Mobilising Private FUNDS for the TRANSITION to a Sustainable ECONOMY

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Preface

In the UN-led negotiations on climate change, climate finance is a main discussion theme. Developed countries in Copenhagen 2009 committed to mobilize 100 billion US dollars annually to help developing countries to adapt to climate change and to foster their transition to sustainable development.

Thus far, the commitments from developed countries are nowhere near the promised amount. Neither is there an agreement on where funds should come from. Some argue that all should be public donations, equalling support for adaptation and mitigation to aid. Others highlight the need for private capital to meet the significant climate change investment needs.

Not only developing countries need to invest in climate-relevant projects. A global technological shift is warranted to curb global temperature rise below 2 degree Celsius. The global warming finance gap is massive. The discussion on how to generate the massive investments needed for a shift of technology in high emitting developed countries is however missing in the global talks on climate.

On the other hand, governments are beginning to acknowledge the potentials of green growth and the strategic advantages of being a first-mover in these high impact sectors. Also, awareness is increasing of the limits to public funds for the scale of the financing needs for a timely energy transition. There is also a growing understanding for the necessity of a well-designed public policy to attract private capital investments.

In Europe strategic focus on renewable energy has, as a consequence of the European debt crisis, and possibly also of the shale gas supply shock, turned into suspension and rollbacks of ambitious and progressive incentive programs. The European political agenda is unclear and private investors are turning to other markets.

Although a plethora of general recommendations and specific policy suggestions on how to mobilize the private capital are circulated in various forums there is a need for a more informed discussion, backing up policy with relevant research. This report aims to relate important theoretical and empirical findings on investment decisions and green technology promotion to recent developments in global cleantech industry and policy. Focusing on the Netherlands and Sweden the report discusses important policy differences and identifies key factors for policy makers to consider.

With this publication, the European Liberal Forum (ELF) hopes to stimulate the public debate on the prospects of the European energy- and cleantech industries and how public policy can leverage and direct private sector capital flows to promote green growth in Europe.

Felicita Medved
President of European Liberal Forum

About the Authors

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About European Liberal Forum

Founded in the fall of 2007, the European Liberal Forum asbl (ELF) is the non-profit European political foundation of the liberal family. ELF brings together liberal think tanks, political foundations and institutes from around Europe to observe, analyse and contribute to the debate on European public policy issues and the process of European integration, through education training, research and the promotion of active citizenchip within the EU.

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Introduction[1]

Emissions of CO_2 and other greenhouse gases need to be curbed, the world population is projected to grow to 9 billion by mid-century (UN 2005) and our global ecological footprint has overstepped our resource base since the early 1970s, currently stands at 1.5 and is projected to reach 3 by mid-century under the business-as usual-scenario (Footprint Network 2013). The use of fossil energy and natural resources is clearly on an unsustainable path, and there is a need to develop and introduce new technologies to ameliorate this, and for the increased diffusion of existing technologies. The estimated required investments vary greatly but without exception are enormous. To keep temperature rise below the 2 degree Celsius threshold alone, the IPCC estimated in 2009 that we would need to invest some 145 billion euro annually. In 2010 the World Economic Forum estimated this cost at 500 billion euro annually with existing technology. These numbers do not include the 50 billion euro annually adding up to another trillion euro needed to achieve access to modern energy for all by 2030 (IEA 2012) and excludes transition technologies, false starts and dead ends. On the other hand, a transition is certainly within our reach. Numerous technologies are available, and to put things in perspective less than 1 per cent of the global annual GDP (Koomey 2012) would be enough to address the climate change issue. It is clear, however, that the private sector will have to engage in order to make the transition.

As well as the relevance for climate change, there are also commercial opportunities in a green transition. In the aftermath of the global financial crisis, improving industrial competitiveness and growth prospects are high on the European agenda. However, in 2012 a dramatic shift in the balance of global renewable energy investments occurred, with the centre for renewable energy investment shifting from West to East. China passed the US as the major renewable energy investor and the EU is in the process of losing the high ground it previously held. Regardless of whether the perspective is that of green growth or climate change, the public policy debates in the EU member states are sparse or overly focused on governmental funds that clearly are too limited to meet the long-term financing needs.

Compelling environmental, strategic or political priorities does not necessarily translate into action as the private sector has its own logic. Private investors, corporations and banks all face hard budget constraints and will only commit their resources if a sound business case can be made (Brealey et al. 2011). They operate in a global and competitive environment and cannot afford too many loss-making projects, to write off their ecologically stranded assets or take excessive risks onto their balance sheets (Cassimon et al. 2003).

It is increasingly recognised in the literature that new, small firms (Jovanovic 2001; Aghion et al. 2006) and in particular (high-impact) entrepreneurship (Audretsch et al. 2006; Acs and Armington 2006; Schramm 2006; Audretsch 2007) are important drivers of economic development in general and in innovative transformational processes in particular. Studies have investigated corporate investment and the diffusion of green technology (e.g. Hart 1995; Hart and Sharma 2004; Moore and Wuestenhagen 2004)

1. We thank Kristina Burrescia and Christofer Sköld for helpful research assistance.

but studies focusing on the role of entrepreneurs and new firm formation in this process are relatively rare (notable exceptions are Cohen and Winn 2007; Dean and McMullen 2007 and contributions collected in Wuestenhagen and Wuebker 2011). The focus of this report is on technological development and the diffusion of new technology in the so-called green sector, and early stage private investors and entrepreneurs are the main actors.

It is clear from the literature that the single most prominent obstacle to entrepreneurial venturing is finance (Evans and Jovanovich 1989). Seed and early stage venturing typically burns cash and involves high risks. Other obstacles identified in the literature include high capital demand, especially high up-front costs, heavy and erratic regulation, low levels of knowledge and the absence of exits (Grichnick and Koropp 2011; Marcus et al. 2011). Understanding entrepreneurial investment decisions from the perspective of the investor as well as from the entrepreneur is thus the starting point for any policy that hopes to effectively leverage public funds and mobilise private capital to accelerate a transition to sustainability. The literature on the interplay between finance and entrepreneurship in green venturing is emerging (e.g. Moore and Wuestenhagen 2004; Wuestenhagen and Teppo 2006; O'Rourke and Parker 2006; Buerer and Wuestenhagen 2009) where Wuestenhagen and Wuebker (2011) point out the rising importance of corporate venture capital.

Although climate finance is an increasingly hot topic in the global debate with international NGOs publishing numerous reports with cost assessments and policy recommendations, the national debates are in most countries sparse or overly focused on governmental funds that are clearly too limited to meet long-term financing needs. In general, the public debates and the policy recommendations offered are not framed by recent research on investments and entrepreneurship. This report intends to fill this gap by relating important theoretical and empirical findings on investment decisions and cleantech promotion to the recent developments in the global cleantech industry, as well as in a few key countries, and to the relevant government policy measures in place.

More specifically, the aim of this report is twofold:

(1) to outline a theoretical framework, backed by empirical evidence, of key factors that affect private investment decisions in green technology ventures;
(2) to describe the policy-frameworks in the Netherlands and Sweden with the purpose of discussing how they enable growth in the green technology sector.

We define "green technology" broadly as those technologies that reduce the footprint of our economy. Green technology, also referred to as "greentech", is often, and also in this report, used interchangeably with "cleantech", which is the term of choice by the financial markets for describing the environmental technology and renewable energy sectors. We concentrate specifically on the investment decisions in the early stages of adoption and market diffusion which puts a natural focus on new entrants, small and medium enterprises (SMEs) and SME growth in the greentech sector.

The Netherlands and Sweden are both small open countries relying on international trade, with a large and advanced knowledge base and a highly educated labour force. Despite strong traditions of R&D and a strong academic knowledge base in green technologies, both countries are less successful in turning this knowledge into practical applications delivered on a commercial scale. As we will see, the specific problems each country face look different, and the policies schemes applied to address these challenges are diverse. The policy analysis results in some general policy recommendations, not intended for specific policy advice but merely for indicating a general direction for new policy design and evaluation.

1.1. Outline of the report

This report is organised as follows. In Chapter 2, the theoretical framework is discussed, drawing upon the literature on technological development, investment decisions under uncertainty and entrepreneurship in greentech ventures. This results in a taxonomy of potentially important factors in greentech venturing. In Chapter 3, descriptive statistics on the energy and environment technology sectors is presented, zooming in from the global to the European and Dutch-Swedish perspective. It ends with a summary of the empirical evidence on green venturing and the role of small firms. Chapter 4 looks at policies in the Netherlands and Sweden aiming at leveraging entrepreneurship and investments in the sectors studied using the framework we develop in Chapter 2. The final chapter discusses the results from the report and proposes areas of future research.

2

Theoretical Framework

2.1. Knowledge creation, technological change and market imperfections

One of the more prominent market failures preventing the rapid diffusion of green technology is the failure of markets to price environmental damages. Internalising such classic externalities by putting a price on emissions is the stated purpose of many policies. The aim is not only to hamper environmentally harmful activities in a cost effective, and static, way, but to induce dynamic efficiency by providing market incentives to develop and efficiently deploy technologies that prevent or reduce environmental damage, that is, they aim to create a positive net present value for investment projects that create benefits (or prevent costs) that cannot be recuperated otherwise. The underlying theoretical basis for doing so goes back to seminal work by Gordon (1954), Hardin (1968), Pigou (1924) and Coase (1960). Gordon (1954) and later Hardin (1968) described the tendency for commons to be overexploited and polluted excessively. Pigou (1924) argued that governments should intervene and internalise externalities through taxes and subsidies, whereas Coase (1960) showed that markets can reduce pollution to efficient levels when private property rights are established, enforced and tradable. Evidence shows that it is not sufficient to merely internalise the environmental externalities. Governments have introduced environmental taxes, subsidies and tradable permits with the aim of "getting the prices right", anticipating that markets would then take off in the right direction.

It has long been acknowledged that markets for knowledge are imperfect, resulting in underprovision of knowledge and underinvestments in all stages of technological change (Arrow 1962). Since knowledge, at least in theory, is a public good with non-rivalry in consumption, there are positive spillovers from innovation. Without governmental protection, firms investing in R&D cannot keep other firms from also benefiting from their new knowledge and can therefore only capture part of the full social value of the innovation. Market forces therefore provide insufficient economic incentive for investments in innovation (Arrow 1962; Nadiri 1993). The government has thus an important role in implementing legal protection, for example patent legislation, to protect ideas and, at least temporarily, prevent other firms from copying them. However, complete protection is not optimal from a social welfare point of view, since new ideas and new technologies may not diffuse to firms and users other than the innovating firm.

As for the adoption and diffusion of new technology, additional market failures may operate. The benefits for a user of a new technology are very much associated with the overall diffusion of the technology. A phone's value is connected and enlarged with an increased number of users, for example. This scale effect of technology adoption can be generated by learning-by-using, learning-by-doing and network externalities (Jaffe et al. 2005).

Market size externalities caused by economies of scale can lead to path-dependence and technology lock-in effects. Traditional technologies will be more competitive than new technology and profit-maximising investors will tend to invest where private profitability is highest. Thus, existing technologies can maintain market dominance and suppress new, potentially socially superior, technologies (Acemoglu 2002; Acemoglu et al. 2002; Kalkuhl et al. 2012). A case in point is of course the fossil fuel internal combustion engine. Alternatives to that technology will not be profitable as long as our entire infrastructure is geared towards supporting this dominant design.

These market imperfections described above, knowledge spillovers, network externalities, learning-by-using and learning-by-doing effects, market size externalities etc., apply to all types of technology investments, although the latter two in particular, risk and path-dependence, are often argued to be stronger for green innovations. Traditional environmental externalities are specific reasons for under-investment in environmental ventures. With environmental costs not or only partially internalised, it is not possible to create viable business models that justify investment. In addition, environmental impacts are often long term, intrinsically stochastic, extending beyond national boundaries and largely unknown. Uncertainty and risk can also emanate from technologies, markets and policy, and cause substantial delay in investment, adoption and diffusion. To summarise, environmental, technology, market and policy risk increases the private risks of investing in green ventures and the resulting delay in diffusion reduces learning, scale and network effects that continue to benefit the incumbent technologies.

The macro-oriented research summarised above, typically assumes rational decision-making in markets and assumes that green technologies will diffuse when externalities are adequately internalised and thus become competitive in the market place. However, it leads us to address the extent to which externalities can be internalised and the role of risk and uncertainty in investment decisions. In the following sections, we discuss theories that highlight different perspectives on the behaviour of entrepreneurs and investors in investment decision-making situations.

2.2. From investment decisions to real options in greentech venturing

In the micro-based investment literature, investment opportunities are traditionally evaluated using a cost-benefit approach.[2] The inherent limitations of such an approach are well documented. It assumes a now-or-never decision and assumes the decision maker to follow a rigid path once the investment decision is taken (Feinstein and Lander 2002). In reality, in a competitive environment with uncertainty and change, ventures will not crystallise in the same shape as the decision maker initially envisioned (Cassimon et al. 2004). During the lifetime of the venture new information might arrive or certain sources of uncertainty might be resolved, making it valuable to adjust the venture (Trigeorgis 2000)[3]. This is especially true with respect to greentech venturing (Heal and Kristrom 2002).

Dixit and Pindyck (1994) stress the importance of timing an investment decision. Their approach implies that decision makers in actual investment ventures have the option to wait/postpone the final investment decision and they may rationally decide to do so if additional relevant information can be expected to reveal itself over time. An investment opportunity constitutes the right—not the obligation—to commit resources and reap future rewards. This gives most investment decisions an option character.[4] The standard cost-benefit model cannot handle the option value that can be derived from operational flexibilities such as delaying, scaling-up/down, shutting down/restarting or abandoning a project (Guerrero 2007).

This option character is valuable in an investment environment characterised by the simultaneous existence of uncertainty, irreversibility of investment and some freedom in the timing of the investment. In theory, taking into account the value of flexibility implies that a firm will invest only if the net present value (NPV) of the project exceeds the value of keeping the option alive (i.e. not committing the resources).

2. Traditional approaches typically rely on the NPV-rule, such as Jorgenson's (1963) "per period marginal product equals per period rental cost" approach and the equivalent Tobin's q theory of investment. See e.g. Nickell (1978) and Abel (1983) for more details on the "user cost" and "Tobin's q" theories of investment, respectively.
3. Knight (1921) defines uncertainty distinct from risk, where the latter refers to stochastic outcomes of which the distribution is known and the former applies when even the distribution of possible outcomes is unknown. In real option theory typically the stochastic processes are assumed to be known and/or a known prior is assumed. This implies, where this literature follows Dixit and Pindyck (1994) and refers to "uncertainty". Knight (1921) would call this "risk". We use the terms interchangeably and refer to "deep uncertainty" when Knight's concept of uncertainty is meant.
4. In general, an option can be defined as the right, but not the obligation, to buy (call-option) or sell (put-option) the underlying asset at an agreed price (strike price or exercise price) during a specific period (as in the case of American options) or at a predetermined expiration date (as in the case of European options). In contrast with financial options, real options refer to the application of the options concept to real physical investment opportunities.

Similarly, a firm will only disinvest in a project if its NPV falls sufficiently below zero to warrant giving up the option to continue operations in the future. Real options theory can thus explain the higher than expected hurdle rates that firms and investors typically apply when considering risky projects, and their reluctance to abandon stranded and ecologically obsolete assets in which they have already invested.

Options valuation and pricing models have originally been devised to value financial options (Black and Scholes 1973). Arrow and Fisher (1974) were among the pioneers incorporating irreversibility and uncertainty into a model where decisions about environmental preservation need to be made. Since then the applications to natural resources have been vast in real options theory. Paddock et al. (1988), for example, focus on undeveloped oil reserves and found that, empirically, the real option valuation performs better than the traditional discounted cash flow (DCF) method. Brennan and Schwartz (1985) investigated whether and when it is optimal to take a copper mine into operation when the price of copper follows a stochastic process. Similarly, Pindyck (1980) used real options to compute the optimal exploitation strategy for an exhaustible resource, but in this case it is not only the future cash flow, but also the level of the resource reserve that can vary stochastically.

From such applications it is very clear that ignoring the option value of investment projects can lead to inefficient investment decisions on the part of investors, and empirical research has verified that investors indeed take option values into account. It is also clear, however, that not all investors are equally sophisticated. Real option models perhaps do not yet capture all the relevant aspects of investment decisions (Sanders et al. 2014). It is all the more important that policy makers understand this well before designing policies that aim to mobilise private funds for investment in green ventures.

2.3. Risk, uncertainty and information

The behaviour of venture capitalists is often influenced by their perceived risk and uncertainty. Investment in innovation as well as in adoption of new technology is also impaired by information asymmetries between investors and entrepreneurs. Entrepreneurship is the process by which “opportunities to bring into existence ’future’ goods and services are discovered created and exploited” (Venkataraman 1997, p.120). Because people possess different information and beliefs, some individuals recognise opportunities that others cannot yet see (Shane 2000). Kirzner (1973) even argues that idiosyncratic information and beliefs are necessary for opportunities to exist. Entrepreneurs may thus have difficulties in credibly conveying the expected potential and pitfalls of their innovations or may act opportunistically in the search for venture capital. Thus the match between funding and ventures becomes a market with “peaches” and “lemons” (Akerloff 1970) and adverse selection and moral hazard will lead to an inefficient funding gap (Popp et al. 2009).

2.4. The behavioural finance approach to investment decisions[5]

Traditional investment theory assumes rational utility maximising individuals or profit maximising firms making investment decisions based on expected return and risk. Even the more sophisticated real option approach assumes that decision makers base their decision on the stochastic properties and regularities they face. This assumption implies that all investors and entrepreneurs would respond similarly to a given project and that policies can affect this behaviour by manipulating the properties of the project alone. That is policy makers can increase adoption of greentech by increasing its NPV through internalising externalities and by reducing private technological (costs), market (revenue) and policy risks on such ventures. However, evidence suggests that the ways humans arrive at economic decisions are inconsistent with standard economic rationality when faced with deep uncertainty (Tversky and Kahneman 1974).

In the field of traditional or corporate finance portfolio allocations, mergers and acquisitions and capital structure decisions do not seem to conform to rational manager behaviour as per the theories. Some deviations from optimal investment behaviour are conscious behaviours explained by, for example, principal-agent problems (e.g. Arrow 1971; Pauly 1968) and biased incentive systems (e.g. Weitzman Scheme (1976)). Other deviations result from unconscious behaviour such as cognitive biases or feelings. Perceptual biases, identified by psychologists and applied by researchers in finance and related disciplines, distort judgment and the actions of investors. When making judgments under conditions of uncertainty,

5. This section has benefited immensely from the excellent overview by Montgomery (2011) of the role of psychology in the financial crisis.

people often use a number of heuristics, sometimes associated with systematic errors in how information is evaluated (Kahneman 2003). That is, unconsciously, people tend to overreact to certain types of information and underreact to other types.

For example, when assessing the probability of an event occurring, people are guided by the ease of recalling similar examples of this event. However, sometimes availability is not related to the objective probability. On the financial markets, the overweighting of easily available evidence in investment decisions will lead to overreactions, whereas underreactions occur when less available information is neglected (Shleifer 2000; Barberis et al. 1998). The availability bias is sometimes combined with a tendency to be over-optimistic about the future, which works in the same direction when times are good and cancel out when times are bad. In terms of investment decisions, research shows that forecasts made by financial analysts exhibit this precise pattern with overoptimistic forecasts in booms and more accurate forecast in busts (Lee et al. 2008).

Anchoring and adjustment heuristics (an initial value, an anchor, is adjusted to reach the final answer) can be useful when making fast assessments. However, research shows that adjustments typically are insufficient and the selected anchoring is typically irrelevant for the estimates (Kahneman and Tversky 1974). When adding probabilities and risk, insufficient adjustment could clearly result in underestimation of the true probability.

Research shows that affects and feelings also influence judgments prior to a cognitive analysis. As a rule, people like familiar objects more than unfamiliar ones (Zajonc 2001). This phenomenon may be related to the endowment effect, which implies that people value objects they own more highly than the price for which they bought the object (Kahneman et al. 1990). In the financial market this could lead to a status quo bias and reluctance to sell financial assets once invested. The resistance to abandoning loss-making projects when large investments are sunk is an example of such endowment effects.

Other heuristics and biases that are relevant for especially long term investment decisions include hyperbolic discounting which means that preferences are characterised by a relatively high discount rate over short time horizons and a relatively low discount rate over long horizons (Laibson 1997; Loewenstein and Thaler 1989). This preference structure implies that people lack self-control. In terms of investments, a decision an investor would make today for the near future would not correspond to the decision the investor would make tomorrow for the same time period, i.e. the preferences held today would be in conflict with preferences that will be held in the future. With such inconsistent preferences, investors prefer short-term gains, for example, although long-term risks are substantial. This type of present-bias results in dynamic inefficiencies and non-optimal investment decisions over time as it emphasises front-loading of financial returns and the need for early exits and high turnaround. It is clear that such biases typically work against investment in greentech industries.

The tendency for people to search for evidence that confirms what they believe is true and to neglect evidence that rejects their beliefs is called a confirmation bias. Such biases can strengthen trends for better and for worse and work both for and against the investment in greentech venturing.

Overconfidence implies that a person's subjective confidence in making a correct assessment is greater than the objective probability of doing so. Törngren and Montgomery (2004) provide evidence of overconfidence in the financial markets, and entrepreneurs are found to be overconfident as a rule (Dushnitysky 2010). DeMeza and Southy (1996) show that (over)optimism strengthens the conventional implications of asymmetric information, adverse selection and moral hazard.

Prospect theory (Kahneman and Tversky 1979) was developed to describe how people make decisions under uncertainty as an alternative to expected utility theory. The theory stipulates that people's economic choices are based on the potential value of losses and gains in relation to a reference point that could vary individually and be dependent on the situation at hand. In prospect theory it is assumed that people value those gains and losses using certain heuristics that can explain certain observations on the financial markets such as investors that tend to be risk avoidant for gains and risk seeking for losses, that losses loom larger than gains and the disposition effect, which implies that investors tend to sell winning assets too soon (risk avoidance) while keeping losing assets to long. Prospect theory implies that there could be a gap between financial institutions and their clients, where the clients behave more in line with prospect theory (Montgomery 2011). This approach also implies that different agents may respond differently to the same policies. Where rational decision theory makes behaviour predictable, prospect theory introduces an element of contingency and aggregate responses become more uncertain.

Behavioural finance describes observed investment behaviour and distortions from optimal, rational investment decisions. The heuristics and cognitive biases depicted above apply to all types of investment decisions, not only to green venturing. However, there might be reasons to believe that some of the distortive mechanisms could be more pronounced for decision making in a context that includes environmental concerns. Given that deep uncertainty exists concerning ecology, technology and politics, greentech investments are more prone to the behavioural biases above. These biases can speed up or delay the adoption of greentech at the aggregate level, but either way merit careful attention in shaping policies.

2.5. Investment, regional clusters and social networks

Having discussed the relevant properties of projects, potentially subjective perceptions of risks involved, and behavioural biases of individual decision makers, we now turn to the environment in which investment decisions are made. New economic geography (Krugman 1998), regional (Richardson 1969) and urban (Henderson 1997) economics have all emphasised the importance of agglomeration, clustering and spatial patterns in innovation and technological change. In entrepreneurship research the importance of geographical proximity has also been established empirically and theoretically (Audretsch and Feldman 1996). Companies in similar sectors can gather regionally, in order to take advantage of any spillover effects or transfer abilities whether it is knowledge, innovation, or financial such as efficiency advancements (Johansson 2005; Maskell 2001). Firms engaged in regional clusters thus have a competitive advantage against those that are not (Feldman 1994; Porter 1998). The literature on the emergence of regional clusters is vast and successful clusters such as Silicon Valley and Route 128 have attracted extensive research, press and policy attention. Thus, the physical environment in which investment decisions are made creates opportunities, imposes limitations and, consequently, has a profound impact on the diffusion of green technologies.[6]

A similarly complex interplay of relevant factors characterises the socio-economic environment. Networks may create high trust environments in which transaction costs are lowered, information is more readily available and resources are consequently easier to mobilise. Social and business networks are ways of overcoming knowledge imbalances and information asymmetry, especially for SMEs (Granovetter 1985; Szarka 1990). Actors in a network develop long-term relationships built on trust and mutual commitment through processes of information exchange, mutual adaptations and learning (Håkansson and Johanson 1993).

Anecdotal evidence (Sanders et al. 2014; Shane and Cable 2002) suggests that networks between investors and entrepreneurs play a key role in managing risks and deep uncertainty, especially in early stage finance. Personal ties and social skills can thus be essential success factors in creating and growing new ventures. In a study by Shane and Cable (2002) it was found that social ties are indeed important for information transfer between entrepreneurs and seed-stage investors. Reputation in the network was also found to mediate the effect of social ties as an information transfer mechanism. That is, networks can help to reduce the inertia that stems from rational individual option valuation. They allow for diversification and risk pooling, reduce information asymmetries and help entrepreneurs and investors turn deep uncertainty into manageable risk by promoting the diffusion of reliable market and technology information. Finally, networks can more effectively pool lobbying efforts to optimise and stabilise the policy environment.

Individual behavioural biases, however, can both be reinforced or cancelled out in regional clusters and social networks. Social psychology and behavioural finance, point to important collective phenomena that may characterise the financial markets. Parallel running, i.e. the tendency to follow other people's behaviour, for example with respect to investments, is called herding behaviour (Sias 2004). Experiments show that people would follow the majority herd in a stock investment situation even when the herd members made apparent wrong predictions (Andersson et al. 2009). Synchronisation of the behaviours of people is also explained by the phenomena of shared reality, which could conflict with objective reality (Echterhoff et al. 2009). A related concept is groupthink (Janis 1972), defined as a type of in-group thinking by members who try to reach consensus without critically testing or analysing, while minimising conflict. A typical symptom of groupthink is suppression of dissent, exemplified by "whistle blowers" being ignored or even punished for their lack of loyalty to group norms (Baron 2005). Group polarisation refers to a situation that could be

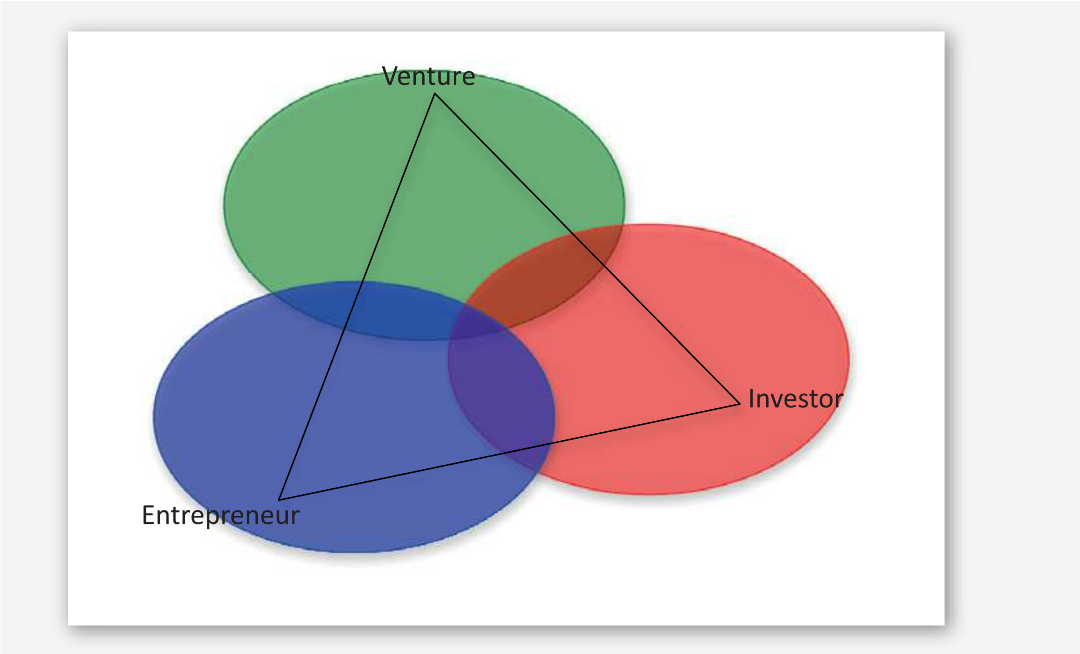
6. Brachert and Hornych (2011) fruitfully apply the concept of a window of local opportunity (Storper and Walker 1989; Boschma 1997) to explain the emergence of the German Solar PV cluster in Eastern Germany.

of significance in the financial world, where group decisions are more extreme, for example with respect to risk taking, than would be the case for decisions made by individual members of the group (Myers and Arenson 1972). Related and reinforcing mechanisms are group-level confirmation bias and self-censorship, which will create an illusion of consensus about how a situation is perceived. There is a rapidly expanding literature that applies behavioural economics thinking to consumer behaviour in energy and greentech markets.

2.6. Summary

In this chapter we have reviewed the extant literature on investment and entrepreneurship with a special focus on what policy makers should keep in mind when formulating their policies on greentech venturing. We have discussed the internalisation of environmental externalities that will create markets in which social costs and benefits coincide with the private ones that investors consider. We then discussed rational decision-making under risk and uncertainty and the option value to delay investments. Rational decision-making models predict that all market participants will respond similarly to policy stimulae. When we consider the issue of deep uncertainty, information asymmetries, the importance of behavioural biases and the impacts of local clusters and social networks, however, we realise that investment decisions are highly context dependent and the same policies may have a wide range of impacts under different sets of circumstances. This leads us to a conceptual model of entrepreneurial venturing and investment as depicted in Figure 2.1 below.

FIGURE 2.1



In the figure we see the entrepreneur and investor as human actors connected to a specific project or venture. Characteristics of the venture, e.g. technical risk, influence the objective value of the venture. Obviously, characteristics in the venture's environment, e.g. market and policy risks, also affect this objective value in the green sphere. Personal characteristics such as information and cognitive biases, as well as the subjective perception of risks and opportunities, affect the subjective value of the project to the decision makers, the entrepreneur and investor. Then both entrepreneur and investor operate in regional clusters and social networks, represented by the blue and red spheres that potentially overlap and interact with their subjective valuation of the venture. A venture is pursued and resources are committed only when all elements in this model can be brought together and key thresholds for the venturer and the investor are cleared.

Private sector investments may be needed to make a timely transition to a more sustainable energy system in Europe, but as we have argued above investment decisions in the private sector follow a logic that policy makers must respect if they wish to leverage public and mobilise private funds. This logic first dictates that an investment yields a private return, exceeding the return on alternative investments and sufficient to compensate for risk. In addition to these standard NPV and CAPM-rules and according to real option theory rational investors will time their investment optimally, structure their projects such that operational flexibility is optimal and value options to delay, scale, abandon and grow the venture in time. Finally, policy makers have to consider the relevance of behavioural biases in investment behaviour. Investors and entrepreneurs are human actors, susceptible to availability, status quo and confirmation biases and will discount hyperbolically, whereas collectively they may show herding behaviour, groupthink and over-optimism/pessimism.

This implies that for a complete characterisation of actual policies we need to assess the intended and unintended effects of the venture's NPV, perceived risk and real option value (ROV) the effects on the entrepreneur (Ent) and investor's (Inv) individual information sets (INF) and behaviours (BEH), and finally the information and behaviour in the network. Table 2.1 below presents this proposed characterisation in a more structured way. Note that in the last row we separate the investor and entrepreneur because policies may increase the NPV or affect the information set or behaviour of these agents differently.

Table 2.1

Venture						Actor				Network			
NPV		Risk		ROV		INF		BEH		INF		BEH	
Inv	Ent	Inv	Ent	Inv	Ent	Inv	Ent	Inv	Ent	Inv	Ent	Inv	Ent

The next chapter presents the empirical evidence to date on green venturing and finance. This will give us an idea of how big the private activity in these fields already is and what challenge still lies before us. Confronting this with a comparative analysis of current energy and environmental policies in Sweden and the Netherlands in Chapter 4 will allow us to draw conclusions on where policy can be improved and strengthened to engage this challenge.

3

Green Technology Venturing

3.1. From global trends to local circumstances

3.1.1. Definitions of the green technology sector

Green technologies include activities and products that may appear under overlapping headings such as cleantech, clean energy, renewable energy, green goods, environmental goods or low carbon goods and services. Whereas the finance sector seems to focus on the cleantech, clean energy or renewably energy sectors, international and national statistics usually categorize markets in environmental, green or low-carbon goods and services.

Clean technology, or "cleantech", does not have a clear-cut definition but is generally including all activities intended to reduce environmental impact and the use of natural resources.[7] Eurostat (2009) specify the environmental sector, in data labelled the environmental goods and services sector, as consisting of a heterogeneous set of producers of technologies, goods and services that:

- Measure, control, restore, prevent, treat, minimise, research and sensitise environmental damages to air, water and soil as well as problems related to waste, noise, biodiversity and landscapes. This includes 'cleaner' technologies, goods and services that prevent or minimise pollution.
- Measure, control, restore, prevent, minimise, research and sensitise resource depletion. This results mainly in resource-efficient technologies, goods and services that minimise the use of natural resources.

Even if the EU member states use the same definition of environmental goods and services, the data collection in practice does not necessarily conform, which presents obstacles when making international comparisons.

The UK has designed its own definition, termed the Low Carbon Environmental Goods and Services (LCEGS) sector, capturing a range of activities with the purpose of reducing environmental impact, including subsectors more or less corresponding to the cleantech segment (LCEGS 2013).[8]

7. As an example, the Cleantech Group, a consultancy providing cleantech market intelligence, collects data from 18 industry segments including transportations, water and wastewater, wind, recycling and waste, smart grid, solar, geothermal, hydro and marine power, nuclear, energy efficiency, energy storage, fuel cells and hydrogen, biofuels and biochemical, biomass generation, conventional fuels, advanced materials, agriculture and forestry and air. Clean energy and renewable energy are sub-sectors in the cleantech sector, excluding for example wastewater, waste, recycling and sometimes investments in energy efficiency.
8. Subsectors include Air Pollution, Contaminated Land Reclamation and Remediation, Environmental Consultancy and Related Services, Environmental Monitoring, Instrumentation and Analysis, Marine Pollution Control, Noise and Vibration control, Recovery and Recycling, Waste Management, Water Supply and Waste Water Treatment, Additional Energy sources, Alternative Fuel Vehicle, Alternative Fuels, Nuclear Power, Building Technologies, Carbon Capture and Storage, Carbon Finance, Energy Management, Biomass, Geothermal, Hydro, Photovoltaic, Renewable consulting, Wave and Tidal, Wind.

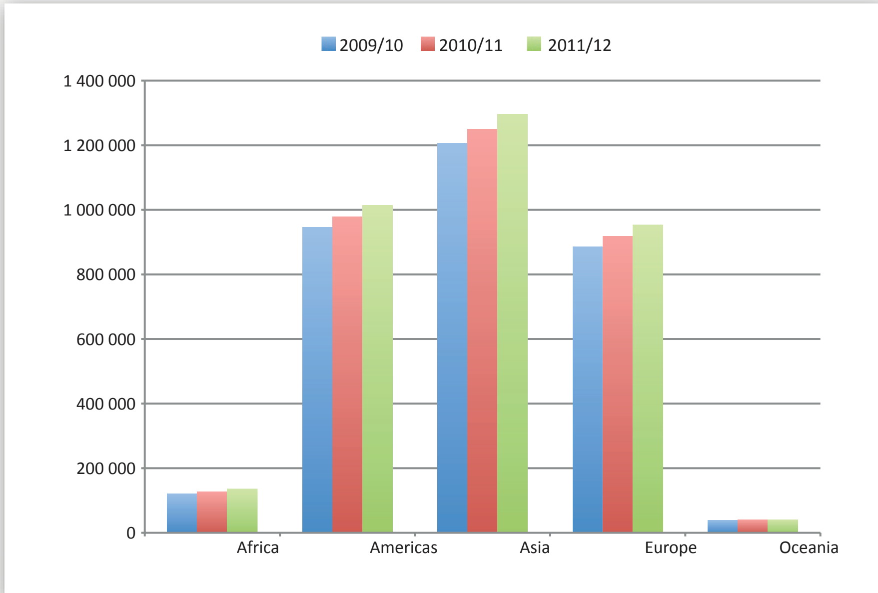
The US collects statistics termed green goods and services, defined as goods and services produced by an establishment that benefit the environment or conserve natural resources. Green goods and services fall into one or more of the following five groups: (1) production of energy from renewable sources; (2) energy efficiency; (3) pollution reduction and removal, greenhouse gas reduction, and recycling and reuse; (4) natural resources conservation; and (5) environmental compliance, education and training, and public awareness (BLS 2012).

The purpose of this chapter is to give an overview of the development and funding of green technology sectors. Definitions and data collection practices differ, and in addition constantly evolve as new activities are identified or reach the market. Even if this section reports data under various labels, however, it still uncovers important trends and developments. We first discuss the sector in general, then turn to investment and finally start-up and growth stage investments, also zooming in from the global level to Sweden and the Netherlands.

3.1.2. The green technology sector

Using sales of low carbon environmental goods and services as a proxy for the economic activity of the green sector, Figure 3.1 shows the recent developments distributed over global regions. In all markets, global sales have increased over the last three years, with Asia accounting for 38%, followed by the Americas (29%) and Europe (28%).

FIGURE 3.1 Global Sales 2009/10 – 2011/12, low carbon goods and services sector, £M



Source: LCGC (2013)

Table 3.1, the breakdown of sales to country level, shows that the US accounts for almost one fifth of global sales, followed by China (13%), Japan (6%), India (6%) and Germany (4%). The Netherlands are ranked as 24th with 0.8% of the global total, whereas Sweden is 34th with 0.4% of the global total. Relating sales to GDP (Tabler 3.2), the ranking changes with Spain in the lead (9.4%), followed by the UK (8%), South Africa (8%) and Japan, Greece, Hungary, Italy, Finland accounting for around 7%. LCGC sales account for 5.9% of the GDP in the Netherlands and 5.4% in Sweden.

Table 3.1 Sales 2011/12, low carbon goods and services sector

Country	Sales £m	Rank	% of Total
USA	660 760	1	19,2
China	444 324	2	12,9
Japan	213 295	3	6,2
India	210 815	4	6,1
Germany	145 267	5	4,2
UK	128 141	6	3,7
France	104 201	7	3,0
Brazil	103 583	8	3,0
Spain	92 136	9	2,7
Italy	89 485	10	2,6
Russian Federation	87 327	11	2,5
Mexico	70 225	12	2,0
South Korea	61 651	13	1,8
Canada	61 146	14	1,8
Indonesia	54 070	15	1,6
Taiwan	36 327	16	1,1
Turkey	33 827	17	1,0
Australia	33 804	18	1,0
Iran	33 496	19	1,0
Thailand	33 228	20	1,0
Argentina	31 087	21	0,9
Poland	29 526	22	0,9
South Africa	29 289	23	0,9
Netherlands	28 056	24	0,8
Philippines	27 243	25	0,8
Saudi Arabia	21 736	26	0,6
Pakistan	21 559	27	0,6
Egypt	20 099	28	0,6
Ukraine	20 062	29	0,6
Colombia	19 726	30	0,6
Belgium	18 826	31	0,5
Bangladesh	18 211	32	0,5
Vietnam	17 793	33	0,5
Sweden	14 675	34	0,4
Hong Kong	14 431	35	0,4
Malaysia	14 412	36	0,4
Austria	14 276	37	0,4
Switzerland	14 128	38	0,4
Algeria	13 554	39	0,4
Greece	13 260	40	0,4
Romania	11 955	41	0,3
Chile	11 700	42	0,3
Czechia	11 444	43	0,3
Norway	10 583	44	0,3
Peru	10 224	45	0,3
Portugal	10 084	46	0,3
Hungary	10 081	47	0,3
Venezuela	10 027	48	0,3
Finland	9 131	49	0,3
Denmark	9 117	50	0,3

Source: LCGC (2013)

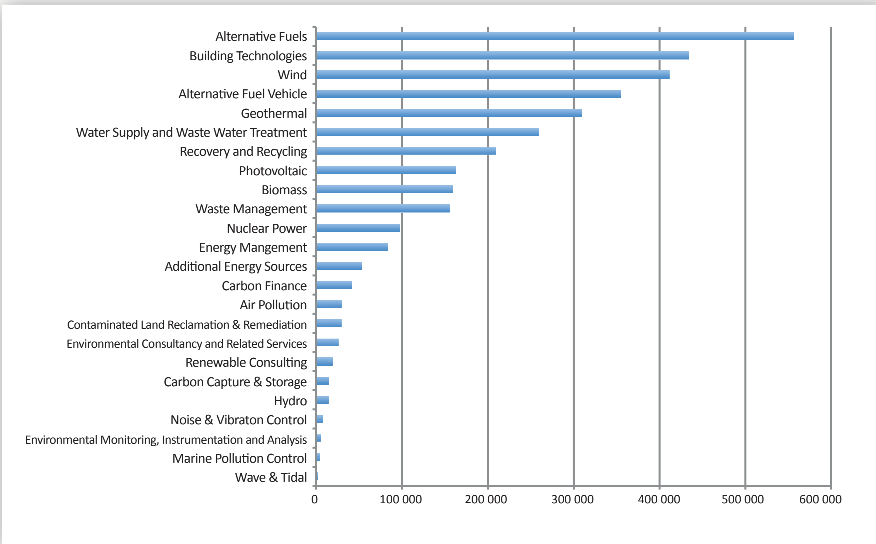
Table 3.2 Sales 2011/12, related to global sales and GDP, low carbon goods and services sector

Country	% of global sales	% of GDP
Spain	2,7	9,4
UK	3,7	8,2
South Africa	0,9	7,8
Japan	6,2	7,2
Greece	0,4	7,0
Hungary	0,3	7,0
Italy	2,6	6,7
Finland	0,3	6,7
France	3,0	6,6
Germany	4,2	6,5
Belgium	0,5	6,4
Canada	1,8	6,4
Czechia	0,3	6,2
USA	19,2	6,2
Netherlands	0,8	5,9
Denmark	0,3	5,9
Austria	0,4	5,8
Portugal	0,3	5,7
China	12,9	5,5
Sweden	0,4	5,4
Mexico	2,0	5,3
Poland	0,9	5,2
Switzerland	0,4	5,0
Australia	1,0	4,9
Norway	0,3	4,9
Chile	0,3	4,5
Russian Federation	2,5	3,9
Turkey	1,0	3,8

Source: LCGC (2013) and OECD.stat

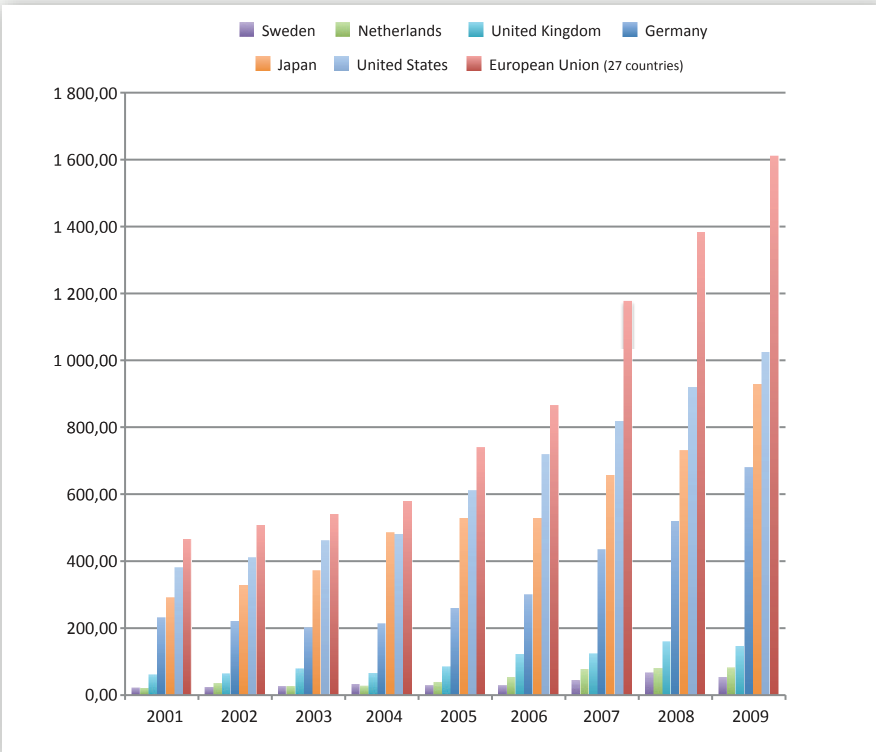
Figure 3.2 shows how global sales are distributed across the sub sectors for 2011/12, the largest sub sectors being Alternative Fuels (16%), Building Technologies (13%), Wind (12%), Alternative Fuel and Vehicles (10%), Geothermal (9%) and Water Supply and Waste Water Treatment (8%).

FIGURE 3.2 Global LCEGS Sales 2011/12 by sub sector, £M



Source: LCGC (2013)

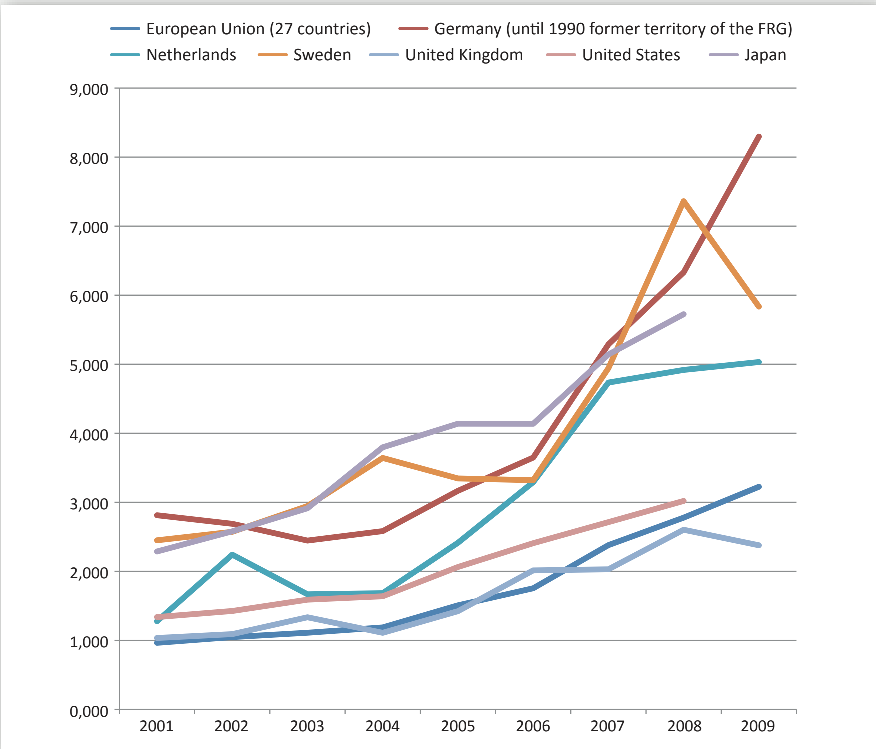
FIGURE 3.3 Energy technologies PCT applications designated to the European Patent Office, (2001-2009), number



Source: Eurostat [pat_ep_nrgpct]

Nuclear power accounts for 2.8% of the global total. Of course one can have a discussion about whether nuclear power should be included in cleantech, but however one defines and cuts the data, the general trend is that this is a growing sector, even in years of global recession, and this growth is concentrated in alternative fuels, construction and renewable electricity production. These sectors also show a strong and growing tendency to develop new technology and innovations. Innovative activity measured as patent applications designated to the European Patent Office for technologies or applications for mitigation or adaptation against climate change are depicted in Figure 3.3 and in Figure 3.4. Germany, Sweden, Japan and the Netherlands reveal higher intensity in terms of patents per capita, whereas the US, Japan and Germany obviously produce more patents in absolute terms. From the figures it is also clear that the European Union as a whole is still lagging behind the US and Japan when it comes to cleantech patenting.

FIGURE 3.4 Energy technologies PCT applications designated to the European Patent Office, (2001-2009), number per capita

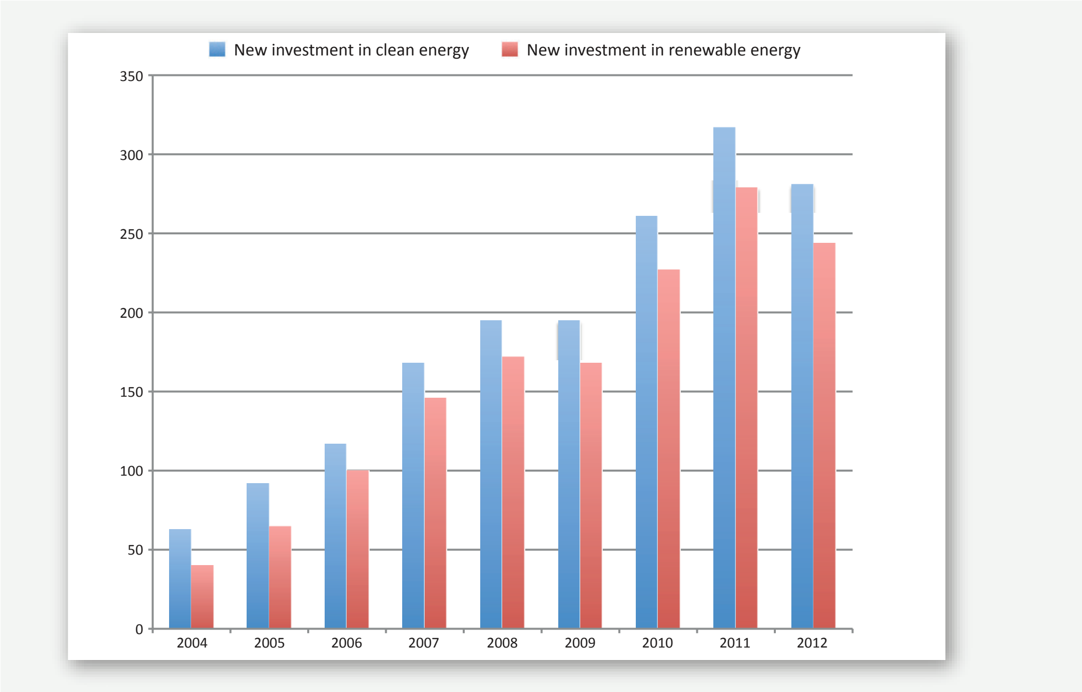


Source: Eurostat [pat_ep_nrgpct]

3.1.3. Investment in the green technology sector

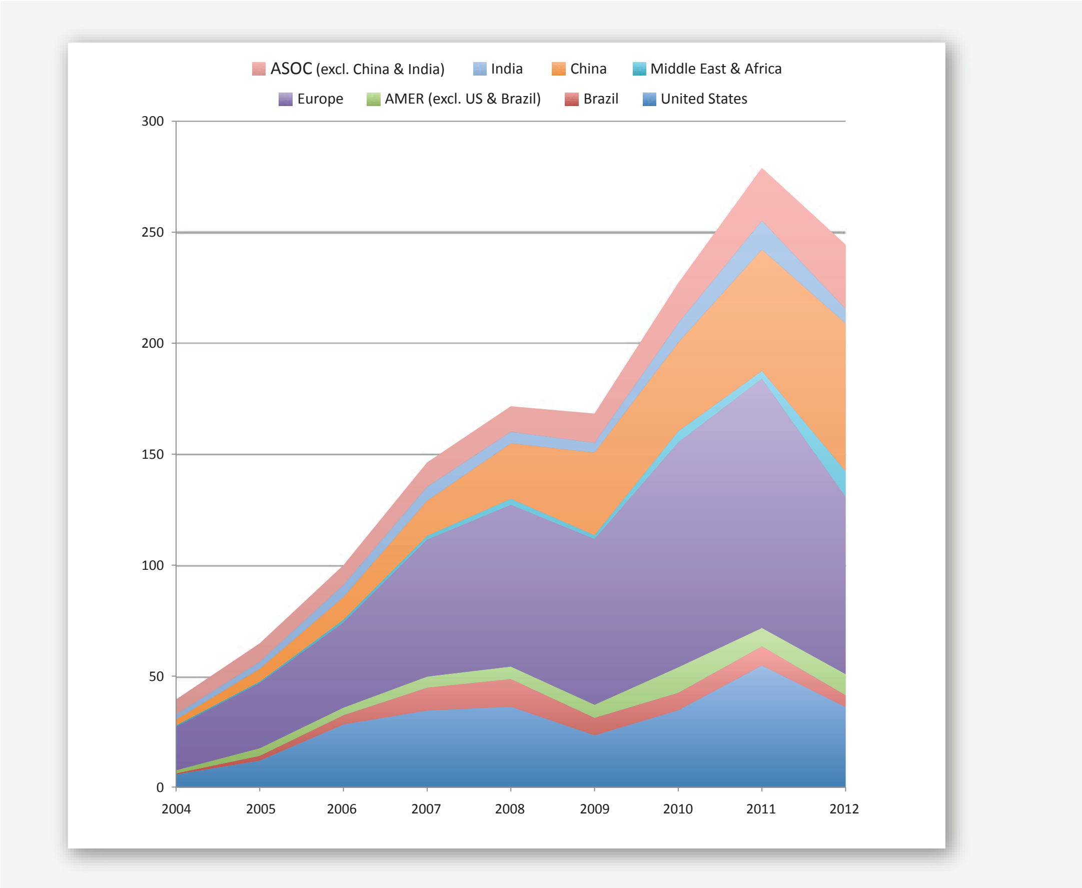
Production and sales typically follow investment in production capacity. In 2012, a shift in the balance of renewable energy investments worldwide occurred, with the centre for clean energy investment shifting from West to East. China passed the US as the major clean energy investor and the EU lost the high ground it held. While investments for former early-movers such as Germany, Italy, the UK and Spain, fell, there were sharp increases in investment from several emerging economies, including South Africa, Morocco, Mexico, Chile and Kenya. Globally, albeit still the second-highest absolute amount ever, total investment in renewable energy was down 12% in 2012, where crisis-hit developed economies accounted for a massive 29% reduction whereas developing economies experienced a 19% increase (Frankfurt School-UNEP Centre/BNEF, 2013). Low global energy prices due to the global recession and increasing pressure on public budgets in developed economies have clearly reduced the incentives to invest in energy transition technologies.

FIGURE 3.5 New global investment in clean and renewable energy (2004-2012), $BN



Source: Frankfurt School-UNEP Centre/BNEF (2013) and BNEF (2013)

FIGURE 3.6 New global investment in renewable energy by geography (2004-2012), $BN

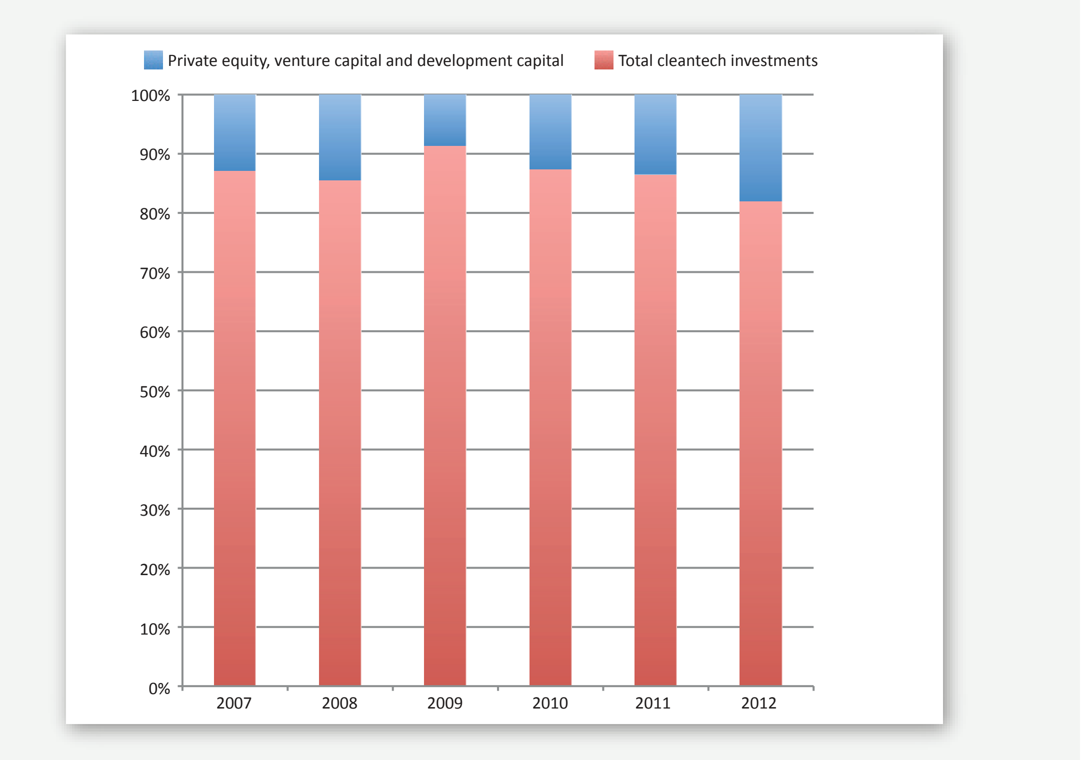


Source: Frankfurt School-UNEP Centre/BNEF (2013)

From Figure 3.6 we see these trends clearly illustrated. China and the developing world are increasing their share and investment volumes, whereas in Europe and the US the crisis has clearly taken its toll.

The role of venture capital, private equity, development capital and M&A investment has fluctuated in the clean-tech sector, hovering between 10 and 20% of the market total (Figure 3.7). This strongly suggests that much of the investment is in early stage activity. Of course this makes sense and is consistent with the sector being in its infancy, both technologically and commercially.

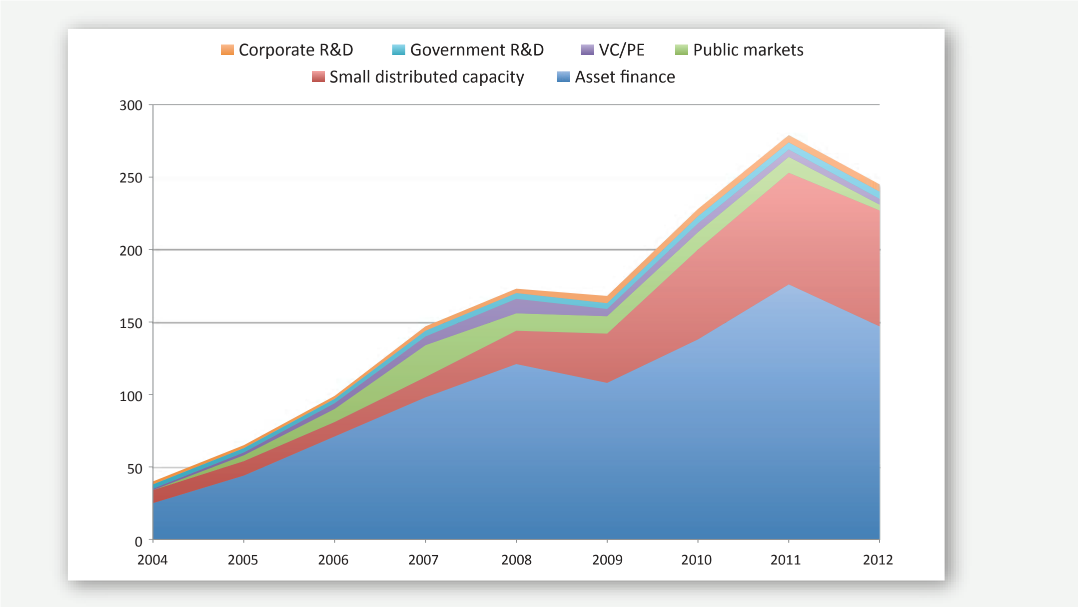
FIGURE 3.7 Global investments in cleantech companies, including VC, PE, development capital, M&A, buy-outs etc (2007-2012), %



Source: ZEPHYR published by BvDEP, ZephyrAnnual Cleantech Report 2012

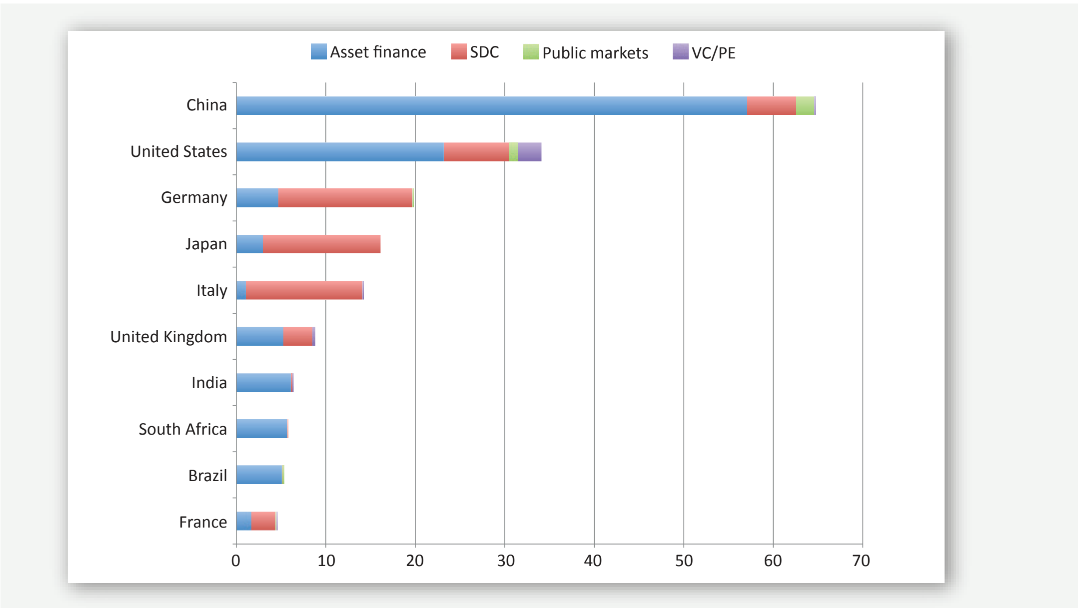
Figure 3.8 shows that asset finance is clearly dominant in share, with investments in small-distributed capacity being second. Investments in the early stages, such as venture capital, government R&D and corporate R&D, however, are a small share but perhaps a more important part of overall investments. As Figure 3.9 shows we also see a clear pattern in types of investments across countries. The US is the leader, and the only country with significant investment levels in venture capital and private equity financing, accounting for 78% of the G-20 total (Pew 2012). In Germany, Japan and Italy small-scale projects dominate overall investments whereas China is clearly focusing on asset finance. This is consistent with a global specialisation pattern in which Europe invests in small demonstration projects and US investors are interested in financing the early stages of commercialising technologies, whereas China is scaling up more mature technology. As European countries compete at the global technology frontier and seem well positioned to develop the cleantech sector into a new engine of growth, we shall now turn to early stage investment.

FIGURE 3.8 VC/PE, public markets, and asset finance investment in renewable energy (2004-2013), $BN



Source: Frankfurt School-UNEP Centre/BNEF (2013)

FIGURE 3.9. New Investment in renewable energy by top ten country and asset class, 2012, $BN



Source: Frankfurt School-UNEP Centre/BNEF (2013)

3.1.4. Early stage investment in the cleantech sector

As Europe seems to be lagging behind in financing, especially the early commercialisation stages, a closer look at such investments is warranted, even if they account for only a small share of global cleantech investments. Table 3.3 shows the volume and value of private equity, venture capital and development capital deals. The US-based cleantech companies were the most valuable and most frequently targeted by (mostly US) private equity and venture capital investors in 2012. Second came the UK, before Norway and South Korea. By volume, China ranked second, followed by the UK and Canada. The Netherlands ranked 8 by volume and 20 by value, whereas Sweden ranked 21 and 17 by volume and value, respectively. This shows that Dutch and Swedish ventures apparently represent attractive targets for investment, but it is hard to raise such funding at home.

Table 3.3 Number of VC, PE and development capital deals targeting cleantech companies (2007-2012), top 25, $M

		2007	2008	2009	2010	2011	2012
1	USA	139	163	139	137	154	121
2	UK	43	41	32	50	33	26
3	Germany	17	22	16	19	19	15
4	Canada	19	12	9	16	19	14
5	Italy	6	4	10	10	12	11
6	France	14	26	19	28	12	10
7	India	10	11	13	13	9	10
8	Netherlands	5	12	6	4	3	6
9	Finland	2	6	1	3	3	4
10	South Korea	0	0	3	1	1	4
11	Spain	12	18	16	9	9	4
12	Norway	2	5	5	4	3	3
13	Denmark	1	3	2	5	0	3
14	Belgium	5	0	9	5	7	3
15	Israel	7	18	7	5	5	3
16	Australia	2	5	6	3	4	3
17	Switzerland	0	2	3	1	1	2
18	Singapore	1	2	0	0	5	2
19	Austria	2	1	1	0	2	2
20	Ireland	0	0	3	0	1	2
21	Sweden	2	5	8	11	10	2
22	China	2	16	10	13	8	2
23	Bulgaria	3	0	0	0	0	1
24	Cayman Islands	1	3	4	2	0	1
25	Indonesia	0	0	0	0	0	1

Source: ZEPHYR published by BvDEP, ZephyrAnnual Cleantech Report 2012

Focussing on Europe Figure 3.10 shows all private equity investments in the energy and environmental sector in Europe by stage. Looking at total private equity investments, including new investments (venture capital and growth capital), and funds in circulation (buyout, rescue/turnaround, replacement capital), France was in the lead, followed by Spain, the UK, Norway and Germany. The Spanish green companies, however, attracted most growth capital, whereas most venture capital was invested in the UK. And while total new investments in Sweden and in the Netherlands are of similar magnitude, the amount of new venture capital is almost twice the size in the Netherlands. This is very different when we consider all venture capital investments. Figures 3.11 and 3.12 show the value of all new private equity investments, in all sectors, by stage, in Sweden and in the Netherlands. Figure 3.13 and 3.14 show the volume of all new private equity investments by stage in Sweden and in the Netherlands. It is interesting to note from these figures that Sweden typically has both a larger number of deals and a larger total value of deals. The average deal size fluctuates.

Table 3.4 Aggregate deal value of VC, PE and development capital targeting clean-tech companies (2007-2012), top 25, $M

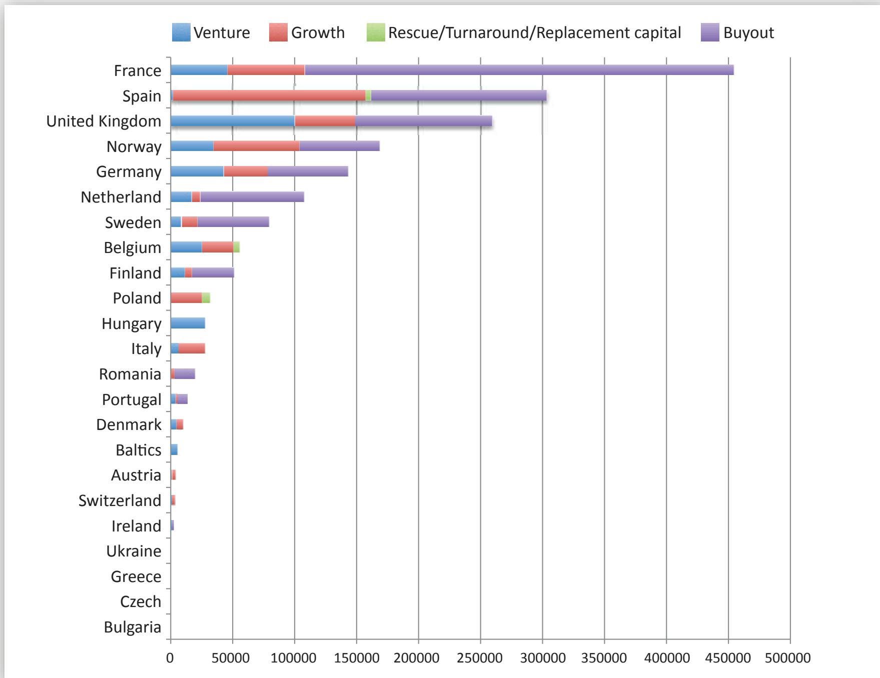
		2007	2008	2009	2010	2011	2012
1	USA	3 829	5 628	3 173	4 470	3 340	6 454
2	UK	5 607	4 362	250	799	391	3 090
3	Norway	907	15	94	26	0	1 533
4	South Korea	0	0	27	177	28	1 194
5	Australia	4	95	42	4	28	753
6	Brazil	0	1 000	47	217	366	600
7	Ireland	0	0	58	0	1	252
8	Switzerland	0	5	0	0	0	133
9	China	86	405	505	209	357	116
10	India	547	303	422	314	110	113
11	Canada	492	139	292	503	2 458	100
12	Germany	213	508	522	93	82	95
13	Italy	10	8	2 566	1 549	35	53
14	Belgium	103	0	174	110	30	48
15	France	144	113	86	337	355	36
16	Cayman Islands	118	73	61	106	0	36
17	Sweden	1	122	80	15	489	33
18	Virgin Islands (British)	0	0	0	50	0	30
19	Vietnam	0	0	0	0	0	17
20	Netherlands	1 093	520	8	728	0	16
21	Israel	39	203	52	54	81	16
22	Denmark	0	804	46	26	0	11
23	Luxembourg	0	0	0	0	0	10
24	Singapore	6	8	0	0	297	8
25	Ukraine	1	0	0	0	0	4

Source: ZEPHYR published by BvDEP, ZephyrAnnual Cleantech Report 2012

From this one would conclude that Sweden has a more active and larger home supply of early stage finance than the Netherlands, but somehow fails to mobilise these resources for the cleantech ventures to the same extent. That conclusion obviously also has important implications for policy. If the aim is to mobilise (more) private funding for early stage and growth finance in the cleantech sectors, Sweden should focus on attracting the attention of already active private equity investors, whereas the Netherlands may want to focus on mobilising more private equity in general.

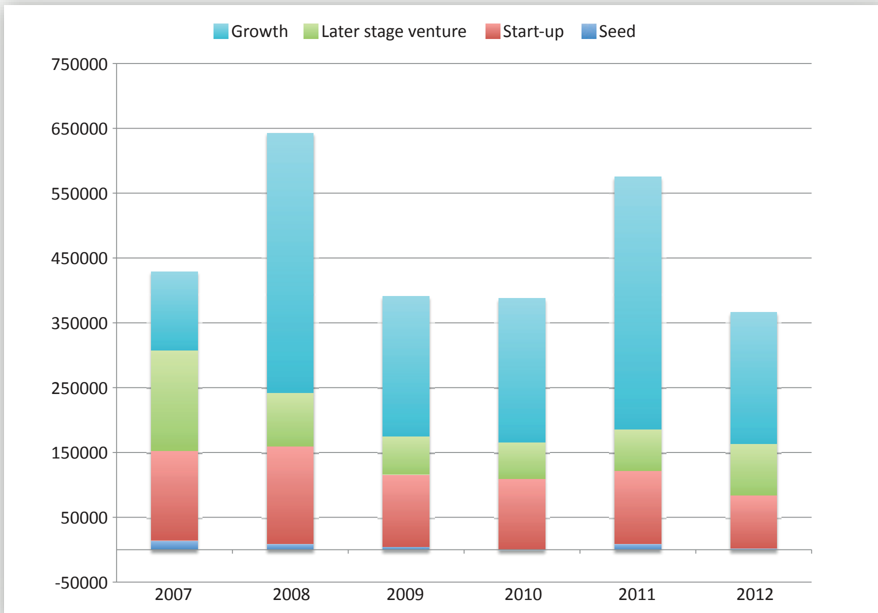
Figure 3.15 compares the sources of funding for venture funds in the Netherlands and Sweden. Whereas the bulk of venture fundraising is from pension funds and governmental agencies in Sweden, insurance companies, family offices and corporate investors raise the bulk of Dutch venture capital. Given the vast untapped reserves of Dutch pension funds this suggests the Netherlands can mobilise much more private equity capital if policies were to be designed to accommodate pension funds engaging more in such investments. For Sweden one might conclude that the involvement of insurance, corporate and family partners can help direct available funds into the cleantech sector.

FIGURE 3.10 New investments (private equity) invested in the Energy and Environment sector (by country of portfolio country) in Europe by stage, 2012, €k



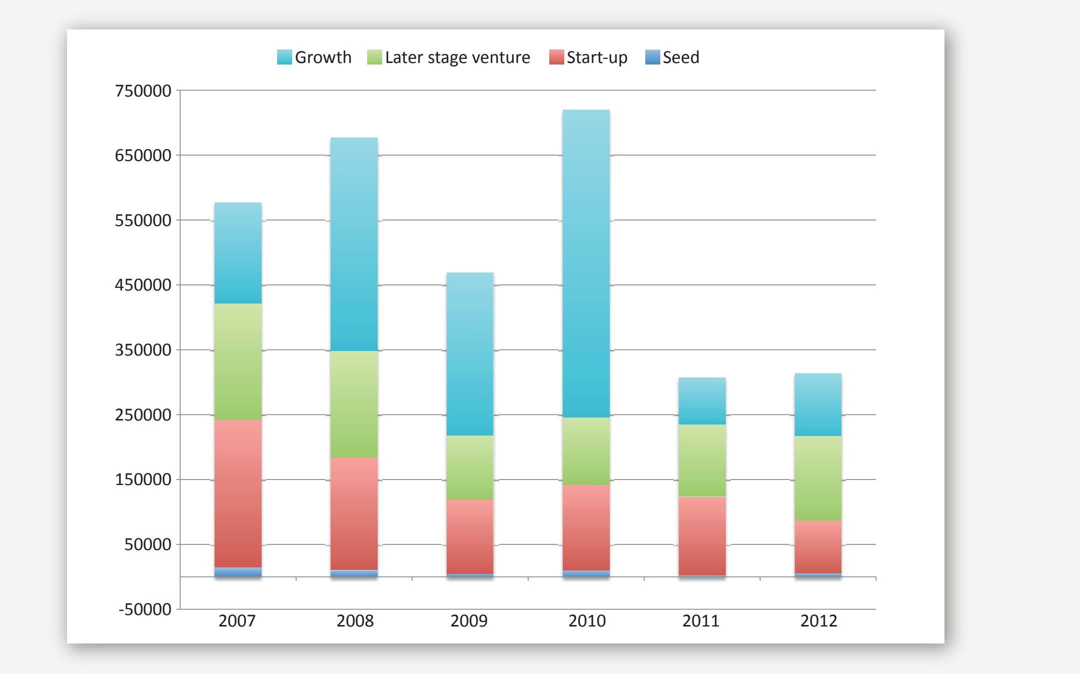
Source: EVCA/PEREP_Analytics

FIGURE 3.11 Value of new private equity investments by country of private equity firm and by stages, all sectors (2007-2012), the Netherlands, €k



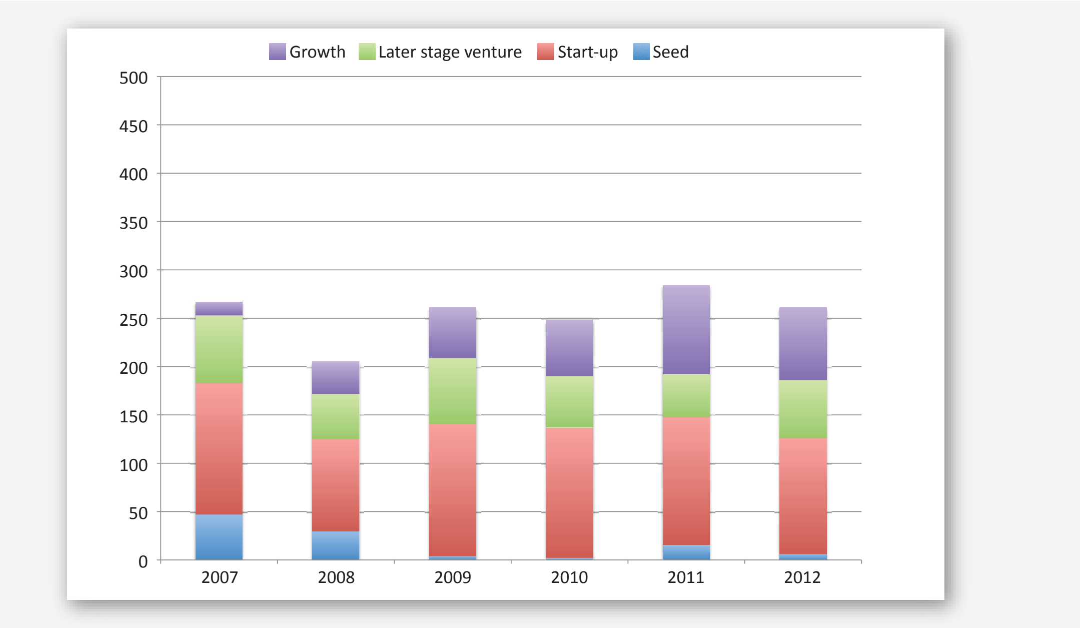
Source: EVCA/PEREP_Analytics

FIGURE 3.12. Value of new private equity investments by country of private equity firm and by stages, all sectors (2007-2012), Sweden,€k



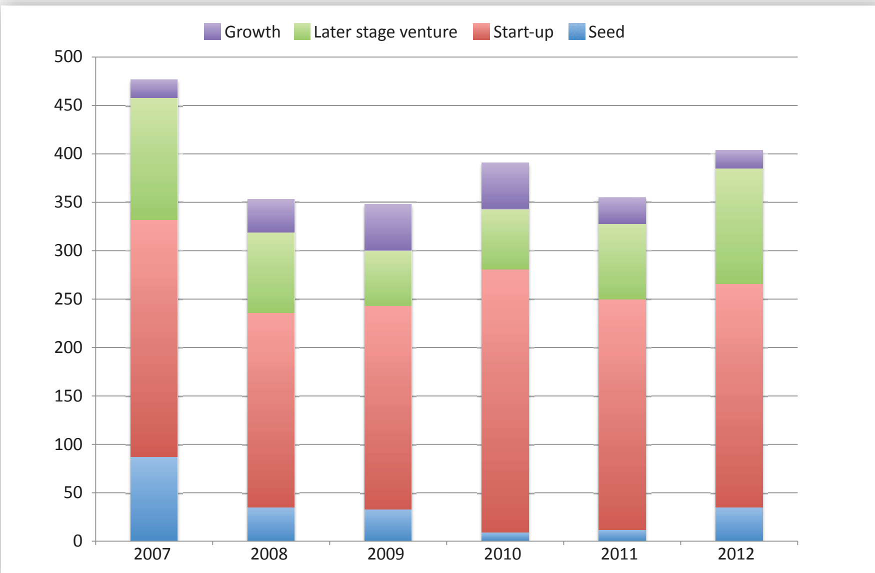
Source: EVCA/PEREP_Analytics

FIGURE 3.13 Volume of new private equity investments by country of private equity firm and by stages, all sectors (2007-2012), the Netherlands,€k



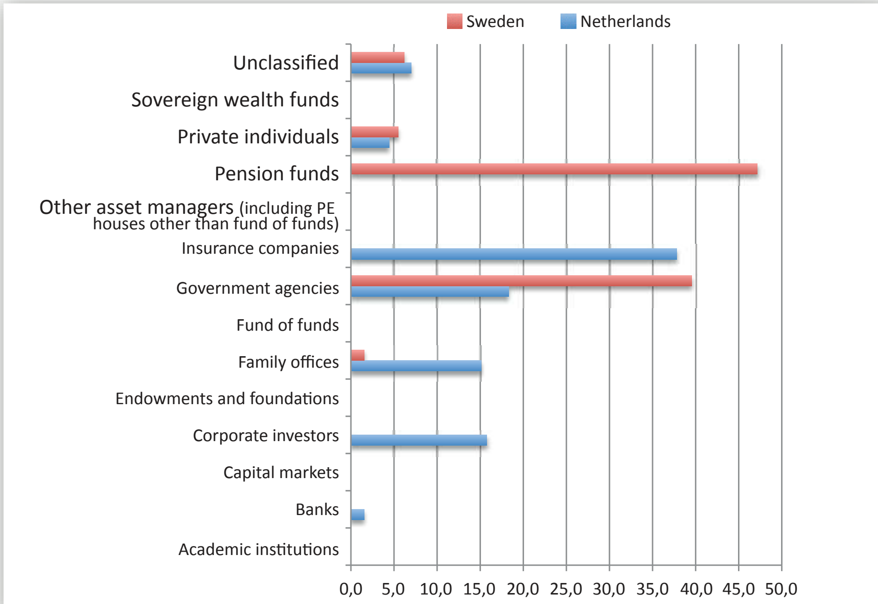
Source: EVCA/PEREP_Analytics

FIGURE 3.14 Volume of new private equity investments by country of private equity firm and by stages, all sectors (2007-2012), Sweden, €k



Source: EVCA/PEREP_Analytics

FIGURE 3.15 Venture funds raised by investor type, all sectors, the Netherlands and Sweden, 2012, €k



Source: EVCA/PEREP_Analytics

3.1.5. Conclusions

From the data presented here we can thus conclude that from a global perspective Europe has traditionally shared a strong position in cleantech investment and R&D with Japan. That position, however, is gradually being contested. On the one hand by the US, leading in the commercialisation and exploitation of emerging technologies, and on the other by China, which is rapidly building up its manufacturing and production capacity in more mature technologies in the sector. Europe in general, and the Netherlands and Sweden in particular, both stand to gain from mobilising more private investment, specifically in the start-up and growth stages of new venture formation in the cleantech sectors. For Sweden this involves, in addition to mobilising more private equity finance, bringing more information and expertise to the already active investors to direct their attention to this sector. For the Netherlands the main challenge will lie in mobilising more private equity finance by making such type of investments more suitable for large institutional investors such as pension funds. Before turning to our policy discussion, however, we first turn to the emerging empirical literature on greentech venturing to complete our summary of the facts.

3.2. A literature review for greentech venturing

3.2.1. Introduction

In recent decades the perspective on innovation and technological transition has gradually shifted away from large incumbent organisations and corporate R&D to high impact entrepreneurship as the primary engine of economic development and transformation (Audretsch et al. 2006, Acs and Armington 2006, Audretsch 2007). In the transition to a more sustainable economy the role of small firms has therefore attracted attention and the Handbook of Research on Energy Entrepreneurship (Wuestenhagen and Wuebker 2011) specifically provides an excellent overview of the emerging literature on the issue central to this report. In this section we will summarise the empirical evidence on green venturing offered in this handbook and the extant literature.

3.2.2. Entrepreneurial venturing in the green technology sector

Dean and McMullen (2007) were the first to define “sustainable entrepreneurship” and argued that neoclassical market failures create opportunities for new business formation. Acting on such opportunities is entrepreneurship and in their view such entrepreneurship is key in moving the economy onto a more sustainable path. Garnsey et al. (2011) argue that an evolutionary approach is more fruitful because market failures also create barriers. They collected evidence on 73 UK ventures and summarised both opportunities and constraints. They conclude that market failures are obstacles not opportunities, and argued that Dean and McMullen (2007) do not distinguish between obstacles and opportunities when all demand-supply disparities are attributed to market failure. In nine cases Garnsey et al. (2011) followed up their phone survey by questionnaire and by case study in another eleven. From their research it follows that a major concern for entrepreneurs is finance. Bank finance is typically unavailable and VC funding implies early exit pressure, equity dilution and loss of control. Entrepreneurs also mention the lack of knowledge of investors (on the technology and sector) as a major impediment. Investors, however, say the same regarding the lacking business knowledge of entrepreneurs. This suggests that financiers and entrepreneurs lack a common ground in knowledge that facilitates their joint venturing in the early stages of development.

Major constraints in energy ventures are the high cost of certification and testing before market entry, templates in building codes etc. that simply do not fit or allow for new technology. Finally, Garnsey et al. (2011) note oligopolistic marketing channels and conservative users (e.g. construction) who severely limit diffusion. Marcus et al. (2011) show that prolonged gestation is common in energy. From their surveys in Minnesota they conclude that supportive networks are key in perseverance and eventual success. Erratic government policy instead is a major reason not to rely on public support. Long gestation and high capital requirements imply that energy and greentech venturing has important real option characteristics. The empirical literature, however, also suggests that venturing in this sector is a social activity that cannot be understood entirely in terms of rational decision-making.

Dickel and Andree (2011), for example, study the German biogas sector and conclude that networks and social skills are important to facilitate learning and personal knowledge acquisition. The importance of non-codified knowledge in successful commercialisation implies the process is largely an intuitive one. Brachert and Hornych (2011) study photovoltaics (PV) in Germany and show that political and social factors were crucial elements in explaining the emergence of the (East) German PV technology cluster over the past decades. The emergence of the Chinese cluster, studied by Meersohn and Hansen (2011) shows, however, that each cluster follows its own specific trajectory. In China the support of well-capitalised incumbent firms, and the government, proved essential in building a globally competitive cluster.

3.2.3. Incumbent firms and venturing in the greentech sector

Schoetl and Lehman Ortega (2011) turn to the incumbent energy producers and argue they can also create revenue from a transition to PV when adopting appropriate business models. These include using PV for large-scale production, organising virtual power plants, building and owning turnkey rooftop PV systems and operating as service provider. Loock (2011) analyses 339 listed companies' business models in wind and solar and concludes that firms with a focus upstream perform better than those that only focus downstream. Teppo and Wuestenhagen (2011), however, show that incumbents in the energy sector typically do not engage and actually moved out of corporate venture capital. Based on 27 interviews with VC and corporate VC managers they conclude that utilities produce and distribute electrons and do not see the need to innovate. It seems it is the technology producers in PV that drive innovation, not the utilities. Utilities will not help strand their own assets. Also, when decision makers lack information they are insecure and become conservative.

3.2.4. Early stage investment in the greentech sector

Grichnick and Koropp (2011) analysed a survey among business angels in Germany in 2009 and find that there is high interest in energy and greentech, but to date low actual commitment of resources due to high capital demand, regulation, low knowledge and lacking fit to an existing portfolio, as well as lacking quality of entrepreneurs and the absence of exit. A small but interesting literature (Moore and Wuestenhagen 2004, Wuestenhagen and Teppo 2006, O'Rourke and Parker 2006, Buerer and Wuestenhagen 2009) investigated the role of venture capital and corporate venture capital finance in the commercialisation of sustainable energy technologies and argues the energy transition offers good returns and opportunities for investment. Wuestenhagen and Teppo (2006) present interviews with 23 venture capitalists and a survey with 26 more. They then discuss at length the factors that affect the investment decision of VCs in the energy sector. They show that risk-return issues in the energy sector do not differ markedly from those in other VC intensive industries, although high capital intensity and long lead times do make VC activity in the energy sector less attractive. More importantly, the lack of success stories and the lack of experienced VCs in the sector create a lock-in and path dependency that is hard to escape. This preliminary evidence suggests that what is particularly lacking and needed in this sector is a community that exchanges information and reduces information asymmetries and transaction costs. Wuestenhagen and Teppo (2006) conclude that venture capital in energy offers reasonable returns and investments are not excessively risky. It is the difficulty of getting the industry started and building up the required complementary systems that keep it down. Kenney (2011) is more sceptical about the potential for VC driven greentech and argues that the criteria for good VC projects are unlikely to be met by greentech. Renewables will arguably experience slow growth and thus are not suitable for VC. Incumbents moving into renewable production can mostly sustain the long low growth that is typical. Few de novo firms emerge and survive. Business angels may have the stomach for the higher risk and lower financial returns of greentech, but VC-investors will not.

3.3. Concluding remarks

From the data and empirical studies discussed in this chapter we can conclude that investment in greentech venturing is increasing and interest is high, even in the midst of the global recession. Still the actual commitment of resources is relatively small and falls far short of the level that a timely energy transition would require. There is a need for more research. We can also conclude that Europe should focus in particular on mobilising early stage investments and where the Netherlands is relatively weak in mobilising funds for such investments across all sectors, Sweden faces the challenge of channelling more of its available early stage capital to the cleantech sector. The empirical literature to date shows us considerations in designing the policies to do so. Reasons for the limited private engagement to date can arguably be traced to the characteristics of the projects under consideration. High sunk costs and technical uncertainty imply it is rational to postpone adoption and keep real investment options open. But research also suggests that limited information and sharing for and between potential ventures and investors can seriously hamper private engagement. The literature also suggests behavioural issues concerning investors and entrepreneurs are in play. Ties in social networks and the political environment are also factors that impact on investment decisions. In the next chapter we will present and discuss Dutch and Swedish policies targeting investment in the green technology sector.

4

Current Policies on Investments, SMEs and Environmental Technologies in the Netherlands and Sweden

4.1. The role of public policy to boost entrepreneurship and investments

The role of public policy for early-stage entrepreneurs and venture capitalists has been discussed by, among others, Lerner (2010) and Mazzucato (2013). This research stresses the need for a holistic view of how markets behave when attempting to facilitate the entrepreneurial- and venture capital sector (Lerner 2010). Entrepreneurial activity does not exist in a vacuum (Lerner 2010, p261), implying that lack of money is not the only barrier that entrepreneurs face. Entrepreneurs are also in need of knowledge support, such as legal advice and marketing knowledge, and committed employees.

In an effort to explain how public efforts can boost entrepreneurship, Lerner (2010) provides guidelines that emphasise public venture programmes that are market-driven and flexible in terms of location, type of securities used and the evolution of firms. The stability of governmental programmes is of equal importance as is reflexivity in assessing programme outcome. This is to assure flexibility as well as ensure continuous success based on creativity.

According to Lerner (2010), a frequent shortcoming of public entrepreneurship and venture capital initiatives has been impatience, when in fact accomplishments in this field need to be viewed from a more long-term perspective. The often-lamented uncertainty of future environmental policies, which increases the risk of investing in green ventures, is an excellent example. Abrupt changes in policy can lead to so-called stranded assets.[9] Moreover, Mazzucato (2013) argues that the emergence of innovative new green companies and technologies that transform energy markets requires policies directed at ventures but also at the investors and the entrepreneurs. In the innovation literature, it is often referred to as technology-push and market-pull (c.f. Burer and Wustenhagen 2009). Technology-push policies, (such as innovation policies like government-funded research and development) aim to increase the amount of technology supply. Market-pull policies (for example, public procurement or production tax credits)

9. Kleindorfer and Crew (1999, p64) define a stranded asset as: "Assets are considered stranded when they were prudently acquired but have lost economic value as a direct result of an unforeseeable regulatory or legislative change, specific to the industry in question".

target increasing demand for new technologies and provide firms and consumers with economic incentives to apply them. The debate about which approach is more adequate than the other has recently been replaced with an agreement that the two approaches are complementary (e.g. Mazzucato 2013).

In the following sections, we present and discuss policies that support venture capital investments aimed at green entrepreneurs and small- and medium enterprises in the Netherlands and Sweden. The Europe 2020 strategy and the 20-20-20 targets guide the selection of policies and how it is "translated" into policies at national level.[10] In addition, policies specifically favouring investments in, and funding of, innovative, early stage small- and medium-sized enterprises were selected.

4.2. Energy policy in the Netherlands

Like all EU member states the Netherlands has committed itself to the 20-20-20 targets and is working on the implementation of the EU 2050 Energy Roadmap. In 2004, the Dutch government presented the "Schoon en Zuinig"-work programme with the ambition of reducing emissions to 150 MtCeq from 220 in 2004. However enthusiasm has been fluctuating strongly over the turbulent political and economic business cycle. The current Dutch government (e.g. Energierapport 2011) is much more reluctant to invest heavily in unproven technologies and recognises that fossil fuels will provide a substantial share of energy needs for decades to come. The Dutch government now aims to balance the transition to a carbon-poor energy system by 2050 and the need to promote growth and economic feasibility while guaranteeing a secure and affordable supply. This implies that ambitions, especially in the short term, are moderate.

For the share of renewable energy, the European goal of 20% was translated to 16% in 2020 for the Netherlands because of limited potential (other EU member states will aim for higher shares). The current government will spend 2.4 billion euros in 2017 (rising to 3.8 billion in 2020) in the so-called SDE+ policy, a subsidy scheme for renewable energy production that will be discussed in more detail below.[11] This is the main policy with respect to promoting renewable energy production. Policies on energy efficiency and greenhouse gas emissions reduction are more diffuse. The government will bring co-firing of biomass under the SDE+ scheme. In more conventional energy production the Dutch government aims to promote European integration of energy markets and creating a level playing field for competing energy options, including nuclear and fossil fuels with CCS. For the latter the government decided to abandon a demonstration project onshore and limit storage to offshore depleted gas fields. In 2013 a large demonstration project for offshore CCS in Rotterdam was postponed. Extremely low European carbon prices forced the commercial partners to reconsider the project and to date it is unclear whether it will be executed.

Dutch energy policy is being proposed, formulated and implemented by the Ministry of Economic Affairs. As a consequence, energy and climate policy are typically approached as a modern form of industry and economic policy. This explains a strong focus on corporate R&D, creating a level playing field, strengthening existing competitive strengths and promoting an efficient energy system. Economic realities are taken as hard constraints on what policies may achieve and the government is reluctant to intervene in a market they only just created (the energy sector was liberalised and privatised in the 1990s and 2000s).

On the webpage http://www.agentschapnl.nl/onderwerpen/duurzaam-ondernemen one finds all Dutch government programmes relating to making the transition to a sustainable energy system. We discuss these programmes in more detail below.

In September 2013 the government also signed the comprehensive national energy accord (NEA) (SER 2013). This accord is the result of a year of extensive consultations and negotiations with unions, employer associations, banks and financiers, environmental organisations, building corporations, consumer organisations and representatives of industry, energy and transport (over 40 organisations in total). All parties involved in this accord have committed to ambitious targets and agreed on actions that go beyond the traditional scope of energy policy. The NEA, however, has caused some changes in government policy and now is the most recent and up to date formulation of current energy policy in the Netherlands. Below we discuss the ambitions, proposals and programmes that make up the energy policy, going from fundamental science and R&D through policies related to sustainable production, trade and use of energy. In production and trade the main focus is on electricity, whereas heat, transport and construction are key policy areas in use.

10. http://ec.europa.eu/clima/policies/package/
11. Regeerakkoord "Bruggen Slaan", http://www.kabinetsformatie2012.nl.

4.2.1. Promoting R&D and innovation

The Dutch government supports innovation and R&D in a variety of ways. These policies are important for, but not exclusively aimed at, green and energy technologies. The Dutch government spends some 2 billion euros annually on innovation and R&D. Some 700 million in the Wet Bevordering Speur en Ontwikkelingswerk (WBSO), 600 million in various thematic programmes including the Topsectoren Energy and Water, another 150 million on SME innovation and R&D and a final 400 million on knowledge institutes (TNO, ECN, Deltares etc.). This money is spent in co-financing and projects in which private funding is often required. The private sector spends about 6 billion, such that total R&D in the Netherlands is around 8 billion euros and about 1.2% of GDP.

Given that cleantech ventures are typically innovative and R&D intensive these policies may be highly relevant in kick starting and fuelling the transition to sustainability. The WBSO is a subsidy in R&D wage costs of 700 million euros in 2013. Up to 38% of the tax and social security benefits can be subsidised. The Research en Development Aftrek (RDA) allows firms to deduct expenditures on materials and other costs in R&D. In 2013 it was worth 375 million and applied to about 2 billion worth of private sector R&D expenditure. The thematic programmes under the Topsectoren Policy leverage government funding through innovation contracts. For 2013-2014 the government and partners, such as public knowledge institutes, pledged 1 billion euros in total. This money is largely spent on research, but collaboration with firms in the various topsectoren is actively sought. In this way public resources are channelled to applied R&D in the private sector.

For profits based on new intellectual property the Dutch tax system has a separate low tax facility for firms. In addition the government provides guarantees and loans under a wide range of programmes, particularly facilitating innovative SMEs in obtaining bank credit and other funding. Increasingly the government also tries to provide information and business services to innovative and growth-oriented SMEs (http://topsectoren.nl/financiering). These policies work towards reducing the costs of R&D. In terms of the above, such policies thus help to reduce technical uncertainty for entrepreneurs and increase the value of innovative projects for the entrepreneur. Because these policies provide in kind support or tax rebates and deductions more than direct subsidies, the policies do not affect the financiers directly. This is different for the policies for SMEs which also include some instruments that provide guarantees and equity for innovative ventures.

4.2.2. Promoting renewable energy production (priority 2 in EU-2050)

The target of 14% renewable energy by 2020 is on schedule. That is, ECN and Ecofys (2013) conclude that the target can be achieved and they agree on what options can contribute how much, for 90% of the target. It is much more doubtful whether this technically feasible scenario will also materialise. ECN and Ecofys simply took the projected 2120 PJ of energy use in 2020 and assessed whether current and proposed policies would be able to achieve 316 PJ of renewable energy production by that time. The portfolio of renewable energy sources contains 78 PJ of biomass and gas, 54 PJ of onshore wind, 50 PJ of offshore wind, 45 PJ of co-fired biomass, 39 PJ of geothermal and heat exchange, 36 PJ of biofuels in transport and 12 PJ of photovoltaic. These estimates were based on policy targets and covenants, however and are not based in any way on a more economic analysis of private and public costs and benefits. For onshore wind, for example, the authors simply assume the government will reach its target of 6000MW installed, where currently there is 2000MW realised and growth has all but stopped in recent years. The authors also mention the problems in financing offshore wind parks, but decide to count the capacity for which the government has given permits instead of the financially feasible capacity. In short, the report focuses on technically feasible options and has little to say about the economic feasibility of these investments.

The main instrument of the government for promoting renewable energy production is the SDE+ scheme. We therefore discuss this policy in some detail. The SDE+ programme was started in April 2013 and a budget of 3 billion euro was committed. For 2014, 3.3 billion is budgeted. The subsidy is open for applications in tranches.

The subsidy works as a feed-in tariff. The Ministry sets a reasonable price per technology based on industry averages (base price) and compensates the producer for the difference between the relevant market energy price (correction price) and this base price. The Ministry also sets a maximum base price per tranche (in 2013 the first tranche was opened for 7ct/KWh or 19.444 euro/GJ and this increases to 15ct/KWh or 41.667 euro/GJ in tranche 6) to focus the subsidy on cost effective technologies. The idea is to first allow cheap renewable technologies to exhaust the budget before more expensive ones can tender.

For producers, the subsidy is limited in time, depending on the technology at 5 years for some forms of biomass, up to 15 years for renewable electricity. Over this period the subsidy is paid out in monthly instalments. These instalments are based on a projection. The subsidy then covers the difference between the pre-set base price for the technology and the projected correction price times of the projected energy production.[12] After every year the actual production and the actual correction price are set and the subsidy is "corrected". If energy prices were high in the preceding year and/or production fell short of the projected levels, the difference is automatically balanced out with future subsidy instalments. Production risks thus remain with the producer and energy price risks may cause a liquidity management issue. As high energy prices imply high revenue in the year preceding, however, such issues are easily dealt with. Very low prices, in contrast, imply the producer must pre-finance the subsidy by up to a year and a half as the balancing is typically done in May-June of the year following. Such financial risks reduce the value of the subsidy.

To keep the budgetary consequences under control the subsidy is also capped over the entire duration of the project by setting maximum peak-load hours for each technology.[13] That is, the subsidy will only be paid on production below or at the pre-set maximum output for the installation. Production above the maximum is sold in markets without the subsidy. Thus, again, the production risks are left entirely with the producer, whereas price risk is eliminated. If energy prices ever exceed the base price, the subsidy is zero. Effectively the SDE+ thus puts a floor on the price of renewable energy and differentiates this floor by technology. Valid concerns over the government budget and the resistance to open-ended subsidies introduce some risks for the recipients. This may reduce the impact of the subsidy. The policy is successful in the sense that the budget is typically exhausted. On September 19th 2013 589 applications for a total of about 3.3 billion euros were received and 432 applications for a total of little under 2 billion euros have been granted to date.[14] Market participants clearly think the subsidy is worth the potential liquidity issues. Of the projects granted in 2013 the bulk consist of about 9000 GWh of wind on land and 100 PJ of heat from biomass. Solar, water and geothermal remain marginal technologies in the programme. In that sense the programme is successful in selecting low cost, close to market parity, technologies without "picking winners".

This policy clearly aims to improve the net present value and reduce price risks of investments in renewable energy production. The policy introduces some distortions by making potential investors wait for new subsidy rounds and introducing some financial risks by delaying the final grant up to one and a half year after production. The policy does not aim to help the investor or entrepreneur with information or affect their behaviour other than through changing the value of the project. That is, the policy assumes rational behaviour and informed agents. Similarly there is no attention for information and behaviour in networks and clusters. The policy is open to all and does not favour clustering or networking directly.

4.2.3. Promoting European integrated energy markets

It is an important priority for the Netherlands to invest in integrating grids with the North-western European energy markets. This allows it to accommodate and smooth out more volatile renewable (wind) energy production and deal with fluctuating demand for gas and electricity. The Netherlands is a net exporter of both gas and electricity, especially after new (coal-fired) production capacity in Groningen and Rotterdam comes online. With more cross border trade and more fluctuating supply there is a need for better interconnectors and larger capacity. There is now a Memorandum of Understanding among the nine North Sea nations which will expand and integrate the European Energy Market. The Dutch government considers the gas and energy infrastructure a public good and consequently retains a majority share in the national grid operator. Currently the government owns 100% of the shares so the latter does imply further privatisation in the hope of attracting private funds for the required investments.

4.2.4. Promoting energy efficiency (priority 1 in EU-2050)

CE Delft concluded in 2013 that some 300 PJ of energy could be saved at negative cost to the user. That is, such energy efficiency improvements would be a good idea even if there was no climate issue. Reasons

12. http://www.agentschapnl.nl/sites/default/files/Folder%20uw%20SDE-subsidie%20is%20bijgesteld.pdf
13. http://www.agentschapnl.nl/sites/default/files/Printversie%20digitale%20brochure%20SDE%2B%202013.pdf
14. http://www.agentschapnl.nl/sites/default/files/2013/09/Tabellen%20Stand%20van%20zaken%20SDE%20-%20 19%20september%202013_0.pdf

why such improvements are usually not realised include the split incentives problem (investing in rented buildings), the lack of knowledge and transparency and credit constraints. At an estimated 80 euros of external effects of emission of CO2, another 300 PJ would be worth saving given the costs of doing so. CE Delft continues to argue that for private households and small- and medium sized companies the decision (not) to invest in such energy efficiency measures is often non-financial and a more directive command and control approach might be warranted. This is, to a lesser extent, even true for the large corporates, although these are typically also sensitive to market based instruments such as taxes and subsidies. Gerdes and Boonekamp (2012) show that energy savings in the Netherlands on average hovered around 1.1-1.2% annually over the period 2000-2012. The crisis had a noticeable, but small effect on the rate of energy savings, but this was not linked to government policies becoming less generous, ambitious or stringent. Rather, the strong reduction in demand reduced the capacity utilisation in most industries, causing energy (complementary to capital stock, not output flows) to be used less efficiently. The rate of replacement of old equipment, usually an important source of energy efficiency gains, has also dropped as investments were postponed.

The Netherlands has adopted the energy efficiency directive, aiming for efficiency improvement of 1.5% annually between 2014-2020. To achieve that aim it follows a generic energy savings policy by levying an energy tax and participating in the emission trading system. The government also allows for tax deduction of energy investments by firms, which also covers energy efficient production means under the Energie Investerings Aftrek (EIA), the Milieu Investerings Aftrek (MIA) and Versnelde Afschrijving Milieuinvesteringen (VAMIL). These policies allow firms to deduct the costs of certain listed investments from taxable profits and write off such investments faster than allowed under standard accounting rules. This makes such investments more interesting to entrepreneurs. That is, for the same gross profits their tax liability is reduced and thus net profits increase. Firms that wish to use this opportunity must apply and get their investment pre-approved before being eligible. In the EIA it is possible to get approval for a government list of investments but firms can also propose their own projects and get them approved. In the MIA and VAMIL the government list is exhaustive. The budget for these programmes is much more modest than for SDE+, but as corporate taxes in the Netherlands are not very high, the investments in greentech and energy saving equipment still have to be substantial to exhaust the budgets. The budget for the EIA scheme is 150 mln euro annually, which will be exhausted when some 1.4 bln euros of private investment are made.

4.2.5. Specific issues and sectoral policies

In addition to the generic policies, the government runs some programmes that specifically address issues such as the split incentive problem in rented real estate and the lack of information and knowledge in small and medium sized business. The European Directive on Energy Services is implemented in the Energiebesparingswet in the Netherlands, detailing the monitoring standards for energy efficiency, information about energy consumption, energy efficiency standards and smart metering.

In its new “Green Deal” programme the government partners with commercial and private actors to promote green growth. The government takes a bottom up approach in this programme. Citizens and companies can submit projects to the programme and the government will provide expertise, network and legal and political support in getting the project off the ground.

With large industrial partners the government has agreements (convenanten) and some 15 sectors in the economy are preparing energy route maps to increase their energy efficiency by 50%. Local governments are also given more room to work with local industry to re-use waste heat.

In transport the government supports the sector in developing and implementing smart logistics software, and facilitates the adoption of electric vehicles through tax exemptions and charging points.

In construction the government will implement the European Directive on Energy Performance and in 2020 new buildings will be energy neutral through standards and command and control measures. Existing buildings will be isolated in the “blok-voor-blok” programme in which local government is again the key player.

In agriculture, especially the energy intensive greenhouses sector in the Netherlands, a 2% energy efficiency gain per year and a 20% renewable energy target have been agreed. This programme is a planned economy style programme that is based on a voluntary agreement with the sector and is being monitored, but not enforced through legal or financial instruments.

4.3. Policies in Sweden[15]

4.3.1. Sustainable energy, climate and environmental policy

Sweden also adopted the vision of having a sustainable and resource efficient energy supply by 2050, including no net emissions of greenhouse gases to the atmosphere. The Swedish ambition is to cost-effectively achieve sustainability in energy systems and reach the targets in this area with its energy, climate and environmental policy. Sweden's policies to reach the EU 20-20-20 targets include measures to improve excellence in research, commercialisation of innovative products and the development of new technologies.

The Swedish climate strategy focuses on general economic policy instruments such as the carbon dioxide tax and carbon emission trading within the EU ETS. In addition to these general policy instruments, specific measures, such as economic, legislative and voluntary are added in order to support development and market introduction of new clean technology.

In October 2012, the government presented a bill on research and innovation, which entails a substantial increase in funding. In parallel with the bill, the government adopted an innovation strategy aimed at strengthening the innovative climate. The innovation strategy embraces a holistic view to purposely enhance innovative capacity and meet social challenges. The strategy emphasises, for example, the importance of relevant actors, without exception, being involved in the lowering of thresholds and the creation of incentives to advance different actors' capacity for growth and innovation. The innovation strategy includes several different areas of policy and affects a number of government bills over an extended period, but no further than 2020.

4.3.2. Economic support schemes and subsidies

Sweden has the highest carbon dioxide tax rate in Europe, levied on fossil fuels, carbon emissions in the industry, and energy production. In addition, an energy tax is levied on electric power and fossil fuels to induce energy efficiency. Renewable fuels are exempted from energy and carbon dioxide taxation. In the transport sector, compliance with certain environmental standards will render a tax-exemption for new vehicles including cars, trucks and buses. Older vehicles, on the other hand, are faced with differentiated rates according to their carbon dioxide emissions and weight. The tax exemption brings about a "super-premium" for green cars emitting less than 50g/km as an additional feature. Other policy measures to promote an emission reduction from transport and increase the adoption of renewable fuels include subsidies for research, and demonstration facilities for bio-fuels.

To support the transition to sustainable energy sources, producers of renewable energy receive one tradable renewable energy certificate (REC) for each MWh produced. The electric power distributers are obliged to buy RECs up to a certain proportion of the power distributed. In addition to the green electricity certificate system, Swedish tax law allows windmill investments to be depreciated at a faster rate than the actual loss in economic value.

4.3.3. Development of new technologies and commercialization of innovative products

Accepting risks and allowing for curiosity-based research is of great importance when one considers the development of new technologies. This can, in the long term, contribute to major advances within this area. The large injections of funding that research funders and seats of learning will receive during the period 2009–2016 will reinforce the conditions for this type of research.

The foundation for the development of new technologies includes major ventures in some twenty strategic areas of research initiated in 2009. These areas represent key enabling technologies and areas of research that are important in meeting the challenges facing society. Specifically, energy and greentech have been identified as strategic areas under this programme.

4.3.4. National environmental technology strategy

The National Environmental Technology Strategy (NETS)[16] was launched in September 2011. "The aim of the strategy is to facilitate the development of new, sustainable Swedish solutions to meet the challenges for climate change and environmental degradation while promoting new business and employment".

15. In the presentation of policies in Sweden, we distinguish between strategies and bills, where strategies are action programmes presented by the government and bills are proposals that the government presents to parliament. In line with the purpose of this study, we also distinguish between the target group of the policies; small- and medium sized enterprises and investments/venture capital investors in general, or environmental technologies in particular.
16. All information on the NETS is from: (http://www.government.se/sb/d/16022/nocache/true/a/187764/dictionary/true).

NETS has a total budget of 400 MSEK during the period 2011-2014, and the funds are distributed between three different Ministries[17].

NETS comprises a broad range of short- and long-term initiatives, targeting research and innovation, as well as exports. The overall ambition is for Sweden to be a pioneer in the environmental technology field as well as furthering past efforts in the area, in order to usher in a deeper impact within the environment technologies field through a clear division of work. The export-focused process is in need of a new direction, something the government is willing to work for and provide, in order to facilitate companies who wish to internationalise. Granted, there is consensus about the need for adaptation to environmental requirements, specialised firms within environmental-technology solutions have the ability to e.g. enlarge employment, advance growth and development geared towards to increased life quality, not only for Sweden but other countries as well, where Swedish innovation and technology can be of assistance. The strategy essentially consists of twenty initiatives that are carried out by about ten different government agencies and organisations. For the overall purpose of this report, we limit the discussion to six agencies.

Efforts to bypass volatile areas of commercialisation and/or internationalisation are examples of actions within the framework of the government's environment technologies strategy. Public-owned incubators, such as Almi and Innovationsbron, have been assigned by the Ministry of Enterprise to enable growth of small- and medium-sized enterprises. The initiatives are presented in Appendix 1 and commented on below.

Business Sweden has a budget allocation intended to build strategic cleantech alliances between foreign investors and Swedish businesses, in order to increase foreign VC to Swedish growth-firms and to encourage foreign businesses placing R&D operations in Sweden. Business Sweden plans to support foreign investors with e.g. regulatory and policy counselling in the process of strengthening Swedish competence-areas. Other initiatives involve facilitating entry to new markets and to building networks among Swedish and foreign actors in the environmental technologies industry.

The concept Symbiocity- sustainability by Sweden - as a sub-divisional assignment for Business Sweden, has the purpose of creating specific communication tools for increased interaction through a comprehensive national platform. Its aim is also to increase Swedish attractiveness from a cleantech point of view. The Symbiocity platform is to be used for the international marketing activities of Swedish cleantech, and together with complementing corporations, Business Sweden will be able to promote Swedish industry and its capacity abroad from a perspective of both demand and need. Targeting venues are, for example, international conferences and industry fairs such as Expo 2012 or the World Urban Forum. As a special project for small businesses (up to 50 employees), Business Sweden will conduct activities aimed at decreasing the threshold to enter and initiate sales in new markets. Business Sweden's analytical services along with sales and marketing support will be made available along with their infrastructure. Even medium-sized companies will be able to use them, should there be potential customers that can be seen as a cooperative target.

Swedish Energy Agency is another institution with a mandate to facilitate the coming together of actors within cleantech, and thus increases the convergence and cooperation between them. The desired effect is to increase the private investment-ratio in the cleantech sector. Swedish Energy Agency, together with VINNOVA, will conduct efforts within technology and innovation in order to advance cleantech solutions as being part of the public offering to a greater extent. This entails, for example, a mapping of networks, the verification of needs within special areas, and methods as well as demands for purchasing-contracts.

VINNOVA, has been allocated funding aimed at bridging the "valley of death", i.e. the perceived gap between public-financed research and privately financed processes within the private sector. This includes, for instance, method-development, standardising, certification, and the development of infrastructure for innovative efforts and /or firms. A special focus is dedicated towards test-beds within cleantech to further cooperative initiatives nationally, regionally, and on a European level as stated in the report. The budget allowance of VINNOVA also covers the aim of increasing the services facilitating knowledge-development for cleantech technology and system solutions along with a specialised research-target for innovative solutions for city evolution, and cleantech implementation in growth markets.

Almi/Innovationsbron works explicitly to cultivate business development support and finance for cleantech firms with the desired effects of increasing the inflow of innovations that can be commercialised.

17. The Ministry of Environment, the Ministry of Foreign Affairs and the Ministry of Enterprise, Energy and Communications.

The Swedish Agency for Economic and Regional Growth has been commissioned to sponsor entrepreneurial progress and regional advancements. In practice, this means to simplify the process of becoming a business owner, boost business procedures aimed at maturation, and increasing their ability to be competitive through knowledge accumulation. This will be expedited through business networks for small-and medium sized businesses on a local, regional, and national level. Other assignments include the facilitation of EU applications for SMEs and a specific cleantech website to promote knowledge sharing in cleantech. Growth analysis has been commissioned by the government to develop the statistics and define the targeted cleantech areas for analysis.

4.3.5. Initiatives targeting SMEs and VC investment

In the budget bill presented in September 2013, it is stated that the recent years' decline in private funding for early stage ventures is troublesome from a social-economic standpoint, in that it can subjugate innovation and growth elements for both individuals and Sweden as a whole. High risk, evaluation and information asymmetry, along with long lead times to reach financial viability and stability, keeps the market at bay. Consequently it can be viewed as a market failure and therefore in need of market complementary financing efforts (Budget bill 2013/2014:68). As a remedy, the Swedish government presented measures aimed at enabling investments and funding for entrepreneurs in general and the environmental technology sector in particular. These measures will become effective in late 2013 or in 2014.

The supply of venture capital is decisive for the establishment of new, knowledge-intensive, enterprises with growth ambitions. With the aim of strengthening the supply of private capital for early-stage companies whilst at the same time promoting the occurrence of venture capital trustees, one suggestion is to set up a fund, using means from the EU regional fund, with the specific purpose of investing in new and current private VC funds. Co-financing is ensured through additional and equal dividends from the public VCs Fouriertransform AB and Inlandsinnovation AB. The overall purpose is to revitalise the private market and subsequently contribute to a more efficient VC chain. Another means of promoting the supply of private VC to early stage companies is an investor deduction that will be introduced on December 1, 2013.[18] The deduction concerns individuals who buy shares in a company when it is established or emits new shares, and the upper limit for the deduction is 650 000 SEK annually.

In 2014 and 2020—with the support from the EU regional fund—Almi Businesspartner and the Swedish Energy Agency will set up a green investment fund directed towards energy and environmental technology in order to strengthen the VC supply to the finance business models that specifically is contributing to lessen the effects of carbon dioxide. The suggestion is however contingent on approval from the EU-Commission (Budget bill 2013/2014:68).

Horizon 2020—with a start in 2014—is geared towards stimulating innovation, as a part of the structural programme of the EU regarding R&D. Sweden is dedicated to working towards increasing innovation that is knowledge-centred and will as a consequence regularly give an account for the results of the national strategy. One goal is to prioritise Swedish participation in Horizon 2020 activities (Budget bill 2013/14:71).

To promote entrepreneurship and job-generating investments for rapid growing businesses, a tax-review will take place, regarding, for example, options and other stock-related incentives related to corporate governance, so as to improve them if possible for the benefit of both employees and owners (Budget bill 2013/14:73).

4.4. Exploring policies in early stage funding and entrepreneurship in environmental technologies

When discussing Dutch and Swedish policies, we have limited the scope to policies that are likely to target or affect the early stage funding for cleantech ventures. These policies thus include those aimed at promoting cleantech venturing directly, but also include policies aimed at promoting small and medium sized business and innovation in general. In our report we do not claim to be exhaustive and other policies may well have an impact on the ability and willingness of entrepreneurs and investors to engage in green and cleantech ventures, but with this list we do cover the largest and most relevant policies in both countries. The objective is rather to, by using an exploratory approach, show the plethora of policies in

18. (http://www.riksdagen.se/sv/Dokument-Lagar/Utskottens-dokument/Betankanden/Arenden/201314/SkU2/).

two countries in the EU and to discuss these policies through different theoretical lenses (see Appendix 2 for an overview of the policies).

The policies are classified into generic and specific policies, where the former are not specific to a technology, project or type of venture chosen by the policy maker and open to large groups of entrepreneurs and/or investors, and the latter are targeted to specific ventures. Linked to the generic or specific categories is the question of what type of actors the policy is aimed at. Typically this means that the actor(s) listed can apply for the subsidy, a grant or a tax exemption. A comparison between the two countries there are several specific policies targeting innovative small- and medium-sized enterprises. The generic policies are aimed at both firms, regardless of size, and consumers. Policies targeting investors are not that common in the two countries. In Sweden, there are initiatives seeking to favour the inflow of foreign venture capital or increase awareness through the supply of information. In the Netherlands, the initiatives are also targeted to increase the supply of information, but are also on fixed feed-in tariffs.

Responsibility for implementing policies in the area of energy and environmental technologies differs in the two studied countries. In the Netherlands, it is usually AgentschapNL, an agency of the Ministry of Economic Affairs, whereas in Sweden different agencies in three different Ministries (Ministry of Environment, Ministry of Enterprise, Energy and Communications and Ministry of Foreign Affairs) implement these types of policies. One strong contributing factor to the involvement of several Ministries in Sweden is the National Environmental Technologies Strategy (NETS). Coordinating the initiatives of different agencies is an important cornerstone in the Swedish strategy.

The policies are classified according to the dimensions derived from the theoretical framework, addressing the question of how a certain policy may impact on ventures, actors and network. We indicate with + a positive impact, 0 no impact and – a negative impact on the value of the venture, for the actors: investors and entrepreneurs, distinguishing between impacts through the ventures' objective NPV, perception of risk and real option value (ROV) and its subjective perception by the actors through individual and network information and behavioural biases. A +/- indicates an assessment that the policy has both positive and negative effects and the net effect is ambiguous.

The policies in Sweden, concerning the promotion of venture capital and entrepreneurship in the energy and cleantech sectors, are to a great extent, directed towards the provision of information, and to some extent economic instruments. This conclusion is well in line with the evaluations made by the Swedish public agency Growth Analysis. Policies aiming at the provision of information focus to a great extent on different networking activities with the purpose of supporting knowledge- and information sharing between actors, as well as business growth through increased innovation activities, commercialisation and internationalisation. These types of measures, so called soft support measures, have been met with scepticism on the behalf of venture capitalists (c.f. Buerer and Wuestenhagen 2009). Policies favouring demonstration grants and public R&D were however perceived by investors as effective.

Policies in the Netherlands are more oriented towards economic instruments, targeting hard and objective characteristics of the ventures and investments themselves. This may be due, in part, to the policies being designed and implemented by the Ministry of Economic Affairs, which perhaps has a slightly more neoclassical perspective on investment processes. It is also possible that Dutch policy makers tend to take a more rational approach in the sense that they trust market participants to engage in objectively beneficial ventures and do not see a strong role for the government in also facilitating the softer aspects of investment decisions.

In Sweden, by contrast, more effort is being put into creating industry networks, promoting green and cleantech ventures, and the creation and sharing of relevant information. Of course this could be a response to the paradox found above, that Sweden seems to have more early stage capital than the Netherlands, but that less finds its way into the cleantech sector. Building stronger business networks to provide and share information and overcome behavioural biases against investing in the sector seems to be an appropriate response. Still the table also suggests that much can be gained by enhancing the effectiveness of policy. For Sweden most of the budget seems tightly controlled by government agencies and leaving more of that funding to be allocated by market forces may well have a multiplier effect, as private sector funding can then leverage public budgets. In the Netherlands, much might be gained by following a more behaviourally informed policy that is also sensitive to the effects of (policy) risk and uncertainty. Both countries should consider the relevance and implications of real option considerations in their policy designs. Reducing (perceived) uncertainty (e.g., access to more, better and reliable information on government policies, market developments, technological evolutions), increasing the opportunity cost of waiting (e.g., loss of first-mover advantages or a limited subsidy window) or staging investment outlays are ways to induce earlier investment. Also, perhaps for the Netherlands more than for Sweden, more sensitivity to information failures and behavioural bias would be useful. In a very recent ESB dossier (ESB 2013) eminent Dutch economists have argued forcefully for such a behaviourally informed environmental policy and we would add that this holds also for policies towards entrepreneurship and innovation. The literature has stressed (1) the importance of networks and clustering when structuring and building new venture driven ecosystems and (2) the government's crucial role in enhancing such networks and clusters (e.g. Frankelius and Norrmann 2013). This might help to mobilise more private funding for the cleantech sector, especially in the context of Dutch policy.

5

Summarising discussion

The estimates of resources needed to make the transition to a green economy greatly varies depending on the assumptions regarding the rate and direction of technological change, it is indisputable that the investments required are massive. It is also clear that public funds are limited and cannot meet the long-term financing needs of a green economy. Private capital investments are hence essential to mitigate the environmental impact of economic activity.

The private finance sector, such as banks and investors, are increasingly interested in clean technologies which for example deliver low carbon energy or increase energy efficiency, and a range of public and private green financial and investment instruments such as carbon finance, green stimulus funds, microfinance and green bonds have emerged in the 2000s. Current green capital flows are, however, still small compared to overall investment needs and they rapidly need to be scaled up if the society will succeed in following an environmentally sustainable path in the near term.

Besides the relevance for global challenges such as climate change, there are also commercial opportunities in green funding. In the aftermath of the global financial crisis, improving industrial competitiveness and growth prospects is high on the European agenda. The BRIICS economies (Brazil, Russia, India, Indonesia, China and South Africa) are making significant investments in environmental technologies and are already focusing more on renewable energy applications than the global norm. Green investments in science, technology and innovation are an important contribution to manage the opportunities and challenges for Europe that the big emerging economies present.

Notwithstanding a limited access to green private capital in general, the financial sectors in different countries have responded to the commercial opportunities of a green economy in different ways. It seems clear that policy and regulatory changes and incentives are needed to leverage private capital at scale towards sustainability.

This is the starting point of this report with the twofold aim of outlining a theoretical framework on key factors that affect private investment decisions in green technology ventures, and to describe the policy framework, targeting energy- and environmental technology in the Netherlands and Sweden.

The data and empirical studies discussed in Chapter 3 concluded that investment in cleantech venturing has not been hit severely by the global recession. That is, committed financial resources are growing, but they still fall far short of the level that a timely energy transition would require. We also concluded that Europe, given its position at the global technology frontier, should focus in particular on mobilising early stage investments, as it must compete on high growth, high value added activities. Sweden and the Netherlands both face that challenge. Reasons for lagging private engagement to date can arguably be traced to the characteristics of the projects under consideration. Externalities are only partially internalised, but there is more. High sunk costs and technical uncertainty imply that it is rational to postpone adoption and keep real investment options open. Research also suggests that limited information sharing and behavioural biases can seriously slow down private engagement. There clearly is a case for government involvement and intervention as the market fails. The governments of both Sweden and the Netherlands have responded with a number of policy initiatives targeting the green technology sectors, innovative SMEs and innovation in general. These policies all affect the innovation ecosystem, in which early stage investments in cleantech ventures are made.

In Chapter 4 we provided an overview of a broad range of relevant policies in these countries. A first conclusion we can draw from this policy survey is that both countries spend significant amounts of money and effort in promoting early stage cleantech investments. It should also be noted that policies in these small, open economies must consider their effect on international competitiveness. Many efforts are thus aimed at building up national competencies and networks that can help the sector be(come) competitive internationally.

Our second conclusion, however, is that it seems like policy in Sweden and the Netherlands do not address real option aspects, information sharing and behavioural issues in a systematic way. In Sweden, the policies aim at building networks and reduce information shortages, but as government agencies control much of the budget, policy risk will typically remain an issue. Dutch policies, in contrast, are based mostly on a rather rational view of investment decisions and to date little attention has been paid to behavioural aspects and information problems in the market.

This may be a response to the fact that in the Netherlands cleantech venturing is not underrepresented in the venture capital portfolio, whereas in Sweden this does seem to be the case. It suggests Dutch venture capitalists and venturers have built the networks and share the information that is needed to effectively engage in early stage investments, and there is less need for government intervention on that front. More research will be necessary, however, to substantiate this hypothesis. We may learn from such follow-up research how Sweden could make its cleantech ecosystem more effective in channelling information and building essential network ties. In addition, Dutch policy makers should systematically consider the softer aspects of early stage venturing and investment. The fact that the Netherlands was once leading in many cleantech sectors, it seems, has left a functional network in place, but the Dutch leading position has now all but vanished. To mobilise more private resources for early stage investment in the sector the Netherlands should try to emulate the more successful Swedish policies towards venture capital in general. We suggest that governments can leverage public funds much more effectively in the Netherlands and Sweden by carefully considering real option aspects, information flows and the behavioural biases of consumers and investors.

5.1. Global outlook and looking ahead

Sweden and the Netherlands both take the EU 20-20-20 targets on energy transition seriously and have implemented a range of policies to help achieve these targets. A key element in both countries' strategies is to promote innovation and new venturing in the cleantech sector. Where the Netherlands is very vulnerable to climate change, with many areas at risk of sea level rise and flooding, Sweden will be more favourably affected, with positive growth effects on forestry and agriculture, as well as an increased potential for hydroelectric power. That slightly different perspective on the issue of energy transition might explain some of the differences in approaching the challenge. Still both countries seem well aware that energy transition is likely to be(come) serious business in the not too distant future and seem bent on capturing their share of the industry. As is typical for countries at the global technology frontier their strength is not in scaling up mature technologies and mass-producing, for example, solar panels and wind turbines. Emerging countries such as China and Brazil are taking over as the heavy investors where Europe and the US move into more profitable but smaller niche markets. To some market analysts the reason for this is policy uncertainty; the unclear direction of future policy and a withdrawal of support systems. We feel this is only partially true. There is no competing against the populous emerging economies when it comes to simple and mass manufacturing. Europe's comparative advantage is in developing and marketing more specialised, high value added products and services, and there are also plenty of gains to be made in the cleantech sectors in that niche. But Europe in general, and Sweden and the Netherlands, do need to act if they are to position themselves in this emerging market. To date too little has been done. In this report we have argued that this is due to a limited consideration of investment decision-making in the way policies are being designed and implemented. For example, when making investment decisions, how do investors frame the investment? Do investors consider the risk of climate change and stranded assets or do they compare the opportunities of green growth relative the opportunities of, for example, information technology? The former case is a negative scenario, whereas the latter is a positive scenario competing with another investment opportunity. With behavioural finance in mind, we know that framing is important. If investors motivate underinvestment in cleantech with financial arguments such as high up-front costs, no exit possibilities, long investment horizons, and high policy risk, other industries with similar problems, like the pharmaceutical industry, lack problems of underinvesting. It is possible that the framing explains such differences, which obviously has profound policy implications.

5.2. Future research

This report has taken an explorative and broad approach to the funding of green innovations with the implicit purpose of generating avenues for future research. We presented the current policies in place in a descriptive manner. A limitation of such an approach is that it is lacking a systematic evaluation of policy outcomes: do policies achieve their intended goals? In future research, it would be interesting to study policies in-depth and to follow their implementation and effect over time.

A second avenue for future research is to focus on the investment models of investors in financing high-technology green ventures and innovations. Although substantial parts of climate underinvestment have structural explanations, such as regulatory, technical and institutional barriers, understanding the investment decision process between the investor and the entrepreneur seems to be vital. This type of study would use interviews and surveys in order to derive findings by triangulation related to the process as such, but also to identify general patterns that can inform policymakers.

A third avenue for future research is to look at the innovation system of environmental technologies, in particular how actors in the innovation system engage (or not) in early stage innovation, especially at the stage where technologies pass through the "technology valley of death". In-depth understandings of the interaction patterns between actors and the impact of policy and external factors over time would increase our understanding of the innovation process, and the role of private and public actors.

A fourth avenue is to replicate the set-up in Sanders et al. (2014) who present three custom-made hypothetical cases of carbon capture and storage projects to relevant private sector decision makers. The business cases were explicitly constructed to incorporate important 'real options' characteristics to assess how investment decision makers respond. The purpose of such a study would be to identify key impediments to greentech investments and test these against the variables in real options theory, and behavioural economics would suggest they are important in triggering the investment decision.

Given the clear urgency for more effective policies in this field we aim to pursue these avenues in the shortest possible time.

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Appendix

Appendix 1

Bill/prop./strategy	Target	Means	Desired effects	Time/Budget (SEK)
Environmental technology Strategy- Overview	***A favorable environment for tech- development and its subsequent export.***	***Facilitating networks***	***Increased coordination and cooperation***	***2011-2014 / 400MKR***
Breakdown activity 1) Business Sweden	Building strategic clean-tech alliances between foreign investors and Swedish businesses	Identifying supply and demand and creating opportunities within clusters and industries. Regulatory and policy counseling.	Increased foreign VC and/or foreign R&D placement in Sweden	20MKR (N2011/5971/E)
Breakdown activity 2) Business Sweden	Lowering entry to new markets	Soft regulations and support-activities with the administration	Overcoming and bridging gaps for SMEs. Identify and create opportunities within companies, competences and ideas	40MKR (N2011/1448/E)
Business Sweden (nb footnote till activity 2)	Foreign delegations interested in Swedish clean tech (symbiocity-concept)	Activities arranged by ASSET (Swedish clean tech association), e.g. Mapping, workshops, follow-up, educational packages	Increased attractiveness for Sweden. Specifically increased interaction with foreign actors and Swedish clean tech industry/firms, statistics	1MKR/yr, i.e. 4MKR (within N2011/1448/E) see above
Symbiocity (nb footnote to activity 2)	Develop a comprehensive and national communications- platform	Communication Tools	Increased interaction, i.e marketing and promotion of Swedish clean-tech industry	1MKR/yr, i.e 4MKR (within N2011/1448/E, see above)
Breakdown activity 3) Business Sweden	Presenting Swedish clean tech	International conferences and expos.	Creating international awareness for Swedish clean tech	2,5MKR (N2012/518)
Breakdown activity 4) Energy Agency	Facilitating the convergence of and cooperation between cleantech actors	Promoting multi-lateral and/or bi-lateral interaction through the creation of meetingplaces between clean-tech actors, e.g. Innovators, entrepreneurs, customers, investors	Increasing the private investment-ratio in the clean tech sector	17,5MKR (N2011/6463/E)
Breakdown activity 5) Vinnova and the Energy Agency	A push for public buying being geared towards clean tech innovations	Mapping of e.g. networks, methods and demand-verifications	Increased ratio of clean-tech innovations as part of the public service-offering	30 MKR (N2012/2145/E)
Breakdown activity 6) Vinnova	Entity- and system-solutions, innovationsupport for sustainable city-development, and cleantech implementations in developing markets	Research and knowledge creation as well as bridgemaking activities to foster innovation platforms	Increased Swedish service offering including clean-tech and formalised partnerships between actors, e.g universities, firms, public institutions	65 MKR (N2011/5142/E)
Breakdown activity 7) Vinnova	Bridging the valley of death between publicly funded research and the private sector	Test-beds/demonstration plants	Contributing to improved prerequisites for tests, verifications, demonstrations, and scale-ups of clean tech innovations	36 MKR (N2012/3381/E)
Breakdown activity 8) Almi/Innovationsbron AB	Cultivate business development-support and financing for cleantech firms. Focus on internationalization considered	Utilizing incubators and their networks, e.g. Investors, in order to reach cleantech start-ups and subsequently enable them to go global (through STING & LEAD).	Making incubators more attractive for cleantech firms, to increase the inflow of innovations that are/can be commercialized	10 MKR (N2011/4387/E, N2011/5143/E)
Breakdown activity 9) Agency for Economic and Regional Growth	Sponsor entrepreneurial progress and regional advancements for international progress	Utilizing SMEs business networks at local, regional and national level. Simplify business processes and to boost maturation procedures	Increase established SMEs (8MKR turnover) ability to compete and do international business through knowledge accumulation	24 MKR (N2012/2523/E)
Breakdown activity 10) Agency for Economic and Regional Growth	Cleantech website	Cooperation with public and private actors to acquire relevant and useful information, e.g. Symbio-City	Publicize knowledge within the clean tech area and to promote knowledge sharing	3,5 MKR (N2012/5754/E)
Breakdown activity 11) Agency for Economic and Regional Growth	Facilitate EU applications for SMEs	Making information accessible and scanning for programs that have not yet been utilized	Increasing the amount as well as the quality of EU-applications	7MKR (N2011/6464/E)
Growth Analysis	Cleantech data	Statistical development based on Swentec's previous work	Definition of cleantech areas and the basis for analytics	1 MKR (N2011/3997/E)

Appendix 2

Policy Table							Venture						Actor				Network			
Country	Policy	Annual Budget	Goal	Method	Generic/Specific	Aimed at	NPV		Risk		ROV		INF		BEH		INF		BEH	
		EURO					Inv	Ent	Inv	Ent	Inv	Ent	Inv	Ent	Inv	Ent	Inv	Ent	Inv	Ent
NL	Stimulering Duurzame Energieproductie (SDE+)	2.4 €BN	promote renewable energy production	Fixed feed in tarif renewable sources	S	investors firms	+	+	+	+	+/-	+/-	0	0	0	0	0	0	0	0
NL	Energie Investerings Aftrek (EIA)	101 €M	promote investment in energy efficiency	Tax deductability energy efficiency investments from list	S	firms	0	+	0	+	0	+	0	0	0	0	0	0	0	0
NL	Milieu Investeringsaftrek (MIA)	open	Promote investment in environmental technologies	Tax deductability environmental investments from list	S	firms	0	+	0	+	0	+	0	0	0	0	0	0	0	0
NL	Vervroegde Afschrijving Milieuinvesteringen (VAMIL)	open	Promote investment in environmental capital assets	Accelerated depreciation environmental capital on list	S	firms	0	+	0	+	0	+	0	0	0	0	0	0	0	0
NL	Green deals program	none	Promote experimentation and private initiative	Reduce red tape and help realise projects	S	citizens firms	0	0	0	0	+	+	+	+	+	+	+	+	+	+
NL	Electric Vehicles	open	Promote adoption and use electric vehicles	Preferential tax treatment electric vehicles	S	citizens	0	+	0	0	0	+/-	0	0	0	+	0	0	0	0
NL	Innovatievouchers MKB	1.6 €M	Promote innovation in SMEs	SMEs can apply for a voucher that cofinances specific external R&D projects	G	SMEs	0	0	0	0	0	+	0	+	0	0	0	+	0	0
NL	Topsector Energie	50 €M	Fund research in energy	Tenders for collaborative pilots, lab research and R&D projects	S	firms knowledge institutes	0	0	0	0	0	+	0	0	0	0	+	+	0	0
NL	Energie Innovatie Catalogus	none	Make information on energy technology accessible	List and describe all government sponsored energy innovation projects	S	investors firms	0	0	0	0	0	0	+	+	0	0	+	+	0	0
NL	Wet Bevordering Speurwerk en Ontwikkeling (WBSO)	700 €M	Support research and development	Subsidize gross wage costs of R&D up to 38%	G	firms	0	0	0	0	0	+	0	+	0	0	0	0	0	0
NL	Research en Development Aftrek (RDA)	open	Support research and development	Allow tax deduction of R&D expenditures	G	firms	0	0	0	0	0	+	0	+	0	0	0	0	0	0
NL	Innovatiebox	open	Support innovation	Revenue on IP is taxed at lower rate	G	firms	0	+	0	0	0	+	0	+	0	0	0	0	0	0
NL	Innovatiefonds MKB+	125 €M	Support SME innovation	Provides innovation credit, seed capital and equity funding	G	firms	+	+	+	0	0	+	0	+	0	0	0	0	0	0
NL	Innovatiekrediet	80 €M	Revolving fund SME innovative projects	Provides loans for projects eligable for funding till budget runs out	G	firms	0	0	+	+	0	+/-	0	0	0	0	0	0	0	0
NL	MIT Biobased	270 €k	Open call for projects in prescribed program	Funds innovative projects in industry	S	firms knowledge institutes	0	0	+	+	0	+	0	0	0	0	0	0	0	0
NL	TKI Tender Wind op Zee	10 €M	Tender for specific projects	Funds predefined projects in offshore wind	S	firms knowledge institutes	+	+	+	+	+	+	+	+	0	0	0	0	0	0
NL	TKI Tender Gas	20 €M	Tender for specific projects	Funds predefined projects in gas	S	firms knowledge institutes	+	+	+	+	+	+	+	+	0	0	0	0	0	0
NL	TKI Tender Solar	11.7 €M	Tender for specific projects	Funds predefined projects in solar energy	S	firms knowledge institutes	+	+	+	+	+	+	+	+	0	0	0	0	0	0
NL	Certificeringsregeling Installateurs Duurzame Energie	unknown	Ensure quality of installation	Provide certificates of quality for installators of renewable energy technologies	S	firms	0	0	+	+	0	0	+	+	+	+	+	+	+	+
SE	NETS	2,3 €M	Increase foreign VC and/or foreign R&D placement in Sweden	Create opportunities within clusters and industries. Regulatory and policy counseling.	S	foreign and domestic firms and investors	0	0	0	0	0	0	+	+	0	0	+	+	0	0
SE	NETS	4,8 €M	Overcoming, bridging gaps for SMEs. Create opportunities. Promote & increase interaction for cleantech industry.	Soft regulation, support-activities, education, communications- platform, follow-ups	S	firms	0	0	0	0	0	0	+	+	0	0	+	+	0	0
SE	NETS	0,3 €M	Increased awareness for Swedish clean tech solutions.	International conferenses and expos	S	foreign and domestic firms	0	0	0	0	0	0	+	+	0	0	+	+	0	0
SE	NETS	2 €M	Boost the private investment-ratio in the clean tech sector	Promoting multi- and/or bilateral interaction. Creating meeting places	S	firms investors	0	0	0	0	0	0	+	+	0	0	+	+	0	0
SE	NETS	3,4 €M	Advance the clean-tech innovation-ratio in public procurement	Mapping of networks, methods and demands for purchasing-contracts	S	firms	+	+	+	+	+	+	+	+	0	0	0	0	0	0
SE	NETS	7,4 €M	Broaden the Swedish service offering, including clean tech. Formalize partnerships.	Research & knowledge creation. Bridgemaking activities to foster innovation platforms.	S	firms, knowledge institutes	0	0	0	0	0	0	+	+	0	0	+	+	0	0
SE	NETS	4,1 €M	Improving verifications, demo´s, and scale-up opportunities	Provide testbeds- and demonstration plants	S	firms, knowledge institutes	0	0	0	0	0	+	0	0	0	0	+	+	0	0
SE	NETS	1,1 €M	Promote incubators to commercialize more clean tech firms.	Utilizing networks to enable clean tech firms to go global	S	firms, investors, incubators	+	+	+	0	0	+	0	+	0	0	+	+	+	+
SE	NETS	2,7 €M	Promote international entrepreneurial progress for established SMEs	Utilizing business networks. Simplify and boost maturity process	S	firms	0	0	0	0	+	+	+	+	+	+	+	+	+	+
SE	NETS	0,4 €M	Promote knowledge sharing within clean tech	Aquire information to form a clean tech website	S	investors firms	0	0	0	0	0	0	+	+	0	0	+	+	0	0
SE	NETS	0,8 €M	Increase amount, quality of EU-applications	Scanning for non-utilized programs, make them available	S	firms	0	0	0	0	0	0	+	+	0	0	+	+	0	0
SE	NETS	0,1 €M	Define clean tech for statistics and analytics	Statistical development	S	firms, investors	0	0	0	0	0	0	+	+	0	0	+	+	0	0
SE	Vehicle tax	open	Promote energy efficient vehicles	Tax exemptions for biofuels	G	firms consumers	0	+	0	0	0	+/-	0	0	0	+	0	0	0	0
SE	Low-carbon car bonus	11 €M	Promote energy efficient vehicles	Subsidies for low carbon vehicles	S	consumers	0	+	0	0	0	+/-	0	0	0	+	0	0	0	0
SE	Green electricity certificate system	none	Increase the share of renewable energy	Distributers obliged to buy certificates from renewable energy producers	G	firms	+	+	+	+	+/-	+/-	0	0	0	0	0	0	0	0

In September 2013 IPCC reconfirmed that limiting climate change will require substantial and sustained reductions of greenhouse gas emissions. The transition to a low-carbon society at reasonable costs will not be possible without technological change. Society needs to develop and introduce new technologies and see a rapid deployment of existing solutions. The required investments are massive, clearly orders of magnitude beyond what heavily indebted nation states and budget constrained international pubic entities could mobilize. Private capital investments are hence essential.

Besides the relevance for climate change, there are also commercial opportunities in a green transition. In the aftermath of the global financial crisis, improving industrial competitiveness and growth prospects is high on the European agenda. During 2012 a dramatic shift in the balance of renewable energy investments worldwide occurred, with the centre for clean energy investment shifting from West to East. China passed the US as the major clean energy investor and the EU is in the process of losing the high ground it previously had.

Regardless if the perspective is green growth or climate change, the public debates in the EU member states are sparse or overly focused on governmental funds that clearly are too limited to meet the long-term financing needs. Research show that entrepreneurs and small, new firms are important drivers of economic development and innovative processes. It is also well known from the literature that the single most prominent obstacle to entrepreneurial venturing is finance. To make effective policies to mobilize and leverage private funding for green tech innovation it is important to understand entrepreneurial investment decisions and to look at policies from the perspective of the investor and entrepreneur respectively. This ELF project studies private investment in green venturing, linking theory, empirics and policy and concluding by suggesting future research.

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