origin: Hohmeyer &Koschel (1995)

2.2.2 Defining Cleantech Innovation

Thus, Cleantech innovation can be seen as a subset of sustainable innovation. From an investor's point of view, where the term Cleantech innovation is increasingly used, the investment sector is generally seen as technology innovation providing commercial product and services that improve the environment.

In this research the term Cleantech innovation is therefore defined as "development of technologies in physical, chemical, biological sciences that enable more efficient, productive and valuable use of, and greatly reduced impact on, natural and other scarce resources as compared to what is commercially available today" (Steen & Frankel, 2003).

As Cleantech innovation seen as a subset of sustainable innovation, the following will describe the relation between innovation and sustainable innovation, with a special focus on the characteristics of Cleantech innovation.

2.3 The Role of Innovation

Innovation is an engine of progress since at least the time of the industrial revolution. It creates wealth in society through more efficient ways and successful implementation of ideas and developments. Innovation is a corner stone of development in society and, as such, an interest of the common. Though innovative processes can take place in many settings, the innovation that takes place in industry is closely connected to technology advance.

The society gain of innovation is increased economic competitiveness and growth. The rate of innovation has a direct relation to the competitiveness of society and has a rising importance with the development of growing knowledge-insensitivity in industrial and economic activities (OECD, 2002). The effects of innovation for more general economic indicators as employment and growth are important, as a significant proportion of the latter is explained of

innovation, and directly impacts positively or negatively on the former (Edquist, 1997; Freeman, 1995).

2.3.1 The Role of Sustainable Innovation

The diffusion of technical innovations has also created an increasingly less sustainable society. These negative effects on the environment have during the past decades come into focus and have created a need for innovation of technology that ensures a more sustainable development, where the industry today is far from meeting the requirements of sustainability (Dearing, 2000). The next 50 years could see a fourfold increase in the size of the global economy but only if there is an action to avert a growing risk of severe damage to the environment (Dearing, 2000; The World Bank, 2004).

Since the world community committed itself to the principles of sustainable development in Rio, 1992, in has become gradually clearer that the needed change to a more sustainable society is far a way and the environmental threats are rising. There is a strong need to increase technological development to meet the new needs of society. Efforts to reduce barriers that reduce the level of innovation and increase the time-span from invention to diffusion in the market are essential to gain needed environmental positive changes (Klaus Rennings, 2000).

2.4 The Innovation Process

In an economic sense, an invention becomes an innovation when an improved or invented product or service is introduced into the market. Thus, an innovation differs from an innovation in that it provides economic value and is diffused into a market to other parties (Garcia & Calantone, 2002).

This provides a view of the development process of an innovation into three phases; the invention, adaptation of the invention and the diffusion of the innovation into the market (Klaus Rennings, 2000). The invention is the creation of an idea, practice or object that is perceived as new. The adaptation phase is the when the innovation is used and developed over time. The diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system, a spread of a message that is perceived as new ideas (Rogers, 2003).

In early research, this view represented a perspective of innovation as a linear model or process, where one step precedes the next. Through the 1970s and 1980s, the linear model, where the technology is assumed to develop directly based on scientific efforts, was discredited by empirical work. The studies demonstrated that most innovations reflect a process where feedbacks from the market interact with the with knowledge creation and initiatives by the entrepreneurs (Lundvall, 1999). Thus, later views of innovation present a more iterative approach, where the innovation process is seen as iterative in nature, and includes the first introduction of an innovation and the re-introduction of an improved innovation (Garcia & Calantone, 2002). In this view, the stages of innovation may not occur in a linear sequence, the time order of the stages may vary and certain stages may not occur at all (Rogers, 2003).

The innovation process varies extensively between organizations depending on the size of operation, and thereby the financial ability, and the type of innovation process. Also, the organizations position in the market is a distinguishing factor, where market leaders have a different agenda for innovation than new entrants have (C. M. Christensen & Raynor, 2003).

2.4.1 The Sustainable Innovation Process

From a sustainable point of view, Rennings (2000) bring up six reasons that emphasises the need to understand innovation processes. The reasons also provide an understanding of the conditions surrounding sustainable innovation.

First, the importance of drastic reduction of environmental burdens, e.g. green house gases, implies that current technology innovation is not sufficient. Thus, technology innovation is needed to reduce and offset the negative environmental effects that caused by society.

Second, innovation is expected to offset burdens and costs induced by environmental regulation. That is, in addition to environmental positive effects, secondary effects as reduced production costs, increased competitiveness, creation of new markets of environmentally demanded products and services and employment effects are expected. This argument was brought forward by Porter (1995), but has been viewed with scepticism by others as Jaffe and Palmer (1997) (Jaffe & Palmer, 1997; M. E. Porter & Van der Linde, 1995).

Third, time-scales for innovation are long. New types of vehicles, e.g. renewable energy, often need at least a decade or more for invention, adaptation and diffusion, respectively.

Fourth, to meet sustainability goals, behaviour changes may be needed. Many scenarios suggest that the innovation in technology must be supplemented by corresponding life-styles, e.g. change of mobility pattern to reduce energy consumption and institutional changes.

Fifth, managing eco-innovation is an increasingly important issue in many firms. Rennings (1999) showed that 80% of all innovating firms are involved in some kind of environmentally friendly innovation projects (K. Rennings, Koschel, Brockmann, & Kuehn, 1999).

Sixth, several sustainability programs and initiatives have been set-up to improve the understanding of global environmental change and it's relation with economic and social systems. As the time-scales until results from the programs are long, a valuation of experiences seems crucial to identify critical factors of innovation processes towards sustainability (Klaus Rennings, 2000).

2.5 Determinants of Sustainable Innovation

Sustainable innovation is driven by technology push, market pull and regulatory push as presented in figure 2-2. Sustainable innovation is normally not, in contrast to other technological innovation sectors as e.g. telecommunication, self-enforcing. The factors of technology push and market pull do not seem to be strong enough and sustainable innovation need specific regulatory support, largely due to that the effects of environmental negative effects often can be characterised as externalities (Klaus Rennings, 2000). Therefore, the regulatory framework and especially environmental policy have a strong impact on eco-innovations (M. E. Porter & Van der Linde, 1995). Though, there is a difference between environmental product and process development. While market pull effects significantly drive environmental product development, environmental process development is more driven by regulatory push/pull effects.

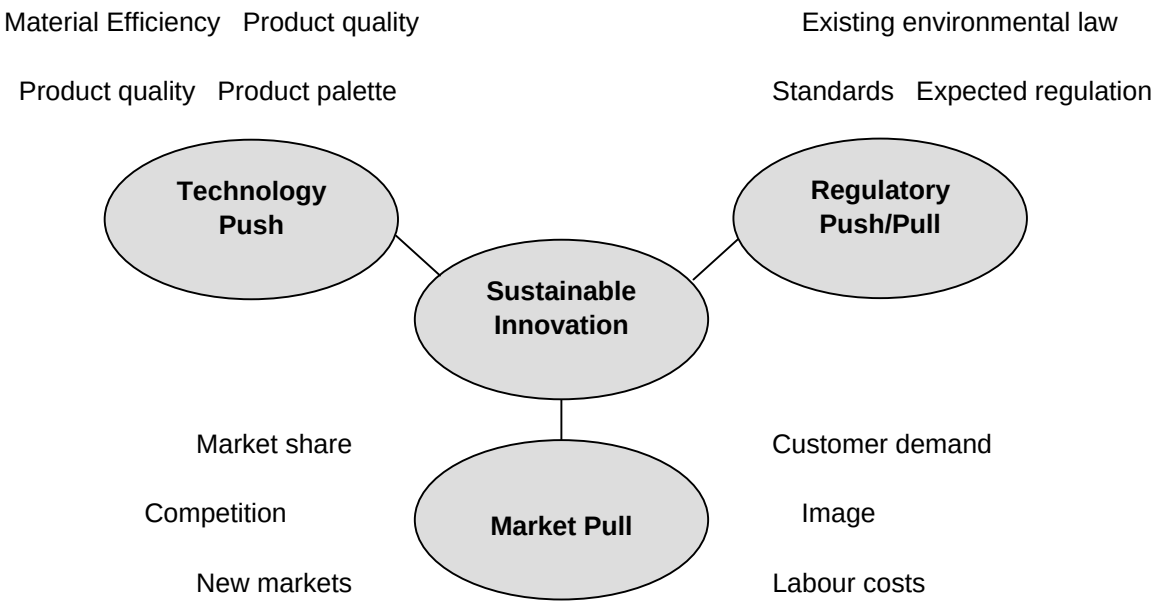


Figure 2-2 Determinants of sustainable innovation

Source: Rennings (2000)

There are two systemic concerns brought forward by Rennings (2000) that are directly related to Cleantech innovation: the double externality problem and the regulatory push/pull effect.

The double externality relates to that sustainable innovation produces positive externalities in both the adaptation and diffusion phases of innovation. That is, positive externalities are produced in the last two steps of the innovation process that the owners of the venture are not rewarded for. The positive spill over effect in the diffusion process appears due to that the sustainable innovation creates smaller amount of external costs compared to competing goods and services on the market. The double externality problem reduces the incentives for companies to invest in sustainable innovation. As long as the market do not punish environmental harmful impact, innovation and competition between competitors are distorted. The creation of negative external effects by competing innovative technologies is what Hellström (2003) would describe as the inherent risk of the innovation process itself, the risk that the innovation will cause ecological or social harm to society. This risk occurs when "when the desire to innovate outstrips the ability to assess and absorb the risks" (Hellström, 2003).

As both externalities cause sub-optimal investment in sustainable innovation, a second matter of concern is created - the regulatory push/pull effect. The main discussion in innovation technology has been whether innovation has been driven by technological development (technology push) or by demand factors (market pull). For Cleantech innovation, new sustainable technologies can be considered under technology push factors, while preferences for environmentally friendly products can be referred to market pull factors. Due to the double externality problem the innovation discussion for sustainable innovation has to be extended to the regulatory framework. This creates an increased dependency of the regulatory framework for investors in the Cleantech innovation and, thereby, an increased regulatory risk.

The financial sector is of strategic importance when a system of innovation is created. The innovation process is not economically self-sustaining as the values it brings are future ones. Therefore, a structure must be in place to support innovative processes internally in corporations and externally in the financial industry (Cooke et al., 1997). The financial markets have an important role in funding and rewarding the more sustainable solutions developed by companies according to Dearing (2000). But the trigger to do so is when there is compelling evidence for that sustainable innovation has economic value.

2.6 Sustainable Innovation and The Role of Policy

Duchin (1999) argues that effective environmental policy requires understanding not only technological but also lifestyle dynamics (Duchin, 1999). The different kinds of innovation co-evolve and as Freeman (1992) puts it: "Social action depends on a combination of advances in scientific understanding, appropriate political programs, social reforms and other institutional changes, as well as on the scale and direction of new investments. Organizational and social innovations always have to accompany any technical innovations and some would have to come first" (Freeman, 1992). For example, an electric car can reduce the climate change effects (Cleantech innovation), and at the same time a shift from car use to bicycling (social innovation) can have the same effect. A network of organizations, scientists, firms and public authorities that promote sustainable transport is an example of institutional or an organizational sustainable innovation.

In line with that, Rennings (2000) argues that progress is still often understood as innovation in firms, with a strong focus on technological progress. Due to the fact that many issues of sustainable use of nature are not technological issues this may lead to a "technology bias", a bias created by the outpacing of the social organization by technology. Thus, institutional and technology innovation must go hand in hand.

The role of policy is to guide and steer the development in society. With aim to achieve a sustainable development, technological, institutional, social and organizational innovation should be integrated in the policy work. As for the influence of individual policy instruments on environmental innovation, influence from "soft" regulatory instrument, as environmental liability, eco-audits, voluntary commitments and from eco-labels can be found, especially on environmentally innovative companies. These instruments enable the companies to benefit from marketing activities and from negotiations with the government. According to Rennings (2000), the "hard" measures, as command and control instruments, seem to be necessary for diffusion of measures into non-innovative companies.

From a Cleantech investor's perspective, the understanding of the policy process is vital for understanding the underlying needs of the technology. The market demand for Cleantech comes from the concerns from what the industrial have caused to the environment and the future needs to cause less harm. The demand is often articulated through regulations, where the regulations create a need for change and thereby a market opportunity for the industry. But a dependence on regulation as a market creator can also be seen as a risk by the industry that can slow down the innovation process (Jaffe & Palmer, 1997).

Many factors influence innovativeness and transformations into value-adding products, services and other kinds of innovation, as innovation and economic growth are the result of numerous micro-processes in different parts of the economy. In order to understand and assess the role and function of these factors and processes, they need to be analysed in relation to each other. The innovation system approach is a general analytical framework for analysing the role, impact and relationship of all factors that are important in generating innovation and

transforming innovation into economic values (Marklund, Nilsson, Sandgren, Granat Thorslund, & Ullström, 2004). The innovation system can also be seen as the vehicle by which the government encourage innovative processes. In order to understand how society facilitates innovation and how it influences the perception of investors, chapter 3 aims to explore the national and regional context of innovation.

3 National and Regional Context of Innovation

3.1 Background of Innovation Systems

The most fundamental reason for scholars to begin think in terms of systems has to do with the fact that it over time was realized that innovation is an interactive process. The success of innovation is dependent on close interaction with external agents. Thus, the iterative process created a need for a better understanding of the activities of the agents, compared to the linear thinking (Lundvall, Johnson, Andersen, & Dalum, 2002). A second reason was the realization of that relationships and interactions between agents had to involve non-market relationships, based on elements of power, trust and loyalty. These interactions must be included as a variable in the analysis. A third reason was the need of a focus on the differences in various geographical contexts. There are important differences in geographical regions as, for example, the interaction between universities and industry, the education and training system, the financial markets (Lundvall, 1999).

The interest in why national growth rates could differ based on the support for innovation, made many national governments set up national systems of innovation. With time, the focus also grew to incorporate the regional level, with the need to understand the supranational co-ordination and rule setting (Lundvall et al., 2002).

The context of innovation is important for how an investment sector attracts financing. Even though the financial actors do not directly assess what support an investment sector as Cleantech has, risk-reducing contribution from the innovation systems makes innovation more attractive. Therefore, characteristics of the innovation process and valuation assessment (risk factors) of Cleantech should be considered in the context of innovation, to gain understanding of the role of investors.

3.2 National Context of Innovation

In a competitive market economy, consumers exchange goods and services freely, which leads to a maximization of consumers' utility. Assuming perfect competition and information, the equilibrium is Pareto efficient. In real life, these assumptions are not always valid, which creates a role for the state to intervene and, for example, assure the internalisation of externalities. Industry policy can be understood, in a broad sense, as the effort of the state to promote, without violating the structural framework of the competitive market, the economical and social development through an efficient allocation of resources (Heitor, Conceicao, & Veloso, 1997).

Within the framework of industrial policy, the specific aspects related to innovation play a specific and important role. Nelson (1959) has concluded that a market, without intervention, would be exposed to sub-investments in R&D due to the public goods characteristics of R&D results. Even if immaterial legislation presents a way to ensure the ownership of inventions and some secrets may be keep from the market, R&D results will always be partially non-exclusive. Adding the uncertainty associated with R&D efforts, Nelson supports state intervention aiming at increasing the level of investment in activities related to the promotion of innovation (Nelson, 1959). Empirical evidence from a number of countries, in particular Japan and Southeast Asia, has contributed to this vision. In these countries, the states with its policies towards innovation, have played a important role in their industrial catch-up process (Heitor et al., 1997).

If a consensus is building towards necessary role of the state, the same is not true for the specific actions to be developed. There is a wide spectrum of possibilities and also a need to integrate several policies. The national policies range from taxes, direct subsidies, public education and training facilities, public R&D institutions, infrastructure facilities, financial support, regulations, standards, to public procurement (Gregersen, 1992). Out of these policy support measures, the next section will view the specific role of the government as a direct financier of innovation supporting activities.

3.2.1 Financing in the National Context of Innovation

Thus, the objective of government financial support to innovative activities is to promote the development in society by allocating resources without violating the competition in the market place. The aim is, on the one hand, that the government should promote that all agents in the market have equal opportunities. On the other hand, it should aim at efficiency to optimize resource allocation (Heitor et al., 1997).

As the resources of society should be used efficiently, a role of the government is to bring knowledge creation in institutions to commercial innovations. The relationship between the roles of the government, universities and the industry becomes fundamentally important. But it creates an issue that concerns policy makers, as universities are focused on fundamental research and knowledge creation where industry is geared towards profitability and is increasingly constraint by short-term reporting of such. The concern is that the gap between the fundamental roles of the university and the industry may induce less than optimal innovative results.

This situation has been the rationale for the establishment of a number of institutions with aim to bridge the gap between the creation of knowledge and the commercialisation of innovations (Webster, 1994). These bodies aim to bring the knowledge creation of the universities, based on internal research, to the industry. They are highly research intensive, and a key differentiation compared to other organizations is that the level of investment in research cannot be funded by the services offered to customers. Thus, the institutions need financial support because of this money-losing way of operation, and government must play a role as a part-financier of the operations (Heitor et al., 1997).

This has created two channels of governmental financing of innovation. First, directly to these kinds of institutions, which promotes the equality concern of the government as the institutions services are offered on equal terms to the industry. Second, direct financial support to innovative companies, which promotes the efficiency concern as funds are used directly in the innovation process. The combination of the two ways of funding establishes a compromise and achieves a balance between equality and efficiency (Heitor et al., 1997) and are the fundamental ways of governmental funding in the national innovation system.

3.3 Regional Context of Innovation

Lundvall (2002) argues that as long as nation states exists as political entities with their own agendas related to innovation, it is useful to work with national systems as a framework for innovation support. But also, that it is necessary to understand the regional conditions in means of policy constraints and policy efficiency of the national systems (Lundvall et al., 2002). Regional policy calls for a focus on the specific conditions of the regional context, when it comes to defining the needs for innovation co-ordination and rule setting.

Regions have evolved along various routes through combinations of political, cultural and economic forces. A region can be defined as territories smaller than their state, possessing

significant supra-local governance capacity and cohesiveness differentiating them from their state and other regions (Cooke et al., 1997). Among the governance powers that all regions possesses to varying degrees is the capacity to develop innovation support policies and organisations.

The regional context is determined at large by two forms of regional evolution. First, the independecy of the super-ordinate (national) state and, second the social capital of the region, that is, the cultural base that creates a systematic potential (J. Christensen, 1992).

3.3.1.1 Financing in the Regional Context of Innovation

From a financial perspective, the regional independency of the national state can be measured in five variables. First, the degree of autonomous capacity of regional public spending. Second, the capacity of the regional government to impose taxes. Third, the need for organisations to approach national capital markets. Fourth, the amount of regional financial intermediaries, and fifth, the level of regional governmental control over financial intermediaries (Cooke et al., 1997).

The first two variables provide information in what degree the regional government can stimulate the regional innovation conditions, where the latter three indicate the level and the regional governments control of the infrastructure of financial intermediaries. For regional financial systems, the greater the degree of jurisdiction and bank control in the regional area, the more regional financing of innovation can be. Also, a regions capacity to mobilise its innovative resources is highly linked to the regional government's budgetary ability (Cooke et al., 1997; Zysman, 1983).

Cooke (1997) highlights two matter concerning financing of regional innovation. The way lenders and borrowers deal with each other is seen to be increasingly important. The lender's lack of information on a project sometimes causes difficult situations. It may result in that the transaction not takes place. In the case of innovation, Cooke points out, the main problems stern far more from the uncertainty created between the two parties than from the varying level of cost of the capital. Second, the level of infrastructure that makes possible the multiple relations that are established between the different agents in a regional economy is essential. Thus, for the configuration of the regional systems of innovation, it is vital to understand what influence the regions have on design and execution of basic infrastructure.

The financial ability to support innovation is also determined by the social capital of the region. Two components that are important for the social capital are the systematic learning capacity in business clusters and the productive capacity of a region. Both components act to increase the interface of communication between financial and industrial parties.

Business clusters are presented as institutionalised linkages between firms and innovation support infrastructures and among firms, both large and small. An innovative regional cluster is likely to have companies with: access to other companies in their sector as customers, suppliers or partners, knowledge centres as universities, research institutes, contract research organisations and technology transfer agencies. There is also likely to be a governmental structure of private business associations, chambers of commerce and public economic development, training and promotion agencies and governmental departments. Where these are available in regions and where those organisations are associative, meaning there is a systematic interchange of matter of importance to innovation, a productive regional learning system is present (Cooke et al., 1997; Michael E. Porter, 1990). But learning is not constraint within the region itself. The significance of a multi-level approach is noted by Asheim (2002),

where firms both use regional resources and international knowledge, to strengthen their competitiveness (Asheim & Isaksen, 2002).

Innovation policy implies the creation of a climate and certain attitudes that enable coordination and communication between agents – a productive culture. In this sense the culture of coordination and communication is learned but is also reinforced by history and links that are motivated by cultural, political and ideological reasons. Culture is linked to the local setting and is in essence the value system that is shared by members of a local or regional area (Cooke et al., 1997; Sweeney, 1995).

3.4 Ambitions for Cleantech Innovation in Sweden

The Swedish government has a high ambition to stimulated innovation of Cleantech innovation. Several national and regional projects have been achieved in the support of Cleantech product development, business development and export. A national centre is planned to stimulate Cleantech export and strategies for innovation and research has been presented (Englund & Leghammar, 2004).

In a governmental report from 2004, the industry sector of Cleantech is mentioned as a key competence area in Sweden that should be supported by the innovation systems. The report presents a strategy where public actors should encourage a development of commercially viable technology in the environmental sector and Cleantech is mentioned as one out of four significant industrial sectors for Swedish industry development. An intention to increase public seed financing in early development stages of ventures is also mentioned (Regeringskansliet, 2004).

The role of financing has been described in the previous sections as an important component of innovation and a keystone in the context of innovation systems. Therefore, the next chapter will view the role of financing and financial actors in relation to innovation and sustainable innovation. The section aims to portray the role of investors, with a focus on venture capitalists, and how they assess and analyse their potential investments.

4 External Financing of Innovation

4.1 General about External Financing of Innovation

4.1.1 Why is External Financing Needed?

External financing is needed when the innovation process requires higher capital investments than the innovative person or company can realize. Typical capital needs arise from long R&D programmes, or during development periods of high growth when the cost of the expansion exceeds the income.

4.1.2 External Financing Methods of Innovation

A venture can be financed by either loan financing (credits) or equity financing. The major difference in the financing is the risk the investor holds and the possible return that the investor anticipates. Equity financiers hold a larger risk but expect a higher return than other investors. In addition to these approaches of financing, there is a range of financial instruments that may provide a cap of the risk for an investor.

An exception from these basic distinctions in the methods of financing are the credits offered by governmental institutions. These governmental credits are often written off in case of failure of a venture. Though these credits hold a high risk for the investor - the government institution - these should not be seen as venture capital (Connect Sverige, 2004).

There are three main actors that provide financing for innovation ventures. First, the government gives high-risk credits, subsidies and provide financial incentives as part of the innovation system to ventures that are believed to give a positive contribution to the development in society. These credits and subsidies are seen as a complement to the private market for development stages of ventures when the market condition does not attract private actors (Neergaard, 2004). The government is also active as a direct or indirect equity investor. In Sweden, the government have had an active role for direct and indirect investments through institutions as Industrifonden and 6:e AP-fonden. Table 4-1 presents the main governmental financing schemes. Second, industry also finances innovation. The rational for such operation can be purely financial or an approach to follow and control new technology innovation in strategically important areas (OECD, 1997). Third, private equity financiers finance innovation where market conditions are assessed favourable, with sufficient financial return in relation to its risks (Isaksson, 2004).

Table 4-1 Main government financing programmes

TYPE	PURPOSE
DIRECT SUPPLY OF VENTURE CAPITAL	
Government Equity Investments	To make direct investments in venture capital firms or in small firms
Government Loans	To make low-interest, long-term and/or non-refundable loans to venture capital firms or small firms
FINANCIAL INCENTIVES	
Tax Incentives	To provide tax incentives, particularly tax credits, to those investing in small firms or venture capital firms
Loan Guarantees	To guarantee a proportion of bank loans to qualified small firms
Equity guarantees	To guarantee a proportion of the losses of high-risk venture capital investments
INVESTOR REGULATIONS	To allow institutions such as pension funds or insurance companies to invest in venture capital

Source: OECD, 1997

4.1.3 Equity Financing

Investors equity financing can be divided in to subgroups. Figure 4-1 describes the relation between these groups. Risk capital investments are investments in the equity of a company. The term reflects that all equity investments are at higher risks than loan financing. As a large part of risk capital investments are investments in companies that are quoted on the stock exchange, the major part of risk capital is not private equity investments. Private equity is investments in companies that are not publicly traded on a stock exchange. It includes venture capital investments, but also other investments in companies that are not listed on a stock exchange, where the investor does not have an active role as investor in the company. Venture Capital are investments in companies that are not publicly traded on a stock exchange and where an investor takes an active role as owner in the company (Isaksson, 2004).

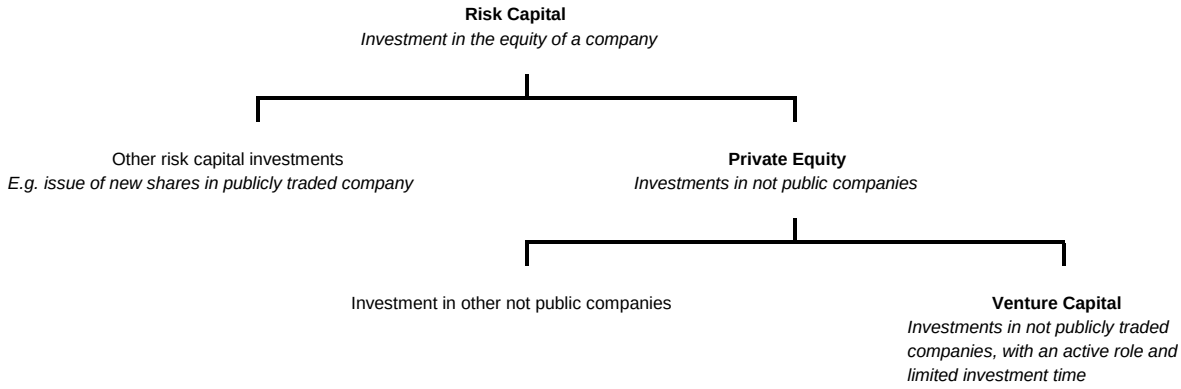


Figure 4-1 Risk capital, private equity and venture capital

Source: Isaksson (2004)

4.1.4 Risk and Return

The understanding of an investor's level of investments and choice of investments is a matter of risk and return. That is, the assessment of the risk that the venture faces during the time from the investor's investment to exit and the assessment of the potential return that the investor sees at the time of exit.

4.1.5 Categories of Investment Risks

In the finance literature, risk is often defined as the deviation from the expected result, where both results that are higher than and results that are lower than the expected result are considered. That is, the risk is the combination of the probability and degree of deviation from the expected outcome. In corporate finance theory, the financial risks with regard to stock markets are divided in systematic risks and un-systematic risks, where the systematic risks relate to the market and un-systematic risks relate to the company itself (Brealey & Myers, 2000). The idea is that the unsystematic risks can be diversified away, or decreased as an aggregate risk, by combining a group of corporate risks, for example by holding an investment portfolio of companies.

This portfolio theory is relevant to venture capitalists, as venture capitalists' investment in a portfolio of companies reduces the aggregate level of risk. The degree of reduction of risk relates to the how diverse the companies in the investment portfolio are, from a market perspective.

Another consideration for the venture capitalist when assessing the risk is the development stages of the portfolio companies. The earlier the development stage of the portfolio company, the more the risk is related to the operation of the company and less to the market. Hoffman (2002) defined operational risk in five categories; people risk, relationship risk, technology risk, physical risk and risks that results from external factors (including regulatory risk) (Hoffman, 2002). Wüstenhagen and Teppo (2004) have developed these categories to be better adapted for the venture capitalist perspective; product market risk, technology risk, exit risk, people risk and regulatory risk (Wüstenhagen & Teppo, 2004). As the scope of this thesis

is concerned with the earlier development stages of companies, these categories will be used to view investment risks.

4.1.5.1 Product Market Risk

Product market risk refers to the fact that demand for a new product and services of a venture are usually little known in advance. The adoption of new products or services depends on the future customer demand and can only to a limited extent be influenced by the venture. The assessment the venture capitalists have to make is the future demand for the venture's product and services.

In B2B markets with high market concentration, there is an additional product market risk. A small number of potential customers decide the use of a potential technology and act as gatekeeper for the venture to reach the end-customers (Wüstenhagen & Teppo, 2004).

4.1.5.2 Exit Risk

Part of the venture capitalist business operation is to exit the investment after some years. Exits can take place in five forms, of which the first two are the most relevant for the scope of this thesis, as these are more common for early development stages; (1) a public offering of the company's shares (IPO), where the shares of the company are quoted on a public stock exchange, (2) a trade sale, where a company acquires the venture, (3) a secondary sale, where the venture capitalist sells its ownership, or part of it, in the venture to another investor, (4) a buy-out, where the company sells its ownership to the management of the company or to a entrepreneurs, often in co-operation with the management, and (5) a write-off in the case of a default of the venture (Cumming & MacIntosh, 2003). Trade sales are about double as common to compared to IPOs. The explanation offered by Amit, Brander and Zott (1998) is that strategic buyers have an information advantage and are in better position to value the a venture compared to an average outside investor (Amit, Barander, & Zott, 1998).

The assessment a venture capitalist has to make is the future possibility to exit an investment and the future market interest in such exit strategy.

4.1.5.3 Technology Risk

As an innovative technology is developed, there is a risk that, at the end, the product and service may not work from a technical point of view. There is also a risk that the technology may be outdated a long the way of the development (Wüstenhagen & Teppo, 2004). To some extent, the investor can manage this risk by requiring a prototype to be developed as a proof of functionality, and by staging the investment so that later financing rounds are tied to the achievement of milestones in the technology development. A problem with setting such milestones are that the route of development may be difficult to assess at the time of the investment and that the development efforts may be tied to certain technological paths.

4.1.5.4 People Risk

In high growth areas, there is per se a constant change in the business environment of a new venture. Therefore, the ability of the entrepreneurs to make sound judgements and to have an ability to adapt to new challenges is crucial for the success of a venture. This risk is typically handled by a venture capitalist by a due diligence of the management team, close monitoring and coaching of the team and sometimes by replacing the existing management (Wüstenhagen & Teppo, 2004).

4.1.5.5 Regulatory risk

Regulatory risk, which is also referred to as political risk, steam from the government regulation of the end-consumer market. Many sector are regulated in varying degree, where the market of Cleantech innovation is seen as being highly dependent on and exposed to regulation. The assessment of regulatory risk is often outside the core knowledge of the investor and is often disliked, as it tends to be hard to influence and manage. A closer look at traditional target industry sectors of venture capitalists' show that while ICT probably has a relatively low level of regulation, sectors as biotechnology and telecom are also highly regulated. The investment interest in such regulated sectors can be seen as an assessment of high expected return and shows that regulatory risk does not have to be a definite barrier for investment (Wüstenhagen & Teppo, 2004).

4.2 Venture Capital Financing

4.2.1 What is Venture Capital?

Venture capital can be defined as investments in companies that are not publicly traded on a stock exchange and where an investor takes an active role as owner in the company, and where the investment is limited in time with a planned exit for the investor (Isaksson, 2004).

There is a distinction between formal and informal venture capital. Formal venture capital is performed in companies specialised in venture capital investments. Formal venture capital is often organised as a management company with management responsibility for a venture capital fund. The investment managers employed by the management company carry out the investments and coach the portfolio companies. The investments are made from the fund and the return from the investments flows back to the fund. Figure 4-2 show the most common operational set-up of formal venture capital. Informal venture capital is investments by private individuals, often mentioned as business angels. Business angels are often executives from the industry that take a new role as active investors in start-up ventures. A recent development is that Business angels organize themselves in networks, Business Angles Networks, with an aim to support the operation of its members (Gullander & Napier, 2003).

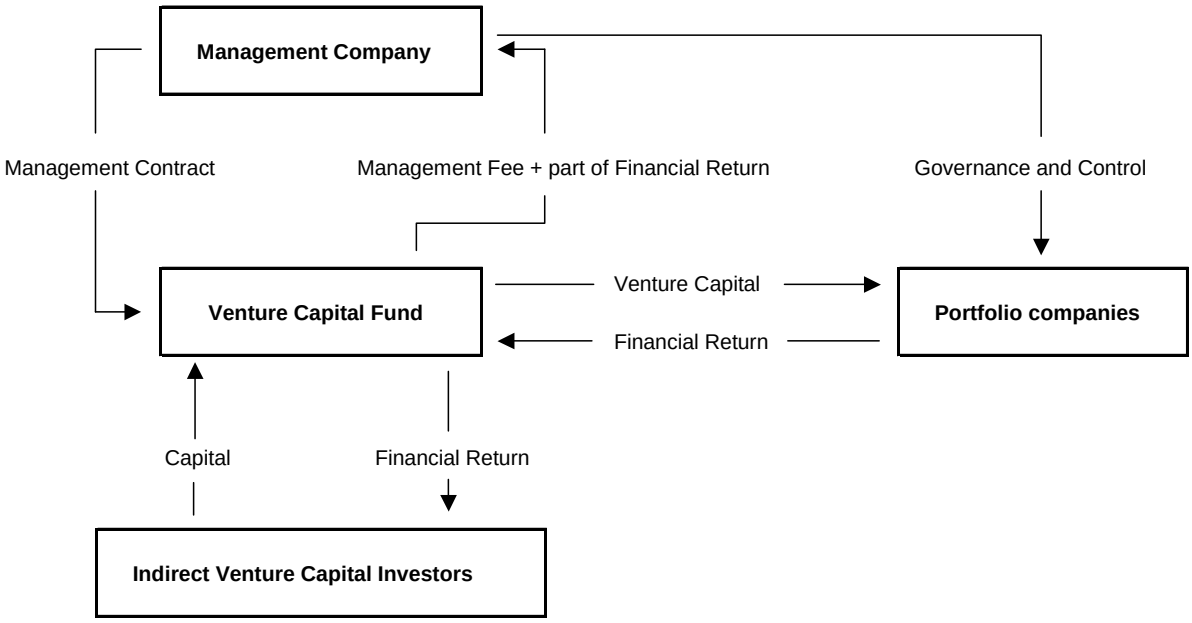


Figure 4-2 Common organizational set-up for formal venture capital

Source: Adapted from Isaksson (2004)

4.2.2 Industry Segmentation

Venture capitalists focus their investments in segments, based on industry sectors, geographic regions and the venture's development stage, with a purpose to increase the competitiveness of the venture capital operation.

The development stages of ventures are:

- Early stage financing, with subgroups seed financing and start-up financing (sometimes the stage pre-seed financing is also used). In seed financing a small amount of capital is invested in a venture to typically try out and show proof of concept. Start-up financing provides capital that could be product development and marketing activities as a first step towards commercial production and sales.

- Early growth financing, with subgroups first-stage and second-stage financing. In first-stage financing the capital is typically used to start commercial production and sales. In second-stage financing, the capital is needed to expand the commercial activities.

- Expansion stage financing, with subgroups third-stage expansion financing and bridge stage financing. In third-stage expansion financing the capital is usually used for expansion in production capacity, marketing and product development for companies that are in a strong growth phase.

- Mature stages, with subgroups leveraged and management buyouts. The capital is used to acquire a part or the whole of a company, often in co-operation with the management of the company (Isaksson, 2004).

Most venture capitalists have a geographic focus. The focus varies depending on the level of focus of industry sectors, but also in what development stage the venture capitalist invest in. The rule tends to be: the broader the industry focus, the more narrow geographic focus. For development stages, the rough rule is: the earlier in the development stage the more narrow geographic focus. Seed financiers, for example, often select target geographic regions in close proximity to the their operations (Gullander & Napier, 2003).

4.2.3 Operations: Processes and Strategies

4.2.3.1 Main Competencies

The main competences that the investor organisation holds are the analytical ability to assess industry sectors and ventures, operational know-how to guide and coach the business development in the portfolio companies, and corporate finance know-how to perform transactions.

The various competences are often divided in specialist roles as analytics, investor managers and corporate finance specialists. In general, the specialist roles have a varying degree of input in the different parts of a venture capitalist's investment cycle.

4.2.3.2 Closing of Investment Funds

Formal venture capital companies often attract external funding when setting up the investment fund. The presentation of the business idea of a venture capital fund to potential in-direct investors is the first step a potential venture capital company takes before being in operation. As a business plan of a venture capital company and fund is being presented to potential in-direct investors, important verification of potential success are track records of prior venture capital activities, professional history of the management and investment focus of the fund. The investment focus can, already at this stage, be tied to target industry sectors for investment.

As the venture capital operation develops, a natural step to expand the venture capital business is to set-up a parallel fund to the existing one. Thus, setting up and closing of funds is an on-going activity in many venture capital operations. The expansion into new target industry sectors may occur with the development of parallel funds.

Informal venture capital more seldom has structured funds, but may co-invest with other investors. The choice and change of investment focus are often steered by the prior professional experience and know-how (Steen & Frankel, 2003).

4.2.3.3 Target Sectors

There is a need for investors to have a competitive understanding of the industry context of a potential investment. Industry sectors where an investor sees a potential of high return in relation to its risk and where the investor management has, or sees a possibility to increase know-how, are therefore selected as target industry sectors. In the selection process, the analysts screen development in society. The large trends of people behaviour and consumption patterns are analysed, together with close monitoring of business and consumption development in leading markets for a particular industry sector. Information about the industry sector is gathered mainly by the investor's own intelligence, company visits, media and by industry sector specific reports from corporate finance institutions. Influences from venture capital operations in other countries are common. The know-how in a target

industry sector is accumulated over time by recruitment, building of external personal networks and from experience by performing investments.

As a competitive know-how in an industry sector takes time to build, there is a hurdle to overcome for an innovation area as Cleantech innovation, before it is seen as an industry sector and has a financial industry sector reporting that support investors' decisions. The target geographic area and the development phase of investments are selected mainly based on competitive advantages of the organisation and organisational structure (NVCA, 2004).

Steen and Frankel (2003) describe the steps of mitigation that venture capital investors take towards a new industry sector. First, venture capital investors educate themselves in the market and industries. Second, they look for outsiders, such as consultants and industry experts, to help them examine markets and technologies. Third, they search for technologies that have potential suppliers and customers in the industries with which they are familiar.

4.2.3.4 Potential Investments

The position an investor seeks to achieve in the pre-investment stage aims to give an overview of the target industry sectors and its ventures to find investment opportunities in early stages of the ventures development. The earlier a venture of interest is identified, the higher the potential return, but also with an accompanying higher risk. An investor also seeks to be seen as a knowledgeable and experienced investor in the industry sector to be able to attract ventures that seek investors. In this active and reactive manner the venture capitalist creates a deal flow, that is, the number of ventures that are screen by a venture capitalist. A large deal-flow increases the probability to identify investment opportunities and is an indicator of operational performance. The primary source of high quality deal flow is from a venture capitalist's network of contacts (Steen & Frankel, 2003).

4.2.3.5 Assessment of Potential Investments

An investor commonly assesses a venture in steps, with a go or no-go decision after each step. As a first step, the investor often makes a general assessment of the ability of the team to be successful with its aims to bring an innovation to the market, based on interviews with the management of the venture and reviews of the presentation material. Also, the investor assesses the management time needed for the venture. If the general assessment is positive, a due diligence process is performed with the help of internal and external expertise to determine the investors risk level of the venture and also as assessment of the capital gross needs of the venture. Based on the gross capital needs, a plan for the ventures need for capital over time until a positive cash flow is achieved in the venture, can be made.

Appendix 1 presents the major investment criteria investors use when deciding to invest capital. Different investors place different weight on these areas when making investment decisions and the weight on each criterion vary by type of investment. However, the factors are the ones citied most frequently in research (Steen & Frankel, 2003).

As a next step, a valuation of the venture is performed. The most common method used for valuation is the discounted cash flow method. An assessment of the business-plan of the venture and its projected income and cost streams is carried out and an adjusted business-plan is created based on the investor's prognosis. Based on the adjusted business-plan, the future cash-flow streams are then discounted to achieve a present value of the venture. When performing the valuation, the gross risk of the venture is included as a factor in the calculation. Other valuation methods are comparative analysis, where the values of

comparative companies are compared to the venture, and equity valuation, where the equity in the balance sheet of the venture is valued (NVCA, 2004).

4.2.3.6 Investment Transaction

In the transaction stage the negotiations between the owners of the venture and the investors take place to agree on issues as the value of the company, the amount of capital that will be injected into the venture and future financing obligations of the investor. Often a shareholders agreement is presented, as a basis for the new government of the venture, before the transaction takes place. Also, follow-up investments are considered. Typically, venture capitalists earmark anywhere from 25% to 35% of a venture fund for follow-up rounds of investment (Steen & Frankel, 2003).

4.2.3.7 Business Development

Venture Capitalist take an active role as a part owner of a venture. Though, the degree of participation may vary. Normally, a venture capitalist provide the venture with investment reports and analysis of the development in the industry sector, operational support in business development, support to attract professionals to the management and the board of the company and to lead the work with attracting capital in follow-up rounds of financing.

As the venture capital funds develop with a growing number of investments, time to support the portfolio companies tends to be a constraining factor for venture capitalists.

4.2.3.8 Exit Transaction

The exit of the investment is often planned from the beginning of the investment. Most probably methods of exit are evaluated and a readiness to begin the work to exit is kept. The success of a venture capitalist is present only after exits of the investments have been made. The exit transaction mainly includes negotiations and corporate finance efforts.

Research has shown a clear link between the between the level of investments and the performance on the stock markets, especially for growth stocks. When stock markets perform well, venture capital activity is high. When there is a decline in the stock market performance, venture capital activity decreases. The market decline after the heavy ICT investments in the end of the nineteenths is a pronounced example. In the U.S., NASDAQ stock exchange fell with 68% between January 3, 2000 and December 31, 2002, and venture capital investments in the U.S. decreased by 80% in 2002. This may seem irrational, as one of the reasons for investors to make private equity investments is to diversify their risk. When public markets perform poorly, private equity should increase rather than decrease from a diversification point of view. On the other hand, a closing window for IPO exits means that venture capital investors may find it difficult to exit their investments with the increased exit risk, which keeps them from investing in the first place (Wüstenhagen & Teppo, 2004).

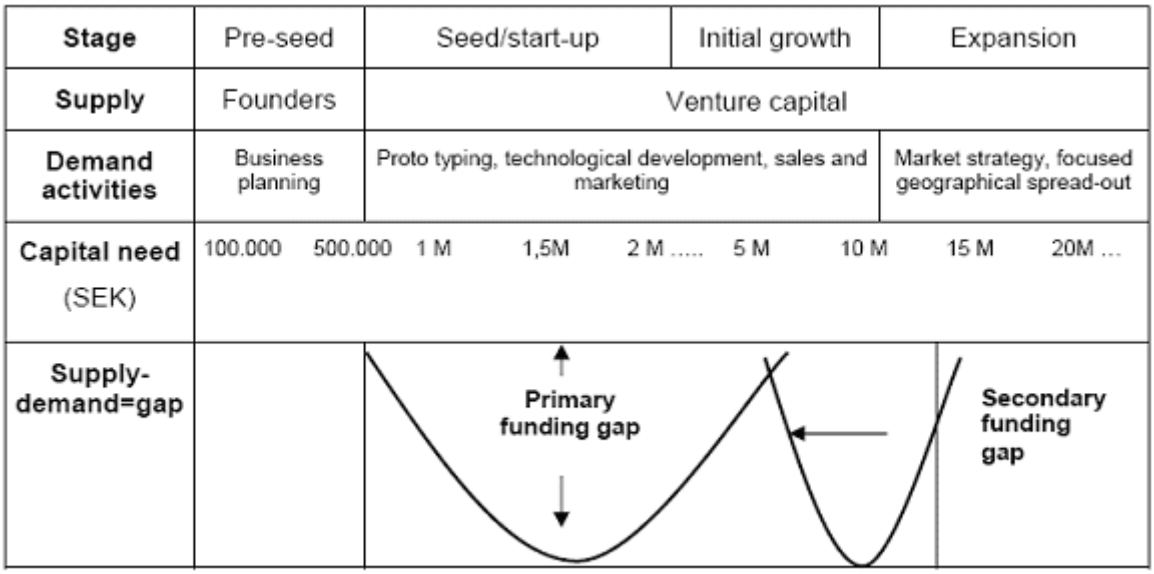
4.2.3.9 Incentives

As an equity owner in a company, the incentive to build the company value is similar to the entrepreneurs of the venture. Though, the limited time span a venture capitalist have may give an incentive to build the value in a quicker pace than what is optimal for the entrepreneurs. On the other hand, the entrepreneur may have incentives other the value growth of the venture, which may cause a conflict of interest.

4.2.4 Demand and Supply of Venture Capital

Access to external capital is difficult for investment seeking entrepreneurial ventures and the shortage of venture capital is one of the greatest hurdles for start-up companies and high-growth business areas. The venture capital market has grown in the last decades to meet the demands of risk capital in early stages of development. But as venture capitalists per se are risk-avert, large sums are invested in stages of businesses once they have passed the more critical development stages. Table 4-2 presents a general view of the demand and supply of venture capital. As the figure presents, there are two funding gaps in the development cycle. First, there is a funding gap in the seed stage of the company development. The capital needs are not large, but as income is often very limited the needs are there. Second, there is a funding gap in the early expansion stage. This gap arise from capital requiring business activities as the introduction of products and services to a commercial market or geographical expansion (Gullander & Napier, 2003).

Table 4-2 Demand and supply of venture capital



Source: Adapted from Gullander (2003)

4.2.5 Private and Public Venture Capital

As the private external investors assess the ROI in relation to the investment risk to be low in some of the development stages, the overall rate of innovation is threatened. One could argue that a strategic external investor should "subsidize" such stages of development, and make investments to support the overall innovation. But empirical studies do not support the existence of such behaviour (Gullander & Napier, 2003).

The lack of funding is also due to an information gap preventing investors in locating appropriate investment-seeking firms, and innovators of locating relevant investors. Financial theory is based on the assumption that venture capital markets function efficiently with fully informed investors and innovators. In reality, the innovating company face a market with only limited assess to relevant information about investors, and vice versa. This market imperfection is especially prevailing in early investment stages (Gullander & Napier, 2003; Sohl, 1999).

The lack of funding in some stages creates a need for the government to supply venture capital in these stages and act as a risk reducer for private venture capitalists. According to Neergaard (2004), the government has a responsibility to supply funding as part of the innovation system, with an aim to secure growth. It is important that governmental venture capital is focuses to venture development processes, when there is lack of capital. A situation when public venture is competing with private venture capital is not desirable (Neergaard, 2004).

4.2.6 Green Venture Capital and SRI

More than USD two trillion of investment capital worldwide is invested in funds that use social, environmental and ethical criteria to select stocks. Most large financial institutions now offer clients SRI possibilities to invest. The larger amount invested in SRI is in part due to the debunking of an early myth that socially and environmentally friendly investments have lower financial return. A survey conducted by Credit Suisse in early 2000 found that the world's largest SRI funds averaged higher returns than the S&P 500 index (Propper de Callejon, 2001).

One can make a distinction between investments where the investor invests in SRI from a pure business perspective and when the investment value the environmental and social dimension in parallel with the dimension of financial return. In the first view, the investment is single bottom-lined, as the investment is based on the belief that socially and environmentally friendly investments have a high financial return. SRI is a way to assess company operations and management performance with an aim to find companies that are more aware of SRI issues, which, in turn, reflects more effective operations. Dearing (2000) describes the view as with enlightened and effective management, the sustainable companies deliver more predictable returns with fewer negative surprises. The latter view reflects a willingness to accept a lower financial ROI, as the investor also values the social and environmental returns.

A natural progression would be that SRI investors - from pension funds and state treasures to financial advisors and individual investors - might seek opportunities in venture capital financing. On average the larger investment portfolios have a more or less established component of venture capital, with allocations to this investment class from 3% to 12% of total assets (Propper de Callejon, 2001).

4.2.7 Venture Capital in Sweden

The Swedish venture capital and private equity industry started during the second half of the 70's. Companies and private people started to organise their investments in innovative ventures with big possibilities for expansion and venture capital companies where founded, with the aim to support start-up ventures with capital and management support.

The Swedish government has traditionally been a large actor in the venture capital market. The first Swedish venture capital company, "Företagskapital", was founded in 1973 and five years later the foundation "Industrifonden" was established. The objective was to support industrial growth through equity investments and development loans. In the early 80's, several venture capital companies and foundation where added and a separate listing for small cap companies was created on the stock exchange. In the 90's, as a development of the government operated tax funds, additional means where transferred to the private equity market. Due to the large involvement in venture capital by the government, the development of the Swedish venture capital market has been subject to several regulations from the government as the venture capital was used as political steering instrument to control and stimulate growth (Dealflower, 2003).

Englund & Leghammar (2004) argues that a targeted public venture capital financing in Sweden of Cleantech innovation is needed. The arguments proposed are:

- There is a need for industry sector specific financing to create growth. The argument is based on the notion that innovations tend to develop in clusters, where one innovative venture support another (Rogers, 2003)

- The change in society to a sustainable development probably calls for radical innovations and technology shifts, which in turn creates a need for public intervention

- As there is a large commercial potential for Cleantech innovation, public intervention should increase the speed of the development in the sector.

- There is a lack of know-how in the financial industry about Cleantech innovation.

- As private venture capital is mostly invested in areas where the investors' have large know-how and experience, it creates a time lag for private investors to select Cleantech innovation as a target investment sector.

- It creates a possibility to co-invest with EIB

Two arguments oppose public target venture capital intervention according to Englund & Leghammar (2004). First, a selection of target investment sub-sectors creates a higher risk in the venture capital operations and from a societal perspective. Second, private venture capital may view target capital as a subsidy, which enforces possible perceptions that Cleantech innovations not are commercially viable (Englund & Leghammar, 2004).

4.2.7.1 Supply of venture capital in Sweden

The Swedish public system for venture capital financing is being currently reviewed. In June 2004 a model was presented, where the structure for venture capital controlled by the government is been revised to increase efficiency in the innovation system. The planned annually supply of public venture capital, high-risk credits and subsidies for early stage financing is planed to approximately SEK 600 million.

The Swedish private venture capital companies that pursue direct investments in unlisted companies and ventures manage a capital of SEK 190 billion. About 58 percent (SEK 111 billion) of the capital is already invested. Early growth financing and expansion stage financing together, accounts for 53 percent of the venture capital (SEK 100 billion), whereof 53 percent (SEK 53 million) is invested (Dealflower, 2003).

4.3 Venture Capital Financing of Cleantech Innovation

4.3.1 The Need for Venture Capital into Cleantech innovation

There is a need for early stage financing of Cleantech innovation that may be larger than in other technology areas, as Cleantech innovation has not yet fully been recognized as an investment sector for private venture capitalists. Swedish Trade Council (2004) has recognized such need and it assesses Cleantech innovation to be the fastest growing industry sector in Sweden. The same financial needs are recognised by Steen & Frankel (2003) for the U.S. market.

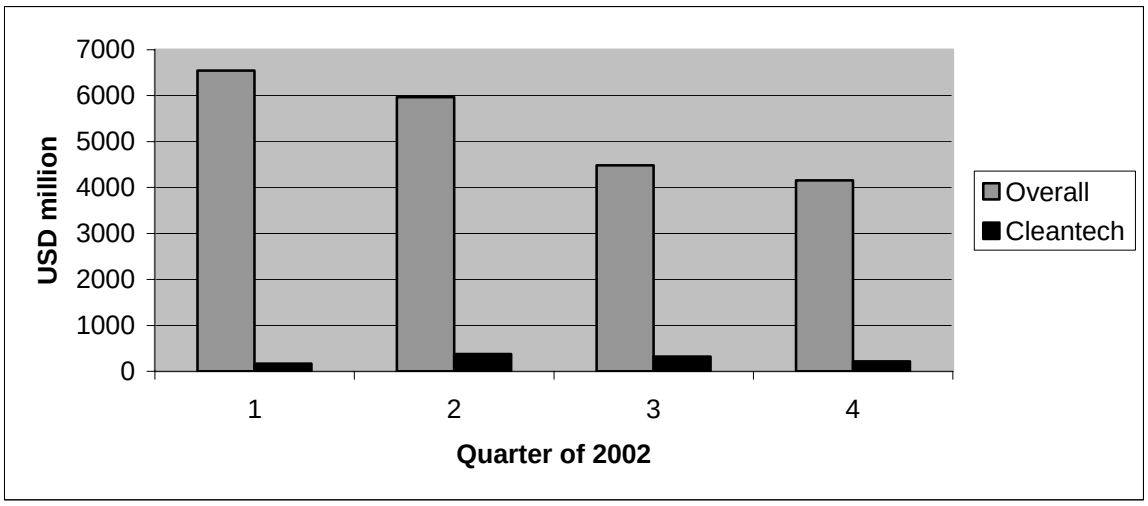
4.3.2 The Flow of Venture Capital into Cleantech Innovation

Steen & Frankel (2003) compare the Cleantech sector with the ICT sector, and argue that utility industries as energy generation, water distribution and waste treatment have vast opportunities for improvement in efficiency, flow and utilization similar to those characterizing the value proposition of ICT ventures. These industries rival the ICT industries in terms of annual revenue, there are many experienced professionals that are available to staff new ventures and there are many innovations that may improve the performance of such industries. Still, the inflow of venture capital is significantly less into these areas than into the area of ICT.

Steen and Frankel found that the amount of capital flowing into an industry had little correlation with the industries revenues. For example, the revenue of the energy industry's electric and gas sectors totalled USD 400 billion in the U.S in 2001. The same sectors had a venture capital inflow of approximately USD 600 million in 2002. In contrast, the software industry revenue was approximately USD 62 billion, while it received a venture capital inflow of USD 4.6 billion in 2002. The capital inflow rate into software was 50 times higher than the flow into the sectors of electric and gas.

For Cleantech, the venture capital investments for 2002 in the U.S. amounted to USD 1,084 million in 2002, compared to the overall venture capital investments of USD 21.149 billion, which correlates to 5.1 percent. The investments are presented in figure 4-3.

Figure 4-3 Venture capital investments in the U.S. quarter 1-4, 2002



Source: Steen & Frankel (2003)

It is difficult to compare the investments in Cleantech in the U.S., to the Swedish market as no such categorisation of the investments have been made and few surveys have been performed. Though, from the interviews in this research and from existing statistics one can assume relatively low investments into the Cleantech sector in Sweden. As an indication, the investments into the energy sectors by Swedish venture capitalists are low, less than 1% of invested capital in Q1 2004 (SVCA, 2004). This is also supported with by the findings by previous research, where low investments in renewable energy technology in Sweden was found (Dealflower, 2003).

4.3.3 Barriers to External Financing of Cleantech Innovation

4.3.3.1 Systemic barriers

The systemic concerns described in section 2.5, lowers the attractiveness for investors to invest in Cleantech innovation. First, as Cleantech innovation creates externalities in the adaptation and diffusion phases of the innovation process, the innovation process may become more costly than the innovation processes of competing goods and services, and thus less attractive for an investor. Second, as the externality problems are concerns for the regulatory framework, it increases the risk for the investor. Therefore, a higher ROI is expected by investors to allow for such increased risk.

4.3.3.2 Specific barriers

Wüstenhagen and Teppo (2004) find three levels of specific barriers to investments in sustainable energy technologies: (1) the perceived risk of investments, (2) assessed returns in sustainable energy, (3) the maturity of the industry sector (Wüstenhagen & Teppo, 2004).

In the research performed in the U.S. market by Steen & Frankel (2003), findings reflected similar barriers. In there interviews with venture capitalist, the five main perceptions about Cleantech innovation as an investment area were: (1) the money flows where the money knows, (2) The returns for investors in these industries are not significant, (3) the regulatory structure makes these industries unattractive, (4) clean technology is still undeveloped, (5) entrepreneurs in these areas are weak in business expertise (Steen & Frankel, 2003).

In chapter six these perceptions of investments in Cleantech innovation will be analysed, with a perspective from the Swedish market.

5 The Need to Categorize: Introduction of the Analytical Framework

5.1 Why investment sectors?

Investors have a need to categorize investment areas to be able to assess industry sectors and possible investments. In the research the following main comments where made by the interviewees of why there is a need to categorize:

- To gain up to date information about the sector performance and estimations of future development in the industry sector
- To have a common definition when talking to investors, analysts and other actors in the financial industry
- To be able to build a network of contacts in the industry and among consultants working with the industry
- To be able to assess possible investments and develop the business of portfolio companies
- To be able to structure the analysis, value the input of data and assess exit possibilities
- To build experience over time and provide for an investment focus

Thus, the main needs to categorize an investment revolve around (1) collection and (2) valuation of information, (3) participation in a common language of reference, (4) building of personal networks and (5) building of organizational competence.

With these mentioned needs in mind, the next section will provide the analytical framework for categorisation of Cleantech innovation. Englund (2004) present the three models as "frameworks to contribute in the understanding of the sector of Cleantech" (Englund & Leghammar, 2004). The three models depict essential parts of Cleantech innovation from a systemic approach, from a development approach and from a market approach, respectively. The purpose of the models is to create a common view of the characteristics of Cleantech innovation and contribute to the definition of the sector.

5.2 Analytical Framework: Three Models of Categorization

5.2.1 The Descriptive Model based on Environmental System Principles

The criteria described in this model are based on four system principles presented by Azar (1996). By the adoption of Englund & Leghammar (2004) the principles are elucidated by what 12 types of innovations that are required to fulfil these conditions. The 12 innovations categories have been developed to characterise and evaluate participating ventures in the environmental competition "Miljöinnovation".[3] Over 500 ventures have been evaluated based

[3] Swedish competition for environmental innovation ventures, http://www.mintlink.com

on these categories during the last six years.[4] In evaluations, the categories have been assessed to be relevant and appropriate as a tool for the jury of the competition (Englund & Leghammar, 2004).

The model is presented in box 5-1. The system principles are presented as headlines, followed by numbered innovation categorizes.

[4] The conditions have recently been adjusted with an addition of point 4,5 and 11.

Box 5-1 The Descriptive Model based on environmental system principles

In a sustainable society, the function of the nature is not disturb by a systematically increasing concentrations of substances from the earth's crust

1. Innovations that reduce the use of non-renewable materials
2. Innovations that reduce the use of non-renewable energy

In a sustainable society the function of the nature is not disturb by a systematically increasing concentrations of substances produced by society

3. Innovations that reduce the use of poisonous substances and substances that are difficult to decompose
4. Innovations that clean discharges of poisonous substances and substances that are difficult to decompose
5. Innovations that clear prior discharges of poisonous substances and substances that are difficult to decompose

In a sustainable society the function of the nature is not disturb by a systematically impoverishing, physical manipulation or over-harvesting

6. Innovations that contribute to keeping or increasing biodiversity
7. Innovations that increases the possibility to use water- and/or land resources in a more sustainable way

In a sustainable society resources must be used efficiently and fairly to meet basic human needs worldwide

8. Innovations that reduce the use of energy
9. Innovations that reduce the use of, or reuse, raw materials
10. Innovations that provides a increased life span of a product or service
11. Innovations that measures and analyses environmental effects
12. Innovation that provides ethical and soldiery values

Source: Englund & Leghammar (2004)

5.2.2 The Staircase Model based on Sustainable Development

The staircase model presents a picture of the sustainable development in society. The model, portrayed in figure 5-1, provides a framework for assessment of the main strategies in society to solve environmental problems, step by step, which creates new commercial markets. The model is a simplification of reality, but may serve as an pedagogic representation for preliminary analysis of potential environmental markets (Englund & Leghammar, 2004). UNEP has presented a similar picture of the development with an extended number of steps (Brezet & Von Hemel, 1997).

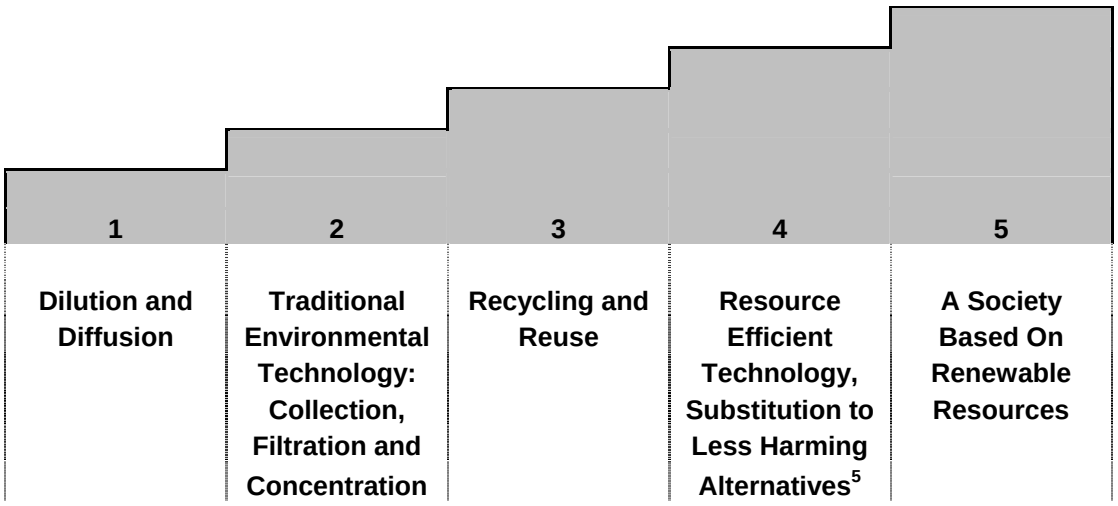


Figure 5-1 The Staircase Model

Source: Englund & Leghammar (2004)

5.2.3 The Market Positioning Model

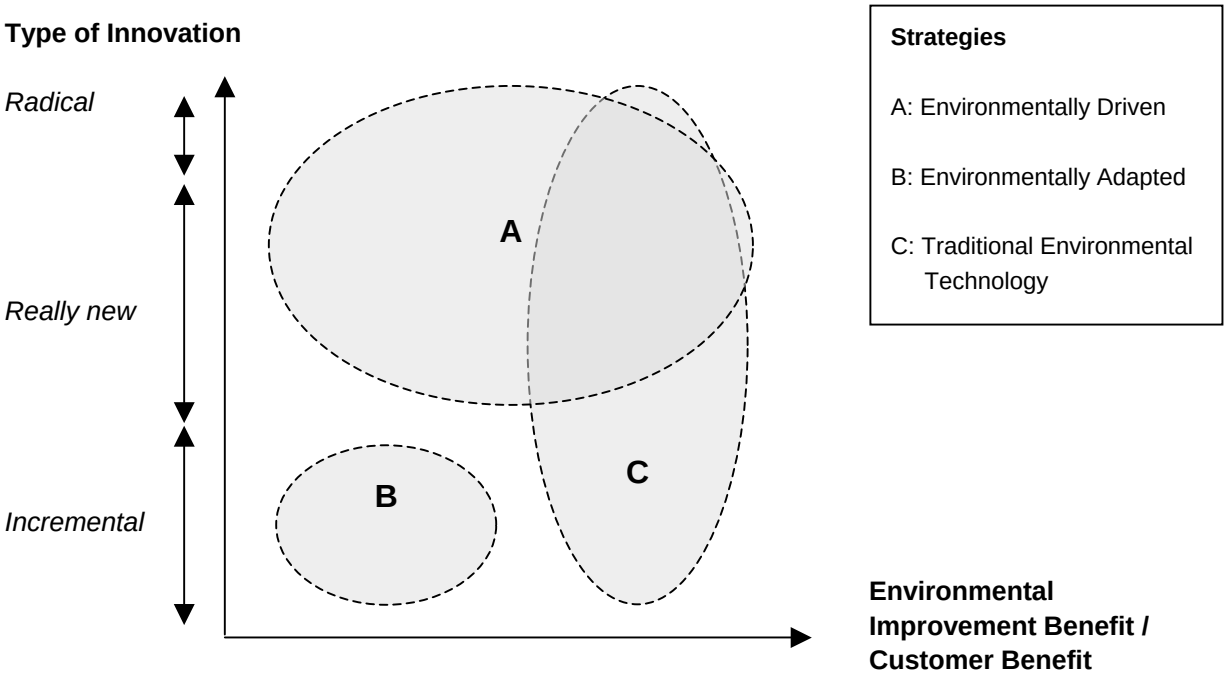
According to Englund & Leghammar (2004), a company may position its environmental innovation strategy according to two factors:

- The level of customer benefit of the environmental innovation
- The level of innovativeness

Figure 5-2 portrays the two parameters of positioning of the environmental innovation development strategy. Three strategies are presented: (A) environmentally driven strategy, (B) environmentally adapted strategy and (C) traditional environmental technology strategy. In the figure, the vertical axis presents the type of innovation and the horizontal axis presents the environmental benefit of customers as a ratio between the customers' environmental improvement benefit and the total benefit of the customers.

For traditional environmental strategy, the main customer satisfaction is an improvement of the environment. For environmentally adapted strategy, the main customer satisfaction is something else than an improvement of the environment. The improvement of the environment is secondary to the customer, but may increase the attraction to the product or service. The environmentally driven strategy has a high degree of innovativeness, but has a varying degree of environmental customer satisfaction (Englund & Leghammar, 2004).

Garcia & Calantone (2004) have presented classifications of how the level of innovation should be measures, and NUTEK (2003) has presented definitions on environmental adapted products and services (the latter is adapted for the model by Englund & Leghammar). The definitions relating to the market positioning model are presented as part of figure 5-2.



Radical Innovation

Innovations that embody a new technology that result in new market infrastructure, with new markets and customers, e.g. world wide web.

Really New Innovation

Innovations that provide technical leaps or radical changes on the market, but not both. For example, the first fax (a technical leap that did not change the market in a radical way) or Sony Walkman (no technical leap but a radical change of the market).

Incremental Innovation

Innovations that provide new features, benefits or improvements to an existing technology in an exciting market. An innovation process in small leaps, e.g. BMW X5 that is iteratively improved and with time gains a large market share.

Environmentally Driven Strategy

To create new markets and business concepts based on knowledge of sustainable usage and possibilities and barriers in the ecological system.

Environmentally Adapted Strategy

To increase the market share based on increase environmental efficiency and adaptation of exciting products and services.

Traditional Environmental Technology Strategy

To increase the market share based on technological and business development in industry sectors as environmental cleaning, clearing and measurement.

Figure 5-2 The Market Positioning Model

Source: Adapted from Englund & Leghammar (2004); orgin of definitions: Garcia & Calantone (2002) and NUTEK (2003)

In the research data was collected on the barriers for investment in Clenatech innovation. The understanding of the barriers is essential to understand in what way categorization can help in reducing such barriers. In the next chapter, the barriers are presented as systemic and specific. The first reflects the barriers that are inherent in the system of Cleantech Innovation. The latter presents the perceived risk of investment among venture capitalist, as a reflection of the assessed financial return of the sector and maturity of the industry. The aim of the chapter is to present the key barriers that reduce investments in Cleantech innovation.

6 Investment Barriers of Cleantech Innovation: Research Findings

6.1 Systemic Investment Barriers

6.1.1 Externalities and Regulatory Effects

The systemic barriers presented in section 4.3, are based on the creation of externality effects in the Cleantech innovation process. The externality effects create non-paid public benefits, which decrease the ROI for investors. This is known by investors and is a concern when assessing Cleantech. The concern is two-fold. First, there are benefit takers that are non-paying customers, and second, it is difficult to assess the amount of externalities of a product or service. Both concerns add to the risk of the venture. Rennings (2000) argued that the double externality risk rising from externality effects takes place both in the adaptation and diffusion process. This was not brought up as a concern by any of the interviewees. Externalities are mentioned as a barrier for investment, but investors do not recognize an increased risk due to externality effects in two steps of the innovation process.

The outcome of the externality effects causes a regulatory risk. It is mentioned by a majority of the interviewees as a major concern in the assessment process of a potential investment. The risk based on demand from regulations is seen as an unstable customer demand. The underlying ecological demands that force the regulations and could contribute to the assessment of the regulatory risk, are little considered. At the same time, the investors recognize the commercial opportunity that arises with extended regulation. But since the investment cycle of venture capital is in average several years, the concern for regulatory changes based on political forces, overweighs the commercial opportunity.

Two findings of the research relate to the regulatory risk. First, as the regulatory risk is a systemic risk, it may also affect other risks for the investor. For example it may indirectly reflect exit risks as the possible takers of the investment (both trade sales and IPOs) will assess the regulatory risk and therefore may have a less interest in the venture. Second, as the both risks arising from externality and regulatory effects are difficult to quantify, the level of risk may be assessed higher than the actual level of the underlying risk. That is, uncertainty is in itself a source of risk. One investor brought up a response strategy to reduce the uncertainty in assessing the risk. The investor mitigates some risk by only looking at investments that both have a non-environmental and an environmental benefit for the customer. The rationale of the diversification is that risks relating to environmental demand are determined by other customer preferences than the risks that relate to other kinds of demand factors.

6.1.2 The double regulatory effect

There tend to be political conflicts that undermine the position of innovative Cleantech companies. Research has shown that regulation in a larger degree than for other innovative technology sectors creates the demand for Cleantech products and services. But there may be regulations and political ambitions that may be in conflict with the regulation steering towards sustainability. It can be seen as a double regulatory risk, as there is a regulatory risk and a risk that the regulation may be in conflict with other regulations. An example mentioned from the interviews is the construction industry, where one can see regulation that aims at decreasing the production costs of new buildings and at the same time regulation that aims to reduce the use of poisonous substances. These regulations tend to be in conflict. For the investor, it

creates a higher regulatory risk, and a higher ROI is needed for pursuing an investment in such venture.

6.1.3 Investment Sector Indexes

The information flow in the financial industry follows the categorisation, or indexes, made by larger institutions, often suppliers of information themselves. Credit institutions and corporate financial service providers have a large influence as these organizations provide indexes that are used worldwide by many actors. Standard & Poor and Morgan Stanley are examples of such financial service providers.[5]

These indexes provide an industrial categorization, with accompanying sector reports of industry performance. The venture capital industry, as information taker and potential customers of the larger financial institutions, follow these indexes mainly for thee reasons. First, it creates a common language in the financial industry. Second, it is a good source of industry specific financial information, and third, it follows the structure of the publicly traded industry. The latter reason reduces the exit risk for the venture capitalists as the major exit strategies all benefit from complying with exciting structures in the financial industry.

Therefore, the larger financial service providers influence in what degree and in what speed an industry sector is treated as an investment sector. But what influences the construction of the indexes and amount of information provided? The interviews provide three basic factors, as an answer from the venture capital industry's point of view.

6.1.3.1 The bulk of value in an investment sector

The amount of possible commercial activity is determined by the value of the industry sector. As such, the bulk of value of the publicly traded companies in a sector has to be large enough for the financial industry to treat it as an industry sector of interest.

This may create a catch twenty-two situation, as innovations per se may be the starting point of a new industry. That is, the innovative industry sector may grow slowly due to that lack of existing mature industry in the innovative area, and the financial industry may therefore have less interest to treat the industry as an investment sector and provide less information than it would have if there would have been a mature industry.

6.1.3.2 The homogeneity of an investment sector

When deciding an investment sector, the homogeneity of the investment sectors' customers determines the scope of the sector. The more homogeneity of customers, the easier it is to treat it is as an investment sector. The Cleantech area, where environmental benefit can be supplied in products and services in various industry segments and where the product and services satisfies a range of customer demand, is seen as a very heterogeneous.

6.1.3.3 Star performers in an investment sector

A third determinant is commercial star performers. This was mentioned in several of the interviews as a necessity to "kick-off" investments in the Cleantech sector. Comparisons were made with the ICT sector and companies like Microsoft and Oracle were mentioned as

[5] See http://www.standardandpoors.com and http://www.morganstanley.com.

important for the emergence of the sector. When there are innovations that turn out to be commercial star-performers the interest of venture capitalist will increase and competence will be build in venture capital organizations.

6.2 Specific Investment Barriers

Steen and Frankel (2003) researched the flow of venture capital into Cleantech ventures in the U.S. The paper outlines the barriers preventing venture capital from flowing at higher rates into industries that offer investment opportunities in technology with environmental and economic benefits. In the research the authors found five categories of specific barriers among the venture investors. They are as follows:

Box 6-1 Perceptions of specific barriers to investment in Cleantech innovation

	Investor Perceptions
1.	Know-how steer investments
2.	There are no ROI's for investors in these industries
3.	The regulatory structure makes these industries unattractive
4.	Clean technology is still undeveloped
5.	Entrepreneurs in these areas are weak in business expertise

Source: Adapted from Steen & Frankel (2003)

The barriers are based on perceptions of investors, reflecting the assessed financial returns in Cleantech and the maturity of the industry. This section views these investor's perceptions from a Swedish point of view.

6.2.1 Perception: know-how steer investments

The perception reflects the view that investors invest in ventures and entrepreneurs with which they are familiar. The deeper the industry experience and expertise the more risk can be mitigated. This is something the in-direct investors of venture capital funds want to see before entrusting the venture capitalist, and is therefore reflected in the selection of target investment sectors of the venture capital fund.

As the venture capital industry of Sweden had a strong growth phase during the rapid growth of the ICT industry, this expertise is often reflected among the investment professionals. The background of these investment professionals from the ICT industry are typically an entrepreneur who has built and exit an ICT company, senior management in an major ICT firm or investment professional who have brokered deals in the ICT industry.

As the primary source of high quality deal flow comes from the investment professional contact network, the professional background of an investment manager influences the selection of ventures that are assessed by a venture capital company. Also, as part of venture capitalists core business is to work actively with the portfolio companies, the personal professional experience of the investment managers may influence in what companies the investor chose to invest. That is, the investment managers' ability to contribute in the value growth of the company steer the investment-focus of the investor. When exploring this for the Swedish venture capital market, we see that it is true that ICT receives the largest part of

venture capital investments (SVCA, 2004). In the interviews, the strong focus towards the ICT sector is recognized. But investors also have a belief that the general business experience is more important than industry sector knowledge. This notion may relate to the development stage of the venture capital industry in Sweden. As mentioned in the interviews, the more mature the venture capital industry is, the stronger industry specific sector knowledge will be required with increasing competition.

There are three arguments that would counter-argue this specific risk for the future development in the Swedish market. First, there has been a strong growth in other industry sectors. Biotechnology is the best example of a growing industry that has received increasing attention during the last five years. There are venture capital firms in Sweden that have adapted to this market opportunity and new venture capital firms have started that have a targeted investment focused towards the biotech sector [6].

Second, as competition in the venture capital industry increases, the commercial opportunity will be to change target sectors. A change of target sectors relate to the investment directives a venture capital funds have from the in-direct investors of the fund. In turn, these investment directives relate to the investment directives and the portfolio analysis of the in-direct investor. Therefore, such changes are often performed as a new fund is started. In Sweden, that development can be exemplified by the recent start-up of a new venture capital fund with Cleantech as investment target sector.[7]

Third, there is an increasing interest to invest in Cleantech in the U.S. The investments doubled in Q1 2003 compared to the same period in 2002, with and investment total of USD 325 million (NVCA, 2004). And as the U.S. market is leading the way into many investment sectors, it is probable that Sweden will follow. Still, the investment represents a small part of the total investment volume.

6.2.2 Perception: there are no ROI's for investors in Cleantech

In the interviews, four reflections where made by the investors regarding the ROI in Cleantech: there is a high degree of replacement customer market, the investment horizon is long, there is no history of successful exits and capital requirements are high.

Compared to other types of innovative technology Cleantech was mentioned to have a larger degree of a replacement customer market. Customers have technology in place that is replaced by more environmentally friendly substitutes. For innovative Cleantech companies this means that barriers as established customer markets and rigid industry supply chain relations must be overcome. As an example, chemicals for waterproofing in the construction industry were mentioned. Even though there are alternative products at competitive pricing, the barriers to reach customers are high. This creates a higher product market risk for investors when assessing investment in Cleantech companies.

Regarding the investment horizon and successful exits, the interviews revealed three issues that may support a longer time horizon for an investment. First, there is a perception that there are no clear trade sale exit routes in the Cleantech industry. No established companies are probable takers for small companies with innovative ideas. For IPO as exit route, it is difficult to assess the public interest in Cleantech companies. Therefore, the exit risk is

[6] As example of specialized venture capital company, see Healthcap, http://www.healthcap.se.

[7] See http://www.engelsberg.se.

assessed by the investors to be one of the larger risks for investments in Cleantech. In comparison, in the ICT industry, there is a culture of achieving technological advances by acquiring small, innovative companies.

Second, the exit strategies for B2C product and services are less attractive than those for B2B. This notion relates to that B2B markets for Cleantech innovation is seen as riskier than B2C markets. Barriers in shape of behavioral changes are often required for creation of demand in B2C markets and these are assessed to be large for Cleantech, where B2B Cleantech areas are seen as a more mature industry. Therefore, investments in B2C may increase the investment horizon.

Third, as the personal networks in the Cleantech sector are less developed among investment executives, it is more difficult to identify strategic exit options. These findings are in line with the experience from the U.S. market (Steen & Frankel, 2003).

The capital requirements for developing Cleantech ventures are seen as high among the interviewees. Also, the uncertainty of what capital requirements are needed is high among investors, which may reflect a less developed industry sector. Looking at the statistics in the U.S. market of venture investments for the first quarter 2003 (NVCA, 2004), there is no evidence for heavier investments for Cleantech development. If one compares industrial and energy companies with semiconductor and software companies, the industrial and energy companies were funded with less investment at every stage of the company development. [8] This an indication on that Cleantech may need, if not less, at least not more capital requirements than target industry sectors as the software and semiconductor sectors (Steen & Frankel, 2003).

6.2.3 Perception: the regulatory structure makes these industries unattractive

Investors perceive the Cleantech sector as highly regulated with an accompanying high regulatory investment risk. The perception of such risk, which is difficult to assess, creates an uncertainty for the investors and is seen as a main barrier.

Compared to the ICT industry this is true. The ICT industry is mostly self-regulated through standards. Standards are achieved via monopoly, standardization bodies and through adoption by a majority of industry players. Though, the customer market of the ICT industry is often highly regulated, for example the financial markets or the telecommunication industry. Thus, if regulation is seen as predictable investors may not be reluctant to regulation itself, but the uncertainty surrounding the regulatory processes. Also, at the customer level, regulation can create business opportunities. While regulation can create difficult barriers, it can also create opportunities for entrepreneurs and for commercialisation of new technologies (Steen & Frankel, 2003). Such view may be facilitated with increased understanding of the underlying change in the environment that push the environmental regulation which can be seen as a long-term process that counter-effects short-term regulatory changes.

[8] Definitions of software, semiconductor, industrial and energy follow the NVCA guidelines of the PWC MoneyTree Survey, http://www.pwcmoneytree.com.

6.2.4 Perception: clean technology is still undeveloped

Many of the ventures in the Cleantech sector are seen to be at a premature stage by the interviewees. The opinion is that the technologies are too far away from a commercialisation stage to be viable investments.

Viewing the Swedish export market for technologies in the Cleantech sector, this perception is less supported by reality. According to the Swedish Trade Council the Swedish Cleantech export has strongly exceeded the expectations, with an export for 2002 of SEK 15 billion and an annual growth of 8,4%. Cleantech is the industry sector in Sweden that shows the larges growth rate and the expectation is that the export will reach SEK 20 billion by 2005. As the export is approximately 38% of the turn-over of the environmentally exporting companies, there should be a potential to increase the rate of exported products and services (Swedish Trade Council, 2004).

Steen and Frankel (2003) point out that e.g. the cost of renewable energy per kilowatt-hour is already directly competitive with coal and gas-fired fossil fuels. The National Renewable Energy Laboratory predicts a further price per kilowatt-hour equalization, as the cost of new, cleaner fossil fuel power sources will be higher than previous, more polluting, techniques. Thus, in the renewable energy sector the technology is competitive (Steen & Frankel, 2003).

6.2.5 Perception: entrepreneurs in these areas are weak in business expertise

The perception among the interviewees is that the entrepreneurs in the Cleantech sector have a lack of commercial experience, with a tendency to focus more on the environmental benefits than the commercial gains.

Viewing the presentation of the participants in the competition "Miljöinnovation", the focus on the environmental aspects of the innovation is true (MInT, 2004). The innovation process may spring less from the market demands than the technology area that provide the innovation, which is reflected by the professional background of the entrepreneurs. Though, the experience from other investment sectors is that experienced executives may be recruited to ventures when the industry sector is seen as a high growth area.

The perception brings out a contradiction for the venture capitalists. One of the offerings of venture capitalists is to support the venture with management advice. If ventures are weak in business expertise, one could see it as an opportunity for the venture capitalists. Findings in the research show that what is required is not always the business expertise itself, but a mind-set that is open and committed to a commercial way of running the operations. This mind-set of entrepreneurs is essential for venture capitalists, to be able to align the commercial strategies of the operation and to be able to contribute with business expertise.

Based on understanding of these systemic and specific barriers, the next chapter will provide an analysis based on the analytical framework. The purpose of the chapter is to discuss the issues of categorisation and to assess the possibility to reduce barriers to invest by the use of the models in the analytical framework.

7 Categorisation in the Analytical Framework: Research Findings

7.1 The Descriptive Model

There is a need for investors to understand what type of customer benefit that an innovation potentially will bring to the market, as the customer benefit is a reflection of the future financial return of the venture. The descriptive model presents the potential environmental benefits of innovation in 12 categories that have been developed to characterise and evaluate participating ventures in the environmental competition "Miljöinnovation". The categories build on the underlying conditions of the ecosphere, presented as four system conditions (Azar, Holmberg, & Lindgren, 1996). The system conditions provide the systemic demand that will drive innovation in the Cleantech area. As such, the descriptive model provides the demands from the ecosphere in two levels on abstraction.

The types of innovations, or ventures, mentioned by investors in interviews are well covered by the 12 categories. The categories have an explanatory value and provide an understanding of what kind of technology is considered as Cleantech. In the same manner, the conditions have a fundamental explanatory value to investors, and may act as a long-term strategic foundation. The conditions add to the understanding of Cleantech by portraying future society needs, which in turn are going to create future Cleantech innovation demand. As such, the main value it provides for the investors is the venture capitalists' selection of target sectors and as an instrument to understand the sustainable benefit of a venture.

A first notion from the interviews is that the Cleantech definition describes technology that brings benefit to the environment. A Cleantech innovation contributes with any kind of technology that could apply to customer demands of a cleaner environment. This is not sufficient for the investors. A recurrent comment from investors is that the area of Cleantech must provide a better understanding of customer demands. That is, to connect the technology innovation stronger to the industry segments that the innovation targets as a commercial product or service, as the industry segments reflect the customer demands. When deciding on what investment category a venture belongs to, the commercial market of the ventures product and services is an important parameter. The competing forces that the future products and services of the venture will be exposed to are important determinants for the probability of success of the venture, and should therefore be portrayed in an attempt to categorize the sector.

A second notion from the investors is that the area of Cleantech innovation is wide, that is, technological environmental innovations can be achieved in a range of industry sectors. For example, companies in the ICT industry sectors can perform Cleantech innovation. As the core knowledge in the company is ICT, it is the industry sector categorization preferred by investors. As one investor expressed it: "To understand the determinants of an industry area is more important than having the industry area presented as an industry sector itself. If the characteristics of the area are such that it cuts through many other industry sectors and has a wide area of possible customers, why not view the sectors as a sub-sector that may be part of other main investment sectors."

A third notion is that, as the area of Cleantech innovation is wide, it creates a necessity for investors to decide on sub-sectors for investments. Such investment focuses can be based on either an industry segment or a sustainability classification focus.

If the descriptive model would be extended with a target industry segment perspective it would provide a connection between the underlying demand from the ecosphere, with a clarification of Cleantech innovation by the sustainability classification of the 12 categorizes, and a reflection of the customer demands from the industry segments.

Figure 7-1 presents a framework that combines the target industry segments with the categories of the descriptive model. The framework contributes by the connection of systemic demand of the ecosphere with the demand reflected in the target industry segment. It provides an opportunity for the investors to view possible focuses of investment within the sector of Cleantech. The framework provides two examples of investment focuses. First, an investment focus that emphasises the knowledge building around selected sustainability classes, and second one that underline knowledge creation of the needs of a target industry segment. One could also see an even more specialized investment focus, which is the interjection between these two, where the investment focus is limited to the selected sustainability categories in selected target industry segments. The narrowed down investment focus increase the possibility for investors to meet the five needs mentioned in chapter five.

Azur (1996) points out that the system conditions provide a frame for ecologically sustainability. The framework of the four conditions is "general enough to be valid for all imaginable scenarios of a future sustainable society in any culture of the world" (Azar et al., 1996). The 12 sustainability categories are developed with empirical information collection from the competition "Miljöinnovation. The target industry segments are developed with empirical information collection by Cleantech Venture Networks from contacts with ventures seeking financing (Cleantech Venture Network, 2004). The latter two may be adopted over time with new experiences and needs.

Sustainability Classification	1	2	3	4	5	6	7	8	9	10	11	12
System demands	A		B			C		D				
Target industry segment												
Energy generation & storage												
Energy infrastructure & efficiency												
Water supply & quality												
Air quality												
Materials & nano-technology												
Manufacturing												
Waste treatment												
Agriculture & nutrition												
Enabling technologies												

Example of Cleantech investment focuses

Sustainability Classification

1. Use of non-renewable energy (reduction)
2. Use of non-renewable materials (reuse or reduction)
3. Use of poisonous substances and substances that are difficult to decompose (reduction)
4. Poisonous substances and substances that are difficult to decompose (cleaning)
5. Prior discharges of poisonous substances and substances that are difficult to decompose (clearance)
6. Biodiversity (sustentation or increase)
7. Sustainable use of water resources and/or land resources (increase)
8. Use of energy (decrease)
9. Use of raw materials (reduction)
10. Product and Service life-span (increase)
11. Environmental effects (measurement)
12. Ethical and soldiery values

System demands

A. Decreased accumulation of substances from the Earth's crust in the ecosphere

B. Decreased concentration of substances produces by society in the ecosphere

C. Decreased impoverishment, physical manipulation and over-harvesting of the ecosphere

D. More efficient and fair use of the resources

Figure 7-1 The Adapted Descriptive Model

Source: Adapted from Englund & Leghammar (2004), Azar (1996) & Cleantech Venture Network (2004)

7.2 The Staircase Model

The staircase model presents the main strategies in society to solve environmental problems step by step, which creates new commercial markets.

Based on the findings of needs of investors the staircase model mainly contributes in three ways. First, it provides a general understanding of the evolutionary development in society towards sustainability. The model is as such a pedagogic model for investors to gain insight in the process of change towards a more sustainable industry production. Second, it is an instrument for investors to assess where in this process of sustainable development a specific geographic region can be positioned. Industry sectors in a geographic region may be in various stages, e.g. the construction industry in Sweden reached step number four in late the 1970th, and is currently in stage five (Englund & Leghammar, 2004). Therefore, the relevance for investors increases with the possibility to target the stage of development for industry segments that are chosen as an investment focus in the adapted descriptive model. Third, the technology of a portfolio company or a possible investment can be positioned in the staircase model. If this outcome is compared to the outcome in point two, it provides a possibility to assess the time gap for the market demand to evolve. Consequently, the model provides value to investors in the assessment of income streams and market risks of a potential investment. Also, it contributes to evaluate possible market strategies for portfolio companies.

As part of public policy systems for innovation, market assessments in various industry segments for various geographic markets according to the staircase model could be beneficial for investors as decision information. For example, the export potential can be presented in the staircase model. Englund & Leghammar (2004) presents the current situation in Sweden for sustainable innovations in the format of the staircase model, where the innovations of the finalists in the competition Miljöinnovation, the sustainable innovation investments of Industrifonden and the export of Cleantech are positioned in the model (see figure 7-2). The amounts are presented as a percentage of innovations belonging to each step as part of the total amount of innovation for the competition "Miljöinnovation", investments in Industrifonden and export of Cleantech, respectively. In the figure one can see high levels of innovation in the later steps of the staircase model. About 78% of the innovations of the finalist of the competition "Miljöinnovation" are referable to the steps four and five. Industrifonden has about 62% of their sustainable technology investments in step four. The export based on Cleantech innovation is currently strongest in step 2, with about 38% of the innovation referable to this step. The figure suggests a strong potential for further export of Cleantech.

If these findings were compared to assessments of market demands as described above, an assessment of the correlation between innovation activity and future market demand would provide value insights for investors to what market demand today's Cleantech innovation in Sweden can expect.

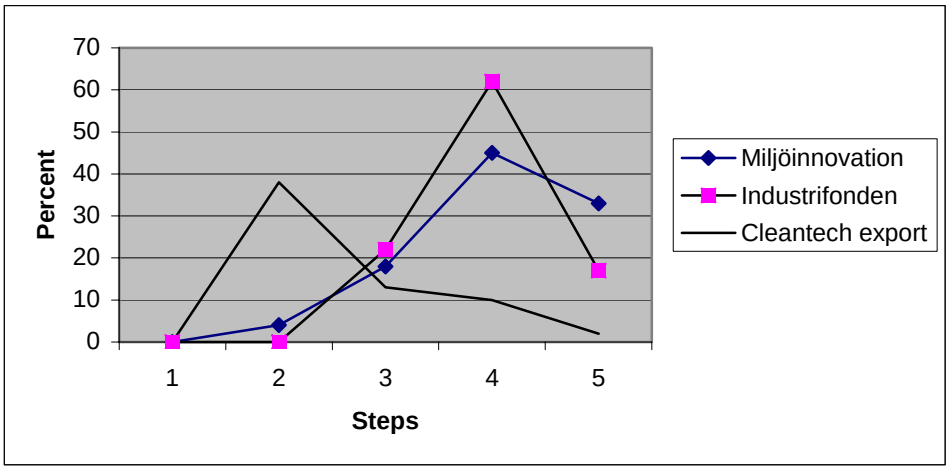


Figure 7-2 Export and innovation of Cleantech in Sweden [9]

Source: Englund & Leghammar (2004)

7.3 The Market Positioning Model

The market positioning model portrays the environmental innovation strategy in a company, according to two parameters: the level of customer benefit of the environmental innovation and the level of innovativeness.

In the model three strategies for innovation are illustrated: (1) traditional environmental technology strategy, (2) environmentally adapted strategy and, (3) environmentally driven strategy. The vertical axis in the figure presents the type of innovation and the horizontal axis presents the environmental benefit of customers as a ratio between the customers' environmental improvement benefit and the total benefit of the customers.

According to the interviewees, one of the problems for investors in Cleantech is the lack of mature reference-companies of the sector. Cleantech as innovation area is seen as a wide area and it is difficult to draw experience from other ventures and companies. As one of the three major methods of assessing the value of a venture is to compare to other reference objects, it is a concern in the valuation process. Portraying the three areas of innovation strategies of an innovative Cleantech company contribute by providing a more specific reference area for comparable studies, especially for an investor in the process of assessing the value of a potential investment.

At the same time, one can ask if a ratio between environmental customer benefit and customer benefit, together with the level of innovativeness is a good way to describe the three strategies. For an investor both factors refer to the value assessment of an investment. The type of innovation predicts in what way the market is going to be changed by the innovation to determine what risks are involved. The second factor, the ratio of environmental customer benefit, presents the type of benefit supplied to the customer. But either of the two factors have a strong benefit as value assessment factors. The type of innovation is per se part of an assessment of the product market risks of an innovation and to divide in various types of customer demand is secondary to determining the level of demand. According to the interviews, it is less important for an investor to be able to divide between customer benefits

[9] About 40% of the export of Cleantech is referable to more than one step.

as environmentally driven and non-environmentally driven, than having a good foundation for assessing the total customer benefit.

Based on the interviews, the most valid reason to present the three strategies to the investors is to create a basis for comparisons in performing valuations (comparative valuation). Such comparative studies could be achieved based on a description of the characteristics of each strategy area of environmentally driven, environmentally adapted and traditional environmental technology. The description may be portrayed in connection to the staircase model.

To test the findings of the previous chapter, two case studies were performed. The aim is to test the validity of the findings in the research towards two innovative companies in the Cleantech sector. As some of the investment barriers refer to the ability for innovative companies to communicate their operation to the investors, this provides an assessment of the models as tools to reduce the uncertainty that revolves around investors' assessment of risks in Cleantech ventures.

8 Case studies: Innovation and its Financing

8.1 Background

The regional industry in Scania has a strong focus on local production and relatively small share of employees within R&D and other knowledge intensive operations. Within the region, there are different industry profiles. The knowledge intensive industry has emerged in the western parts of the region, whereas the industrial structure of the eastern parts is more labour intensive and focused on primary production. The population follows the division into an eastern and western part, with the highest population density in the western part (Region Skåne, 2002; Rolfstam, 2004).

The public sector in Scania has an emphasised program of sustainable development. The region has, as part of the regional innovation system, established organizations that act as facilitators between government, industry and university. Several initiatives have been initiated by these organizations to promote a sustainable production and export of sustainable products and services (Sustainable Business Hub, Länsstyrelsen i Skåne, & Region Skåne, 2004). Three key areas for urban sustainable development in Scania are:

- Sustainable construction and building administration
- Energy and climate efficient solutions
- Water purification

8.2 Description of the companies

The two selected companies are KMI Kemimäklarna International AB and ANOX AB.[10] Both are active in the area of purification of poisonous substances and have their main operations based in Scania. The selected companies are in different stages of development, which provides for a better testing of the findings of the research.

8.2.1 Presentation of Anox AB

Anox is a bio-technical development company with a commercial focus towards Cleantech. The business idea is to develop new bio-technological products and processes for cleaning and clearance of substances in water and to commercialize these on a worldwide market. Anox also provides consultancy services, educational services and laboratory testing.

Anox was started in 1986 as a spin-off from the University of Lund. The foundation of the company was the knowledge in microbiology field together with know-how and practical experiences from the environmental area. The combination provided for new methods of biological purification, which were more efficient and more sustainable than previous methods. In 2002 Anox expanded its operations with an acquisition of a Norwegian company in the same business area. The acquisition rendered Anox to seek external funding. Additional capitalization is expected in the near future. Anox employs 30 people and had a turnover of SEK 106 million in 2002.

[10] For more information about the companies, see http://www.kemimaklarna.com and http://www.anox.se.

8.2.2 Presentation of KMI Kemimäklarna International AB

KMI Kemimäklarna International (KMI) is a development-company for chemical purification products and processes. The business idea is R&D to provide for new innovations with aim to create commercially viable technologies for waste treatment processing. KMI also provides consultancy and mediation services. The research and development of the company has provided a portfolio of five registered patents in the area of chemical purification. Several patents have attracted commercial interest and there have been discussions with venture capitalists and industry parties about start of operations based on the patents. So far, KMI has not received any external funding from venture capitalists.

8.3 Analysis of Case Studies

The analysis of the case companies aims to test the validity of the findings of the research. A categorization and an analysis are provided with an analytical framework that constitutes the adapted descriptive model, the staircase model and the market positioning model.

8.3.1 Case analysis in Adapted Descriptive Model

The operations of Anox can be described in the adapted descriptive model, as presented in figure 8-1. The categorization in the model provides a distinct position for the company. It describes the target industry segment of water purification as customer, the three sustainable classifications and the ecological underlying demand. For investors, it clearly depicts if the company's operation is within the investor's investment focus.

In the interviews with Anox, it was mentioned that the core knowledge of the company is biotechnology, Cleantech and know-how around the environmental customer demand. Also, as Cleantech has a low descriptive value (to wide), the company has decided to describe itself as a bio-technology company in the Cleantech field. This is in line with the comments made by investors. If biotechnology is the core knowledge of a company, this is seen as the investment sector. In the case of Anox, knowledge in Cleantech is seen as a specialization to meet the demands of customers. Therefore, a description of Anox as bio-technical development company with the addition of the presentation of figure 8-1 may be a successful presentation of the company for investors.

Figure 8-1 also presents the operations of KMI. As for Anox, the model provides a distinct position for the company. It describes the target industry segment of waste treatment as customer, the three sustainable classifications and the ecological underlying demand. The core knowledge of KMI is chemical engineering. KMI presents itself as development-company for chemical purification products and processes, with purpose to emphasize both the core knowledge in chemical engineering and in waste treatment processes.

Sustainability Classification	1	2	3	4	5	6	7	8	9	10	11	12
System demands	A		B			C		D				
Target industry segment												
Energy generation & storage												
Energy infrastructure & efficiency												
Water supply & quality			**Anox**									
Air quality												
Materials & nano-technology												
Manufacturing												
Waste treatment			**KMI**									
Agriculture & nutrition												
Enabling technologies												

Sustainability Classification

3. Use of poisonous substances and substances that are difficult to decompose (reduction)
4. Poisonous substances and substances that are difficult to decompose (cleaning)
5. Prior discharges of poisonous substances and substances that are difficult to decompose (clearance)

System demand

B. Decreased concentration of substances produces by society in the ecosphere

Figure 8-1 The Adapted Descriptive Model portraying case studies

Source: Adapted from Englund & Leghammar (2004), Azar (1996) & Cleantech Venture Network (2004)

8.3.2 Case Analysis in Staircase Model

The Staircase model present a description of the technology that the case companies are developing, with aim to fulfill the demands depicted in the adapted descriptive model. It provides a possibility to compare the technology development in the company with present and future needs in a specific geographic region and therefore valuable information on the gaps between the developed technology and market demands.

However, for both Anox and KMI the figure 8-2 presents a picture of a widespread development approach. In Anox, this is due to that the technology that is currently in production could be referred to step two or possibly three. This is the technology provided commercially to customers. At the same time, a large part of the resources in the company is used for the development of new technologies that can be referred to step four. These technologies are not commercially available yet, but is seen by Anox as products that may have an epoch-making importance.

In the contacts with investors Anox encountered an issue of valuation based on these issues. If the company is seen as a operating company with steady revenue flows and a R&D to meet

future demands, the company will be valued based on historic valuation principles. The historic revenues will be viewed and valuation ratios as price per earnings may be used. Thus, the R&D in the company is valued as a natural part of the operations to meet future demands. But if Anox would be valued as a truly innovative company, the valuation would be based on the future income streams of the business to come and it may end up at another value for the company than the previous one. This may be a reflection of the investment barriers of the Cleantech sector. Investors may be reluctant to value innovative efforts, as the uncertainty and risks are too large. It may also reflect a lack of know-how to value innovative Cleantech.

This presents a problem for Anox of how to present the company for investors. As a bio-technical development company, the word "development" indicates a continuous growth and Anox feels that it refers investors to the first valuation approach, with the risk that the innovative efforts are less appreciated. An alternative route mentioned in the interviews, would be to separate the daily operations and the innovative part into two legal identities, with purpose to make to values more transparent to investors.

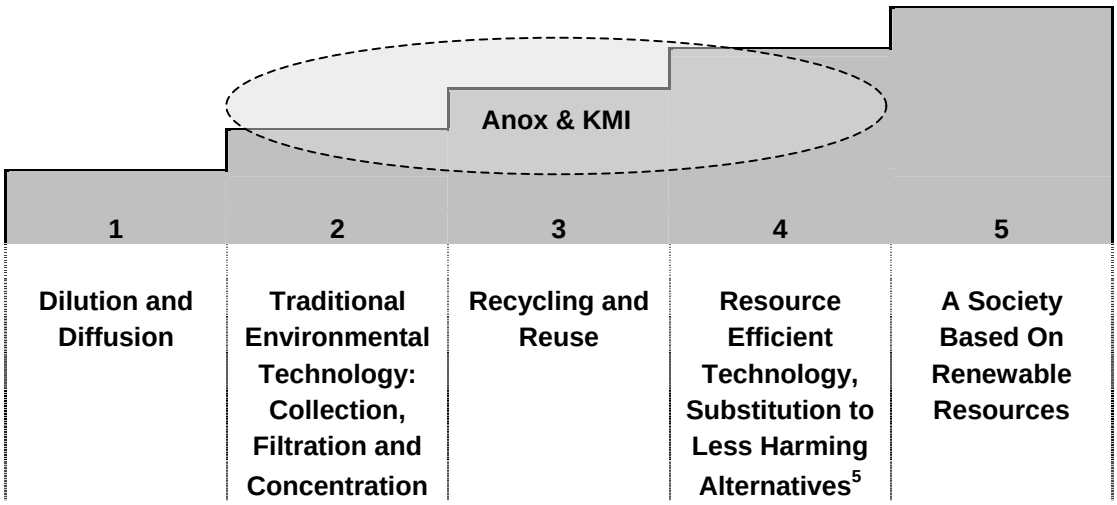


Figure 8-2 The Staircase Model portraying case studies

Source: Englund & Leghammar (2004)

KMI holds a portfolio of five innovative patents. The patents reflect several steps in the staircase model, as can be seen in figure 8-2. This is a reflection on that the innovations are based on an understanding of waste treatment processes, but that the sustainability and technology approaches used in each case differ. This may arise from the development method used in KMI. The patented innovations of KMI are developed in co-operation with customers. Each customer has specific needs, and different approaches are used to solve the situation for respective client.

In contacts with potential investors, this has raised a problem for KMI. A portfolio of patents is difficult to value, and it is less probable that all innovations can create commercial operations within KMI, as the business focus would be too wide. A separation between the consultative activities and the portfolio of patents into two legal identities is one alternative

route for the operations of KMI. The patents could then be offered to third party customers, which may facilitate venture capital financing.

8.3.3 Case analysis in Market Positioning Model

The staircase model presents the environmental innovation strategy of a company. Anox and KMI are presented with similar strategic innovation focuses (see figure 8-3). For Anox, it is divided between the daily operations, which can be described by a traditional environmental technology strategy, and the R&D, which relates to an environmentally driven strategy. The customer benefit is a mix of environmental and other benefit. For KMI, the innovations are related to customer needs and different strategies are used, which best could be described as a range from traditional environmental technology to environmentally adapted strategy. Also for KMI, the customer benefit is a mix of environmental and other benefit.

Even for the case companies themselves, it is difficult to divide the type of innovations and the type of customer benefit into groups, as different kinds of innovation is pursued in the same project and different kinds of benefit arise for different customers. This indicates that the distinctions also are difficult to make for investors.

In the interviews with Anox, an issue of categorization and key-ratios was mentioned. It was noted that investors' categorization of a company reflects on the key ratios used in valuation assessments. If Anox is presented as a bio-technical development company, "bio-technical" presents the investors with a reference to set the valuation ratios based on experience and know-how about that industry sector. The experience of Anox is that such ratios are lower for the Cleantech sector. The area of water cleaning can be a strategy of traditional environmental technology but also more advanced forms of solutions. If the company is benchmarked towards the wrong innovation strategy, and therefore the wrong technology development approach, also wrong values will be applied. If this is the case, it may reflect a lack of understanding among investors of the innovation strategy a company in the Cleantech sector is pursuing and what potential market such strategy targets.

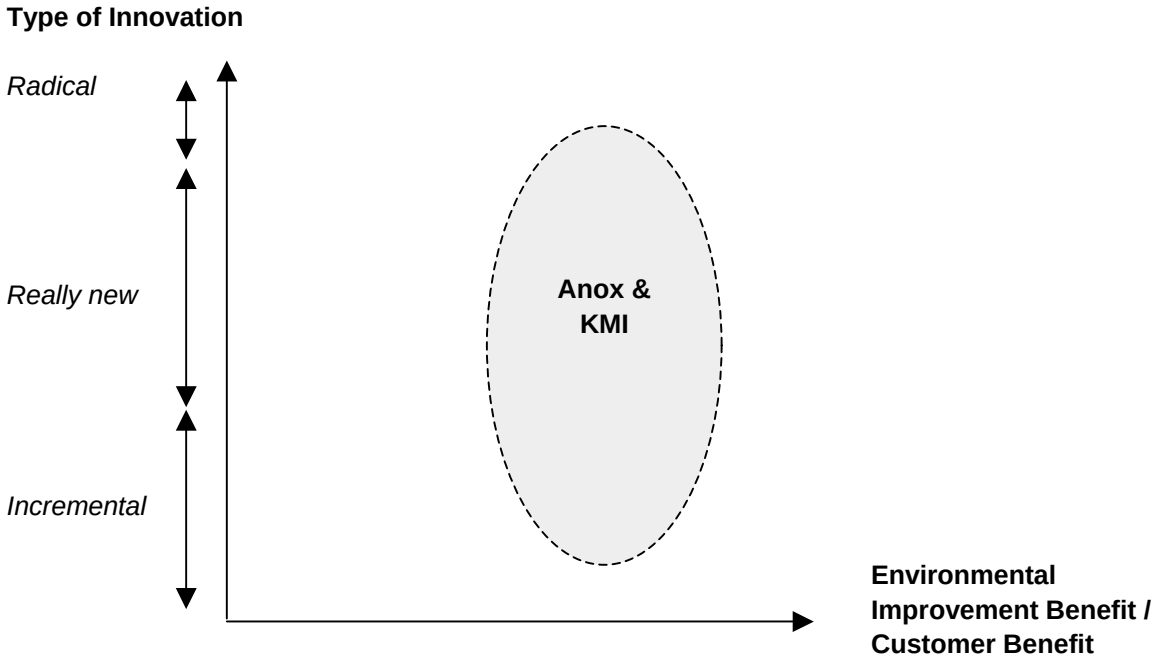


Figure 8-3 The Market Positioning Model portraying case studies

Source: Adapted from Englund & Leghammar (2004). For definitions see figure 5-2.

9 Conclusions, Recommendations and Further Research

9.1 Conclusions and Recommendations

As the core operation of the venture capital industry is to attain financial returns of a large amount of invested capital, one expects the assessment methods used to be efficient and the knowledge in the industry sectors to be profound. Though, two main issues in the research indicate that there might be a lack of efficiency for investments in the Cleantech sector. These findings support the notion of Cleantech innovation as an investment area that attracts less funding than other technology innovation areas.

Cleantech innovation is an emerging investment sector among venture capitalists. Therefore, the information support channels are not as developed as in more mature investment sectors and the personal experience that is built over time has not been gained. Venture capitalists have a dependency on structured information flows for investment assessments and to decide exit strategies. The large financial institutions have a principal role in this sense. When these institutions see the potential in the area and provide sector analysis reports, the venture capital industry has a framework to build their actions and planned actions upon. So what will make the large financial institutions view Cleantech innovation as a substantial industry sector? Three findings are indication of what is needed. First, the bulk of value in the sector must be large enough too make it worth while too organise the analysis into an industry sector. Second, a venture that makes a venture capital backed success case would help to put the industry sector into the spotlight. As one interviewee put it: "If the investment case similar to a fast growing ICT company happens, the hunt will be on and the financial industry will adapt and learn the rules of the sector". These two points create a catch twenty-two situation. The investors need the information in order to invest, and the institutions wait for the industry to flourish. Third, the homogeneity of the investment sector's customers determines the scope of the sector. The more homogeneity of customers, the easier it is to treat it is as an industry sector. The Cleantech area, where environmental benefit can be supplied in various products and services as part of satisfying a range of customer demand, is seen as a very heterogeneous.

Also, the venture capital industry is still an emerging industry in Sweden, and as such has been a follower to the venture industries of other nations. As a period of fast growth in the venture capital industry took place during the years of a fast increasing ICT industry, the professional experience and contact networks among venture capitalists is highly connected to this industry sector. As most of the high quality deal-flow rise from personal contact networks, some industry sectors become of less interest.

In the research various kinds of investment barriers were identified. These barriers are due to systemic and specific investment risks.

The key systemic risks derive from the externality effect, that is, the creation of non-paid public benefits. In turn, that creates a need to regulate to reduce the effect of the external costs, which creates a regulatory risk. The regulatory risk reflects the dependency on regulation as market demand for the developed products and services. An amplification of the regulatory risk was identified in the research, mentioned as the double regulatory risk. It suggests that different regulations may be in conflict and thereby increase the risk level for investors.

The specific risks can be viewed as perceptions among investors. A better understanding of the risks provides for an opportunity to reduce the perceived risk level among investors, but also for policy makers to adapt the enforcement of the regulatory framework. For example,

Cleantech was mentioned to have a larger degree of a replacement customer market compared to other types of innovative technology. Customers have technology in place that is replaced by more environmentally friendly substitutes. For innovative Cleantech companies this means that barriers as established customer markets and rigid industry supply chain relations must be overcome. If such market is created by regulation, an increased understanding of the specific risk may induce changes in the enforcement of the regulation. Also, some of these perceptions among investors have more support in reality, some less. More information to investors about the actual situation of Cleantech innovation may reduce the uncertainty surrounding such risk and thereby reduce the assessed risk level by investors.

As both the systemic risks and the specific risks are difficult to assess, models for categorisation are needed. Investors need to have an understanding and instruments for how to view Cleantech innovation. Based on the properties of Cleantech as a wide sector the recommendation of this research is to look at Cleantech as an investment sector that relates to other investment sectors as in a matrix. If other investment sectors run vertically, Cleantech runs horizontally and adds benefit to ventures that are part of other investment sectors. That is, Cleantech is an investment sector that may bring benefit in other investment sectors. If this is viewed from the perspective of a venture, the main determinant for the categorization should be the core knowledge of the venture. As seen in one of the case studies, the core knowledge of biotechnology categorise the company as a bio-technical development company. Other determinants as the industry segment of customers (e.g. water supply & quality) or sustainability class (e.g. purification) are explanatory values that bring usefulness in the understanding of Cleantech properties.

When assessing the benefit that Cleantech innovation brings to a venture, it is this research recommendation to use the adapted descriptive model and the staircase model to categorise Cleantech innovation. The models provide investors with a good understanding of a Cleantech venture and are well suited for the characteristics of Cleantech innovation described in the section above. The market positioning model is not recommended for three reasons. First, the benefit it provides is of less significance for investors. Second, the value it may provide for comparative valuations can be provided in the staircase model, and third, the model is difficult to understand and use.

The adapted descriptive model was provided as part of this research. It supplies a connection between the underlying demand from the ecosphere, with a clarification of Cleantech innovation by 12 sustainability classifications, and a reflection of the customer demands from the target industry segments. The model also provides an opportunity for investors to view possible investment focuses within the sector of Cleantech. The investment focuses could either be directed towards a sustainability class, towards an investment segment of customers or even more specific, the crossover between the two.

The staircase model adds to this by providing a view of the main strategies in society to solve environmental problems. Based on the findings of the research, it provides a general understanding of the evolutionary development in society towards sustainability. The model is as such a pedagogic model for investors to gain insight in the process of change towards a more sustainable industry production. Second, it is an instrument for investors to assess where in this process of sustainable development a specific geographic region is positioned. The relevance for investors increases with the possibility to target the stage of development for industry segments that are chosen as an investment focus in the adapted descriptive model. Third, the technology of a portfolio company, or possible investment, can be positioned in the staircase model. If this outcome is compared to the positioning of a specific geographic market, it provides a possibility to assess the time gap for the market demand to evolve. As

such, the model provides benefit to investors in the assessment of income streams and market risks of a potential investment. Also, it contributes in the evaluation of possible market strategies for portfolio companies.

Table 9-1 Perceived Specific risk: Adapted Descriptive Model and Staircase Model

	Adapted Descriptive Model	Staircase Model
Perception: Know-how steer investments		
Perception: There are no ROI's for investors in these industries		
Perception: The regulatory structure makes these industries unattractive		
Perception: Cleantech is still undeveloped		
Perception: Entrepreneurs in these industries are weak in business expertise		

Possibility for perceived risk reduction:

Several of the perceived specific risks may be reduced by the use of the adapted descriptive model and the staircase model, as can be seen in table 9-1. The perceived risks related to the first perception ("Know-how steer investments") can be reduced by the adapted descriptive model with the possibility to decide on investment focuses. Such selection of investment focuses provide for an increased understanding of what competences are needed in an investor's organization. The staircase model depicts a further understanding of desired technology competence, with the possibility to position the selected investment focus in the development stages. Also, the use of the models creates a structure for the collection and valuation of information and it creates a common language of reference, which facilitates the building of personal networks in the investment sector and development of organizational competence.

Both the adapted descriptive model and the staircase model can reduce the perceived risk related to the second perception ("There are no ROI's for investors in these industries"). Together, the models provide for a better understanding of when a market opportunity for a Cleantech innovation will arise. Such understanding reduces the risk in the assessments of potential financial returns.

The perceived risk related to the third perception ("The regulatory risks makes these industries unattractive") can probably not be reduced by the adapted descriptive model and little reduced by the staircase models. The latter provides an understanding of the evolutionary development in society towards sustainability, which may offer some insights into the development of the regulatory framework.

Regarding the perceived risk related to the fourth perception ("Cleantech is still undeveloped"), the technology of an assessed venture can be positioned in the staircase model, which provides an understanding of the stage of development of the innovative

technology. If this outcome is compared to the positioning of a specific geographic market, it provides a possibility to assess the time gap for the market demand to evolve for such technology.

The perceived risk related to the fifth perception ("Entrepreneurs in these area are weak in business expertise") is not covered by either of the two models. However, the models provide for a structured way to communicate the risks with the innovative companies, which may reduce the communication gap between investors and innovative companies.

The systemic risks may be less reduced by the use of the models. Though, the models offer a long-term possibility to understand the investment sector and thereby an ability to assess the development of systemic risks over time. Such understanding provides for an understanding of what kind of information is needed, what regulations are more or less established as market demand factors and in what sectors externality effects can be expected.

Currently the innovation systems in Sweden are being reviewed and reorganized to increase efficiency (Neergaard, 2004). In performing such review and reorganization, the proof of Cleantech innovation as a growing export industry is hopefully recognized and incorporated in the innovation system. The findings of this research suggest actions in line with what is presented by Englund & Leghammar (2004), that is, to stimulate demand and build relationships between innovators and customers. A valuable outcome of this would be that one or several commercial success cases based on Cleantech innovation would bring the financial industry attention to the industry sector. This notion is based on research findings that the financial industry can move its focus to a new target industry sector when it believes that the right financial returns are in place and a commercial success case seems to be crucial for the financial industry to focus on a new industry sector.

9.2 Suggestions for Further Research

This research has opened up many issues that require further research to be fully addressed. As shown in this thesis, a reduction of the barriers of venture capital financing of Cleantech innovation would decrease the negative effects on the natural environment. Three suggestions for further research are mentioned that would contribute to the understanding of how these barriers may be reduced.

First, as mentioned in the analysis, the staircase model could be used to predict future demands in a specific region. Such information could be compared to the current Cleantech innovation performed in Sweden. An analysis of the correlation between these two parameters would help to show the strengths and weaknesses in Swedish Cleantech innovation. The findings of the research could be related to the efforts of the Swedish innovation system.

Second, as mentioned in the conclusion of this research, the ICT sector can be seen as a well function area of venture capital investment. Also, ICT is similar to Cleantech as regards the cross-segmental pattern of customers. Therefore, it would be interesting to draw experience from the area of ICT by performing a comparable study between the industry sectors.

Third, the use of investment sector indexes is described in section 6.1. Such indexes are provided by large financial institutions, often suppliers of information themselves. The creation and information flows these indexes support influence the emergence of a new industry sectors. In the research, three deciding factors, as perceived by the investors were mentioned. A research performed with primary data collection from the large financial institutions would contribute to the understanding of the influence of indexes.

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Abbreviations

B2B	Business to Business
B2C	Business to Consumers
EIB	European Investment Bank
EVCA	European Venture Capital Association
ICT	Information and Communication Technology
IPO	Initial Public Offering
LBO	Leveraged Buy-Out
MBO	Management Buy-Out
NVCA	National Venture Capital Association (in the U.S.)
OECD	Organisation for Economic Co-operation and Development
ROI	Return on Investment
SRI	Social Responsible Investment
SVCA	Swedish Venture Capital Association
UNEP	United Nations Environment Programme
VC	Venture Capital

Appendix 1: Investor decision criteria

The list below presents the major investment criteria investors use when deciding to invest capital. Different investors place different weight on these areas when making investment decisions and the weight on each criterion vary by type of investment. However, the factors are the ones citied most frequently in research (Steen & Frankel, 2003).

Econometrics

- Is the market opportunity for the innovation large enough to bring the type of returns that the venture capitalist expect on their investment?
- Can the product be developed, produced and sold in manner that will make the firm profitable?
- What is the potential financial return?
- Are there appropriate financial instruments and vehicles for funding in place?

Management team

- Is an experienced team in place, or are there personnel readily available who are well suited to make this venture into a success?
- Does this team have the right set of skills and experience to guide the firm through the growth phase?

Uniqueness and quality of innovation

- How unique is the innovation?
- How efficacious is it?
- How defensible is it (patents, trade secrets, copyrights, control of resources etc.)?

Location and context

- Are there sufficient sources of needed input within the close proximity, such as talent, services, innovation support?
- Is there sufficient information available to support investment decisions?
- Is there a large enough deal flow to ensure the availability of suitable investments?
- Is the investment opportunity in close enough proximity to allow the investor proper oversight?

Exit

- What is the exit strategy for the investment?
- How likely is it to achieve the exit strategy?
- What is the time horizon to exit?

Risk assessment

- What is the over-all risk level of the venture?
- Is the venture in position to overcome the risks?

Appendix 2: Interview questionnaire sample set

Each group of interviews utilized a unique set of questions, with follow-up questions adapted to the answers of the interviewees. A sample set of the main questions for each group is presented below.

Interviews questions for venture capitalists (formal and informal)

1. Do you see environmental technology innovation (Cleantech innovation) as an investment sector?

2. Have you performed any investments that you categorize as Cleantech innovation?

3. Do you believe that you have the internal competence to assess and develop an investment in Cleantech innovation?

4. Do you believe that you have the external networks to assess and develop an investment in Cleantech innovation?

5. Do you find it difficult to assess and value and Cleantech innovation?

6. Do you believe that it is necessary to have Cleantech innovation as a target industry sector to be able to perform good investments in the innovation area?

7. How do you assess the exit possibilities for Cleantech innovation?

8. What investment risks do you see for Cleantech innovation?

9. Regarding an investor's understanding of Cleantech innovation: what can be done to increase the understanding for the innovation area?

10. If I describe Cleantech innovation in the following ways, what do you find is the most helpful to increase understanding (description on models in Methodology section)?

Interviews questions for analytics/in-direct investors

1. Do you see environmental technology innovation (Cleantech innovation) as an investment sector?

2. Have you performed any investments that you categorize as Cleantech innovation?

3. Do you find it difficult to assess and value and Cleantech innovation?

4. What investment risks do you see for Cleantech innovation?

5. When you assess Cleantech innovation, how do you structure the analysis?

6. How do you assess the exit possibilities for Cleantech innovation?

7. What supply of analytical information has the most influence on deciding the industry sectors?

8. Regarding the supply of analytical information, what can be done to increase the awareness of Cleantech innovation?

9. What is needed for Cleantech innovation to become more accepted as an industry sector?

10. Regarding an investor's understanding of Cleantech innovation: what can be done to increase the understanding for the innovation area?

11. If I describe Cleantech innovation in the following ways, what do you find is the most helpful to increase understanding (description on models in Methodology section)?

Interviews questions for entrepreneurs 1

1. Why was it difficult to find external equity financing?

2. Did you find that the investors understood the operations?

3. Did you find that the investor could value the operation properly?

4. How did you present the operation to the potential investor?

5. Would you present anything differently today?

6. What support do you expect from an external advisor?

7. Do you believe that you will gain such support?

Interviews questions for entrepreneurs 2

1. Are you in discussion with external financiers regarding any of your projects?

2. Do you wait with external financing due to any market conditions?

3. Do you wait with external financing until interest from investors has increased?

4. Do you find that investors understand the operations?

5. Do you find that investor can value the operation properly?

6. What support do you expect from an external advisor?

7. Do you believe that you will gain such support?

Appendix 3: Interviewees

Interviews with venture capitalists

Interviewee	Position	Company or Organization	Type of Interview
Håkan Nelson	CEO	Malmöhus Invest AB	Telephone
Anders Brännström	CEO	Volvo Technology Transfer AB	Telephone
Adan Schatz	CEO	Teknoseed AB	Telephone
Bo Björkman	CEO	Uppfinnarspar AB	Telephone
Per H Börjesson	CEO	Investment Spiltan AB	Telephone
Mats Kraitsik Kalvik	CEO	Engelberg Industriutveckling AB	Telephone

Interviews with financial analysts of in-direct investors

Interviewee	Position	Company or Organization	Type of Interview
Magnus Angenfeldt	Founding Partner, Financial Analyst	Manticore Capital AB	Telephone
Fredrik Qronqvist	Financial Analyst	Innovationskapital AB	Telephone
Mikael Hindrika	Financial Analyst	Fjärde AP fonden	Telephone
Anonymous	Financial Analyst	Anonymous	Telephone
Anonymous	Financial Analyst	Anonymous	Telephone

Interviews with entrepreneurs

Interviewee	Position	Company or Organization	Type of Interview
Nenna Olsson	CEO	KMI Kemimäklarna International AB	Telephone
Thomas Welander	CEO	Anox AB	Telephone

Consultations and interviews with industry specialists and academics

Interviewee	Position	Company or Organization	Type of Interview
Jonas Lindgren	Director	Hjalmarsson & Gunterberg Corporate Finance AB	Telephone
Magnus Empfel	Acting Chairman	SWESIF - Swedish Sustainable Investment Forum	Telephone
Fredrik Billing	CEO	DealFlower AB	Personal
Glenda Napier	Programme Officer	IKED – International Organisation for Knowledge Economy and Enterprise Development	Personal
Andreas Englund	Director	MInT – The environmental innovation market	Telephone and e-mail