Global Vision

Emergence of the Clean Technologies Sector in the Baltic Sea Region – Executive summary

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Enabling a Global Vision for the Baltic cleantech industry

Environmental issues and clean technologies

Environmental issues in general, and the climate challenge in particular, have recently become one, if not the, leading issue in the public and private debate.[1] There is much focus on clean technologies (cleantech), which refers to environmentally friendly technologies that represent a diverse range of products, processes and services intended to reduce or eliminate pollution and waste while at the same time improving the effective and responsible use of natural resources. Clean technology comprises of a number of sub-fields like energy technologies, biofuels, material technologies, water purification, waste management, ambient air protection, information and communication technologies related to environmental protection, environmental equipment, green construction, renewable energy and green services. Most clean technologies are technologies that are both new and quite advanced.

The clean technology industry is generally regarded as an arena where business interests and environmental awareness can meet through a mutually strengthening partnership. The purpose of this complementarity is to create sustainable economic growth by making and facilitating investments into new products, services and processes that can generate increased turnover, value-added, employment and exports for the industry. At the same time there are benefits to the environment through reductions in the depletion of finite natural resources, pollution and waste on a national and international level.

Policy makers at a global level, but increasingly also in the Nordic countries and in the Baltic area, have understood the importance of the clean technology field and are developing and implementing policies to support the development of environmental technologies for use and also enhancing the competiveness of the sector. However, the clean technology sector in these countries is dominated by small and medium-sized companies (SMEs) active in local markets, whereas the future growth potential is highest in international markets.

The project and methodology

In light of the above, the initiation of the research and training project, Global Vision, had the aim to analyse barriers for business/economic growth through a transregional project with the focus on assessing existing policies, developing tools and approaches, as well as developing new structures and processes, for supporting the growth of the clean technology industry in the Central Baltic area. The following countries and regions are included: Sweden (covering regions of Stockholm, Örebro, Östergötland, Uppsala, Gävleborg, Södermanland, Västmanland), Estonia and Latvia. The project runs from 2011–2013.[2]

More specifically, the project addresses the challenges faced by SMEs that produce technological innovations in the field of clean technologies in reaching global markets with their products and services. By connecting clean technology firms in regions covered (in this study) and by actively promoting co-operation amongst companies, the project aims to make further specialization possible and simultaneously enable the SMEs to take on larger contracts abroad. The project also aims at improving public policies in the field of clean technologies.

The project is divided into three broad steps or phases. The first step consists of an analysis of existing firms and policies and the actual resource demand with the aim of providing a roadmap for strengthening sector's internationalisation activities and/or exports. The second step involves the development and delivery of tailor-made training materials and programmes for SMEs as well as transregional match-making activities for both regional decision-makers and SMEs. The third step consists of the assessment of existing regional relationships and networks with a view to developing a joint transregional model for utilising such contacts for sales activities for the development of the clean technology industry.

The current report is the culmination of the first step of the Global Vision Project, and provides an analysis of regional clean technology industries and their global market reach, and policy initiatives. The report is largely based on interviews with 95 companies in Sweden, Estonia and Latvia. The methodology deployed included mostly face to face interviews, an in-depth study of these interviews along with other company information and annual business reports. Also used were available statistical databases (however data was rather more limited for Estonia and Latvia) and expert workshops. The analytical framework applied in the present study generally followed the model developed by the National Research Council of Canada for the analysis of clusters with some aspects adapted by the authors specifically for the analysis of the clean technology sector.

The analysis covers the economic, social and policy context – including human resources, infrastructure, business climate, support measures, related industries (called current conditions) – as well as the characteristics and dynamics of the clean technology companies (current performance; covering aspects like the nature of clean technology companies, interaction with other stakeholders and internationalization). Each country chapter concludes with a synthesis of strengths, weaknesses, opportunities and threats, as well as related policy recommendations.

On-site visits – like here at Svensk Biogas – and face to face interviews were important parts of the research method in the cleantech cluster study.
Photo: Per Frankelius.

Clean technology sectors and clean technology developers in Sweden, Latvia and Estonia

Sweden

There are 6,530 clean technology companies active in Sweden according to the Swentec database (2009). More than 40% of these companies are related to the sub-field waste management and recycling. About 15% are developing, producing and/or selling technologies for sustainable building and energy efficiency. Other main technology sub-fields engaged in by these companies includes consulting services (15%), water treatment (7%) and bioenergy and biofuels (7%).

For the current research, clean technology developers from seven Swedish counties covered by the project were identified (see the result list below the "Filter" in Figure 1).

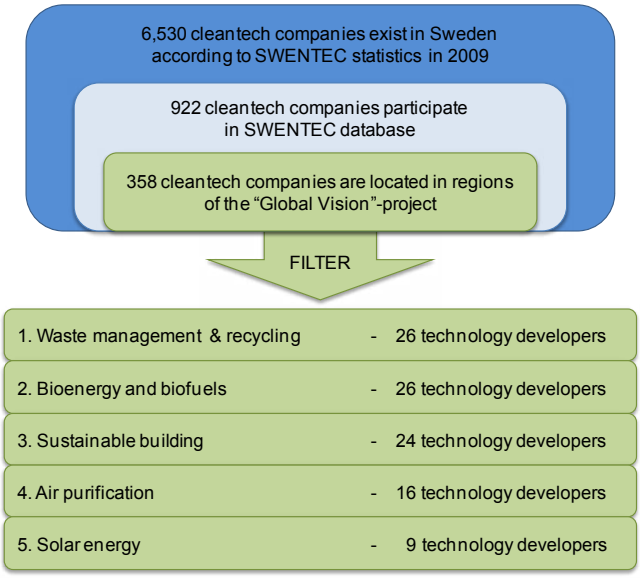

Figure 1: Selection of clean technology developers in Sweden
Source: Authors.

Fifty percent of the clean technology developers identified are located in Stockholm County, other main locations are Östergötland County as well as the counties of Södermanland and Gävleborg (Figure 2). The companies analysed from Sweden altogether employed 13,860 persons in 2009, corresponding to 33% of all persons employed by Swedish clean technology companies.

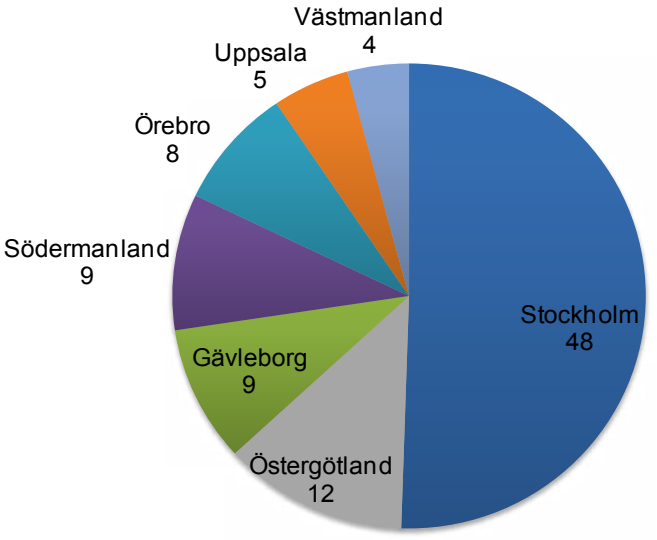

Figure 2: Geographical distribution of regional clean technology companies
Source: Swentec database 2011.

The importance of the regions analysed was also evident by the review of patenting activity. Patents filed by Swedish applicants to the European Patent Office (EPO) indicates that technologies related to pollution abatement and waste management represented most of the patents between 2003 and 2007. 55% of Swedish clean technology patents filed in 2007 have their origin in the concerned regions, and this was slightly higher than the 51% for the period 2003 and 2007 (Figure 3).

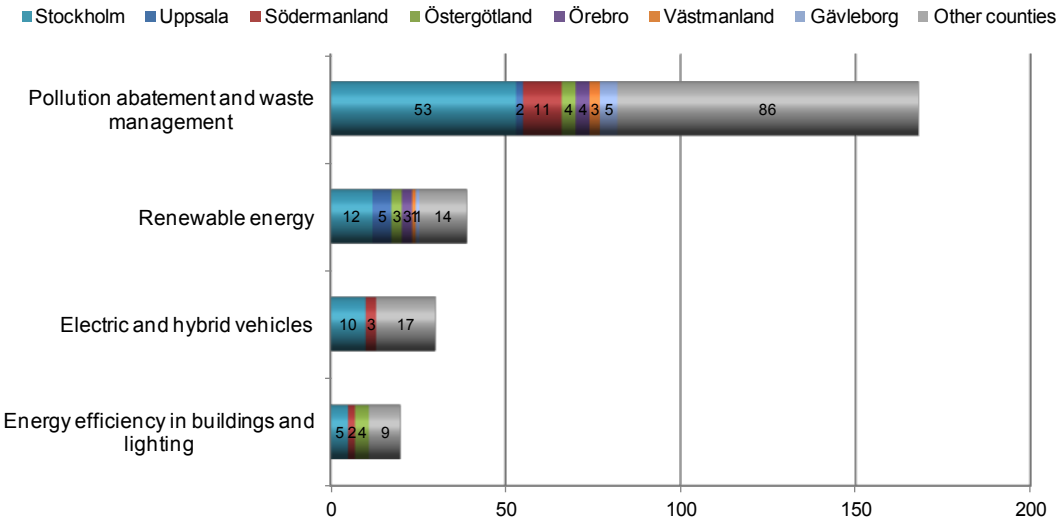

Figure 3: Total patents filed to EPO between 2003 and 2007
Source: OECD 2011.

Estonia

Compared to Sweden, the clean technology sector in Estonia was much smaller. The number of companies that could be related with environmental technologies was approximately 200 to 300, according to some studies. These companies were active in sub-fields like energy technologies, biofuels, material technologies, waste management, water and ambient air protection, green construction, clean technology consulting, environmental research equipment as well as information and communication technologies (ICT).

However, the majority of these companies comprised resellers or representatives of foreign clean technology enterprises or technology users. For the purposes of the current study, 36 clean technology developers were identified. These were the companies in Estonia that were relatively active in the development of new environmentally friendly solutions in the field of clean technologies. Over one third are developing energy technologies (wind turbines, semiconductors, photovoltaics, ultracapacitors, fuel cells, electrical and power engineering, and heat exchangers); the other larger segments are biofuels and clean technology

related ICTs (Figure 4). The 36 clean technology developers that were analysed from Estonia employed altogether 911 persons in 2009.

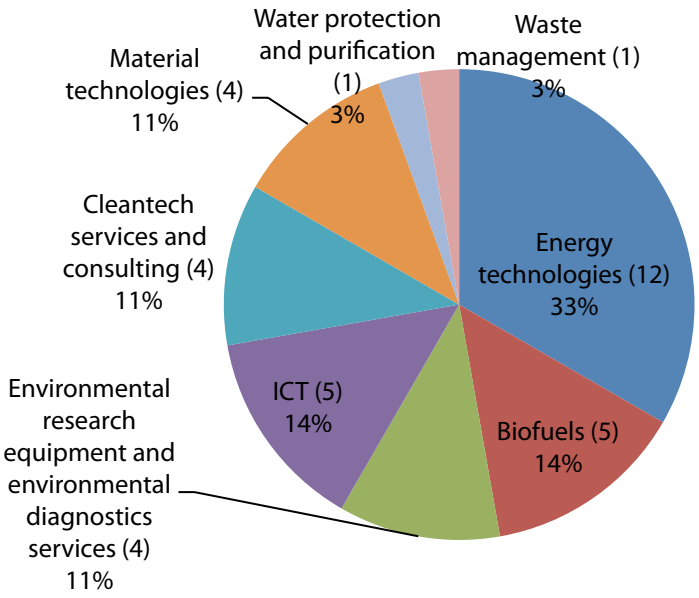

Figure 4: Clean technology developers in Estonia
Source: Authors.

Latvia

The Latvian clean technologies sector was more comparable to Estonia rather than of Sweden. 58 clean technology enterprises were identified for purposes of the current study, although this figure may be susceptible to possible overestimation as the count may include more than just technology developers. The 58 companies analysed from Latvia employed a total of 1,240 persons in 2009.

Emergence of the clean technology clusters

Five clean technology clusters were found in the Swedish regions covered by the study. The map below (Figure 5) illustrates clean technology clusters in the fields of 1) waste management and recycling, 2) bioenergy and biofuels, 3) sustainable building, 4) air purification, and 5) solar energy.

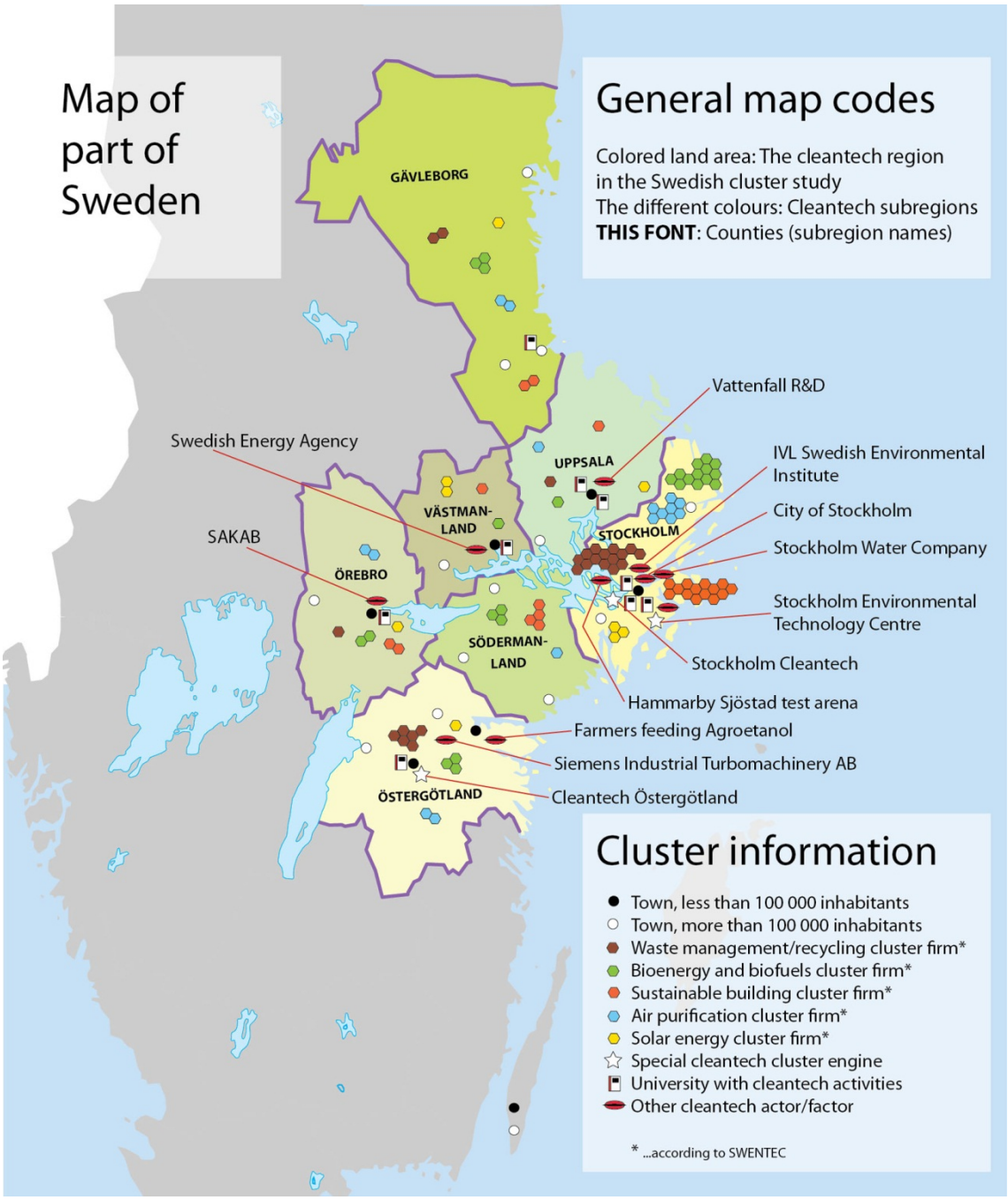

Figure 5: Clean technology cluster and sub-clusters in the region included
Source: Authors.

In Estonia, the majority of clean technology companies develop energy technologies, clean technology related ICTs and biofuels. In Latvia the emerging clusters were in the fields of environmental protection, green services and renewable energies.

Clean technology developers in Sweden, Latvia and Estonia

Company establishment and size

Clean technology developers were the subject of the analysis related here. They tended to be rather young companies. Nearly 60% of the Swedish regional companies analysed were founded in or after 1990. Of the 36 Estonian clean technology developers, 21 companies were founded between 2000 and 2010. Also in Latvia, the founding of new enterprises as well as the activities of the already established enterprises became more active following 2003. This may be attributable to Latvia's accession to the EU and the consequent accessibility of new financial support measures in environmental protection and other fields of clean technology.

In all three countries, the majority of the clean technology companies were micro companies, i.e. employed up to ten employees. Clean technology developers with the largest number of employees in the regions analysed were found in Sweden: YIT Sverige AB (4,578 employees [2009] in Sweden) and Munters AB (4,087 employees, both Stockholm County), as well as Systemair AB in Västmanland County (2,013 employees), but also Camfil Svenska AB in Södermanland County (316 employees), Econova AB in Östergötland (256 employees) and BooForssjö AB in Södermanland (210 employees).

Even the largest clean technology related companies from Estonia – Konesko (312 employees in 2009), Graanul Invest (131 employees) and Estiko-Plastar (128 employees) were rather small in international terms, and of the 36 companies analysed 23 had less than 10 employees. This was also true for Latvia where the field was dominated by micro- and small-enterprises. Only five of the enterprises in Latvia were medium sized enterprises.

Financial characteristics

In 2009, the turnover of the Swedish clean technology companies reached SEK 119.3 billion (EUR 11.2 billion), of which SEK 44 billion (EUR 4.1 billion) was in the counties covered in the project and SEK 25.3 billion (EUR 2.4 billion) in the 93 companies identified through the Swentec database. On the national level, companies active in waste management and recycling together with companies active in sustainable building and energy efficiency generated 50% of the national turnover from clean technologies. Furthermore, one fourth of the turnover was generated by technologies related to bio-, solar-, wind- and water-energy.

For Estonia the net sales volume of the 36 companies studied amounted to EUR 124 million in 2009. Almost 50% came from biofuels (mainly due to one large company, Graanul Invest) and 30% from energy technologies which was the largest Estonian clean technology sub-sector.

For Latvia the turnover of 58 clean technology enterprises totalled EUR 211 million (2009) and the renewable energy group had the highest turnover with EUR 157 million.

Total assets of the 93 regional clean technology companies in Sweden amounted to SEK 17.8 billion (EUR 1.7 billion) in 2009 and reflected the size structure. More than 50% of the companies had total assets of less than SEK 25 million (EUR 2.4 million), nearly 30% had even less than SEK 5 million (EUR 0.5 million). Total assets of the Estonian clean technology companies amounted to EUR 107 million (2009).

Of the 93 Swedish companies analysed, 60% produced a profit from their operating activities in 2009 (total profits amounted to EUR 108.5 million). Most companies which operated in the clean technology sub-fields, namely waste management and recycling, sustainable building, and air purification were successful and their results indicated profits at the financial year end. Most businesses that sustained a loss in 2009 were in the sub-field, bioenergy and biofuels. The total profit of the Estonian clean technology developers amounted to EUR 5.3 million (2009).

The financial results of companies in Estonia and Latvia, in particular, revealed a high degree of stratification. In other words, there were some successful companies according to financial results but a majority of enterprises evidenced rather poor financial performance. But this should be treated with some caution as these firms were mostly, at that point, in the technology development stages.

Exports

In Sweden, one in four clean technology companies exported its products or services to other countries in 2009. Total exports of clean technologies reached SEK 38.9 billion (EUR 3.6 billion), an increase of SEK 18.8 billion (EUR 1.8 billion) or 94% since 2003 (Figure 6) showing the increased competitiveness of Swedish companies in the international market.

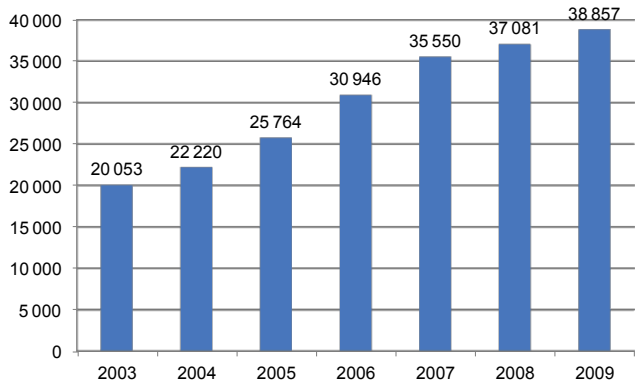

Figure 6: Export of Swedish clean technology companies 2003–2009 (in million SEK)
Source: Swentec 2010.

The sub-fields waste management and recycling had the highest total export value between 2007 and 2009 for Sweden (Figure 7). This accounted for nearly one fourth of the national clean technology exports in 2009. However, as this sub-field also consists of the largest number of clean technology companies (2,764 companies) the high share of clean technology exports was not surprising. In contrast, exports have in recent years also reached a relatively high level for two smaller sub-fields in terms of enterprises engaged, namely sustainable building and energy efficiency (956 companies), and solar, wind and water energy (504 companies). For both clean technology sub-fields, a steady increase of exports had been noted since 2007. Companies with a business related to solar, wind and/or water energy increased their exports by 60% between 2007 and 2009, while the number of employees increased during these years from 2,327 to 2,766.

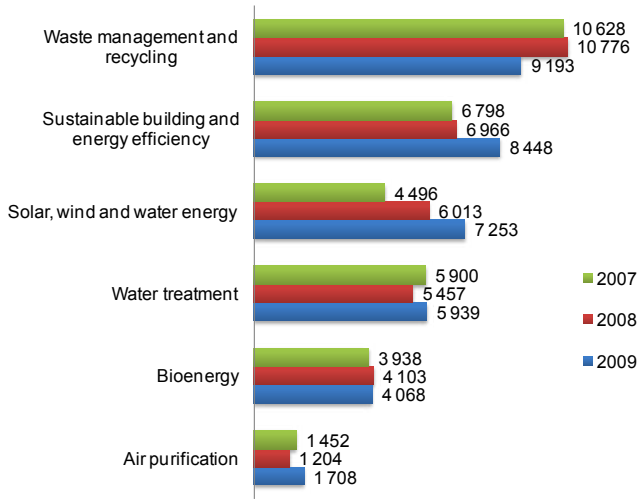

Figure 7: Swedish clean technology companies' export by technology area (in million SEK)
Sources: Swentec 2009; Swentec 2010.

In Estonia, total exports amounted to EUR 124 million (2009) and this trade was dominated by few companies. Out of the 36 companies analysed 16 companies exported their products. Graanul Invest, Konesko, Balti Kaubad ja Teenused and Airel were the export leaders, although Konesko was in the process of developing its wind turbines and as yet had not exported any cleantech products. Graanul Invest exported all its production while Konesko had only a tiny part for domestic consumption. This indicates that export markets were very important for the Estonian clean technology companies (Figure 8).

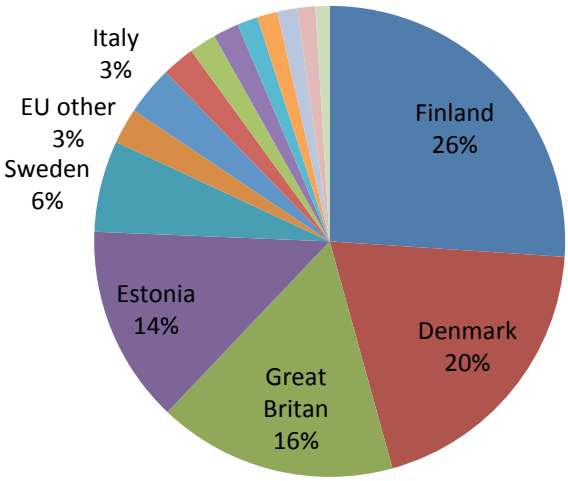

Figure 8: Sales in Estonia and exports of clean technology developers, 2009[1]
Source: Authors.

In Latvia, total exports amounted to EUR 192.4 million (2009). Exports were highest in green services and renewable energies (Figure 9). The relatively large export percentage of the green services segment was due to the activities of one company, Primekss Ltd.

[1]Only destinations with export volume over EUR 1 million are presented.

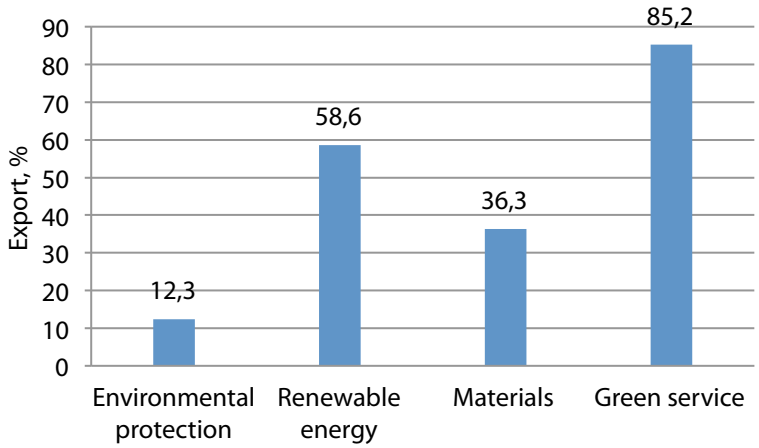

Figure 9: Export share of clean technology enterprise export in different clean technology groups

Source: Authors based on interviews.

The major export destinations of the Swedish clean technology companies are European countries, but also China and the USA. European export destinations that were among the top ten export markets together amounted for 50% (SEK 19.6 billion, or EUR 1.8 billion) of the total clean technology export in 2009. Germany was by far the largest export market for Sweden with regard to clean technologies. In addition, all three Nordic countries sharing a border with Sweden (namely Norway, Denmark, and Finland) were important export destinations accounting for nearly 20% of the total clean technology exports.

For the Estonian clean technology developers, the biggest export revenues were from Finland (EUR 136 million in total; 2007–2009), Denmark (EUR 61 million), Great Britain (EUR 25 million), Sweden (EUR 14 million), Spain (EUR 11 million), France (EUR 11 million), Russia, and Latvia (EUR 7 million). In the period 2007–2009, the exports to the EU totalled EUR 356 million and outside the EU EUR 18 million. Outside the EU the biggest export destinations were Russia (EUR 8 million), China (EUR 2.6 million) and Belarus (EUR 1.6 million). For Latvia also, the European Union countries were largely the major export destination.

Supply of human resources in the field of clean technologies

The regions analysed host some of the major universities that offered programs related to clean technologies and thus serviced the needs of companies in the sector with qualified personnel. In Sweden the most important universities were

University of Gävle, Uppsala University, Swedish University of Agricultural Sciences (SLU), Stockholm University, Royal Institute of Technology (KTH), Mälardalen University, Södertörn University, Örebro University and Linköping University. In total, approximately 3,100 students were attending programs and courses related to clean technologies in autumn 2010.

In Estonia, there were six higher education institutions that offer altogether 65 curricula associated with environmental technology and clean technologies. Next to the key universities – Tallinn University of Technology and University of Tartu – there were also other institutions, namely the Estonian University of Life Sciences, Euroacademy, Tallinn University, and University of Applied Sciences that host such programs and courses. The number of graduates at the bachelor and master level was between 800 and 900 annually (2007–2011).

In Latvia, seven higher education institutions have study programs related to clean technologies, namely the University of Latvia, Liepaja University, Daugavpils University, Mechanics and Technology College of Olaine, Rezekne Higher Education Institution, Riga Technical University and Latvia University of Agriculture. The number of graduates at the BA and master's level in the related programmes had been between 219 and 268 annually for the period 2007 to 2011.

Government policies and instruments, and support organisations

Government support to clean technologies was most visible in Sweden. A Research Strategy for Environmental Technology was approved by the Government in 2007. The strategy highlights research and development of environmental technologies in six research areas, namely sustainable planning, sustainable transport, environmental protection technology, biological resources, ease and advanced materials, and energy.

Furthermore, there exists an action plan for the Swedish clean technology sector (2010) which was prepared by Swentec on behalf of the state. The Action Plan indicates a focus on five strategic areas: political management, skills for sustainable development, commercialization, business models and partnerships. The action plan includes 82 concrete measures in these areas.

Swedish efforts include the government's national initiative providing SEK 560 million (EUR 52.6 million) for support measures between 2007 and 2010 in the field of clean technologies. For the period 2011–2014, an additional SEK 400 million (EUR 37.6 million) was allocated for the promotion of development and export of environmental technologies.

There are numerous national initiatives and funding programs, e.g. "SymbioCity", "DemoEnvironment", and "ProEnviro". In addition to governmental

initiatives, the regional clean technology sectors are supported in Sweden by a number of private cluster organizations and networks, including the network ”Sustainable Business Mälardalen”, Stockholm Environmental Technology Centre (SMTC), and Cleantech Östergötland .

In Estonia, two strategic documents relate to clean technologies on the general level – Estonian National Strategy on Sustainable Development ”Sustainable Estonia 21” – and the Estonian Environmental Strategy. The most important document guiding R&D and innovation is the Estonian R&D and Innovation Strategy 2007–2013 “Knowledge-based Estonia”. The strategy identifies three key technologies for Estonia: 1) information and communication technology, 2) biotechnology and 3) material technology. Although some clean technology related prioritization can be found in those strategies, there were no extensive and specific support instruments dedicated to the development of clean technologies in Estonia. While R&D and innovation support organisations were well established in Estonia, there are not specific measures dedicated to clean technologies. However, over the last few years a number of associations and umbrella organisations related to various sub-fields of clean technologies have emerged.

For Latvia, the key policy documents were the National Development Plan 2007–2013 and the National Environmental Policy Plan 2004–2008. Similar to Estonia, there existed no specific support instruments for the development of clean technologies. The government support for enterprises in Latvia was mostly implemented through the Investment and Development Agency of Latvia (IDAL). In the provision of support to new products and technologies and support to the centres of competence and excellence, there were some support measures, similar to those found in Estonia, for clean technologies in Latvia. Another similarity with Estonia was the existence of a number of professional associations in the field of clean technology.

Cooperation between industry and academia

Co-operation between industry and academia was most developed in Sweden. There are regional centres of excellence in the field of clean technologies, e.g. “Svenskt VattenkraftCentrum”, Centre for Molecular Devices and the Centre for Renewable Electric Energy Conversion. A majority of the companies interviewed had cooperated with research institutions with the objective of developing clean technologies. A majority of the interviewed companies claimed a moderate or significant contribution of academic and other research organizations in the development of clean technologies. The perception of several companies was that academic participation in clean technology related projects was high. Universities were seen as excellent in various specialized research fields and companies found it important to develop personal contacts with researchers engaged in projects.

Interaction with individual researchers was seen as critical. Moreover, company representatives requested a larger focus on knowledge about commercialization of technological products.

For Estonia, the companies' representatives interviewed were familiar mainly with the activities of universities from which they had graduated, where their employees were studying, or with whom they have had some co-operation linkages. A few very active science groups at the leading universities in the field of clean technologies (photo voltages, fuel cells, passive houses) that also work closely together with certain companies exist.

The most common and relevant problems mentioned by the clean technology entrepreneurs during the interviews were that the gaps between the science (undertaken at universities) and entrepreneurship were too wide, universities were not sufficiently cooperative and also frequently made extensive requests for funds in lieu of co-operation. Some companies mentioned that quite often different departments within universities competed with each other and were not working together. Additionally the intellectual property (IP) terms and conditions were seen as restrictive and impeded co-operation between universities and enterprises, even to the extent where foreign universities were believed to be more pragmatic and open to co-operation. Some companies also claimed that the prevailing system did not facilitate co-operation between universities and entrepreneurs, the former were used only for on short-term and project basis.

Approximately half of the company representatives in Latvia confirmed that the collaboration with academic or other research institutions often used state support through grant programmes. At the present, nine grants were related to the clean technology industry. In addition, research institutions carried out projects under various national programmes launched by ministries, EU funded projects and contract research for private companies.

Co-operation with other stakeholders

Co-operation amongst companies with the goal of developing clean technologies was more evident in Sweden than in Estonia and Latvia. In Sweden more than two thirds of the companies were involved in such co-operation at the national level. The main co-operation partners are ClimateWell AB, Solarus Solkraft i Roslagen AB, Chemrec AB, Munters AB, Seabased AB, SkyCab AB and HiNation AB. Most companies have enjoyed extensive interaction with other players in the clean technology field. Moreover the interactions were not limited only to companies in their interactions, around half of the interviewed companies also had links with universities and research organisations.

Such interactions were increasingly evident in Estonia as well. All of the interviewed companies were cooperating with other organizations with an objective to

develop clean technologies, but only the very active clean technology developers were related to international networks. However, there were limits to domestic co-operation as competencies sought were sometimes not available within the local R&D and innovation system.

Over half of the cleantech companies in Latvia indicated interactions with government organizations. Most of the clean technology companies were also members of respective professional associations. Partnership between companies was perceived positively and industry players did attempt co-operation. At the same time, partnerships were typically based on short-term contracts and may not in the long run provide substantial benefits to businesses to strengthen their competitiveness.

Perceived development problems

Business development capabilities

All of the interviewed companies from the three countries emphasized the importance of specific competencies (namely technical, marketing and business competence) for success in the clean technologies market. According to them it was essential to develop an appropriate mix of these three competencies to achieve good market performance. Furthermore, experiential and practical competence was seen as valuable but also formal education in specific technical areas. In Sweden, more than the half of the companies interviewed claimed that these capabilities were apparent in their companies. A smaller share stated that these capabilities were partly manifested. Such competences were less present in the Estonian and Latvia companies.

Problems related to exports

In all of the countries concerned, interviewees pointed out the most crucial barriers to exports of their products and services related to customer relations, laws and regulations (in destination countries), and customer contact problems. Deeper discussion of these issues revealed, however, the need for further strengthening of strategic business competences in the companies interviewed. Business competences might be as hard to build up as technical competences.

In Sweden quite many companies pointed at problems with “customer value” as one of the top three problems. That can be interpreted that some companies lacked state of the art product offerings. Many companies pointed at “contact

problems" and on "customer relations". It is obvious from this study that relationship management is crucial for exporting clean technology.

Regarding the problems identified concerning laws and regulations as a main challenge to international expansion, it was not possible to reveal, whether the problem concerned laws and regulation per sè or the companies' ability to access and use information about such laws and regulations.

For the Estonian companies the issue of trust and recognition came up as well since Estonia was a small state and rather unknown to the world.

Problems related to financing

The majority of the clean technology companies interviewed planned major investments in R&D, production and market expansion. In Sweden and Estonia many companies claimed that they already had made significant investments in R&D and were currently planning and taking measures for development of production as well as market expansion. This also shows that the majority of the companies interviewed were focused on foreign markets and thus needed to have good strategies for success in these ventures. However, and this is common to all regions, the companies were generally not able to finance such strategic investments by means of their own capital.

The venture capital market in Sweden was considered well developed and some of the best practice cases showed how public support measures could enhance private investments in the clean technology sector.

In Sweden, venture capital for clean technology companies was provided by both private and public funds that either had a very strong clean technology focus or were specialised in a small number of sectors. Five major funds were identified as being officially specialised in clean technology investments, namely: Sustainable Technologies Fund, IKEA GreenTech, Volvo Technology Transfer, Alder Fund, and Midroc New Technology. IKEA GreenTech and Volvo Technology Transfer, in particular, intended to support companies developing or producing technologies or services which may be of future interest for businesses within their company groups.

The analyses of these funds' investments in recent years shows that most of the investments in clean technology companies took place in 2006 or later. Further, it became clear that several funds aimed to act as co-owners. This was particularly true for the public funds like Industrifonden and Fouriertransform. Clean technology companies that were attractive for a number of VC funds and included for example Chemrec, Powercell Sweden, Effpower, and El-forest. Areas of particular importance have been energy efficiency, renewable energy generation, and biofuels.

Due to increasing public awareness of the need for clean technologies as well as Sweden's reputation as a clean technology innovation centre, several new capi-

tal venture funds have been created in Sweden in recent years with clean technology as the major investment area. At present, the Swedish Private Equity & Venture Capital Association (SVCA) comprised 40 member organisations investing in businesses related to clean technologies. While venture investments in clean technology companies reached SEK 775 million (EUR 72.8 million) its highest level since 2006, investments showed a decreasing trend in the subsequent years. In 2010, the SVCA's member organisations conducted 66 venture investments in Swedish clean technology companies corresponding to an investment amount of SEK 512 million (EUR 48.1 million).

The circumstances regarding financing prevailing in Sweden was once again quite different from Estonian and Latvian situation. The Estonian venture capital sector was considered to be in formative stages of development. In 2007 the overall volume of venture capital investments in Estonia was EUR 36 million. In 2008 and 2009 the amount of investments invested into Estonian companies decreased drastically, from EUR 15 to 5 million, respectively. The Estonian Private Equity and Venture Capital Association (EstVCA) currently had 16 members who have also invested into clean technology companies. The most active investor in clean technologies was the Estonian Development Fund.

In Latvia, venture capital company Eko investors has been most active in the field of clean technologies. Currently two venture capital funds – BaltCap Management and Imprimatur Capital Baltics – are operating investment programmes.

In Sweden the companies did not state that there was lack of capital on the venture-capital market or other capital markets. However, they argued that it was very difficult and time-consuming to attract capital investments. The main problems, according to the companies, were not the products, technologies or business models in the companies. Rather the problems were related to communicating information about the products, technologies and not least the business models, and the need for the right contacts. The availability of capital generally, and venture capital more specifically, was much more limited in Estonia and Latvia. Further in these two countries the business model development and its communication remained an issue.

Clean technologies related strengths and weaknesses in Sweden, Estonia and Latvia

Strengths

The particular strengths of the Swedish clean technology sector related to human resources and community support.

There were well functioning **higher education institutions** in the relevant regions in Sweden that addressed the sector's future demand for qualified personnel. A range of courses and studies that were demanded by clean technology companies were on offer. Examples of Master's programmes specific to clean technology specific includes "Environmental Science" (Stockholm University), "Sustainable Technology" (Royal Institute of Technology), and "Energy and Environmental Engineering" (Linköping University). More than half of the companies interviewed claimed to have had sufficient access to qualified personnel. However further research is needed as the same companies indicated the need for personnel with more business knowledge and the above educational programs mostly were technology-oriented.

One of the strengths regarding clean technology in Estonia and Latvia lay also in local universities that have strong technical, engineering, chemistry, physics, etc. base which was essential for clean technology development. The relevant companies were satisfied with the overall availability of skilled workforce and held the opinion that there were enough clean technology related programmes at universities.

One of the strengths of the Swedish clean technology sector was related to the comprehensive **community support system.** Examples here include the Swedish government's national initiative providing SEK 560 million (EUR 52.6 million) for support measures between 2007 and 2010 in the field of clean technologies. For the period 2011–2014, an additional SEK 400 million (EUR 37.6 million) was allocated for the promotion of development and export of environmental technologies. Examples of government programmes supporting clean technology companies include "Green Nano", which promotes research on nanotechnologies for a better environment, and "DemoEnvironment" which promotes the testing of new environmental technologies. Moreover, special initiatives were conducted in order to promote the export of Swedish clean technology to Asia (i.e. India and China). An example of this was the establishment of the Centre for Environmental Technology (CENTEC) in China. On a regional level, five community support organizations were of particular importance for the clean technology sector's development. Here examples were the Stockholm Environmental Technology Centre (SMTC), Cleantech Östergötland and the network "Sustainable Business Mälardalen".

Again, the Swedish experience was rather different from Estonia and Latvia where such large-scale and clean technology specific support programmes and instruments were lacking. Still, public awareness about the relevance and possibilities of "being green" and developing clean technologies had been increasing in Estonia over the last years as indicated by the thematic conferences that have been organized, cluster initiatives which have been started, community support organizations that were in the process of being established, green public procurement was increasingly discussed, etc. Such developments were largely directed by EU policies and guidelines, as well as co-funded by the Cohesion Fund measures.

One of the overall strengths was that **various clean technology sub-fields** were developing in the regions covered. Sweden was the most advanced with the following existing clusters which were being developed further: waste management and recycling, bioenergy and biofuels, sustainable building, air purification and solar energy. In Estonia, a variety of clean technology sub-fields were represented and were being developed and the largest sub-fields were energy technologies and clean technology related ICTs. For Latvia renewable energies posted the most significant growth. Especially in these specific fields there was also co-operation at national level (including between the academic and industrial sectors) and internationally, expressed both by the exports of the companies as well as their participation in global innovation networks.

Weaknesses

One of the weaknesses regarding the clean technologies sector in all countries was related to **lack of integration of business courses** in clean technology related education. That is, in order to successfully start and drive a clean technology company, specific knowledge about both business administration as well as business development were needed. It was thus seen as a weakness that business-related topics such as marketing were not a major part of studies in the clean technology field. Although a lot of technology development goes on in the companies, this could be much better integrated to business models (i.e., how to profit from the technologies) and business development, and also in communicating these.

Companies in all regions experienced problems with the **acquisition of funds**. This was expressed by the companies interviewed and was regarded as the most serious issue for Estonia. Problems were related to heavy administrative burden, lack of support schemes for some stages of R&D and product development, and the limited presence of the (clean technology specific) venture capital, although this partially could be related to lack of skills in linking the technology to the firm's business model.

Although co-operation between the industry and academia existed in all the countries, the **contribution of academic and other research organizations** to private sector development could be enhanced significantly. In Sweden it was desirable that those academic organisations became more active in commercialization of knowledge as well in patenting activity in the field of clean technologies. In Estonia and Latvia there was also the expectation that universities would offer more services to companies instead of basic research and the production of high-level publications.

In all the regions covered clean technology companies perceived considerable **barriers to exporting and marketing** their products and services. Companies in Sweden, Estonia and Latvia experienced difficulties in finding and contacting customers and building up a long-term relationships with them. In addition, laws and regulations in export markets were seen as a major export and marketing barrier. A more specific aspect related to Estonia was the issue of trust and recognition. The country is small and relatively unknown and this makes successful entrance to other markets even more difficult.

Policy recommendations

The interviews and analysis carried out have led to some of the following ideas about the improvement of policies and undertaking joint actions. These are preliminary policy recommendations and need further analysis and interrogation before being used as a guideline in practice.

Firstly, there was lack of integration of business courses into the clean technology related education curriculum. That is, in order to successfully start and drive a clean technology company, **more knowledge in business administration and development** was needed. Technology development should be located much more substantively to business models (i.e., how to profit from the technologies) and business development, and in communicating it. One option could be joint master's programme driven by a consortium consisting of carefully selected actors in the Baltic Sea region. The primary target group would potentially be the managers in clean technology companies. The pedagogy of such a course ought largely to be employ practical cases with ready application in practice. The intended outcomes would be both a higher level of competence among the participants with a view to enhancing business success.

Second, the forum of clean technology stakeholders from the all regions involved was largely missing. **Better interaction of the support organizations** from Sweden, Estonia and Latvia, and involvement of the other clean technology organizations from the other Nordic countries, is also recommended. One of the actions undertaken could be related to better information exchange and further co-operation between the clean technology companies from Sweden, Estonia and

Latvia. This could take the form of match-making events. In a similar vein, many clean technology companies were currently too small to invest enough in export projects on their own. To address this need policy-makers should consider funding allocations towards organizing co-operative trade fair operations, wherein clean technology companies work together. For example this could include integration of their marketing budgets to attend trade-fairs.

Thirdly, joint actions could be initiated in the field of **public procurement for innovation**. Public procurement for innovation means that a public agency places an order for a product that does not yet exist, but which could probably be developed within a reasonable period of time, based on additional or new innovative work. Mostly it is undertaken to solve an existing or emerging societal need, but compared to the procurement of "off-the-shelf" products, public procurement for innovation arguably has a potential to enhance providers' innovativeness and to support economic development. Many governments around the world are currently re-discovering policies that would put public procurement – usually worth 10–20% of countries GDP – explicitly into the service of technology and innovation policies. Since environmental issues are largely cross-border issues and as such are susceptible to joint actions which could be initiated and innovative solutions to societal needs sought. The possibilities are good considering that Sweden has extensive experience in carrying out public procurement for innovation especially since both Estonian and Latvian stakeholders have shown increasing interest in this as well.

Endnotes

1. It has not escaped our notice that the financial crisis to some extent has dampened the political interest in environmental issues in favour of purely economic issues. "Advanced economies are slowing down and the euro area appears to be in a mild recession", wrote OECD in their Outlook No. 90 (November 28, 2011). Even the U.S. Congress view of environmental issues is pending (despite President Obama's promotion of the issue – see his "Blueprint for a Secure Energy Future", The White House, March 30, 2011). At the same time new warnings calls for still more environmental action. According to OECD's latest analysis, global greenhouse gas emissions are projected to double in the next 40 years (November 24, 2011). This, OECD writes, would result in a 3-6 degree increase of the average global temperature by the end of the century unless governments take decisive action.

2. See http://www.global-vision.se for details.