What should a public venture capital fund intend?

A study on Denmark, Finland, Norway & Sweden

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Abstract

The cleantech sector has had its own issues regarding attracting venture capital (VC). Capital intensity, longer time horizons, exit issues etc have either led VC to transition from early to later stages where technology risks are low or to totally disappear from the sector. The early stages and demonstration phases of the technology cycle have been particularly suffering from lack of funding. In order to address these issues governments have come to the rescue and are infusing VC to support the sector. Government playing the role of a VC investor may be contested on the grounds that it may compete against other private players and public agencies may not necessarily be adept at doing an investor's job. Therefore it becomes important to understand how a public VC fund should operate such that it catalyses private capital rather than inhibiting it and is able to guide its investees to success. This study is therefore an attempt to understand how public VC funding initiatives in four NORDIC countries, viz. Denmark, Finland, Norway and Sweden, work. Inputs received from 16 interviewees representing different public & private organisations have helped shape this work. It was understood that public VC intervention should aim at alleviating risks of the private investors and catalysing private capital into the sector. It should help address the funding gap issues and thus support technologies that have a growth potential but are not able to raise apt capital. Public VC agencies should also be able to provide adequate governance support to their investee firms and may thus syndicate investments with private players to gain from their expertise. The idea of government being fund-of-fund's can be explored where it lets the private investors make the investment choices but funds a VC fund. Last, it was suggested by interviewees that government may help create mutually beneficial synergies by developing an ecosystem involving large corporations, investors and ventures.

Keywords: cleantech, venture capital, government, additionality, NORDIC

Executive Summary

Despite of the political interest in developing new cleantech solutions and development of policy instruments that promote the diffusion of clean technologies (such as feed-in-tariffs and green certificate schemes), there is a lack of venture capital being invested in the cleantech sector. Further, there is evidence that existing private venture capital funds are shifting towards the later stages of the venture development cycle. This has led to the creation of a funding gap in the early technology commercialization stages. This funding gap can be attributed to the general characteristics of the cleantech sector, including long development and pay back periods, high capital intensity, and dependence on regulations and other environmental policies to secure markets for future technologies. There is also a tendency in private funds to invest in conventional technologies which are commercially mature, and hence less risky. At the same time there is a need for rapid development of radical or break through innovations in order to simulate economic development, employment creation and meet the ambitious climate goals. Further, the future market potential for new cleantech solutions is enormous. Therefore in order to realise the potential of this sector, encourage private participation, innovation & entrepreneurship and meet the climate goals, governments are increasingly funding early stage development of cleantech ventures or start-ups.

This thesis is a study of government or public cleantech funding mechanisms in the following NORDIC countries (Denmark, Finland, Norway & Sweden). It is relevant as it would provide guidance for public organisations to structure their venture capital funds by defining focus areas where public intervention would be most needed (for example, by defining the target sectors and stages of intervention). Thus the thesis includes a brief study of the environment and innovation related policies, organisations involved in financing, different financial instruments used and inputs from public and private actors that are involved in the cleantech ecosystem of a particular country. An attempt is made at understanding the advantages and disadvantages of governments taking equity ownership in the projects or ventures they support. This entailed understanding issues like the relationship between private and public investments, the potential crowding out of private investments, and whether governments should focus on technologies that attract few private investors. The latter may include "high risk, high rewards" type of investments.

The results of the research alluded to a visible funding gap in the early stages of the venture cycle, and the drifting away of private capital to the more attractive and secure; later stages. Cleantech investors in all the four countries acknowledged this issue and suggested that government intervenes here by providing additional financing to fill the funding gap, sharing risks and encouraging private players to participate. It was also seen that private investors readily invest (if at all) in conventional technologies with low technology risks (usually in the later stages) or in those technologies that are "capital light", have a "strategic value" and potentially scalable. Public funding should also be "additional" in nature and thus target areas that suffer from lack of adequate private capital but have future growth potential. Government's ownership or co-ownership in the ventures is also welcomed by private investors, given certain consideration are met. These considerations are to do professional treatment of the ventures (as would be done by a private investor) and selection of ventures that are unable to gain adequate funding from private sources thus encouraging private participation in the later stages. In this regard government acting as a fund-of-fund's was suggested by interviewees, by investing in funds, laying rules for their operations and letting private fund managers govern it. Last, the role of corporations in development of cleantech venturing, as an investor and strategic buyer, was also suggested in the research.

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1 Introduction

"Without tradition, art is a flock of sheep without a shepherd. Without innovation, it is a corpse."

Winston Churchill[1]

The aforementioned quote on innovation expresses the need of this hour. Even from the perspective of economic development, an entrepreneurial and innovative economy can be abedrock of what is so acutely needed today, i.e. sustainable growth without compromising the health of our planet and its people. After all, as David Karp, Tumblr founder and CEO, remarked, "*An entrepreneur is someone who has a vision for something and a want to create*"[2]; an entrepreneurial undercurrent may be instrumental in fostering innovations and the much aspired for, sustainable growth. In this regard we can observe that the challenge of climate change has led businesses and societies worldwide, to innovate on their products and services, and stimulate systemic modifications. Even governments are paying increasing attention to expand Research & Development (R&D) initiatives that promote cleaner technologies (cleantech) and support entrepreneurship for ushering lab based innovations to the market.

The current upheaval in the global society concerning alarming environmental issues has captivated political and business attention internationally. A report suggests that in order to limit global warming to 2 Degree Celsius, investments in low carbon energy technologies have to double annually in order to reach $ 1 trillion by 2030 (from $ 281 Billion in 2012) (Fulton & Capalino, 2014). In Europe, the European Union (EU) has formulated the ambitious 2020 targets, also referred as EU 20-20-20 target(E. E. Agency, 2013). They set three key objectives,

- 20% reduction in EU greenhouse gas emissions from 1990 levels
- 20% share of renewable energy in EU energy consumption
- 20% improvement in the EU's energy efficiency

Following this, individual EU member states have also set their individual targets and initiated various programs and policy measures to achieve them. These measures have been implemented from two ends, firstly to increase the volume of innovations in the market and secondly to create a market for these innovations. This is also a means for countries to gain first movers advantage in developing a certain cleantech segment, generating exports of its technologies and creating domestic employment opportunities(Ghosh & Nanda, 2010; Mazzucato, 2011).

In this regard venture capital (VC) plays a crucial role in fuelling capital at the early stages in a venutre's lifecycle where the risks are high and technology is not yet proven. This capital supports development of the product and service offering to the point where it becomes commercially viable. VC has already aided the development of information technology (IT) and biotechnology sectors. The cleantech sector on the other hand is characteristically different from other investment domains (like IT) and there is little clarity on how VC would help in take-off of radical technologies. The sector faces barriers, such as being capital intensive, requiring longer times for paybacks and being regulation dependent. This has led the actors in this space to look for safer investment bets either in the later stages or in support of technologies that are already proven and commercially viable (even though not radically helping the environment). One main aspect of the friction faced by the cleantech sector is that

[1] http://www.notable-quotes.com/a/art_quotes.html

[2] http://www.businessinsider.com/101-best-inspirational-quotes-for-entrepreneurs-2013-9

being traditional in nature, there is a systemic lock-in in existing technologies which make uptake of novel technologies very difficult and commercially unattractive.

This thesis deals with governments support to cleantech industry in the Nordic countries (Denmark, Finland, Norway & Sweden), especially their initiatives in financing innovations. As has been discussed in the beginning of this section, it is in government's interest to develop cleantech solutions for environmental sustainability and economic development. Although funding early stage cleantech also promises development of new innovations and entrepreneurial growth that also leads to job creation. Cleantech, although potentially attractive and lucrative is not insulated from challenges. The very traditional nature of this sector demands large capital investments, longer payback times and challenge from the conventional technologies in which the system is locked-in as well as dependence on policy support. This especially has implications on the private sector that may not be very keen to invest VC in a domain that is plagued with uncertainties while other sectors offer better opportunities.

Therefore the thesis explores the role of government in this scenario, especially in financing of innovations and encouraging investors by alleviating uncertainties and risks or private players. Due to lack of capital investments in early-stage cleantech, the role of public early-stage financing and consequent issues of equity ownership and treatment of ventures become relevant. It is also relevant to understand on what basis government should decide to fund a venture or technology (and exclude other) and therefore what should be the target of such an intervention. Should the government own equity in the venture it supports? Or why should it do it at all? These questions are also important as government, has traditionally not played the role of "choosing market winners" by investing in profitable ventures and therefore may not be equipped with requisite skills and experience to make such choices. At the same time, public money invested as VC may also lead to social benefits such as increased employment opportunities, environmental sustainability and even returns on the investment.

The four countries thus selected for the study have been historically related and cooperate on a variety of governance and policy issues. They also rank high in the "Global Cleantech Innovation Index, 2012", that highlights the state of cleantech innovation in start-up companies across thirty eight different countries, with Denmark topping the list(Knowles, 2012). These factors make them attractive for the study and to draw lessons for other interested countries with nascent cleantech ecosystems. The Table 1 exhibits the ranks of these countries in the Global Cleantech Innovation Index.

Table 1Global cleantech innovation index (2012) ranking of countries

Country	**Rank**
Denmark	1
Sweden	3
Finland	4
Norway	11

Source: (Knowles, 2012)

1.1 Problem definition

In a study commissioned by the Swedish Energy Agency (SEA), "Public cleantech financing in Denmark, Finland and Norway"and produced by the International Institute for Industrial Environmental Economics (IIIEE), an attempt was made to develop a broad understanding of public cleantech financing in those countries. It included studying of the usage of different financial instruments for cleantech development, understand how European state aid rules may limit state financing to cleantech and to answer the "equity" question(Sonnenschein & Saraf, 2013). The author, co-authored that report and was prompted to extend the study to Sweden and delve deeper in understanding public VC initiatives in all these countries combined. Some empirical material and analysis has therefore been presented in that study as well. While this study was assumed by the author, to aid his understanding of cleantech funding, and to be better able to aid SEA's decision making.

There is a dilemma surrounding the equity question (of government taking ownership) when it has been addressed in literature, as the opinions addressed have been varied. While some argue strongly in favour of government ownership, citing importance of government interventions where commercial market forces fail and appropriateness of generating commercial value from public money(Ghosh & Nanda, 2010; Mazzucato, 2011); others tend to take a strong negative view citing that government should remain in the role of a facilitator than an actor and it lacks professional competence required in making investments(Hargadon & Kenney, 2012; Rosen, 2013). Another thesis study commissioned at IIIEE attempted to answer these questions using a case study approach and concluded with some context specific recommendations(Andersen, 2013). Nonetheless, there is still no specific study encapsulating the specific case of Sweden, Denmark, Norway and Finland and the author believes that the current paper can be of immediate use for the governments of countries being studied.

1.2. Research questions

The study aims to understand the existing models for public financing of cleantech in Sweden, Denmark, Norway and Finland, with a focus on VC. This would involve getting answers to the following questions, from private as well as public actors.

- What should be the target of public cleantech VC funding?
    - What are the objectives of cleantech funding?
    - Which stages of the venture cycles should the state intervene in?
    - Which sub-sectors within the cleantech sector should be targeted?
- What are the pros and cons of state owning equity?
    - What are the "additionality" criteria for qualifying for public funding?

1.3. Method

The study involves a combination of primary and secondary research methods. The primary research alludes to data gathering from interviews with private & public VC funds dealing with cleantech or those (consultants and academicians) which have an experience with such funding. In total 25 potential interviewees were approached out of which 16 responded positively. Out of the sixteen, ten interviewees represented the private sector, five represented the public sector and one was from the academic community. These interviews (Appendix 1) were then conducted across the months of December 2013 to February 2014, through Skype, phone or in person meetings. They were semi-structured, guided by an interview guide (Appendix 2) and usually lasted from 30-60 minutes. The names of interviewees have been kept anonymous, referred as "A", "B" or "C" etc. In selecting the interviewees, care was taken

to have a mix of interview partners from public as well as private investment organisations that are active in the countries of interest and have had experience in cleantech.

Personal interviews were seen as the most important way of gaining primary information. Although the literature review did provide general information about organisations involved in public VC funding and their activities, the facts were only well corroborated when confirmed with live people. In this regard all efforts were done to incorporate inputs from public as well as private actors. The method thus used was to first develop an objective understanding of the situation in a respective country, then contact governmental organisations active in interest sectors and confirm the facts from them as well as get their subjective inputs on few questions and last, to reach private VCs active in the respective countries and understand how they perceive governmental intervention and their suggestions for making the existing situation more effective. Thus inputs collected from the players are the most important data source for the study. Undoubtedly, literature review did reveal general answers to the research questions but context and geography specific understanding was only developed with the help of interview partners.

Secondary data was gathered from scientific journals, google scholar, Lund University library and individual websites of funding agencies. The analysis of literature thus collected helped in understanding the relevant issues which were the focus of the paper. The literature review was initiated by middle of November 2013. This guided the author to formulate relevant questions and identify knowledge gaps where existing. The national policies of the four countries, which focused on cleantech innovations, were studied to identify issues which each government was attempting to solve by those policies. This became a basis for developing country and context specific questions in interviews with public cleantech funding agencies. At last, interviews with private funds helped in understanding the effect of public initiatives in the cleantech sector from what they perceived.

The author also sourced macro level quantitative data on venture capital investments in the countries of interests (from European Private Equity & Venture Capital Association (EVCA)) along with data on measurement of entrepreneurial activity in them. This data, especially VC investment figures, were helpful in understanding general trends in the countries but could not have solely supported the development of understanding of the research questions.

1.4. Limitations and scope

The geographical scope of this report is limited to these four countries viz. Denmark, Norway, Finland and Sweden. This makes the findings and conclusions of this study to be exclusive to these geographies and thus application of these findings in other countries should require local context specific analysis. The cleantech industry structure differs from country to country, with respect to the commitments of the country to environmental goals or targets, social issues, status of cleantech development etc. Further, the paper has a special focus on understanding VC initiatives of the government in the respective countries. Therefore, other financial instruments like grants and loans were not explored in detail. A few limitations to the paper can be:

- The results are specific to the selected countries and hence they may not be generally applicable, but could be applied with context specific analysis.
- Specific numerical data on actual deal flow into companies operating in the cleantech sector could not be obtained, as this data is usually kept confidential.

- The subject of the paper (with the scope) has not been researched before; therefore the author had to rely on primary sources for data for information.

1.5. Audience

The study can be of interest to the cleantech funding agencies in the countries under consideration. It can also be beneficial for funding organisations in general (private or public) who may get to learn about the cleantech related public financing initiatives in these countries. This obviously does not exclude academicians who are researching on similar topics.

1.6. Disposition

Section 2 contains a detailed literature review for understanding different terms and theories relevant to the research.

Section 3-6 contains findings on Swedish, Danish, Finnish and Norwegian funding systems and organisations in cleantech sector

Section 7 presents an analysis of the data, based on the literature review and drawing inputs from interviews.

Section 8 presents the discussion and reflections on the research

Section 9 presents the conclusions& recommendations.

2 Literature analysis

This section gives a brief overview of some concepts and interrelations that are relevant for the further understanding of the paper. An attempt is made to develop an analytical framework to base the analysis of primary data and that has been presented by this end of this chapter.

2.1 What is cleantech?

The term "cleantech" has been defined in various literatures to mean technologies, processes, systems or products that promise higher benefits to the environment that their incumbents. As such, the term refers to various sectors spanning waste, water, energy or material domains. A SEA report (S. E. Agency, 2010) defines it as,

> "*A shortening of clean technologies and refers to energy and environment-related technologies developed with the objective of reducing harmful effects on the environment. The sectors included in the cleantech concept are energy, transport, waste, agriculture, water and air".*

At the same time another report by LADEC[3](Hjelt, Illman, Pokela, Vaahtera, & Teppo, 2013) defines the same as,

> "*Clean technologies (cleantech) include all products, services, processes and systems that result in less harmful environmental impacts than their alternatives. Cleantech brings added value to customers while also reducing direct and/or indirect negative environmental impacts. Cleantech is relevant to many different industries, often creating cross-cutting solutions to global challenges."*

It is noteworthy to observe the conflicting notions of what cleantech is, while comparing technologies that can fundamentally improve the state of the environment with those that merely reduce the negative environmental impacts than their incumbents (in for example resource extractive industries). Till now there has been no standard definition of cleantech and the term~~s~~ has been defined differently in various places.

2.2 What is Venture Capital?

Venture Capital (VC) is a high risk financial investment made in the early stages (also referred as seed stage) of a technology or a venture. It has of a high risk nature due to being invested in technologies that are not commercially proven. At the same time VC has been instrumental in promoting an entrepreneurial and innovative economy(Development, 1997; Grünfeld, Iversen, & Grimsby, 2011). It is for the same reason that VC, as a funding instrument, is of interest to a government that wants an innovation intensive economy. In cleantech sector the VCs have been shifting focus to the later stages of the venture where the risks are relatively low. This is because cleantech, unlike other innovative sectors, for e.g. Information & Communication Technology (IT) requires in general, longer time for reaching technical or commercial maturity. An article in Forbes(Rosen, 2013) said that,
"*clean energy companies have capital requirements and competitive landscapes categorically different from IT companies."*

[3]Lahiti Regional Development Ltd (LADEC) is an agency in the Lahiti region of Finland.

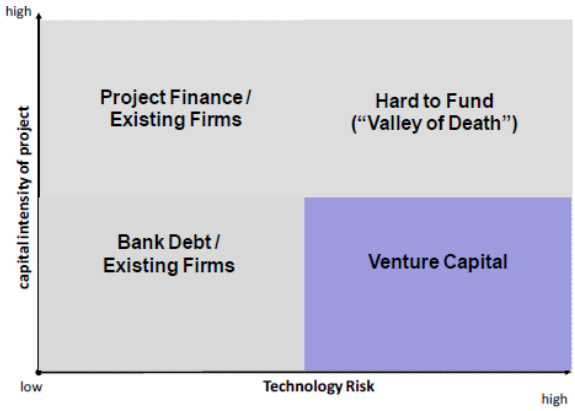

Figure 1 Scope of VC Investments

Source: (Ghosh & Nanda, 2010)

Figure 1, exhibits the usual scope of VC investments, which are generally made in technologies that are not capital intensive but yet risky. Figure 2, on the other hand details the investment stages (seed, start-up, later stage and growth) in the life of a venture from seed to the growth stages. VC can be invested in any of the stages and different VC funds may have different stage focus. In this regard early stage fund VC funds focus on the seed and start-up phase while later stage funds focus on the expansion or later stages (Association, 2013; Grünfeld et al., 2011).

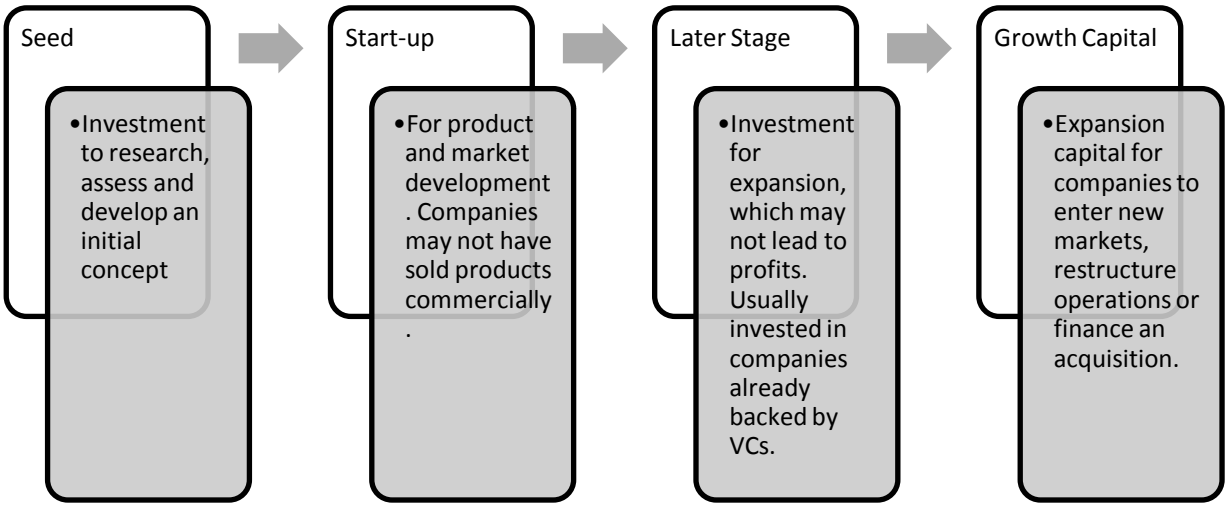

Figure 2 Investment Stages of a venture

Source: Adapted from (Association, 2013; Grünfeld et al., 2011)

2.2.1 The Technology or Innovation Cycle

The Innovation Cycle depicts the progress of an innovation from very early stages of basic research to commercial maturation and market expansion. Different kinds of support are needed by a venture at different stages. VC targets the middle technology commercialisation phases. While the earlier stages are mostly supported through grants, the later stages are financed via private equity or banking institutions. Private equity is also like VC, but applies in the later market expansion stages of the venture. The Figure 3 depicts a technology cycle with different kinds of financing available at respective stages. Another noteworthy point from the

figure is the role of government policy interventions (technology push & market pull) in facilitating technology development(Bürer & Wüstenhagen, 2009; Grubb, 2004).

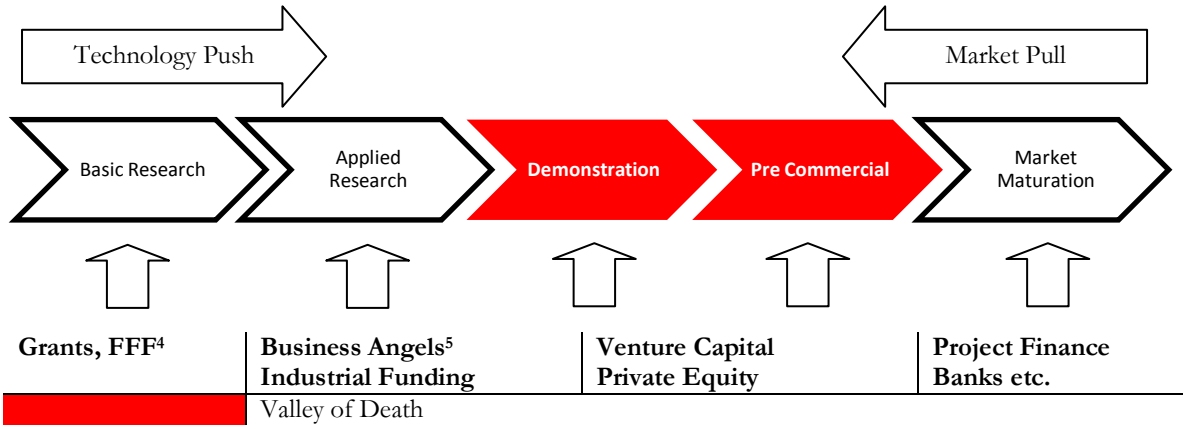

Figure 3 Technology innovation cycle;

Source: Adapted from (Grubb, 2004)

As per a study on the relationship between public policy and cleantech growth in Scandinavia (Lidgren & Dalhammar, 2012), the majority of governmental or public funding is focused on the very early research and development (R&D) stages with little focus to fund SMEs to develop commercial prototypes of the technology. The transition from lab to market requires infusion of high amounts of capital and is a challenging task for a young venture due to lack of appropriate funding. This is also the reason why the stages in between R&D and market maturation are often termed as the "valley of death" due to the occurrence of a funding gap, because of lukewarm private interests to participate in those stages (Bürer & Wüstenhagen, 2009; Grünfeld et al., 2011; Lidgren & Dalhammar, 2012).

In the same study (Lidgren & Dalhammar, 2012) it was found that availability of public funding at the very early R&D stages of a venture acts as an enabler for attracting private investments at the later stages, due to increased investor confidence and reduced risk. However, public funding has to be well coordinated and planned such that it ensures development throughout all the stages. In the event of a funding gap in the commercialisation phase, if the public funding doesn't provide access to finance beyond R&D then it risks reducing the impact of its early stage investments. This calls for an improved coordination in between diverse funding agencies targeting different phases of a venture.

2.3 How does a VC fund work?

A VC fund raises from external investors, which are also called Limited Partners (LPs), and then invests that capital in its portfolio companies, which are selected after proper due-diligence. In this process the fund is managed by Investment Managers or General Partners (GPs) who takes investment decisions by screening or selecting ventures. The GPs, in the process, get a management fee which is a small percentage of the size of the fund (~2%) and after the investment has borne fruits then the profit is distributed to them (above a certain rate of return) and the LPs (along with the capital they initially invested).The average size of a fund

[4]Friends, Fools & Family

[5]Private individuals who invest their own money in potential high growth start-ups in exchange for a share in the company

may vary from a few million Euros (seed funds) to multi-million Euros (later-stages), depending on its target. The entire life cycle of a fund ranges from 7-10 years, after which it has to generate returns by profitably "exiting" its portfolio companies. The term "Exit" refers to the final state of a portfolio company that may be listed in the stock market (IPO sale), acquired by another company (trade sales) or sold back to the entrepreneur. The expectation of the fund is to generate around 20% profit over the value of the investments every year. The initial investment is made for 1-3 years after which the fund may do follow-on investments(B, 2013; Ghosh & Nanda, 2010).

The time limit imposed by LPs may be an issue of concern for cleantech funds. As cleantech (especially with a hardware orientation) may require time longer than the usual 10 years to generate a desired return at par with what they can get by investing in other sectors (like IT). Therefore it may be the case that pure financial investors may not be willing to invest in all types of cleantech (software & hardware). Although software oriented cleantech may offer an investing opportunity similar to what is provided by typical IT ventures and therefore may attract traction from financial investors. On the other hand strategic LPs (corporations) may be interested to fund or participate in the sector with other funds as they may be interested in aspects beyond financial returns, like buying strategic innovations, outsourcing their domestic R&D etc.

It should also be mentioned that most of the public VC funds are structured as "ever green" funds, which have no closing date and profits generated are invested back into the fund. The owner, which is the government do not expect the money back anytime soon, but they do expect the capital to grow and may have an expectation of a specific rate of return.

2.4 Push v/s Pull Instruments

In order to foster development and uptake of technical innovations, a Government can use different kind of instrument. In this regard market/technology push or pull instruments have been used to influence and facilitate the development of the cleantech market. The instruments have different targets, for e.g., technology push policies aim at increasing the technology supply by investing in R&D, grants for demonstration projects or providing tax incentives to innovative technologies. On the contrary, market pull policies aim at creating a pull for the technology from the market in order to foster and sustain demand. This can be achieved by subsidising the technology (or removing subsidies from fossil fuels), setting norms, public procurement etc (Lidgren & Dalhammar, 2012). A CERES[6] report on clean energy investments also suggests development of policies that "de-risk" deployment of clean energy technologies. This includes regulations that are not complex but rather provide stable and long term support, removal of subsidies to fossil fuels and consequent pricing of carbon. These should enable sizeable investments that are able to attract investors and make the price of technologies decrease in the long-term (Fulton & Capalino, 2014).

In a study surveying 60 investment professionals from European and North American VC and private equity funds on how they perceive various clean energy policies, it was found that market push instruments like public VC funding, were not as popular among private VCs as market pull instruments, such as feed-in tariffs, fossil fuel subsidies reduction and strict environmental standards. This preference for feed-in tariffs was more in European investors

[6] Ceres is a nonprofit organization mobilizing business and investor leadership on climate change, water scarcity and other sustainability challenges

comparing the American counterparts. In market push instruments, Government support for demonstration projects was supported by VCs. This can be explained by the "valley of death" hypothesis cited in section 2.2, as demonstration stage is where the funding gap occurs. There is lower confidence for Government support of VC, due to lack of trust among private investors on Governments choice of ventures (or technologies) to invest it. The VCs believe that the Government should only set incentives for the market to operate than being a player itself (Bürer & Wüstenhagen, 2009).

It was noted in another study (Lidgren & Dalhammar, 2012) that was based on inputsfrom Scandinavian cleantech developers and investors, that there is more faith from investors in environmental taxes or standards, and less so in legislation that costs public money – particularly feed-in tariffs. This is because such legislations (such as feed-in-tariffs) are considered unpredictable and therefore reduce investor's confidence. It was suggested that the policies should be "simple, transparent and predictable to ensure that investor's confidence in the sector is nurtured. It is interesting to note how the above mentioned studies, (Bürer & Wüstenhagen, 2009) and (Lidgren & Dalhammar, 2012), differ with regard to investors preference for feed-in tariffs. This may be understood by the timings of these two studies i.e. in 2009 and 2012 respectively. While one was carried out before the economic recession (2008-09) when the feed-in-tariff system was being pushed by the government, the other concluded post-recession (2012)when capital availability to fund such mechanisms had become an issue.

In this study the focus will be on market push instrument, and in particular public financing of cleantech innovations with VC.

2.5 Public cleantech financing Instruments

2.5.1 Grants

As depicted in Figure 3, grants are usually given at the early stages or in R&D stages of a technology cycle where economic risks are very high. Grant has been a popular instrument with government and private investors alike(Bürer & Wüstenhagen, 2009). This is because for the governments it is easy to administer and manage, while for the private investor it reduces his risks when investing in a particular technology at later stages. It would be nearly impossible to fund demonstration projects in absence of these grants.

On the other hand grants may be criticized on the grounds that they don't ensure that the grantee develops commercially mature technologies quickly, which may lead to the money going into research that is not market driven and commercially viable. This incentive may be produced by disbursing grants in a phased manner or funding only when specific targets have been reached. At the same time grants given at the later stages of a venture may not be the best financing option as the government does not gain over that investment made with public money. Therefore grants as an instrument may be best suited in the stages where risks are very high to attract any private attention.

SBIR (Small Business Innovation Research) grants scheme in the United States (US) has been cited as a positive example of such a public scheme to fund clean technologies to encourage both incremental and disruptive innovations. In this relatively smaller amounts of grants are allocated to different areas with the focus of producing commercially and market relevant technologies(Hargadon & Kenney, 2012).

2.5.2 Loans

Loan instrument may be used in fostering cleantech development. This can be done by providing cheap finance or low interest loans for companies as working capital or expansion capital. Comparing grants, loans have an incentive effect on the entrepreneur to strive for commercial maturity of the venture or technology as the loan has to be paid back. In the European Union (EU), under the state aid rules, loans given as aid are expressed as "gross grant equivalent", which has to be calculated by the authority that is disbursing it. This is because the loan is made cheaper by the public authority (or more expensive for itself) by issuing it at low or no interest comparing the prevailing market rates(Sonnenschein & Saraf, 2013).

2.5.3 Guarantees

Governments can offer loan guarantees for cleantech ventures so that they are able to secure financing from local financial institutions. This may help is risk reduction of the investor. Alternatively the financial guarantees can also be issued to the buyers of the technology (cite Jonas). On the other hand massive loan guarantees issued in the US to few VC backed cleantech firms has been criticized. This is because the sizes of the guarantees are so enormous (electric vehicle startups Tesla and Fisker received $465 million and $539 million, respectively, and solar panel manufacturer Solyndra received $535 million) that it creates a lock-in effect and distorts the market by favoring or rather subsidizing certain technologies (Hargadon & Kenney, 2012).

2.5.4 VC

VC has already been defined in section 2.2 and has been studied in detail for this paper. Unlike private VC, the government VC is expected to meet objectives that are beyond profits and thus create high social welfare. This includes meeting societal level objectives like generating employment, nurturing research and innovations and developing entrepreneurship capabilities in the economy. Hence a venture deemed unprofitable from a private VCs perspective may be profitable for the society when public money is invested. The Figure 4 depicts the same situation.

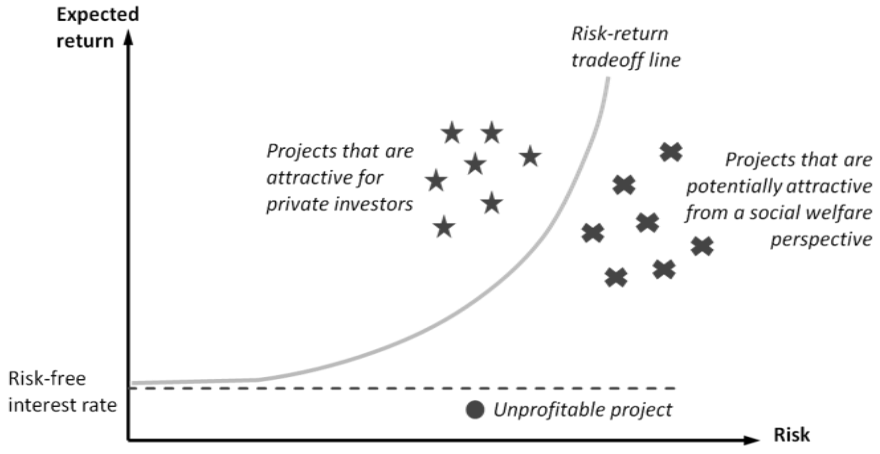

Figure 4 Risk vs. return evaluation of projects

Source:(Grünfeld et al., 2011)

As the private VC investors in cleantech are moving towards the later stages, the early stages are where government can intervene and support. This transition of private capital to later

stages is because in cleantech, the incumbent technologies are well established & mature and thus dominate the market. This makes it difficult for the VC to result in disruptive changes as market growth, scalability and rapid value creation are difficult to achieve(Rosen, 2013). Apart from this clean technologies that are of "hardware" type generally require huge amounts of capital and long time horizons to achieve commercial maturity and hence private VC desist from entering at early stages and thus avoid taking huge risks then. A study done on the state of early stage VC in Norway suggested the following (Grünfeld et al., 2011).

> *"For the earliest stages (seed stages) there is now a clear and increasing shortage of risk capital for funding projects with a high growth potential. We claim that there is a clear need for establishing new support measures that are able to follow potential high growth firms over a long period with significant amounts of equity capital."*

At the same time findings from other studies (Bürer & Wüstenhagen, 2009; Hargadon & Kenney, 2012) do not positively support government VC in cleantech. An often cited reason against government VC is the lack of competence in public agencies to make the right investment choices for technologies or firms.

2.5.5 Choice of instrument

A combination of different financial instruments may be used to develop different stages or aspects of the cleantech domain. Whether one instrument is better comparing the other depend on the context of applications. For e.g. a combination of grant-based technical assistance and investment can be effective in clean energy ventures. The grant issued for concept development may be returned to the grant provider if the concept develops into a mature product (Garcia-Robles, Ramos, & Chkourenko, 2010).

Another suggestion is to harness the power of open technology platforms to enable investments in nascent technologies. Example of such a platform can be crowd funding, where projects or ventures could be advertised to the public who may then want to fund it. The design of public financing should also be in a way such that it follows the innovation from the basic research stages to the later stages(Hargadon & Kenney, 2012). In the same report it is said that,

> *"Probably the single best way to encourage the adoption of clean technologies would be a much higher tax on carbon fuels."*

Overall there are no specific or set criteria for choosing a financial instrument over another. If the aim is to develop a market, it would require a context or situation specific research for understanding the characteristics of the market and designing funding programs. Also, market development can also be fostered in different ways (beyond using financial instruments. For e.g., it has been discussed that in order to create an enabling ecosystem for cleantech VC, public procurement could be used to target emerging industries and drive their maturation(Hargadon & Kenney, 2012). In another book documenting cleantech situation in the United Kingdom it was said that, "*The issue is not of the lack of a green investment bank to provide seedcorn finance but of an underdeveloped ecology of networks and government procurement systems designed to wrench technological progress out of that system*"(Mazzucato, 2011).

2.6 Target of Public Cleantech Funding

2.6.1 Target Objectives

The objectives for cleantech VC funding by government are usually related to economic and social development (through creation of jobs, exports, infusion of innovations and other social benefits), profit generation through exits and environmental sustainability.

Environmental betterment was an obvious objective in supporting cleaner technologies. In fact, pushing for environmental objectives in other funding schemes (including demand side interventions) can also support the cleantech market. The sector being dependent on policies, the government can has an important role to play in creating and sustaining demand for environmentally better alternatives (Ghosh & Nanda, 2010; Mazzucato, 2011; Sonnenschein & Saraf, 2013).

Regarding **profit generation**, it has been explained earlier (in section 2.5.4) that for a government VC fund, profit should also lie in the social welfare value generated by the venture beyond monetary benefits. A profit motive for funding may inhibit selection of certain ventures over others and hence a due consideration should be given that what kind of venture should the government support through equity. Although it is argued that if public money is invested as risk capital then it should also reap the benefits. At the same time the idea government ownership is not well supported among the private investor, due to lack in trust on government to run such a scheme professionally(Bürer & Wüstenhagen, 2009; Hargadon & Kenney, 2012). Therefore, professional management and profit-orientation are critical for the success of a public VC scheme. The apparent anomaly between profit generation and societal welfare was succinctly expressed as, "*it seems to be useful to make a distinction between profit-orientation as a necessary mode of operation, and profit-maximization as a questionable target."(Sonnenschein & Saraf, 2013)*

By having **economic development** as a funding objective, the schemes aim at creating exports and employment opportunities for the economy. Rather fiscal stability is an important parameter for a venture to run on a sustained basis, even so in the cleantech sector. Therefore economic development and environmental betterment have to run in parallel for achieving national and international climate goals(Ghosh & Nanda, 2010).

2.6.2 Target Sectors

On comparing different cleantech sectors on the basis of their commercial maturity, technical viability and economic feasibility, it would result in different sector comparing better than other on these criteria. A study noted that in 2009 in the United Kingdom the private VC funds shifted focus on cleantech investments with a less than two year period payback with incremental innovations being prioritized over disruptive ones(Mazzucato, 2011). The same study found that investors have been funding ventures that did not even had patented technologies, meaning radical innovations were not being targeted. At the same time there was a lack of industry focus in the investors or prevalence of "generalist" VCs. An investor who is focused on a specific industry may have apt resources, expertise and networks to guide a venture to success.

It is suggested that government should be investing in commissioning of high risk or breakthrough technologies in sectors it has competitive advantage, creating a pull for the innovations to flow. It is also argued that rather than playing safer bets for existing technologies or the so called "dash for gas", a focus on radical innovation was needed so that the EU 20-20-20 goals can be met(Mazzucato, 2011).

A study (Ghosh & Nanda, 2010)on VC in clean energy technologies classified them according to the capital intensity and risk (Figure 5). It identifies that energy production ventures in general face a massive funding gap around the initial stages of the project (in demonstration and pre commercial stages). Thus, as opined by literatures the government should focus on high risk technologies that would attract scarce private investment.

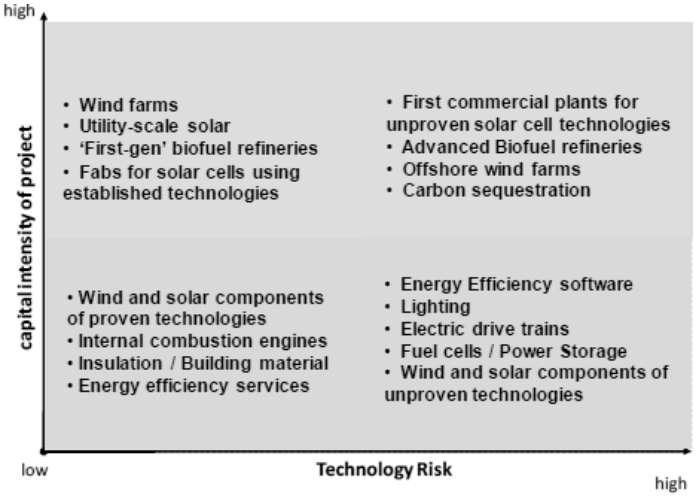

Figure 5 Categorization of cleantech sectors

Source: (Ghosh & Nanda, 2010)

2.7 Government ownership in ventures

As has been discussed, the cleantech domain is facing a transition of private investors to the later stages of the venture, leaving a funding gap. This funding or equity gap is where the government can intervene and infuse VC. In this regard, there are varied opinions regarding state's ownership in ventures, with some for it and others against. Overall there is a consensus that the ventures are to be managed professionally and with a long term objective in sight. A study done on Norwegian risk capital identified the need for pursuing the ventures from initial funding in the early stages to the later stages or exit. This would involve attracting private investments or co-investments at the appropriate stages of the venture cycle and manage it professionally (Brander, Egan, & Hellmann, 2010; Grünfeld et al., 2011; Tillväxtanalys, 2012).

The main arguments in favour of governmental equity participation are the availability of public money, existence of the funding gap (or market failure) where the government can intervene and profitable returns to the public for their money. As a VC fund works, it basically relies on a few companies from its portfolio investments to outperform others to an extent that the returns garnered through exit of those companies pays for the initial investment, as well as makes profitable returns. In this regard, one such successful exit may be able to refund the whole initial investment made through a public fund, hence making the fund financially sustainable.

One the other hand, there is also criticism regarding government's ability to own and manage young ventures, the way it can be done by private investors. A study analyzing relationship between public and private source of VC in fifteen European countries over the period of 1990-96 reflected on various situations where public intervention can be counterproductive. First, public fund managers may not have the right professional experience, skills and incentives to select and invest in companies. Second, in a private fund the profits are shared among partners via performance linked bonuses, while public institutions do not distribute

dividends to partners and instead offering fee based incentives. Last, public funds may invest for objectives beyond profits and in doing so may distort the market conditions. For e.g., project financing at below market rates may lead to "crowding-out" of the private investments as all attractive projects would then try to avail cheap public capital(Leleux & Surlemont, 2003).

Thus, governance provided by VC investors is thus a key attribute of venture capital compared to other sources of finance and is also believed to be a source of competitive advantage across venture capital investors (Ghosh & Nanda, 2010). This issue is addressed as the "selection" or "treatment" effect of public funding or,

> "*selection effect in which private venture capitalists have higher quality thresholds for investment than subsidized venture capitalists, or whether it arises from a treatment effect in which subsidized venture capitalists crowd out private investment and, in addition, provide less effective mentoring and other value-added skills*"(Brander et al., 2010).

Therefore, in order to ensure that government VC does not become counter-productive, "additionality" constraints are needed to be considered (described in section 2.6.1). This requires understanding of whether public interventions "seed" underdeveloped VC industries; lead to "crowding-out" private funds; or facilitate their development ("crowding-in"). The funding is to be carefully targeted to sectors or ventures that are not inherently so profitable so as to attract private money. In this regard, the study by Leleux & Surlemont, 2003 which studied effects of public participation in venture capital industry, "*supports a negative correlation between the magnitude of public participation and the size of the venture capital industry*". They found that public VC involvement is triggered by industry development and not that it gets an industry off the ground. This involvement may not really "crowd-out" private money but may cause more capital to be invested in an industry (Leleux & Surlemont, 2003).

2.7.1 Additionality in funding

Additionality aspects are an important consideration for a public funding scheme. The terms means that the government financing programs should stimulate private sector investments by creating a commercially viable market, and eventually phase itself out as the private capital expands(Development, 1997). In order to effectively leverage public money and use it for accelerating cleantech growth, a careful consideration with regard to choosing the right target for ventures or sectors. This means selecting those technologies or ventures that will face difficulties in attracting private capital. In R&D funding activities, additionality can be proved by showing how public investments can increase the speed and volume of innovations or technologies, while in VC funding additionality may be proved by how government intervention can lead to "crowding-in" of private investments. In this regard, there is a visible funding gap in the technology commercialization stages in the cleantech sector, as the private investors are moving towards the later stages and this makes a case for government intervention(Tillväxtanalys, 2012). Although there are also issues in public ownership of ventures that it may lead to selection of such ventures which don't need public funding and therefore lead to "crowding-out" of private investments.

2.8 Analytical Framework

For developing an analytical framework to help in guiding the direction of the study, various reports and policy papers were studied. The author perused different frameworks that dealt with public equity financing of early stage ventures which identified principles to be incorporated in the design and operation of public VC funds. These were OECD risk capital guidelines (1997), UNECE guide on early stage financing (2009) and Directorate-General for

Enterprise and Industry, European Commission's document on best practices for early stage equity finance (2005). These guidelines helped the author develop and further define interview questions and helped guide the analysis of results. They have been presented further in this section.

The **OECD Risk Capital Guidelines** (1997) on government funding in technology based firms identify some general principles for the design of a public VC instrument(Development, 1997). These are as follows.

- **Target equity gaps**: The funding should target those stages or technology based firms or funds which lack funding.
- **Fund size**: The fund should be of an appropriate size in order to make investments which can achieve commercial returns.
- **Fund management**: The responsibility of the investment decision making process should be delegated to private investment professionals who have required expertise. The government can maintain transparency of the investment process and monitor the program.
- **Management support**: Investee companies should receive value-added advice regarding management, strategy and finance.
- **Additionality**: It should stimulate private sector investment and create a commercially viable market, eventually leading to the phase out of public capital.
- **Effect on private sector**: Inflow of excess money in the market may drive returns down to unacceptable levels. Care must be taken not to drive private investors from the market.

Another early stage financing guide by UNECE (**Policy Options and Instruments for Financing Innovation**) lays down different considerations to be accounted in public financing programs(Europe, 2009). It also calls for better coordination or synergy between different programs and policies for an effective and efficient outcome. As per the report, a program aiming to create a sustainable national VC market can be evaluated on factors like their ability to enhance private funding and create self-sustaining VC firms. For e.g. government seed funds may be unsustainable from the point of view of their inability to provide an appropriate magnitude of initial or follow-up funding. While larger funds may drift their orientation towards expansion stages, thereby not targeting the funding gap. This anomaly may be addressed by fund-of-funds programmes which leverage private capital and align attractive incentives for the VC fund managers by capping returns on government funding, making it easier to do follow up funding in early stages of a venture. At the same time care should be taken to not fund the fund entirely with public money as then the long term sustainability of the program may be compromised.

Thus designing a successful program requires a pre-emptive approach to tackle possible conflict areas in the future and which involved regular monitoring. Some issues that need particular attention are as follows.

- **Crowding in/out Private Funding**: The program should encourage crowding in of private capital in the market and thus create activity in the intended sector. If the program is entirely dependent on public money then this may also lead to ineffective investments into enterprises of sub-standard quality.
- **Target**: The target of the program should be clearly defined in terms of the sector as well as stage of funding.

- **Measuring Success**: This involves setting mile stones and success metrics for enterprises to avail follow up funding.

A report by the expert group (Directorate-General for Enterprise and Industry, European Commission) documenting **best practices in public support for early stage equity finance in European states** and those of the European Union, sets four criteria's to be addressed at the design phases of the public equity program(Industry, 2005). These criteria's are as follows.

- **Objectives**
  - Correcting market failures. The program should aim at correcting a market failure.
  - Establishing clear objectives. The program should have clear targets, including the target stage of investments, creation of viable and innovative enterprises etc.
  - Including the full supply chain of finance. The program should address the investment readiness of the entrepreneurs and the entire venture investment cycle.

- **Design of programmes**
  - Working with the private sector. This involves working with the private venture capital organizations on a commercial basis to gain from their expertise.
  - Making the performance of funds transparent. By encouraging public disclosure of funds performance.
  - Emphasizing efficiency. Requiring private co-investments and limiting to a certain percentage, the participation of the public sector.
  - Delivering funds effectively. To ensure that fund management costs are as per normal market practices and to set a time limit.
  - Giving the funds the right incentives. Making equity investments with the same conditions as the private sector and limit public sectors share in the funds profits.
  - Making the programme useful in the long-term..

- **Quality control of programmes**
  - Assessing the quality of fund management and teams. Selection of funds on the basis of their track record and performance.
  - Keeping transaction costs low, and limiting additional bureaucracy.
  - Assessing feasibility – possibility of finding private co-investments.
  - Leveraging with private money.
  - Shortening the time to market from public investment.
  - Avoiding political pressures – working with funds at arm's length. Avoiding political intervention in the workings of the fund.

- **Transferability of good practice**
  - Making programmes scalable and reproducible.
  - Addressing technology transfer.
  - Addressing cultural factors.
  - Addressing sectoral factors.

The aim of this thesis research is to understand how public equity financing in the cleantech sector has been able to or can address issues faced by the sector in the selected countries. The criteria's mentioned by various documents addressing this issue as presented above, point factors that can be incorporated in the design phases of structuring a public funding program . Thus for for the purpose of this research, selected criteria's were chosen and classified that targeted the design phases of the program and these will form the basis of further analysis.

- **Target of funding**: The targets of the funding program should be well defined in terms of the stage of investment and effects on the private sector.
- **Fund management**: The fund should be managed with private expertise and in a transparent way.
- **Additionality**: The funding should be additional in nature or should target areas with a funding gap and encourage crowding in of private capital.

3 Cleantech in Sweden

3.1 Environmental policy

Swedish government has taken up the environmental agenda very seriously and has set ambitious targets and goals for the same. The country which has a high renewable energy penetration (~47%) has also set up a commission to drastically reduce oil dependence. It identifies the following objectives to be achieved by 2020 for the same.

- Through more efficient use of fuel and new fuels, consumption of oil in road transport shall be reduced by 40-50 %.
- In principle no oil shall be used for heating residential and commercial buildings
- Industry shall reduce its consumption of oil by 25-40%(Independence, 2006)

For 2013-2016, Sweden will allocate approximately SEK[7] 22 billion to environmental measures. Apart from this Sweden's environmental policy identifies 16 environmental quality objectives covering various sectors. Reduced climate impact was decided as an interim target in 2009, post which 13 more such targets were added in 2012. These new targets covered the areas of air pollution, waste, biodiversity and hazardous materials(Government, 2014).

Sweden also has uses other policy instruments like carbon taxation for fossil fuels, renewable energy certificates (REC) with Norway (also called the electricity certificate system), real estate tax reductions for wind power and solar PV subsidies to achieve its goals(Mundaca, Dalhammar, & Harnesk, 2013). Apart from national level policies the country also has to follow EU level policies (for e.g. Eco-design Directive)((SEA), 2010). The climate targets are mentioned in Table 2(E. E. Agency, 2013; S. E. Agency, 2009).

Table 2 Climate targets in EU & Sweden

	Share of renewable energy in gross energy consumption	**% GHG reduction (non ETS emissions)**
Sweden	49%	-17%
EU	20%	-10%

3.1.1 Innovation policy

The Swedish Innovation Strategy (Swedish Ministry of Enterprise, 2012) document refers to the purpose of the strategy, which is,to contribute to a climate with the best possible conditions for innovation in Sweden with year 2020 in sight. The aim is to,

- Address the global societal challenges
- Increase competitiveness and create more jobs in a global knowledge economy
- Deliver public services with increased quality and efficiency

[7]Swedish Krona

Factors like weak linkages between Swedish industry, academia and other stakeholders, and investments in R&D not leading to the expected level of innovation and economic development, are the driving forces behind innovation policy. The innovation policy also recognises the role played by demand based or innovative procurement for fostering sustainable growth(Swedish Ministry of Enterprise, 2012).

VINNOVA, is the Swedish innovation agency and is also responsible for disbursing grants. It and other funding agencies (will be described in section 3.2) usually seek co-investments from private investors for effective leverage. The private sector also pressures the government institutions to foster effective collaborations between academia and industries(Melin, Håkansson, & Thorell, 2011). The following Figure 6 illustrates the important actors in Swedish research and innovation system which are particularly active in cleantech domain.

Figure 6 Adjusted research and innovation system in Sweden 2014

3.2 Cleantech funding in Sweden

In all, SEK 31 billion a year in VC was invested between 2007 and 2012, of which 872 million a year was invested in cleantech(Tillväxtanalys, 2012).

VINNOVA (the Swedish Governmental Agency for Innovation Systems) is a government agency under the Ministry of Enterprise, Energy and Communications. It funds needs driven R&D and development of efficient innovation systems for the purpose of promoting sustainable growth. It thus invested SEK 2204 Million in Sweden for basic research as well as promoting innovation capacities in Small & Medium Enterprises (SME). It works in sectors like healthcare, transport, environment, ICT & services and manufacturing and gives grants to academia, public agencies and businesses(VINNOVA, 2013).

The **Swedish Energy Agency** invests in basic & applied research as well as experimental development through grants. The energy technology department of the agency works within areas of fuel, building sector, industry, power systems, energy systems and transport. This funding is received by academia as well as companies and trade organisations. They also offer conditional loans (with co-investment), for business development of start-up and seed companies within the energy area. At later stages growth loan is also offered to companies with funding needs to expand the innovation. In the expansion stages the agency helps in export promotion as well as in creating network between companies, investors and buyers. Apart from this tax breaks are given to industrial companies that implement energy efficiency measures and aid to local government agencies that seek energy efficiency support. The agency along with VINNOVA is implementing an initiative on technology and innovation procurement(S. E. Agency, 2010, 2013). The figure 7 illustrates grants and loans given by the agency in the year 2013.

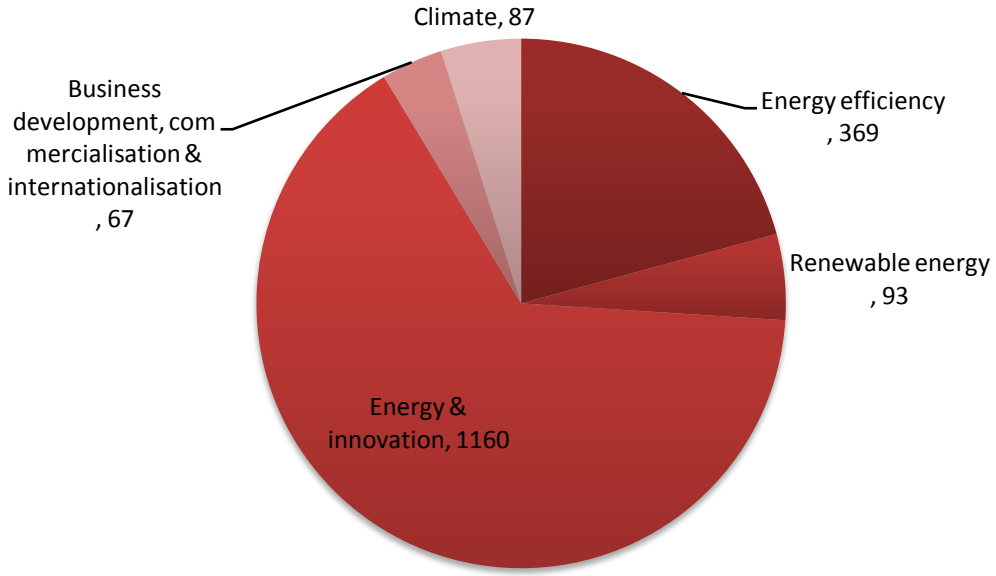

Figure 7 Grants & loans given by SEA in 2013 (Million SEK)

Source:(D. E. Agency, 2013)

Industrifonden is an independent foundation set up by the Swedish government in 1979. Being a foundation it is completely independent (financially) to make its own decisions but it's governed by a board, and runs like a private VC firm. Till the mid 1990's they used to give out loans and royalty but from 1996 they started working like a VC. They don't have an owner and employees do not get dividends. It is an evergreen fund as all the profit is invested back. Around SEK 1495 million was invested in 2013 in SMEs. The fund usually co-invests with other funding agencies, in the start-up or expansion phases of Swedish companies, with investment size averaging SEK 5-100 million per company. They usually own 15-30% of the venture. The sectors covered are life sciences, cleantech and industrial(Industrifonden, 2013).

ALMI is a state-owned organisation with the task to promote the development of Swedish SMEs and stimulating entrepreneurship. The company is regionally active and industry neutral

and always co-invests with investment size averaging EUR[8] 0.2-1.2 million and maximum ownership of 49%. Their investments are mostly in early and expansion stages(Invest, 2013).

Swedish Agency for Economic and Regional Growth – **Tillväxtverket** is working to strengthen regional development and facilitate enterprise and entrepreneurship throughout Sweden for the purpose of sustainable growth. It also supports programmes and processes that strengthen conditions for regional and business growth, and was responsible for the EU regional structural fund programme (2007-12) that is primarily aimed at companies in the expansion stage and also funds other fund's (Tillväxtverket, 2013).

Inlandsinnovation is a state-owned venture capital company with a capital of SEK 2 billion, active since 2010. Its geographic mandate is to invest in the northern half of Sweden. They co-invest equity capital in high growth potential companies, irrespective of the sector in early or later stages. They also make investments in other funds(Inlandsinnovation, 2013).

Apart from this Sweden also has a network of private investors and business angels that are actively investing in the cleantech sphere(Tillväxtanalys, 2012).

3.3 Total early stage entrepreneurial activity (TEA) in Sweden

The data for early stage entrepreneurial activity in Sweden came from the Global Entrepreneurship Monitor (GEM) project. It is an annual assessment of the entrepreneurial activity, aspirations and attitudes of individuals. The data is presented Figure 8 and explained in Table 4. Early-stage entrepreneurial activity in any economy is an indicator of the dynamism, innovation and introduction of new ideas. These young enterprises not only generate economic activity for the country, but also jobs and other social benefits. As per GEM data, there is an increase in TEA in Sweden (from 3.4% in 2006 to 8.3% in 2013), but a simultaneous reduction of growth expectations can be seen. The growth expectations took an acute dip in 2009 and have not recovered since, as 31% of TEA expected to employ at least 5 employees 5 years from 2006, while only 14% expected the same in 2013. The new business ownership rates were also modest throughout these years (1.4% in 2006 to 2.5% in 2013), which signify that only a few ventures are able to perform consistently and support themselves or the teams working with them.

[8]Euro

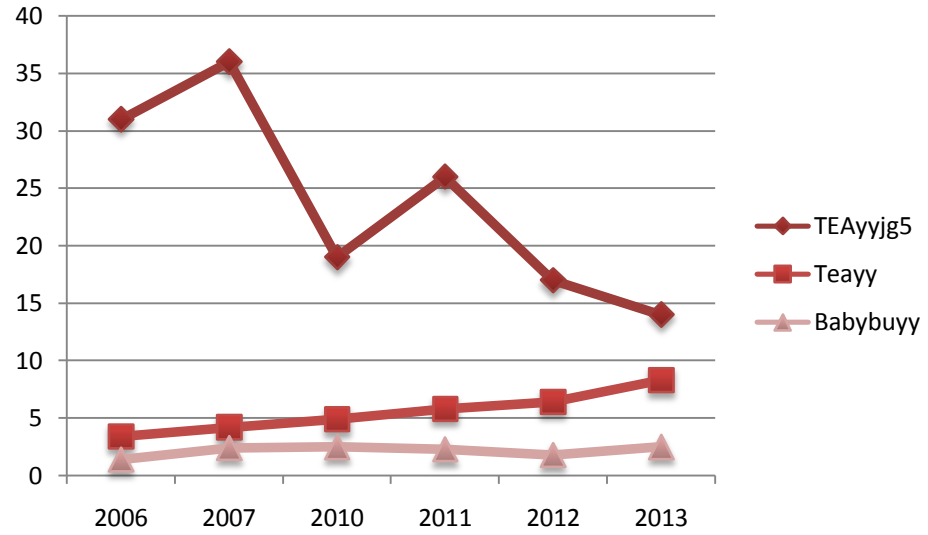

Figure 8 TEA in Sweden (%)

Source: (Global Entrepreneurship Monitor, 2014)

Table 3 GEM variable description

Variable	Name	Description
TEAyyjg5	Growth Expectation early-stage Entrepreneurial Activity	*Percentage of TEA who expect to employ at least five employees five years from now*
Teayy	Total early-stage Entrepreneurial Activity (TEA)	*Percentage of 18-64 population who are either a nascent entrepreneur or owner-manager of a new business*
Babybuyy	New Business Ownership Rate	*Percentage of 18-64 population who are currently a owner-manager of a new business, i.e., owning and managing a running business that has paid salaries, wages, or any other payments to the owners for more than three months, but not more than 42 months*

Source: (Global Entrepreneurship Monitor, 2014)

3.4 Early stage funding in Sweden

A report on VC in Swedish cleantech industry noted that seed phase or early stage investments have almost vanished (2007-12) and shifted to the expansion phase(Tillväxtanalys, 2012). From data retrieved from the European Private Equity & Venture Capital Association (EVCA)(Association, 2013), we can note a considerable dip in overall VC funds raised post 2009. It is also interesting to note the gradual rise in government VC fund raising, from 0.2% in 2007 to 39.5% in 2012, with the highest 84.2% in 2009 (From Figure 9).

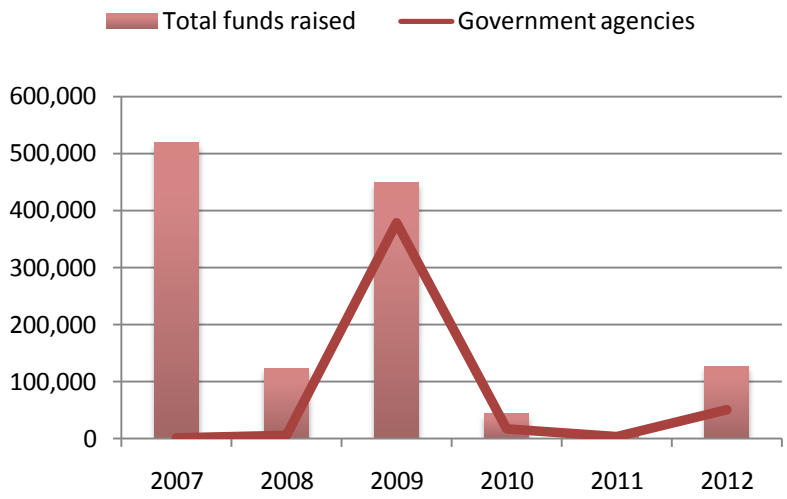

Figure 9 Total funds raised & proportion of government contribution in venture fund raining in Sweden (in Euro'000)

Source: (Association, 2013)

From data on investments in different phases of ventures in Sweden, it can be noted that early stages of a venture, in general, were in general 7-20% of the total investments made in that year (2007-12). A decline in total investments in seed stages could be observed, from 0.5% in 2007 to 0.3% in 2012. This also alludes to a visible funding gap in the seed stages of the venture cycle which would require attention from concerned authorities. VC investments in energy & environment companies decline steadily from 21.8% in 2009 to 4.1% in 2012 (Figure 10&11).

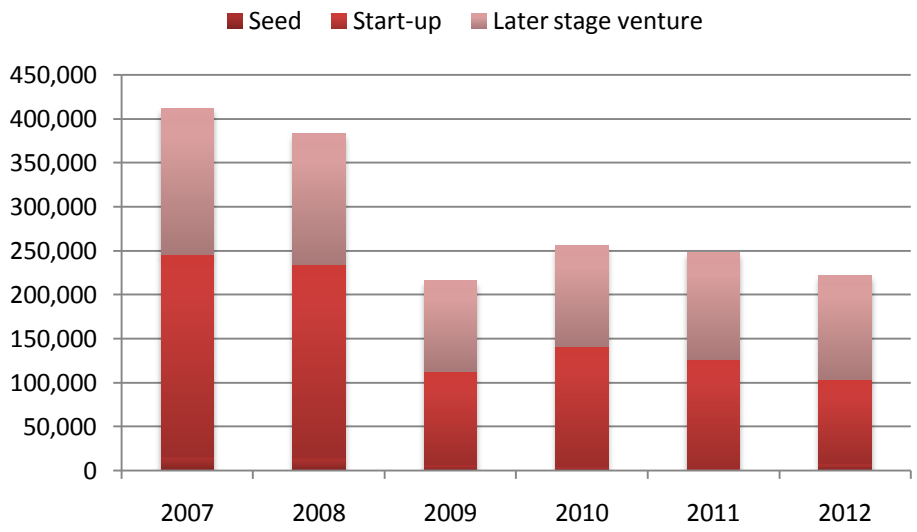

Figure 10 Total investment in Swedish start-up's by different venture stages (in Euro'000)

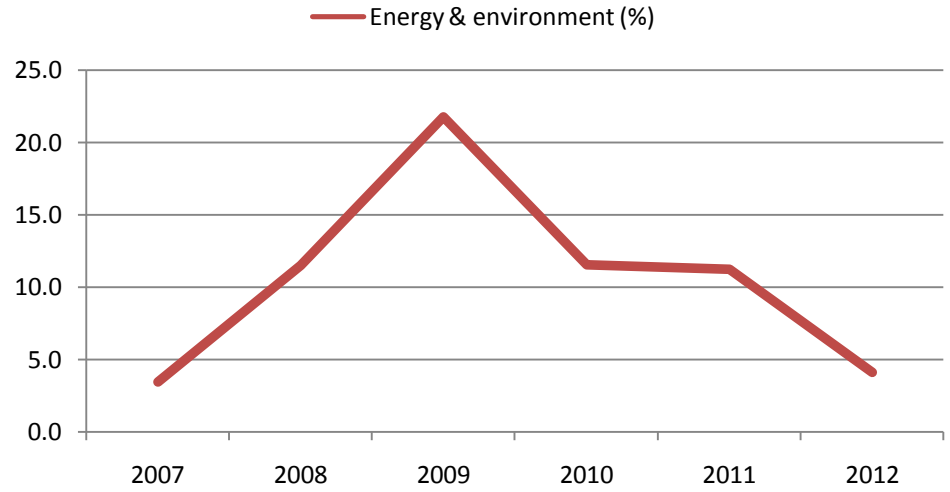

Figure 11 Percentage of venture investments in Swedish energy & environment start-up's

Source: (Association, 2013)

3.5 Summary

The following table 4 summarises the activities of organisations active in Sweden cleantech financing domain.

Table 4 Summary of Swedish cleantech funding agencies

Name	**Type**	**Target**	**Cleantech Focus**	**Stage**
Industrifonden	VC	Profit & economic development	Partly	Early stage
Inlandsinnovation	VC	Regional & economic development	Partly	Early & later stages
Almi Invest	VC, Loan	Profit & economic development	Partly	Early & later stage
Swedish Energy Agency	Grants, Loans	Environmental & economic development	Exclusive	Early & later stage
Tillväxtverket	Grants	Regional & economic development	Partly	Early & later stage
Vinnova	Grants	Innovation & economic development	Partly	Early & later stage

4 Cleantech in Denmark

4.1 Environmental policy

The Danish government has introduced an Energy Strategy 2050 for the country in 2010-11. The aim through the strategy is to achieve independence from fossil fuels like coal, oil and gas, alongside reducing carbon emissions, by 2050. As around 80% of the energy needs of Denmark are supplied by fossil fuels the strategy has set certain ambitious targets to reduce this dependence. More specifically it wants to increase the share of renewable energy to 33% from 19% in 2010 and reduce fossil dependence by 33% by 2020. The government's initiatives to increase the use of biomass, wind and biogas may ensure that the target is achieved by 2020, if not exceeded. The country also provides feed-in-tariffs, loan guarantees for wind planning and subsidies for small scale renewable energy technologies (Denmark, 2014; Mundaca et al., 2013).

To achieve the above mentioned the government is also promoting strict building regulations for energy usage, public transport, energy efficiency etc. In this regard the city of Copenhagen has also introduced its own bicycle strategy for 2011-25(Department, 2011). While the initiative for 10% bio fuels by 2020 will also spur adoption of low carbon transport, another target for energy efficiency (to have the 2020 primary energy consumption 4% lower than that in 2006) may be exceeded due to government's initiatives in reducing energy in commercial and residential areas. Overall the key objective is to source all of Denmark's energy needs from renewable energy by 2050(I. E. Agency, 2011a; Denmark, 2014). The following Table 5 enlists the climate targets for the country in comparison with EUs targets (E. E. Agency, 2013).

Table 5 Climate targets in EU & Denmark

	Share of renewable energy in gross energy consumption	**% GHG reduction (non ETS emissions)**
Denmark	30%	-20%
EU	20%	-10%

Overall there is an emphasis and support on cleantech innovations from the early stages of development to advanced commercial stages. The total amount of green exports from the country represents 10.4% of the total exports while 8.5 % of Danish employees are involved in green production in 2010(D. E. Agency, 2012).

4.1.1 Innovation policy

The following innovation related challenges have been indentified for Denmark in various policies and programs(Klitkou, 2011).

- low productivity growth
- international competitiveness is under pressure
- lagging renewal and innovation
- few new growth companies
- efficiency in the public sector

To meet the challenges identified above, various measures and initiatives have been adopted. This includes initiatives for manoeuvring good ideas to the market, turning knowledge into commercially viable business, supporting development of innovative environmental technologies, solutions for food sector, agriculture, fishery & aquaculture among others. Innovative partnerships are promoted through combination of research, innovation and regional clusters. In cleantech, specifically, many agencies are involved at various stages of the technology life cycle (Figure 12). In Denmark, pre commercial procurement has also been adopted in certain policy measures for strengthening eco-innovations.

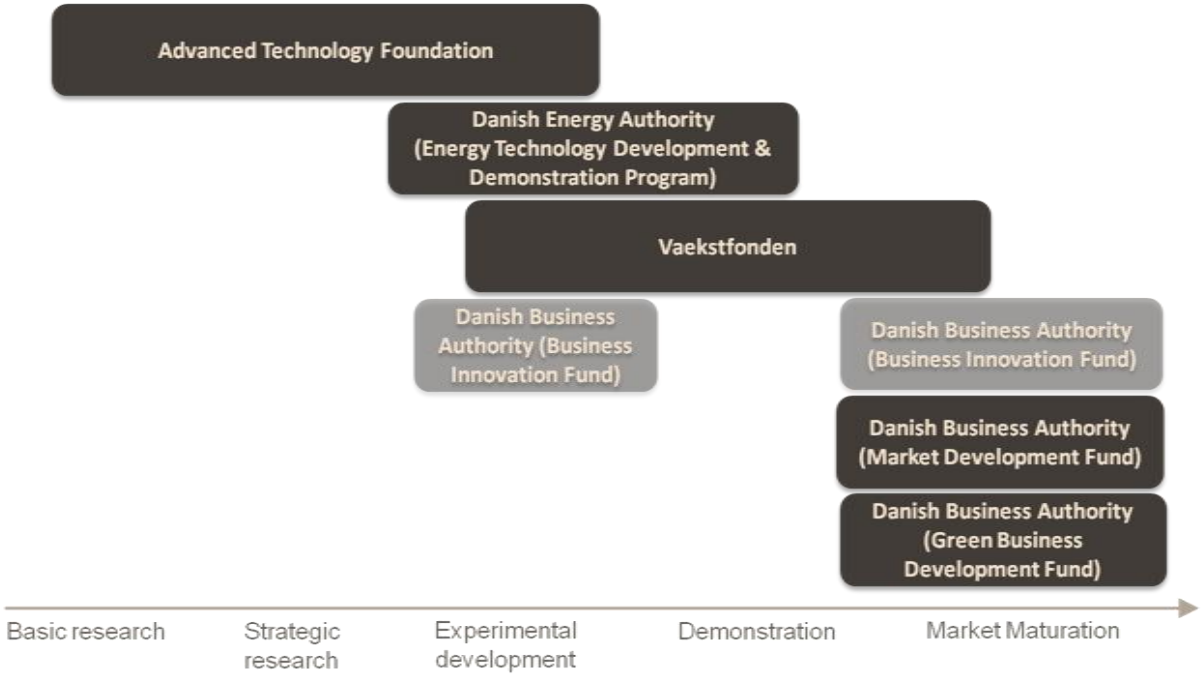

Figure 12 Research and innovation system in Denmark 2013

Source: (Sonnenschein & Saraf, 2013)

4.2 Cleantech funding in Denmark

Vækstfonden is a government funding agency engaged in creating innovative growth companies by investing (equity) in them and providing expertise for development. The fund usually co-invests with other private investors and has been active since 1992. Since then it has invested more than 12 Billion Danish Krowns (DKK) in over 5000 companies. The fund also provides loans and guarantees in cooperation with other Danish financial institutions. The aim of the fund is to promote growth and innovation in small and medium-sized enterprises for higher socio-economic returns. The companies which Vækstfonden has co-financed since 2001 employ about 20,000 people all over the country(Vækstfonden, 2014).

Vaekstfonden is the largest VC investor of Denmark and invests in ICT, cleantech and the medical sector, with a focus on start-up and later stage investments. Its cleantech investments are mainly in energy optimization and pollution control (not in renewable energy). The fund is purely profit-oriented and has DKK 1.1 billion under administration. The average investments

are usually between DKK 5 and 25 million and represent a share of 20-30% (not more than 50% in one venture) (Sonnenschein & Saraf, 2013).

The Danish Government founded the **Advanced Technology Foundation (ATF)** in 2005 and gave it the mandate to support advanced research and innovation in order to enhance growth and strengthen employment in Denmark. From 1 April 2014, its name has been changed to InnovationsFonden with an annual budget of EUR 200 million. The ATF offers funding for companies and academic institutions for carrying out research that has a commercial perspective. The general objective of the foundation is to enhance growth and strengthen employment by supporting strategic and advanced technological priorities within the fields of research and innovation. It has so far co-invested in 273 advanced Technology projects with a total budget exceeding EUR 700 million. Half of the investment comes from the companies and research institutions(Foundation, 2014).

ATF can also curtain funding in a project if it fails to reach certain benchmarks. This has proven effective in ensuring efficient project management (Sonnenschein & Saraf, 2013). Since 2005 the foundation has made a total of 238 investments of which 47 were in the energy-environment sector. This investment in the energy-environment sector represented 24% of the total investment of EUR 708.5 million. There is no mandate for a certain share that energy and environment technology should have in the total ATF portfolio(Foundation, 2013).

The **Danish Energy Agency (DEA)** was established in 1976, and is a body working under the Ministry of Climate, Energy & Building. It is involved in the work related to reduction of carbon emissions and matters concerning energy supply and consumption. It is also responsible for Danish building policy through which it promotes sustainability in building materials, energy consumption and economic issues.

The Agency has taken up the mammoth task of implementing energy agreement having the objective "to transition to a Denmark with a power supply met by renewable energy based on credible, stable and long-term framework of the Danish energy policy." Apart from this they aim at developing an energy efficient society with less wastage of energy, expansion of wind power and other renewable energy technologies, promotion of co-generation , district heating, biomass, smart power grids better framework conditions for biogas development , electricity and biomass in the transport sector as well as increased research, development and demonstration.DEA has worked to establish a new subsidy for renewable energy to increase the Danish production and use of renewable energy(D. E. Agency, 2013).The total DEA funding for energy technology R&D&D was DKK 1billion in 2012, which triggered co-financing of another DKK 750 million.

Some other programs are also functional in commercialising energy technologies. The main support scheme managed at the DEA is the **Energy Technology Development and Demonstration Programme** (EUDP) to foster technological development which is commercially viable. The EUDP has an annual budget of DKK 375 million with an average total investment of about DKK 10 million per project, of which DKK 5 million is typically grant money. The split between different types of applicants for EUDP grants is roughly: one third small enterprises, one third large enterprises, one quarter universities. Medium sized companies represent only a small fraction of all applicants(ERAWATCH, 2012).

The **Danish Business Authority**is an organisation under Danish Ministry of Business & Growth. It has various departments and divisions that work n regulations, digitization, business support, business development and international relations. The division for Growth and Business Development is responsible for managing funds among other things. Three such funds for cleantech business development are Business Innovation Fund (2010-2012), Market Development Fund (2013-2015) and Fund for Green Business Development (2013-2016). All funds focus on SMEs and mainly provide grants. The overall target is to stimulate economic growth, employment and exports(ERAWATCH, 2014).

The **Business Innovation Fund** (BIF) supports innovation (early stage start-up's) and market development (later stage companies). Half of its funding is earmarked for cleantech. During its operation the fund had a total budget of DKK 760million with more than 80% of the funding going to small companies.

The **Market Development Fund** (MDF) has DKK 135 million to manage for each year from 2013-2015, with most of the funds being earmarked for market development of Danish companies. These companies can use the funding for testing existing prototypes and concepts in a realistic environment. The fund has a small portion committed to demand side intervention, with 20% for public sector procurement and 10% for guarantee to alleviate buyer's risk. The aid intensity is limited to a maximum of 60%, which applies for a small enterprise in a consortium. Larger companies receive less, but at least 25%.

The **Fund for Green Business Development** (FGBD) aims to support or adapt Danish companies in dealing with resource scarcity that they may face in the future. It aims at long term green transitions of the economy. The focus areas of the fund are product design innovation, developing green business models, promotion of sustainable materials, green transition in the fashion and textile industry, reducing food waste, and sustainable bio-based products based on non-food biomass.

4.3 TEA in Denmark

The TEA in Denmark showed a downward trend from 2008 (Figure 13), with a parallel decrease in venture funds raised (Figure 14) from 2008-2010 (Refer Table 3 in section 3.3 for a description of y-axis variables). Although, the growth expectation by your ventures increased in 2012 (from 24% in 2011 to 32% in 2012), the TEA remained stable through the years. Even new business ownership rates were stable (2.7% in 2006 to 2.4% in 2012).There was a decrease in overall venture funds raised (from EUR 173 million in 2011 to 90.790 million Euros in 2012).

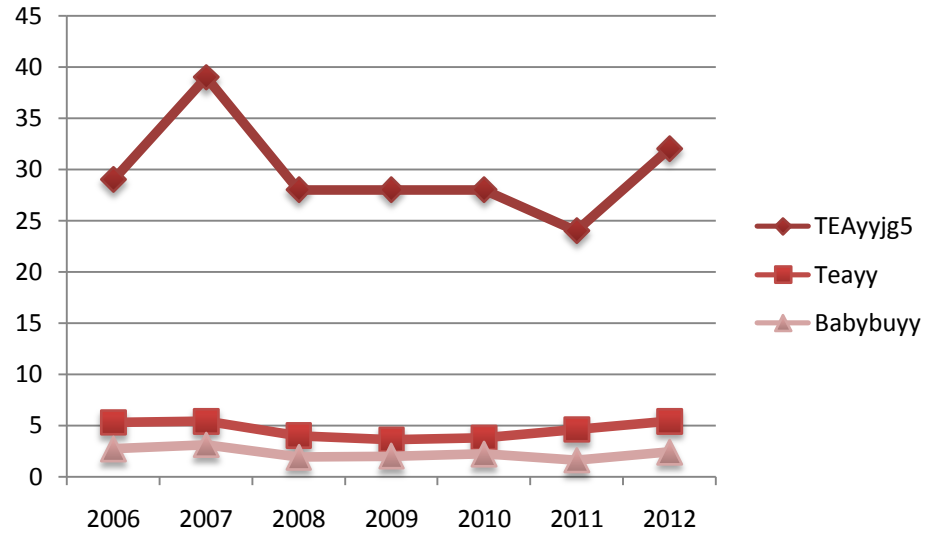

Figure 13 TEA in Denmark (%)

Source: (Global Entrepreneurship Monitor, 2014)

There was a sharp decrease in venture funds raised in 2008 (EUR 43.2 million) comparing 2007 (EUR 550.5 million). The maximum contribution from Government agencies to venture funding has been 34.9% in 2011, while it was 0% in 2008 and 2009 (Figure 14).

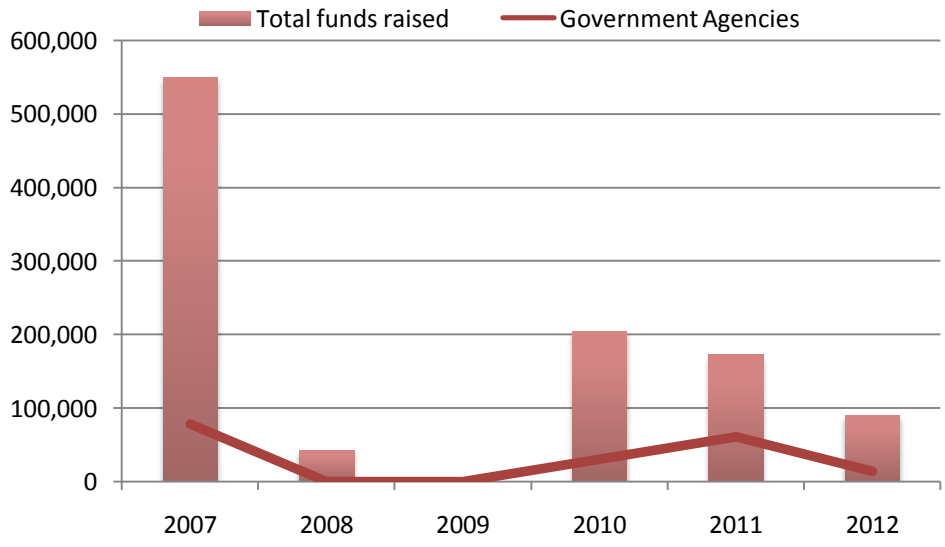

Figure 14 Total funds raised & proportion of government contribution in venture fund raining in Denmark (in Euro'000)

Source: (Association, 2013)

The seed investments have been consistently low in overall venture investments over the years (2007-12). The maximum seed investment that was made was 2.6% of the overall venture investment in 2010. It is also surprising to note that when the total venture investments went down in 2009 there was an increase in overall investments in energy and environment companies (1.6% in 2008 to 14.6% in 2009) (Refer Figure 15 & 16).

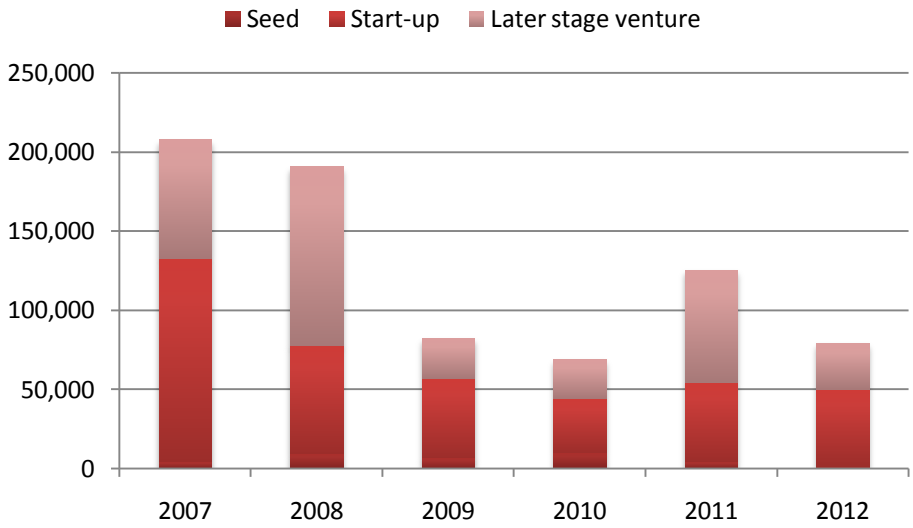

Figure 15 Total investment in Danish start-up's by different venture stages (in Euro'000)

Source: (Association, 2013)

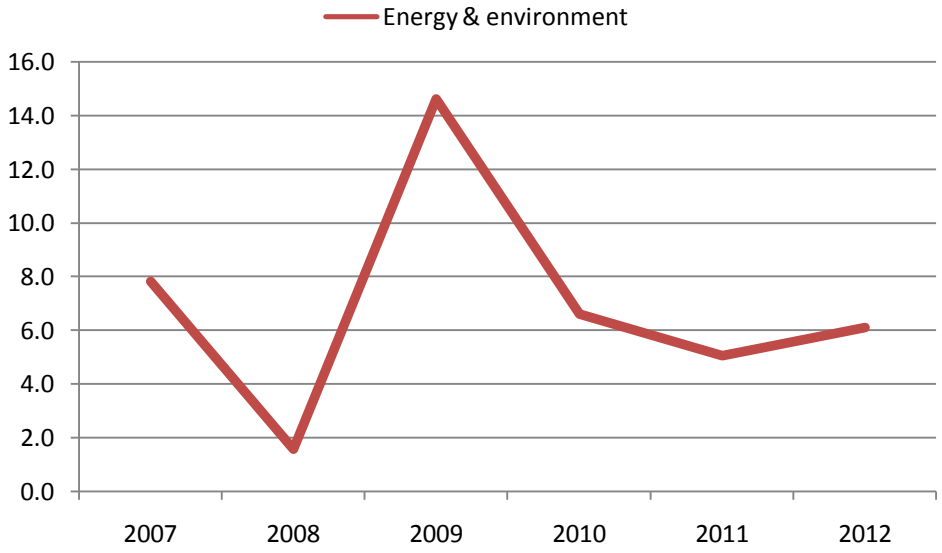

Figure 16 Percentage of venture investments in Danish energy & environment start-up's

Source: (Association, 2013)

4.4 Summary

The following Table 7 summarises the activities of organisations active in Danish cleantech financing domain.

Table 6 Summary of Danish cleantech funding agencies

Name	Type	Target	Cleantech Focus	Stage
Vaekstfonden	VC	profit & economic development	partly	start-up & expansion
EUDP (Danish Energy Authority)	grant	decarbonization of the economy	exclusively	early stage (demonstration)
Business Innovation Fund (Danish Business Authority)	grant	economic development	mainly	seed & later stage
Market Development Fund (Danish Business Authority)	grant	economic development	partly	later stage
Fund Green Business Development (Danish Business Authority)	grant	economic development & green transformation	mainly	later stage
Advanced Technology Foundation	grant	advancing research and economic development	partly	research & early stage

Source: (Sonnenschein & Saraf, 2013)

5 Cleantech in Finland

5.1 Environment policy

The Ministry of Environment, Finland has devised a strategy named "Working towards a sustainable future" which is operational until 2020(Ministry of the Environment, 2014). The key objectives of the strategy as follows:

- to stabilise atmospheric greenhouse gases at a level preventing dangerous changes and enabling adaptation
- to provide a viable, energy-efficient built environment that improves human wellbeing
- to ensure that housing conditions meet people's needs and to secure a well-functioning housing market
- to safeguard biodiversity and scenic value, while ensuring well-functioning ecosystem services and sustainable natural resources
- at a minimum, to achieve a good status for the Baltic Sea, surface waters and groundwater bodies
- to ensure the identification and management of environmental risks

The strategy enlists a number of projects spanning sectors that have an influence on the environment (for e.g. energy efficiency, sustainable consumption & production etc). To promote renewable energy technologies the government provides feed-in-tariffs for electricity produced from renewable energy and also gives a heat bonus to CHP plants that use biogas and wood as fuels(Mundaca et al., 2013). The Ministry is also coming up with various legislations concerning environmental protection in 2014.

As Finland is not endowed with hydrocarbons, it relies heavily on imported fuel and thus energy security becomes an important aspect of their energy policy. To combat this issue, the government had built strategic fuel reserves that match at least 5 months of consumption, it has also diversified the electricity mix by incorporating fossil fuels, renewable sources and nuclear. Last, it also plans to reduce total energy consumption of the country by 11% of the total consumption comparing business-as-usual scenario. Decarbonisation of the economy in the long term is also in the agenda of the government(I. E. Agency, 2013). The climate targets for the country for 2020 are listed in the Table 7(E. E. Agency, 2013).

Table 7 Climate targets in EU & Finland

	Share of renewable energy in gross energy consumption	**% GHG reduction (non ETS emissions)**
Finland	38%	-16%
EU	20%	-10%

As per Cleantech Finland, a national program that aims at supporting the growth of cleantech companies in Finland, a combined turnover of 24.6 Billion Euro was generated from Finnish cleantech businesses, with 40% of the public R&D funding going into cleantech and 1% of Finnish public procurement directed at cleantech solely(Finland, 2014).

5.1.1 Innovation policy

The innovation stimulus in Finland is for measures that directly promote employment, including investments in transport infrastructure and broadband, support to construction and raising social insurance contributions. Public financing for cleantech innovations is present in all the stages and the core public actors in this field are Tekes (public funding of research, development and commercialization), Sitra (independent fund under supervision of the Finish parliament), Finnvera (state-owned financing company) and Industry Invest (state-owned investment company). The funding by Tekes is equally targeted at young SMEs and established enterprises. The Figure 17denotes the cleantech sectors that require public funding the most, as per a research carried out by Cleantech Finland in which 74 of the top 100 Finnish cleantech companies were interviewed by them for inputs (Finland, 2013).

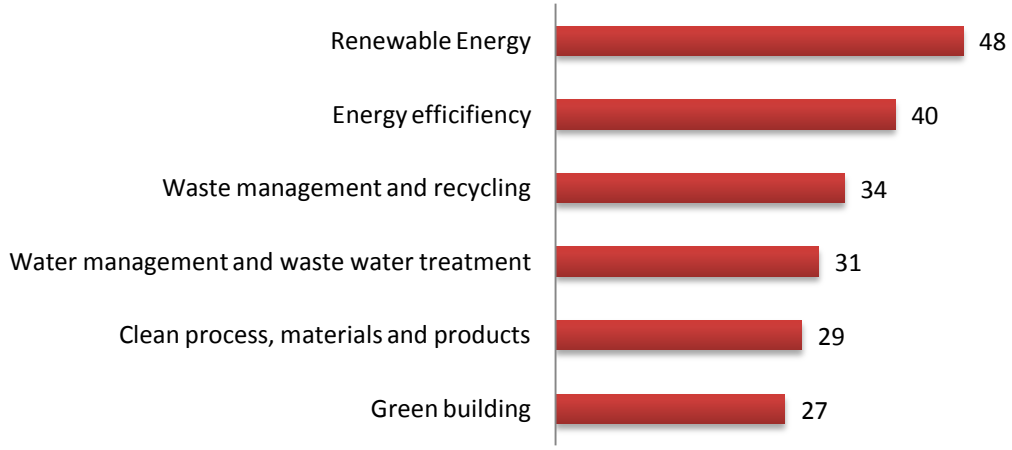

Figure 17 Cleantech sectors in most need of public funding in Finland as per respondents to a survey by Cleantech Finland

Source: (Finland, 2013)

An emphasis is also given to public procurement programs for developing markets for nascent technologies. For e.g. the MotiVoittaja project, launched by Motiva, a state-owned company responsible for promoting energy in 1999, aimed to promote and standardize concept of low-energy housing through a technology procurement competition and labelling system(Viljamaa & Kotiranta, 2011). The following Figure 18 illustrates organizations active in different stages of the Finnish innovation system for cleantech.

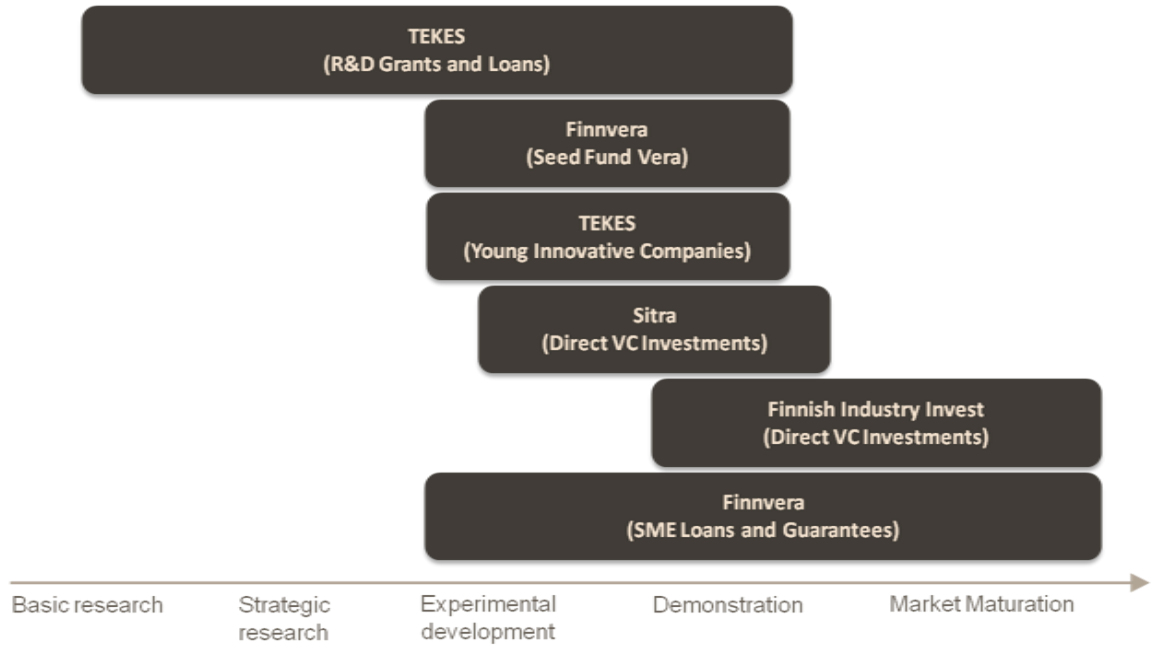

Figure 18 Research and innovation system in Finland 2013

Source: (Sonnenschein & Saraf, 2013)

5.2 Cleantech funding in Finland

Tekes is a government funded organisation in Finland that is especially engaged in financing research & development and innovation. Apart from investing in technical innovations, the organisation also puts emphasis on service based, upcoming green business models. Annually the organisation funds around 1,500 business research and development projects, and almost 600 public research projects at research and academic institutions. Its funding can be availed by companies, research organisations and organisers of public services operating in Finland.. Tekes does not derive any financial profit from its activities, nor claims any intellectual proprietary rights.

In 2013 Tekes disbursed EUR 577 million in funding to companies and research organisations. Out of this EUR 349 million went to companies (of which 67% went to SMEs, and EUR 133 million to young growth companies). The funding to companies is aimed at developing innovative products and international growth, whereas funding to research organisations is aimed at developing commercially or socially viable scientific research and funding to public services is aimed at developing organisational management and innovative public procurement. Natural Resources and a Sustainable Economy and Intelligent Living Environment are two of the six focus areas for Tekes(Tekes, 2014). The current ongoing programs related to the cleantech domain, as supported by Tekes are as mentioned as follows in Table 8.

Table 8 Cleantech related programs supported by Tekes currently

EVE – Electric Vehicle Systems 2011–2015	The aim of the Electric Vehicle Systems programme is to create a community of electric vehicle and support system developers in order to develop new technology, business and service competence.

Green Growth – Towards a Sustainable Future 2011–2015	The aim of the Green Growth programme is to support the generation of innovations enabling significant leaps in energy and material efficiency and to create foundation for the development of new value networks based on green growth.
Green Mining 2011–2016	The main objective of the Green Mining programme is to make Finland a global leader of sustainable mineral industry by 2020.
Smart Procurement 2013–2016	The programme will speed up the introduction of innovations through procurement excellence and the development of markets.

Furthermore, Tekes runs different campaigns promoting commercialization of innovation and growth of young companies. Those relevant to cleantech are "Vigo accelerator program" and the "Growth track program".

The VIGO program aims to facilitate the creation of innovative growth companies in Finland by developing the Finnish venture capital market and attract international investors to the country and thus ensure early stage funding for promising innovative growth companies. In this program the participating companies get business support from an accelerator, a private VC company (Cleantech Invest for cleantech) for 1.5 to 2 years. The companies get access to a EUR 1 million public grant of the Young Innovative Companies Programme and the accelerator also co-invests smaller amounts of about EUR 30 -300 000 into the portfolio company. VC invested into portfolio companies comes both from private and public sources. Public VC is provided by Finnvera, who is partner of the Vigo programme.

The **Growth Track programme** addresses firms at a later stage comparing the VIGO program. The companies are provided expertise and funding for aiding their growth and internationalisation. The growth track programme is jointly run by Tekes and several other organizations(Tekes, 2014).

The **Strategic Centres for Science, Technology and Innovation (SHOKs)** are public-private partnerships that aim for speeding the innovation process with the goal to create radical innovations and renew industry clusters. They help create cooperation between industry and academia therefore enabling technology, service providers and end-users cooperate in the research programmes.

There are 6 SHOKs in operation and each is represented by a non-profit limited company, jointly owned by the shareholders who include relevant companies, universities and research institutions. The one dealing with cleantech is called Cluster for Energy and Environment and claims to be "designed to bring focus and industry lead to the research." The cluster receives base funding from Tekes(SHOKs, 2014).

Sitra is a public Finnish innovation fund and reports to the parliament of Finland. Sitra invests in companies, funds and projects that matches with its vision. It invests equity, grants, convertible loans (or regular loans) in early stage Finnish companies. The companies are also provided access to Sitra's internal expertise and networks. Over the years, Sitra has invested in

58 funds and currently it is partnered with 17 domestic and 27 international venture capital funds. Sitra gets its funding from returns on the investments that it makes and is therefore independent of state financing(Sitra, 2014).

In the cleantech domain, Sitra has investment in both companies as well as funds. The investments into funds are worth EUR 24 million and it holds 10 investments into companies. Sitra invests in total about EUR 10million into ventures every year with the investment range of about EUR 300,000 to 1 million per venture(syndication is preferred). After the first funding round Sitra typically has shareholding of 10-30%(Sonnenschein & Saraf, 2013).

Finnvera is a state owned company that is engaged in the business of providing investments for starting, growing and internationalisation of enterprises. It also provides guarantees against risks arising from exports. It offers loans, domestic guarantees, venture capital, export credit guarantees and other services associated export financing, with the aim of strengthening Finnish companies and their competitiveness. Export related risk guarantee includes political and commercial risk cover. Political risks are those which arise from the economic or political situation in a country where a Finnish export company has customers while commercial risks pertain to the buyer.

Finnvera is led by policy goals laid down by the State and is supposed to run in a financially sustainable manner. The goals are: increasing the number of start-up companies; enabling financing for challenges encountered by SMEs; and promotion of enterprise growth, internationalisation and exports(Finnvera, 2014).Finnvera has ownership in two VC ventures which are; Veraventure Ltd (100% ownership) and Seed Fund Vera (93% ownership). Since 2003 Veraventure has been managing regional VC fund investments for Finnvera and thus also holds significant minority shares in 12 regional VC funds. Whereas Seed Fund Vera aims at supplementing the financial market in overcoming gaps existing between product development funding and later stage private equity investments. It holds shares amounting to 10-40% per venture with initial investments up to EUR 0.5million. It is a revolving or evergreen fund where returns are reinvested in to new targets. Currently less than 10% of the portfolio companies are from the energy and environment sector(Finnvera, 2014)

Finnish Industry Investment (FII) is a government-owned investment company formed in 1995 with the aim to promote Finnish business, employment and economic growth through venture capital and private equity investments. They are focused on developing the Finnish venture capital and private equity sector and are often a co-investor in the first fund of new venture capital teams. In addition to financing FII also helps Finnish businesses internationalise by networking with international funds and investors. Since its formation FII has invested a total of EUR one billion with the current portfolio comprising around 510 companies(Investment, 2014).

Direct investments by FII are usually focused on the expansion stage with it being the minority investor. The initial investments range from EUR 0.5 to 10 million. Cleantech represents a minor share of FII investments with the only dedicated focus sector being mining. FII has also invested EUR 680 million in funds, of which more than EUR 100 million are dedicated towards Finish VC funds(Sonnenschein & Saraf, 2013).

5.3 TEA in Finland

The TEA in Finland has remained stable since 2006 (from 5% in 2006 to 5.3% in 2013) but the growth expectations of young ventures have increased sharply since 2010 (from 14% in 2010 to 21% in 2013). The new business ownership rates have also remained fairly stable, oscillating in between 2 – 3.5% (Figure 19). In the same years there was a drop in the total venture funds raised (2009-10) but that has gradually grown from EUR56.9 million in 2009 to EUR 98.7 million in 2012. The government has been an active player in venture fund raising by contribution almost 50% of the total funds raised every year, post 2009. The highest contribution was of 65.3% in 2009 (Figure 20).

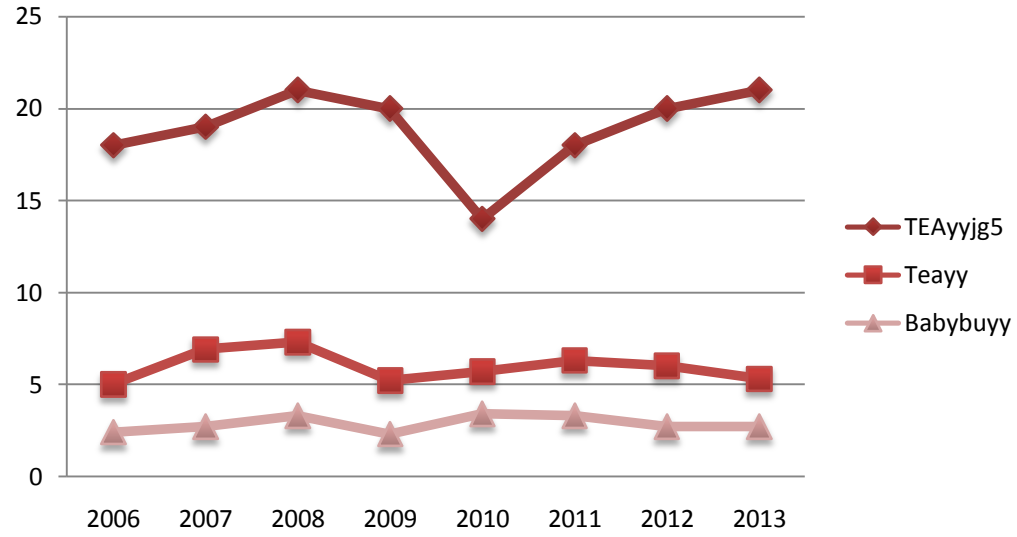

Figure 19 TEA in Finland (%)

Source: (Global Entrepreneurship Monitor, 2014)

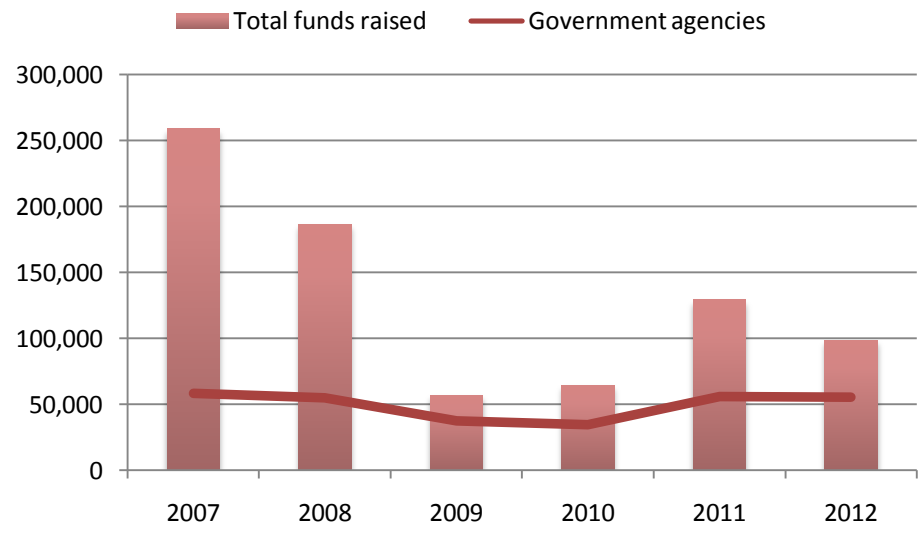

Figure 20 Total funds raised & proportion of government contribution in venture fund raining in Finland (in Euro'000)

Source: (Association, 2013)

The total venture investments have witnessed a gradual decline since 2007 (with a total of EUR 132.1 million invested in 2007 to EUR 79.06 million in 2012). This may be an indication of VC moving towards the later stages where risks are relatively low. The maximum seed investments as a percentage of overall venture investments were in 2007 at 1.6%. At the same time maximum percentage of overall investment in energy and environment companies was 14.9% in 2012 (Figure 21 & 22).

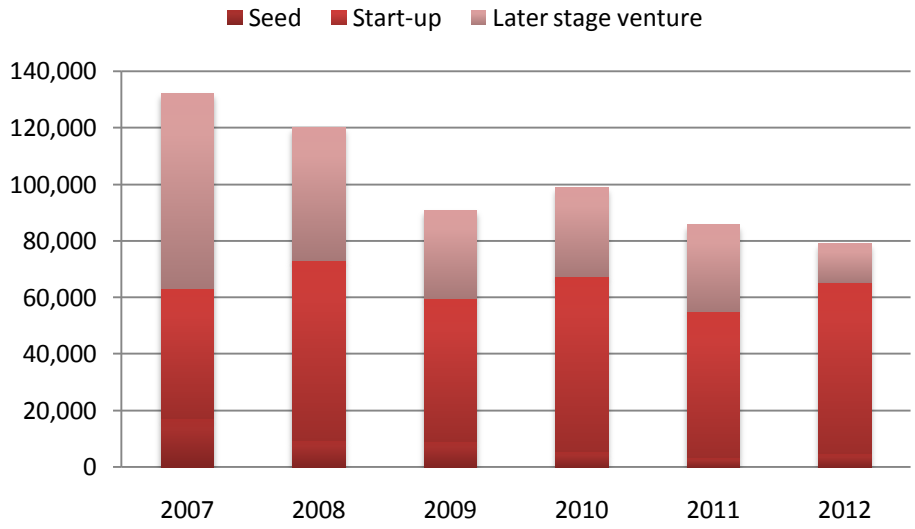

Figure 21 Total investment in Finnish start-up's by different venture stages (in Euro'000)

Source: (Association, 2013)

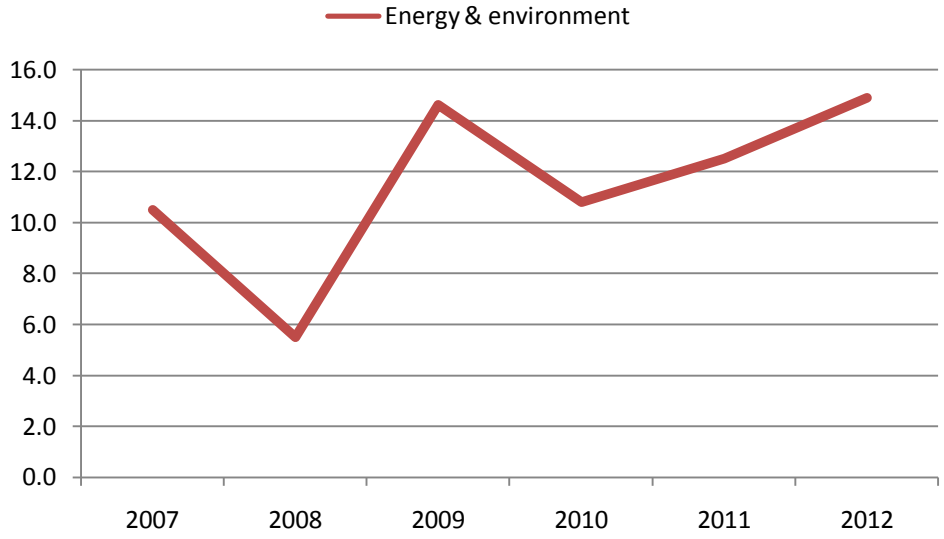

Figure 22 Percentage of venture investments in Finnish energy & environment start-up's

Source: (Association, 2013)

5.4 Summary

The following Table 9 summarises the activities of organisations active in Finland's cleantech financing domain.

Table 9 Summary of Finnish cleantech funding agencies

Name	Type	Target	Cleantech focus	Stage
Young Innovative Enterprises (TEKES)	grant	economic development	partly	seed
R&D aid scheme (TEKES)	grant	advancing research and economic development	partly	early stage
Seed Fund Vera Ltd (Finnvera)	VC	economic development	partly	early stage
Sitra	VC	profit & socio-economic development	partly	start-up
Industry Invest	VC	profit & economic development	partly	expansion

Source: (Sonnenschein & Saraf, 2013)

6 Cleantech in Norway

6.1 Environment policy

The Norwegian environmental policy (2004-05) covers various aspects of environment including noise pollution, climate change, biodiversity etc. and lays down ambitious targets for the policy(Environment, 2004-05). The Norwegian Environment Agency (under the Ministry of the Environment) which is the outcome of a merger between the Norwegian Climate and Pollution Agency and the Norwegian Directorate for Nature Management, enlists the following tasks for achieving national level environmental objectives(N. E. Agency, 2014).

- a stable climate and strengthened adaptability
- biodiverse forests
- unspoilt mountain landscapes
- lush wetlands
- a toxic-free environment
- an active outdoor life
- well managed cultural landscapes
- living oceans and coasts
- healthy rivers and lakes
- effective waste management and recycling
- clean air and less noise pollution

In order to promote renewable energy, the government has a tradable green certificate scheme in conjunction with Sweden and also a funding scheme for renewable heat and electricity. Being an oil and energy producing nation it also contributes to the energy security of many other countries. Environmental considerations are well integrated in natural resource management. Norway has also announced plans to go carbon neutral by 2050 and to change this deadline to 2030 lest significant number of other countries also take major obligations in this regard. The Norwegian parliament in 2008 undertook a Climate Agreement, that has resulted in tripling of public funding into R&D&D from 2007-09(I. E. Agency, 2011b; Mundaca et al., 2013). The climate targets for Norway (2020) are listed in the Table 10 below(E. E. Agency, 2013).

Table 10 Climate targets in EU &Norway

	Share of renewable energy in gross energy consumption	**% GHG reduction (non ETS emissions)**
Norway	68%	-30%
EU	20%	-10%

The cleantech industry is considered a medium-sized sector in Norwegian economy. In 2010 the industry achieved a total turnover of NOK 192 billion, while employing more than 38000 people in 2011. Sub-sectors like hydropower, power distribution and trading and waste management, treatment and recycling employ most people(Intpow, 2011).

6.1.1 Innovation policy

Energy & environment is an important area of Norway's innovation policy. The government measures ensure international competitiveness and market development of domestic environmental technologies. A strategy for environmental technologies announced by the government in 2011 intends to develop environmental technologies by supporting commercialization & demonstration, R&D, public & private procurement, networking and regulations. The target is large and SMEs.

Energi21, Norway's national strategy for the energy sector is an effort by the government to "boost value creation, facilitate energy restructuring with the development of new technology and cultivate internationally competitive expertise". It identifies six focus areas:

- Solar cells
- Offshore wind power
- Utilisation of resources using balance power
- Flexible energy systems – smart grids
- Conversion of low-grade heat into electricity
- Carbon capture and storage (CCS)

To boost innovations through innovative demand side instruments the government wants public sector to lead the way in buying environmentally & socially acceptable products and services. This was highlighted in the Environmental and Social Responsibility in Public Procurement Action Plan(Scordato, 2011). The Figure 23 illustrates agencies active in the Norwegian cleantech innovation system.

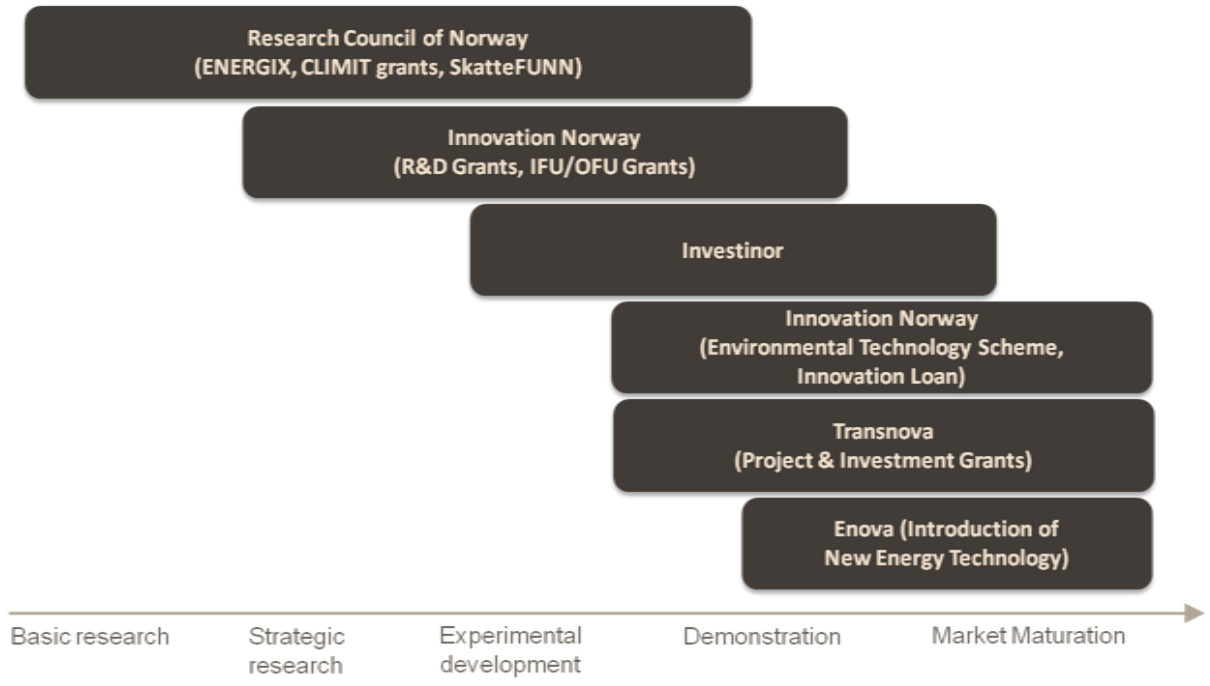

Figure 23 Research and innovation system in Norway

Source: (Sonnenschein & Saraf, 2013)

6.2 Cleantech funding in Norway

Innovation Norway supports innovative development of Norwegian enterprises to enhance their domestic and international competitiveness through financial and business support. They provide advisory, promotional and network services and promote industry-academia interactions. In some cases enterprise support (loans or grants) may come from other organisation like the Research Council of Norway and Enova(I. Norway, 2014). The organisation is not entirely focused on cleantech and uses the following instruments.

- **Grants**. Accessible for (mainly) SMEs in all sectors.
- **IFU/OFU grant scheme**. Grants for industrial R&D, which are up to 50% for SMEs and 65% for consortia including SMEs. The grants are disbursed basis an agreement with a technology provider and an established company that is in need fo the applicants technology.
- **Innovation Loan**. The loan is offered to innovative projects with a profit potential which have difficulties finding finance from the market. It can be used to finance up to 50% of a project and is targeted at the expansion phase.
- **Low risk Loan**. The low-risk loan provides well-secured long-term financing does not specifically target innovation funding.

Some programs of Innovation Norway that are relevant to cleantech are:

- The **Environmental Technology Scheme** is a grant scheme that targets cleantech companies in the late start-up phase through co-financing. The aid intensity ranges from 25% for large enterprises to 45% for small ones. A 15% bonus can be obtained if the project is carried out together with additional private companies. In 2012 public funds worth 33M EU were allocated to the program (Refer Figure 24 for grants disbursed under this scheme).
- The **Innovation Cluster Scheme** is jointly run by Innovation Norway, the Research Council of Norway and SIVA and includes two main programmes: ARENA and the Norwegian Centres of Expertise (NCE). ARENA supports clusters that do not fully function as industrial innovation clusters. In it four of the regional clusters are in the cleantech sector (two wind energy, one bio energy, one material technology). NCE programme, on the other hand, supports mature clusters and aim for international growth and increasing competitiveness. One of the 12 centres of expertise is in the cleantech sector and deals with smart energy markets(I. Norway, 2014).

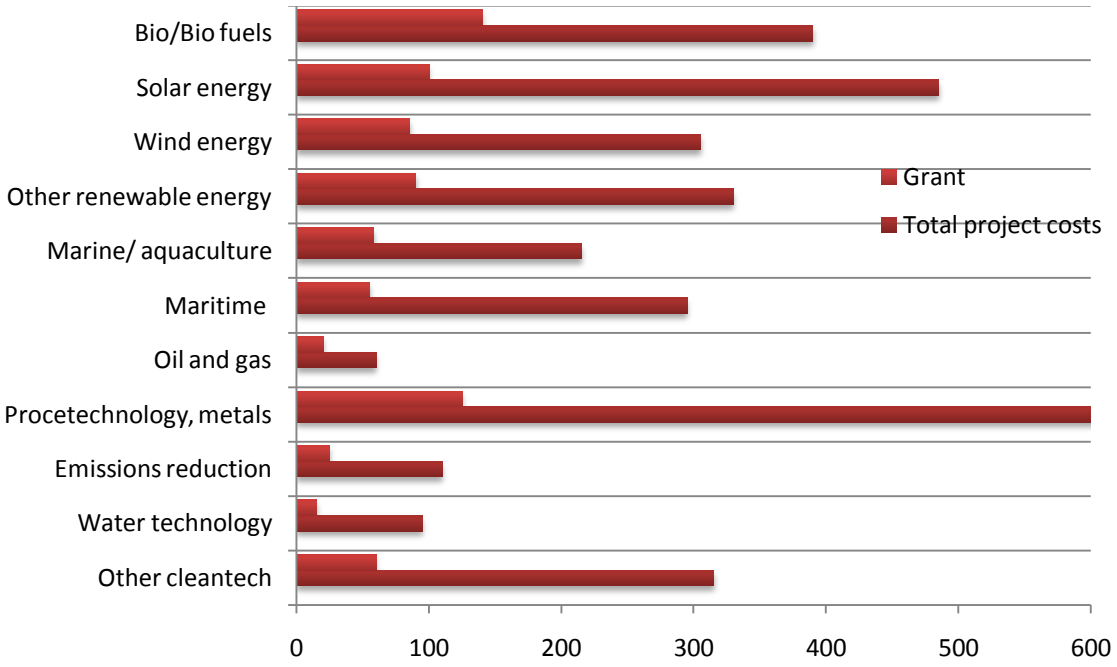

Figure 24 Grant from environmental technology scheme versus total project costs 2011-2013

Source:(Norway, 2013)

Investinor is a government owned Investment Companyalso funded by the Norwegian government. They invest in later expansion stages of a venture aiding its international growth. It is a ever-green fund where the earnings are invested back into the fund and co-investment is a preferred mode of investment. Investinor takes minority stakes (<50%) in the portfolio companies and focus on the following sectors; ICT, oil and gas, the maritime industry, Aquaculture, biotech, cleantech, travel and tourism. In cleantech they have a total of 4 companies in their portfolio currently with NOK[9] 281 million invested in them. In 2012 the government mandate of investinor was slightly modified in order to give it more freedom in prioritizing sectors. This has led to shift away from cleantech as the old mandate earmarked certain amounts for sectors like maritime and cleantech(Investinor, 2012).

The Research Council of Norway carries out research in different areas including climate change and environment. Out of its four such research divisions, the Division for Energy, Resources and the Environment is responsible for research and innovation targeting national and global challenges associated with the energy, petroleum, climate, polar, environmental and marine resources sectors. Through this division they conduct activities pertaining to policy development & design, strategy making and planning pertaining to resource management. In 2012, The Research Council of Norway's total budget amounts to NOK 7433 million(T. R. C. o. Norway, 2014). In the area of energy R&D there are currently three relevant programmes:

[9]Norwegian Krone

- **ENERGIX** is an applied energy research programme with a budget of EUR 45million per year aim restructuring of the Norwegian energy system. In the first funding round in 2013, 25 projects have been awarded funding.
- **CLIMIT** is the Norwegian research programme for Carbon Capture and Storage (CCS) with a budget of about EUR 12million /annum. It is run together with the state-owner CCS company Gassnova.
- The **Centers for Environment-friendly Energy Research** conduct focused long-term research involving industry, academia and research institutions. The Research Council of Norway funds up to 50% of the budget of the centres for a duration of 5 to 8 years. There are currently 8 centres in cleantech which mainly deal with renewable energy and CCS. The annual volume of the scheme is about 15M EUR.

In addition the Council also runs other schemes for R&D commercialization:

- **User-driven Research based Innovation (BIA)**: BIA aims at crowding-in industrial R&D funding to increase the total level of R&D in Norway. In 2013 the programme had a budget of 400M NOK for the first application round
- **SkatteFUNN**: SkatteFUNN is a tax incentive scheme that gives companies a facility to apply for tax deduction based on certain R&D project costs. If tax deductions are greater than tax liabilities, companies get the difference in cash(T. R. C. o. Norway, 2014).

Enovais a government owned energy fund owned by Ministry of Petroleum & Energy, which was established in 2001 for driving environmentally friendly production &consumption of energy including renewable energy production. The enterprise is financed via funds allocated from the Energy Fund which in turn is funded via an additional charge to electricity bills.

In addition, the Energy Fund is also allocated proceeds from "The "Green Fund for Climate, Renewable Energy and Energy Efficiency Measures". The Green Fund's capital in 2013 was NOK 35 billion, with NOK 5 billion to be added in 2014 and 2015.In 2013, Enova supported projects with a total energy result of 1.4 TWh, distributed over energy efficiency measures, conversion and increased utilization of renewable energy.

One of the most relevant scheme at Enova is **Programme for the Introduction of New Energy Technology**that supports concrete, physical installations(Enova, 2013).

Transnova provides grants and business support for pilot and demonstration projects concerning future-oriented sustainable mobility solutions. For 2013 Transnovas budget was EUR 87.2 million (~EUR 11.75 million). The main support instrument is competitive grant programmes to projects that are between R&D late phase and market introduction(Transnova, 2014).

6.3 TEA in Norway

The total TEA in Norway has seen a gradual decline from 8.9% in 2006 to 6.3% in 2013, while the growth expectations among young ventures (to employ 5 or more employees in the

next 5 years) has also plummeted, being 31% in 2006 to 19% in 2013 (Figure 25). The data for the year 2010, regarding growth expectations, was not available in the GEM survey and hence had to be left out in the graph. As is the trend with other countries there was a startling decline in the overall venture funds raised in 2009.

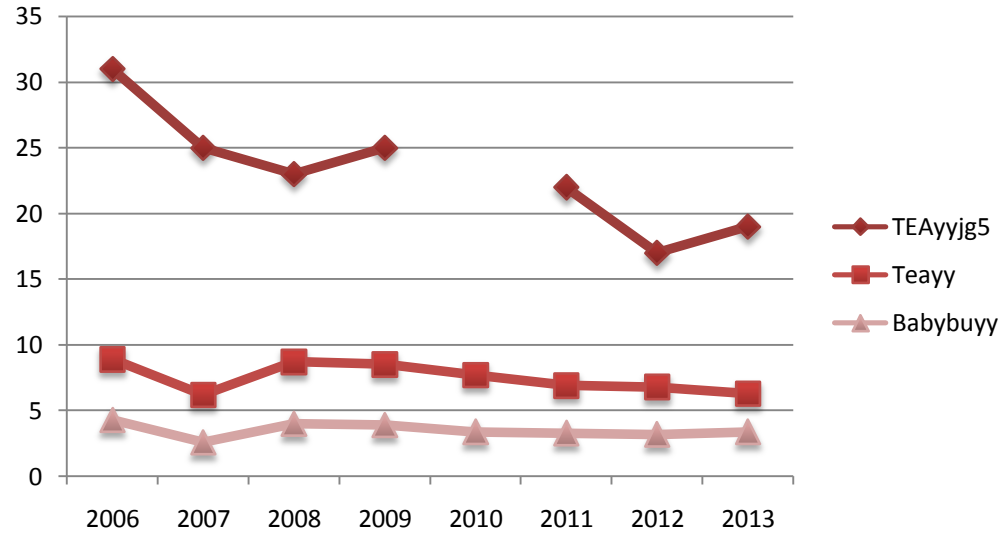

Figure 25 TEA in Norway (%)

Source: (Global Entrepreneurship Monitor, 2014)

In Norway the total venture funds raised dipped down to EUR 14.3millionin 2009 and has been gradually rising since then. In 2012 the total funds raised were EUR 207.8million in 2012 with government raising the massive share of 97.5% of the total amount (Figure 26).

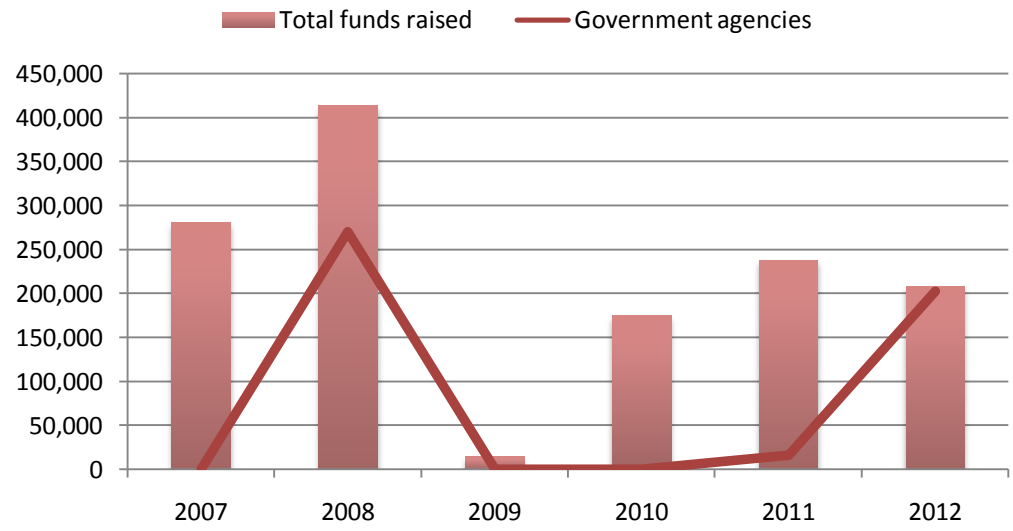

Figure 26 Total funds raised & proportion of government contribution in venture fund raining in Norway (in Euro'000)

Source: (Association, 2013)

The maximum seed investments in venture funding stood at 2.1 % in 2007 and dipped down to 0.1 % in 2012. Although the total investments made in energy & environment companies has been consistently more than 30%. In 2011 the total such investments made in energy/environment companies stood at 52.9% (Figure 27 & 28).

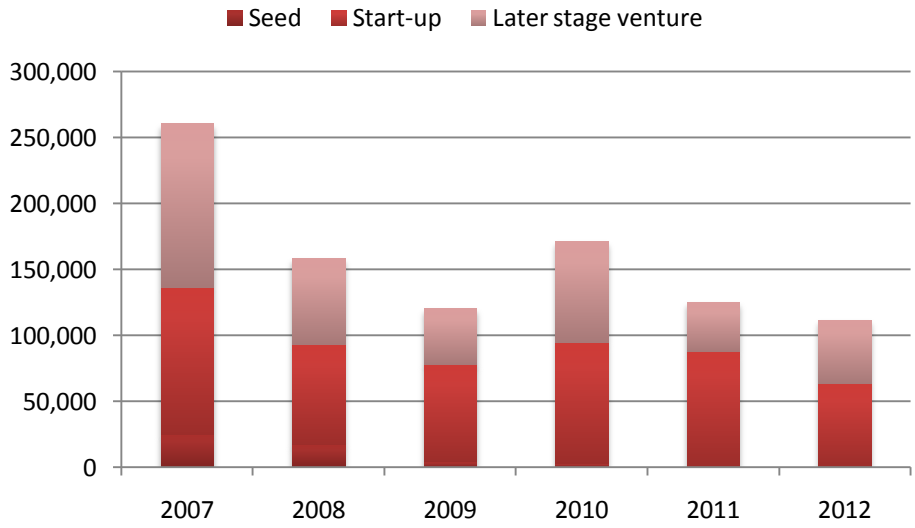

Figure 27Total investment in Norwegian start-up's by different venture stages (in Euro'000)

Source: (Association, 2013)

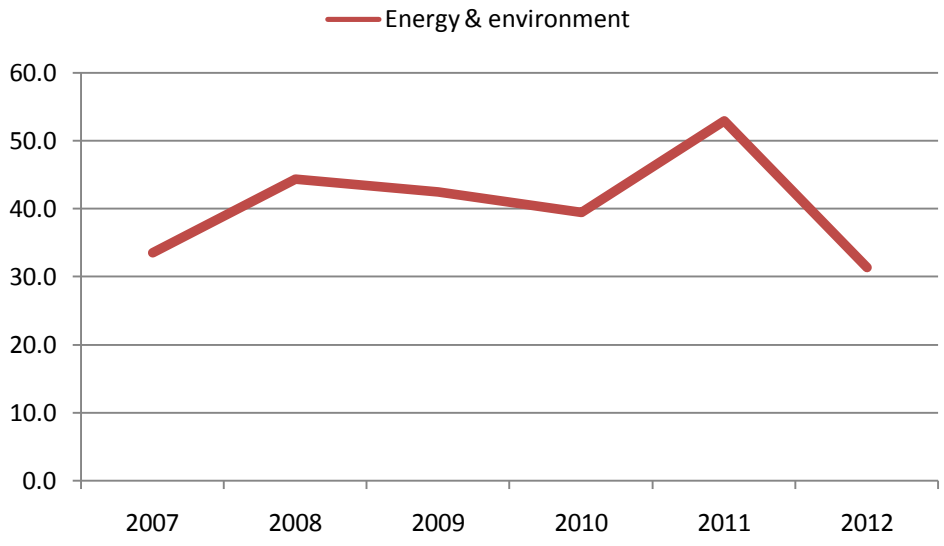

Figure 28 Percentage of venture investments in Norwegian energy & environment start-up's

Source: (Association, 2013)

6.4 Summary

The following Table 11 summarises the activities of organisations active in Norwegian cleantech financing domain.

Table 11Summary of Norwegian cleantech funding agencies

Name (Organization)	Type	Target	Cleantech focus	Stage
Investinor	VC	profit & economic development	currently not	start-up & expansion
Environmental Technology Scheme (Innovation Norway)	grant	economic development	exclusively	early stage
Innovation Cluster Scheme (Innovation Norway)	grant	economic development	partly	early stage
ENERGIX (Research Council of Norway)	grant	restructuring the energy system	exclusively	early stage (demonstration)
CLIMIT (Research Council)	grant	advancing CCS technology	exclusively	early stage (demonstration)
Centers for Environment-Friendly Research (Research Council)	grant	innovation through research	mainly	early stage
User-driven Research based Innovation (Research Council)	grant	economic development	partly	early stage
SkatteFUNN (Research Council)	tax break	increasing private sector R&D activity	partly	early & later stage
Introduction of new energy technology (Enova)	grant	economic development & emissions reduction	exclusively	later stage
Transnova	grant	substitution of fossil fuels in transportation	exclusively	later stage

Source: (Sonnenschein & Saraf, 2013)

7 Results & Analysis

This section would build upon the inputs received during the interviews and lessons drawn from the literature review. An attempt will be made to answer the research questions stated in the initial section of this study.

The current study brought to light various aspects of the current state of cleantech in the four chosen countries. Although environmental priorities have been identified and strategies chalked out in all the countries, funding of cleantech innovations did seem to face turbulence. This is especially true for technologies which are highly capital intensive or too disruptive to be able to be "exited" profitably. There is a shift of private investors to later stages of the venture cycle where technology risks are low, while there is a consequent lack of early stage risk capital availability. This was well corroborated in the figures on total venture investments in respective countries that has decreased with time (from 2007-12). The overall situation could not be better described as done by one of the interviewee (an Investment Associate with a public VC fund in Norway).

"There is not very much liquidity in any of the cleantech sectors, and hence not much of private capital is there. But they see that new technologies like wave power, tidal, fuel cells etc are coming up, and hence believe that growth in such sectors may be possible in the future."(L, 2014)

All the countries were also using different financial instruments (loans, VC, grants) to target different phases of innovation. Generally all the public VC funding agencies agreed to be working in a similar way as any other private investor, in terms of profit motive. Although the private investors in these countries had a different view regarding the operation of these government funding agencies and expressed specific concerns over their expertise in governance of VC funds. At the same time private investors also agreed that public funding was advantageous especially because it helps reduce their risks. While there was a general consent on the usefulness of public support mechanisms, interviewees presented varied opinions on how these schemes should be targeted and implemented. These opinions are presented in the further sections.

7.1 Target of cleantech financing

7.1.1 Target Objectives

As discussed in the previous sections that cleantech is usually capital intensive, has higher gestation periods and is difficult to scale up. This situation would obviously pose high risks to an investor and if it were just for profits, the private players have other lucrative options to invest in besides cleantech. Therefore, the best which a government can do is to alleviate or share the risks of these investors, in order to let the market grow. In this regard, target of public funding, as discussed in Section 2.6was cited to be environmental development, economic development, job creation, export promotion and profit generation. Further details from the interviews regarding the objectives are presented henceforth.

In Sweden, Vinnova, the Swedish Agency for Innovation systems also works with the objective of fostering an innovative economy by funding research and innovation grants in SMEs as well as established organizations. The SEA issues conditional loans with the aim of profit generation, export promotion, employment generation and the amount of funding raised through private actors. Another obvious implicit consideration was to develop domestic

technologies or ventures, for better control on the venture and leveraging knowledge of the domestic market(B, 2013). Apart from this, **regional growth and development** was also an important agenda for all public funding organisations. Taking the GEM data on TEA as a proxy for regional growth and development, one can see in Sweden and Norway that the TEA remains stable while the growth expectations (to be able to employ at least 5 employees 5 years from now) are seen to be plummeting. This indicates that although there is early stage entrepreneurial activity in these countries but whether this activity sustains itself (and alongside sustains the benefits it creates in terms of employment, economic development, regional growth etc) is a question. On the other hand in Denmark and Finland the growth expectations are seen to be gradually rising, TEA remaining stable.

The agencies also want that the technology should have an **international appeal**to have an **export potential**as the market for such technologies when it comes to "exit" lies usually beyond the boundaries of the countries(F, 2014). Talking of public VC funds only, all such funds that participated in the research cited **profit generation** as an important objective. Almi Invest & Industrifonden (Sweden), Vaekstfonden (Denmark), Investinor (Norway) and Sitra, Finnvera & Industry Invest (Finland) offer VC instrument. They shared that they also behave like any other private VC on commercial terms but may have certain principles to follow which are laid by the Government. None of the funds want to be majority partners in the transactions, to avoid suppressing the private capital and rather channelling it. At Investinor (Norway) "They don't take more than 49% equity in a transaction" and thus conditions for **crowding-in** of private capital are created. Thus the parameters of success for their investments are usually related to turnover, percentage of turnover that goes in exports, employment generated and amount of funding raised through private actors. In fact, almost all the funds want to **syndicate or co-invest** along with other private investors by sharing risks. "Our mission is to attract private investors and make the company attractive enough for them." (F, 2014).

The public VC may take a passive role in syndicated investments by providing capital, while the mentoring and growth of the venture is taken care of by the private investors. Although this may seem to be the best use of respective strengths, the private players still struggle when it comes to **exit**ing the ventures. It was therefore suggested by some private investors that the government VC funds may also try to create a network or integrate buyers (usually corporations which act as **strategic buyers**) for the technologies. Unlike the biotech sector, in cleantech there is no market for pre-commercial stage ventures but the industrial companies may add value in this regard by supporting new technologies by offering test bed facilities and being the first customers. "A strong network of industrial companies can be very helpful as the start-ups can then see a ready exit market. " (K, 2014).

Also all the four countries have made some proportion of the total venture investments into energy and environment sector companies thereby signifying commitment to **environmental sustainability**. In this regard, Norway has made the most VC investments in energy & environment related ventures (more than 30% per year from 2007). All the four countries have had comparable early-stage entrepreneurial activity.

7.1.2 Target Stages

The quintessence of rationale behind targeting appropriate venture stages is that public funding should be capable of manoeuvring the innovation from the early to later stages without gaps. This also entails that the funding should be targeted specifically at stages from which private investors are desisting. Regarding venture investments, as per the EVCA data all

the four countries had low overall **early stage** investments irrespective of the sector and interviewees identified gaps in early stage (especially **seed stage**) cleantech investments in all these countries. Although the countries had structured instruments and measures that were supporting all the phases of innovation, whether those measures are appropriate or sufficient may not be the case. One interviewee who is also the head of a corporate venturing unit in Sweden told that the amount of money government was providing for building **demonstration pilots and prototypes** was "peanuts", with reference to his company's investments in tidal energy technology. This gap in technology demonstration phase was observed by private VC investors in the four countries. Another private investor said the same thing, that, government funding should rather focus on the early stages (research, development, demonstration etc.). He further went on to mention that the government should intervene when the market forces are not working properly and should not assume that markets will sort problems on their own(A, 2013).Even in Finland an investor voiced similar concerns;

"The cleantech sector would need help in pilot projects, like quite expensive pilots. Hence subsidy support from the Government is needed. Finland has lost lot of technology developmentbut support for pilot demonstrations has been very small."(J, 2014)

It is understandable that in early stages it may be difficult for companies to attract VC due to issues of technology risks, exit and high capital requirement. Therefore a public VC fund may well target these stages to lower the risk perception of the private investors. Of course, if the markets would have solved this issue without government intervention then an intervention may not be needed. But the fact that there is not enough capital in the market in those stages makes it important to have governmental venture capital to be there to work.

Another aspect of targeting a stage in a venture cycle is to **avoid overlaps** with other support instruments which are meant for the same stage. This situation leads to increased complexity, inefficiency and administrative burden for the agencies to deal with. The support instruments or mechanisms should be so streamlined that the innovation is guided through the entire value chain and be able to benefit from different funding instruments and support schemes.

In Sweden, private VCs were content with the work of a public VC organisation by the name Almi whom they observed to be doing very "helpful" work in taking or sharing risks at the very early stages of the venture. In Norway also, Investinor & Innovation Norway, public organisation involved in VC, loan and grant funding have been appreciated for their funding support to cleantech ventures. The idea is that public organisations serve as catalyst for private capital as its sometimes difficult for companies to attract VC at early stages (F, 2014). In this regard funding support in early stages of the venture as well as highly capital intensive demonstration phases were identified to be very crucial. A few quotes from our interviewees in this regard are as follows.

"Investinor does always co-invest, and it is very helpful to do co-investment as early-stage investments is hard to gain in any sector."(N, 2014)

"It's difficult to find co-investors in the cleantech space and therefore the capital intensive cleantech projects are very difficult to get funding for."(M, 2014)

7.1.3 Target sectors

As was noted in the study, cleantech is a wide domain encapsulating various sectors like energy, waste, water etc. One of the interviewees mentioned that "cleantech is not a proven asset class" as there is no standard definition of this term (M, 2014). Thus different sub-sectors in the cleantech domain have completely different investment characteristics from each other. Therefore there can be no blanket application of a recommendation to anything and everything within cleantech. Also different countries have their strength in different kind of clean technologies.

From the interviews, there was a clear indication that cleantech, as an investment domain, is not an attractive sector among the private investor. Now the cleantech referred in the previous sentence denotes technologies that have a "hardware" orientation and require relatively higher capital investment compared to the "software" oriented cleantech. Also, while the software oriented cleantech would generally support an already existing technology by making that particular be cleaner than before, it has a rather incremental nature. On the other hand hardware kind of technologies may be fundamentally different and better comparing existing technologies but may need high capital, longer payback time, less exit opportunities among other things (P, 2014). An interviewee noted that government intervention is necessary in **immature but potentially good** technologies (foe e.g. wave energy) as well as sectors that have a **high capital requirements** such that private money is not sufficient(C, 2013). On the other hand another interviewee from Sweden, mentioned that government should **play on its strength**, which is in component suppliers or ancillary market and thus should attempt to develop it further(D, 2014).One of the private investors remarked,

> "*We want to invest in technologies that are able to reap financial benefits quickly, promote sustainability and have a competitive edge. We should adopt a futuristic mind-set for technologies in this regard*".

Thus it was clear that private VCs would not like to invest in areas that require large amounts of money and where return multiples may be low or come very late. They want to invest in those technologies that have strategic value or fit and can be easily sold to buyers. "… *Financial requirement is very difficult to fulfill. Thus there needs to be a* ***strategic value*** *in the investments made in cleantechby VCs"* remarked another private investor(I, 2014). Even for a public VC fund that operates with a for–profit motive, a lucrative exit is always needed for financial sustainability of the fund. Thus strategic investments in technologies which require public VC intervention should also fulfil a niche and generate value for the buyers. In this regard, the sectors that have a growth potential but may not have very much liquidity (like wave power, tidal etc.) can be supported by public VC. A professor makes the following case for government intervention;

"The strongest challenge is capital intensity of developing energy tech. This is difficult to reconcile with the traditional VC model of putting a few millions and then reaping the benefits quickly. Another issue is that of ***policy risks****, people hear about solar energy as promising but when Government revoke subsidies this scares them away."*(P, 2014)

Hence the above mentioned approaches are for cleantech sectors that have special needs. Some organizations in all the four countries run programs that target a specific sector like Finland (Tekes) and Norway (Innovation Norway) ran **specific support programs** for bio-refineries. While it may be debated that Government may not be best equipped to choose market "winners", at the same time many technologies would not have developed without its intervention. On the other hand, another approach as taken by the Danish Business Authority and also the Danish Advanced Technology Foundation is to have schemes that cover

technologies irrespective of the sector and choose the most promising ones. Although there funds are not specially earmarked for cleantech, a significant portion of funding goes into cleantech projects that have a **strong commercial perspective**.

7.2 Government equity ownership

As has been corroborated in the figures on venture financing in the four countries, it was clear that there is less capital available in the early stage of the ventures and private VCs are moving towards later stages. This may make government intervention in the early stages a necessity, to fund innovations that are profitable but may need patient finance. In public equity ownership, a few things are very important. Like being able **to provide adequate management support** to the ventures and also sourcing the right ventures, to be able to make **follow-on investments** and make the venture grow and to be able to **mitigate risks for private investors** and **catalyse private capital** at later stages.

In the interviews, some interview partners had no opposition to the idea of government owning equity in the project it supports. In this regard it was obvious that all the interviewees who were working with public VC funds opined positively for their involvement. Like one of them said that public money should be very carefully utilized and government should have stakes in the ventures so as to **generate returns on this public capital**. He noted that when a market failure is discovered then the government should intervene but it may be so that they own a **discounted equity** comparing private investors (less than 10%). This means that government should generate value out of its investments but avoid being the decisive owner(B, 2013). A private investor noted that the purpose of the ownership should be very clear for the Government VCs. This was in the context that government has been usually co-investing with private investors and does not take the lead in making investments. The contention was not with co-investments but with clear delineation of operation duties. He said that the government may leverage private expertise to manage the funding while setting the rules of operation, otherwise he said, *"Shared responsibility means no responsibility."(A, 2013)*

Actually, there is no room for public intervention in sectors or stages where private investors would anyways be attracted to come. One General Partner of a private VC firm in Sweden said, *"It's the top 0.05% of the companies which actually do well, generate revenues and do not require any governmental funding. The remaining half may do well with some government support and the rest are good for nothing*". He also said that his firm prefers not to have government as a co-investor as the incentives of the investment managers (in Government firms) are not aligned with that of a private investor. For e.g. bonuses of government employees in a VC firm are not dependent on portfolio performance (I, 2014).

The problem is when government money starts to compete with private capital. This makes the market situation distort to an extent that it scares off private investors. Early stage financing by government has been lauded by all the interviewees and some also opined that soft funding from the government in the form of cheap loans or grants has also been very helpful. The co-investment model consisting of a public-private hybrid was also welcomed. Here government invests capital in the venture along with another private VC, take minority ownership and then the let the private investor develop or grow the company. Some issues with such intervention were pointed out by a Finnish investor.

"… no one wants to have government as a VC along with them. You want to have them as a follow-up investor, may be, but not VC. Government VC has professional, or semi-professional managers which may get political and their interests may not align with the private party involved." (K, 2014)

One suggestion was given regarding having Government to be **fund-of-funds** rather than doing direct funding into enterprises. These funds may be then mandated to invest in specific sectors or allocate part of the investments in specific sectors and make investment decisions themselves. This idea may seem better as government can maintain some neutrality and avoid conflict of interest. Sitra, based in Finland has been funding funds.

7.2.1 What are the "additionality" criteria to qualify for public funding?

A closer look at additionality principle becomes important in public financing initiatives, for reasons mentioned in section 2.6. A careful consideration has to be accorded to understand the best means in which public capital can create most effective leverage without discouraging private investors or offering them competition. In this regard, as pointed out in the above mentioned sections that any stage or sector that suffers from less liquidity due to less private capital may be an apt area for government to intervene. It is therefore likely that is such domains public funding would be additional. The agencies which were covered in this study, do take a thoughtful consideration while making investments in this regard. The Swedish Energy Agency, for e.g., connects the ventures that approach it to private investors lest they may be interested to fund those ventures. The idea is to fund technologies or ventures that are really unable to attract enough private capital and eventually to accelerate such investments. On the other hand of the spectrum are the technologies that are not able to get any private capital due to them being very nascent or in pre-commercial. Such technologies are better funded through R&D or demonstration grants rather than VC. Also care has to be taken in not funding commercially unviable or junk ventures with public money, thus creating losses or diverting private capital to unviable areas.

Overall public intervention should help in reducing risk perceptions of the private players and not compete against them. This notion was also supported by private investors who were interviewed for the thesis. One of them said, "*It was extremely difficult to raise funds after the financial crisis. Generally it would take one year before but now it may take some two to three years. Although this trend is changing for good, if public money is not there then it would be bad news for cleantech sector.*" (K, 2014).

7.3 Analytical Framework

The analytical framework for the paper was described in the section 2.8, which identified criteria's for effective implementation of a public funding scheme. This section would expand on how the findings in the previous section concur with these criteria's.

Target of funding: *The targets of the funding program should be well defined in terms of the stage of investment and effects on the private sector.*

The public funding agencies reported clear targets for their funding programs in terms of the type and the stage of a venture, use of different instruments for funding and sector focus. There is evidence of VC funding activities shifting to the later stages of the innovation cycle, making the case for a governmental intervention distinct and clear. As the trend goes, private investors are moving to later stages and funding ventures where technical risks and capital requirements are low. Thus there is a lack of funding in also those projects that have high capital requirements and at demonstration stages. Nearly all the public funding bodies have an early stage focus, but a move towards later stage is noticed even in public VCs except for Seed

Fund Vera (Finland) and Almi Invest (Sweden). Whether this intervention is appropriate or sufficient in terms of the investment required is another question. As a Finnish investor suggested;

"The VCs including us are going for software type cleantech companies. Not for those ground breaking technologies which would need at least EUR 60 Mn or more. Hence we VCs go for companies that pay quicker and don't require a lot of investments. If they want to go in early stage then the public money leverage should be very big."(K, 2014)

As was also suggested in section 2.6, governmental funding is supposed to create overall net social welfare benefits for the society in general beyond financial gains. This was visible in the investment motives of the organisations that were studied for the thesis, as all of them intended to generate regional economic growth, export promotion and societal benefits like employment. Added to that, pubic financing should also be ensuring support for the technology in the stages it is needed to lower risks for private investors to join. This idea was ingrained in the investment objectives of the VC funds, which would either co-invest with other private investors or come in at very early stages where private capital is nil.

Fund management: *The fund should be managed with private expertise and in a transparent way.*

The governance of the fund is an important parameter that influences its performance. The interviews did highlight a general unease with government directly funding ventures. There was specially scepticism in its ability to manage ventures professionally (selection and treatment). If a government VC plays on the same rules as other private investors then it may also act like a competitor against them, on the other hand by not intervening in the needed areas it may also create junk activity. Much has also been said regarding these aspects in this section at other places. As was noted in the study, public VC funds usually followed the evergreen structure where the earnings were invested back into the funds. In contrast, a private fund manager reaps the benefits of these earnings through dividends, performance linked bonuses or profit sharing and is thus incentivised to lead the ventures well.

All the public agencies tend to syndicate investments with private investors. This co-investment route was seen in a positive light by private investors as it helps alleviating their risks and involving them to use their skills in the development of the venture. Hence private players can manage the venture and lead its growth while public investor may invest (passively) and take a minority stake. Last, government acting as an intermediary and not as a direct stakeholder was also welcomed (the fund-of fund's approach), as there it can play a neutral role in the market but laying the ground rules and providing funds to a privately managed VC firm.

Additionality: *The funding should be additional in nature or should target areas with a funding gap and encourage crowding in of private capital.*

Public funding agencies are targeting early stage and high capital intensive sectors to catalyse private investments. There is no need of intervening in areas where private capital is working as it may lead to distortion of the market. For e.g. if the public VC fund makes direct investment in ventures which are anyways attractive for a private VC, it would be competing against private capital. Rather public investments should be meant to take ventures or technology to such a level that they are needed no more.

Also such funding bodies prefer co-investments with other private investors, and share risks. This co-investment aids the decision making of the private investors and also influences their

risk perception in the investment. Some investors also opined that post the economic crisis it has been generally difficult for investors to raise funds. A Danish investor said, *"If you don't have an environment where you can syndicate with others then it's useless. Hence I think it's also required that there be an eco-system for cleantech, so that syndication can be done*."(O, 2014)

The Figure 29 is a representation of what types of ventures or technologies will be interesting for a public or private VC active in cleantech domain, based on the inputs gained during this research. The different cells denote the kind of technologies or ventures that may generate "low" or "high" interest from either public or private investors due to their different characteristics.

		Public VC	
		Low	**High**
Private VC	**Low**	• Technologies or ventures at basic research and development stages • Conceptual ideas without any proof of functional concept. • Ventures which are commercially unviable and lack growth characteristics.	• Promising technologies or ventures at very early stages. ' • Technologies at pre-commercial stages with a growth potential. • Technologies with social benefits surpassing the investments needed or financial benefits.
	High	• Promising and profitable ventures with clear growth & exit potential, scalable and requiring funding commensurate to the VCs investment size. • Ventures which would get privately funded without government intervention.	• Ventures requiring co-investors or follow-on investment where other private co-investors are not available. • Technologies that have growth potential but need demonstration or prototype building support.

Figure 29 Matrix mapping characteristics of ventures to which private or public VC may be interested

8 Discussion

The thesis aimed at understanding public VC in cleantech in Sweden, Denmark, Norway and Finland. The main aim was to inquire about what should be the target of cleantech funding and the pros and cons of government equity ownership.

As it was expected, any government intends to create economic activity and involve or motivate private actors for it. The government itself usually plays the role of a facilitator, laying the ground rules for the markets to play. Hence it was not a surprise to learn about the targets which the public funding agencies had, pertaining to this thesis. The quintessence was to promote economic development, create social welfare and environmental sustainability, and target areas where private markets have failed. In this regard there were a few questions that came to the author regarding government setting targets for a sector, which in this case is cleantech. Any technology that has a commercial viability, customers, market acceptability may be able to attract VC. The technology produced by R&D at academic or technical institutions thus should have a commercial perspective and market focus from the day one. This was something the author observed in the study. The public VC funds should ideally be in close coordination with other public agencies that fund very early stage technical research. The VC arm can communicate what's the current need of the market, while the research agency can make sure that technological development produces commercially viable options. This should also have been one of the targets of the funding agency i.e. to regularly communicate and coordinate with other agencies that fund technology development. Needless to say, even corporations can fill in the gap here by providing inputs from their business experience in technology development.

Another observation was that capital being moving away from the cleantech domain, to either other industry sectors or towards later stages. It may be easy to assume, that the issue may be that of lack of capital availability. But on the other hand, one may also reflect that it may not always be the lack of capital availability as capital is available but is simply moving somewhere else where it can be multiplied better. The issue can also be with how mature or investable are the technologies or ventures. If the venture is lucrative, irrespective of the industry sector, capital would flow towards it. Thus another target area that may be the focus of a public funding agency could be how to make ventures investable? This can be done better by providing mentoring, technical or business support than immediate venture funding. There are plenty of technology or business accelerator programs that are meant to achieve this purpose. Further to it, the ultimate success of a venture fund depends on its exits. In cleantech, the incumbent technologies are largely conventional and any new technology has to compete against the established ones, which are held by large corporations and utilities. Therefore it would be a great step forward to develop an ecosystem in cleantech where large corporations are able to interact with young ventures and provide them business as well as technical support. These corporations may also play the role of buyers as well as be the first consumers. Hence, involving corporations in the sector could be another important work area which the government can target.

The author also came to learn that different sub-sectors of cleantech may drastically differ from each other when it comes to business, service and investment characteristics. Hence referring to cleantech one has to further define which sector in cleantech? When it comes to venture funding, the sectors that have traditionally been a VCs favourite were Information Technology (IT) ventures. What made them attractive for VC was that they were easily and quickly scalable, required relatively less capital investments and had a clear exit potential. In cleantech, this may not be the same as some technologies may require funding to the tunes of

millions (EUR) just to develop a prototype, while some technologies that have a software orientation may easily attract VC funding. Thus why some cleantech sectors are not VC friendly depends a lot on its investment characteristics. An easy assumption is that not all cleantech ventures fit a VC business model too, who are accustomed to investing in a venture, growing it, and then probably selling it forward in less than 10 years' time. In fact, this was also one of the reasons why private VCs chose to invest in later stages in cleantech, as they are risk averse and later stages do not pose high technology risks.

It may also sound weird to assume than if not private VC, public VC should come forward and invest in any technology no matter what the cost is. Why should they? Venture funding of a technology that does not fit the traditional VC investment approach needs to be done with patience. A government agency is expected to work with a "beyond profits" approach but regardless of that precaution is to be taken that such intervention may not cause harm to the private investors. Hence "additionality" consideration in funding should be given a serious thought. Although it may be difficult to exactly determine the "additional" nature of the investment, none the less, with dialogue and communication with stakeholders an informed decision should be taken. In this regard, one of the interviewees in this project who represents a public funding agency told that when he receives applications where he senses that private parties may be interested to invest, he first sends the applicants to those investors.

A question can be raised, should government at all do equity financing? The answer is no simple yes or no. If funding gap is observed in a cycle, as in this study interviewees did voice concerns over low early stage financing in cleantech, the case for government intervention is strong. Now this funding can be done even as a loan or a grant, but by not screening potentially profitable start-up's, such grant making can only partially help trigger a long term sustainable change. As it will be these commercially viable ideas, which will be better equipped to face market dynamics and see the light of the day. Thus for an effective solution selecting promising ideas, and investing VC in them will help grow these ventures, and may possibly offer returns on the public capital that is invested. It was interesting to note that the fund-of funds approach may offer the facility to the government to not play the role of a direct investor but rather let private players choose the market winners.

Although the author was satisfied in the inputs received for the questions. The research in itself inspired questions that may be pursued further. The idea of government intervention in an important sector as cleantech, is crucial due to long-term sustainability concerns which is faced by our planet. Despite environmental sustainability agenda being highlighted globally as an important agenda, there must be strong reasons why private investors are still desisting to utilise this opportunity. Especially VC investments in cleantech have either been moving to later stages or being made in sectors or technologies that offer incremental than radical benefits. It is obvious that financial aspects are crucial for investors to make decisions and cleantech may not fare well there; but further probe also requires understanding the issues with the current VC business model. As has been explained in the literature review section about the operations of a VC fund, the LPs are the ones who invest capital in a fund with an average life of 10 years or less. These LP's are typically insurance companies or pension funds who manage billions (EUR) at a time. It can be of great benefit for policy makers to understand why LPs desist from making investments for more than this 10 year period and how can conditions be created to inspire their interest. An effort can also be made to understand what can drive VC investors to turn their attention towards cleantech.

9 Conclusions& Recommendations

The study aimed at understanding public funding of cleantech sector in Sweden, Denmark, Norway and Finland and was focussed on answering the broad question on what is the target of such funding and whether government should take ownership in the ventures it funds. In the research one could spot a visible funding gap in the early stages of the venture cycle, and the movement of private money to the later stages of the venture. The interviewees had a positive opinion for government's intervention in these stages (R&D, demonstration) and some also opined that it should own equity in its projects. This was backed by the argument that public money should be used effectively and government should gain from its investments. It was further suggested that investments in technology, with high risks and requiring high capital expenditure, should be made to mature these sectors. Last, it was suggested that investments should be carefully made with "additionality" criteria being taken into consideration. It was said that public investments should generate value for the society, even beyond money.

In the literature analysis, a visible knowledge gap was identified relating to the subject of this research. This study is an attempt to add to the body of knowledge and can at least initiate or instigate further research and development into a very important sustainable solution for the entire globe. Here the author would like to revisit the research questions.

Q. What should be the target of public cleantech VC funding?

Objectives

The objective of public VC funding should be to promote economic development, environmental sustainability, generate profits and develop technologies with an international appeal. Most important is to ensure that public finding catalyses private capital into the sector and risks are shared through investment syndication. Last, government should ensure development of an ecosystem involving private investors, corporations and technology ventures, where the actors can benefit through mutually beneficial cooperation.

Stages

The public VC funding should support the "valley of death" stages in which technologies with growth potential suffer. These are early, seed stages or technology demonstration stages. Care should also be taken to avoid overlaps between other support instruments offered by other governmental agencies, which may create confusion.

Sectors

Funding should target technologies which may be commercially immature but have a potential for growth and fulfil a strategic niche in the market. Even high capital requiring technologies should be thus supported. Another recommendation is for the government to play on its strengths and invest in those areas where its strength lies. For e.g. supporting sub-sectors that

are ancillary to a sector which is a country's mainstay.

Q. What are the pros and cons of state owning equity?

Public VC funding should aim at utilising the strength of the private sector in choosing ventures to support, and may compliment them as a minority shareholder. The idea is to provide adequate management and governance support for the ventures to grow along with future follow-on investments. The equity ownership should not compete with private investors but rather mitigate their risks and catalyse private capital. Overall, public VC investments should be able to generate returns to the society from a welfare perspective along with ensuring fiscal sustainability.

Governments can look at the fund-of-funds approach of investing in funds managed by private co-investors and let them take investment related decisions. It can lay ground rules for the operations of these funds by defining sectors or stages in which the fund should operate.

q. What are the "additionality" criteria for qualifying for public funding?

Government should ensure that its investments are additional and are actually needed to fulfil a funding gap or fix a market failure. In this regard sectors or investment stages that suffer from less liquidity may be an apt area for government intervention. The idea is that by public funding those ventures or technologies will eventually become attractive for private investors.

*A few **recommendations**, for funding agencies in particular, can be;*

- Government taking equity ownership, should aim at "crowding-in" of the private capital in the further stages and be aimed at specific targets. Measures should be taken to engage private investors and play on their strengths to manage venturesthrough investment syndication or funding funds. By thus active as a passive investor and laying the ground rules, government can provide freedom of choiceto the private investors to do their job. This would lead to best utilisation of respective strengths.
- There should be clear targets and purpose to the funding. These targets should be selected only after careful consideration to the "additionality" principle and aim at reviving sectors or stages where private activity is fading or is scarce, but have a growth potential. In the end public funding should gradually fade giving way to private investors.
- All attempts should be made to syndicate investments.Such syndication can be helpful in reducing the risk perception of private investors in the cleantech sectors. In this model, care should be taken to use the expertise of private players in deal flow activities.
- Further to syndication, there is a necessity for developing an eco-system where even corporate organisations that have strategic interest in clean technologies be engaged. Their presence can be helpful not only from financial point of view but also in supporting young ventures with business and technical knowledge. Further such organisations can be the first to test and experiment with innovations.

- There is also a need of periodic communication between public and private players (in VC) regarding the state of cleantech industry. Such regular engagement would apprise either parties and may help informed decision making. Such a committee of industry experts may also be beneficial for young ventures to gain from their counselling and develop into investable enterprises.
- There should be coordination among different government agencies to usher the technology from R&D stages to market launch. Especially R&D should be aimed to produce technologies that are commercially viable, have a market acceptability and fulfil a niche.

Further research *can be commenced in various directions. A few suggestions for future directions are*:

- Effectiveness of public procurement initiatives in the cleantech sector: To understand how can public procurement instruments help develop nascent technology? A consideration here is that procurement is usually done where the technologies have matured and can be scaled-up. This may exclude young but path breaking innovations from being a part of this system.
- Comparisons and effectiveness of various financial instruments to promote clean technologies: A study on how can combinations of various financial instruments be optimally applied in cleantech.
- Facilitating industrial capital and creating shared value: To study factors which encourage corporate involvement in the start-up eco-system. These organisations can not only provide financial, business and technical support but may also be test-beds for young innovations.
- Investment rationale of limited partners in VC funds: A study aimed at understanding factors which influence LPs to make investments in funds (especially focused on cleantech).

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Appendix 1

List of interviewees

	Interviewee	Date Spoken	Time	Country
A	Partner with at private VC firm	12/6/2013	60 min	Sweden
B	Business Developer at a public funding agency	12/18/2013	60 min	Sweden
C	Investment Manager at public VC foundation	12/20/2013	40 min	Sweden
D	Vice President, Head of Business Unit Energy and Environmental Technology at Government Business Exchange Organisation	1/8/2014	30 min	Sweden
E	Consultant at Private Technology Consulting firm	1/2/2014	25 min	Sweden
F	Fund Manager at public VC firm	2/5/2014	30 min	Sweden
G	CEO of a Corporate Venturing unit	2/7/2014	45 min	Sweden
H	Venture Partner with a private equity fund	2/7/2014	30 min	Sweden
I	General Partner with a private VC firm	2/6/2014	30 min	Sweden
J	Partner with a private VC firm	1/31/2014	30 min	Finland
K	Partner with a private VC firm	1/31/2014	60 min	Finland
L	Investment Associate with a public VC firm	2/10/2014	30 min	Norway
M	Partner with a private VC firm	2/12/2014	40 min	Norway
N	Partner with a private VC firm	2/11/2014	30 min	Norway
O	Investment Manager with a private VC firm	2/6/2014	30 min	Denmark
P	Prof. Dr. at a Swiss University	2/12/2014	30 min	Switzerland

Appendix 2

Questionnaire

For public funding agencies:-

- *What is the target of your fund or how is the success of your fund measured? (economic development, SMEs, environmental betterment, leverage to private capital etc...)*
- *Which phase of the venture cycle do you target and why? (growth, early or seed, demonstration, R&D....)*
- *What cleantech sub-sectors are the target of your fund and why?*
- *What kind of funding instrument is used? (Loan, VC, grant...) Why should you own equity in the ventures?*
- *What should be the role of government in cleantech financing? How does it help to secure private capital? (co-investment, syndication...)*
- *Does government financing lower the risk perception of private investors? Is so, how?*
- *How does public VC avoid offering competition to private VC? How is "additionality" of the investment ensured?*

For private VC firms:-

- *What are the challenges you face in cleantech investing? (Issues like high capital intensity, exit...)*
- *How does government financing alleviate your risks? Has government intervention in cleantech been helpful in your country? If so, then of what type?*
- *Does public VC competes against or compliments your business? Explain the reasons.*
- *Should the government own equity in investee firms?*