Eco-innovation in Finland

EIO Country profiles 2010
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The Eco-Innovation Observatory functions as a platform for the structured collection and analysis of an extensive range of eco-innovation information, gathered from across the European Union and key economic regions around the globe, providing a much-needed integrated information source on eco-innovation for companies and innovation service providers, as well as providing a solid decision-making basis for policy development.

The Observatory approaches eco-innovation as a persuasive phenomenon present in all economic sectors and therefore relevant for all types of innovation, defining eco-innovation as:

“Eco-innovation is any innovation that reduces the use of natural resources and decreases the release of harmful substances across the whole life-cycle”.

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Eco-Innovation Observatory

EIO country brief 2010: Finland

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Part 1. General profile of the country: innovation & environment

Finland is known for the abundant and clean forest and fresh water resources. In fact, 86% of the area is forest land, and annually the growth of forests fairly exceeds the loggings. Furthermore, the population density is only 17.64 habitants per km², yet the inhabitants are clustered in the southern Finland. In addition to forest and water, also peat and mineral reserves are extensive. (Finnish National Board of Education 2011.) On the other hand, ecological footprint of Finland is one the highest in the world. This is due to resource intensive industry, high energy consumption, increasing amount of municipal waste and incoherent regional structure.

Finnish industry is specialised in utilising natural resources. Basic metal and mineral industries and the use of wood, both as raw material and for energy production, are characteristics of Finland. Extensive material consumption can be explained by exports. Products of the most material intensive industries such as pulp and paper and basic metal industries are mostly exported. In the long run, availability and price of natural resources as well as efficiency in their industrial use are the most essential issues for Finland. (Ministry of the Environment 2009a.)

According to the Eco-Innovation scoreboard, Finland is one of the most innovative EU Member States based on its innovation performance (see below). The Finnish national innovation system is an extensive entity, based on education, research, product development as well as knowledge-intensive business and industry. The innovation policy is bound to science and technology policies, which together aim at ensuring balanced development and extensive cooperation within the innovation system (Research.fi 2010). The Finnish innovation performance is a result of various factors of which strong innovation input is not the least. Eco-efficiency and environmental approach has traditionally been a baseline of Finnish production technology, which has been apparent through the research and development (R&D) funding and development of increased eco-efficiency in industrial processes.

Today, the national innovation system in Finland is explicitly involved in the environmental sector. Ministry of Employment and the Economy is developing operational preconditions for ecologically sustainable and competitive business life, and for the growing field of environment and eco-export. Hence the innovation policy includes a principle of integration of environmental considerations within all aspects of R&D. For example, new products and manufacturing processes are utilised faster, if they also involve economic and other improvements in addition to favourable environmental aspects. (Tekes 2006; Ministry of Employment and the Economy 2009.)

From the 1990s the industrial sector has emphasised the importance of eco-competitiveness, environmental technology and ecological product policy for competitiveness. This indicates a wide consensus on the need to develop new environmental technologies in order to tackle environmental problems and secure competitiveness as well as to create new environmental business sector and employment. Furthermore, in Finland, different ministries have together funded R&D activities administrated by the Ministry of the Environment. Within these projects, such as Environmental Cluster Programme (1997–2009), the development of basic knowledge for eco-innovations and environmental policies has been a persistent goal. (Tekes 2006.)

Nonetheless, in Finland future challenges also concern structural change of the Finnish industry, aging of population, globalisation of the world economy, and climate change (Ministry of Employment and the Economy 2009). These challenges are considered possible to tackle with the help of broad-based and effective public innovation policy.
Part 2. Eco-innovation performance

The analysis in this section is based on the EU 27 Eco-innovation scoreboard (Eco-IS). Eco-IS via its composite Eco-innovation index demonstrates the eco-innovation performance of EU Member States compared with the EU average and with the EU top performers. Eco-IS is based on 13 sub-indicators which are aggregated into five composite indicators, reflecting the five components: eco-innovation inputs, activities and outputs as well as the environmental outcomes and socio-economic outcomes of each EU27 member state.

![EU27 Eco-innovation scoreboard, composite index](image)

Figure 2.1 EU27 Eco-innovation scoreboard, composite index

As presented in figure 2.1, Finland ranked first out of the EU27 Member States with its eco-innovation performance. Finland has been especially successful in measuring eco-innovation inputs and outputs, as figure 2.2 portrays.
Eco-innovation inputs

Finland is one of the most research-intensive countries in the world. Currently, the national spending on R&D is approximately €6.5b a year (Cleantech Finland 2010). According to Eco-IS data, total gross domestic expenditure on R&D as a percentage of GDP was 3.9% in 2009, the highest of EU Member States. The data also shows that governmental allocation in environmental and energy R&D (0.1% of GDP) is the highest in Finland. Finland has also the highest percentage of people employed in research in the OECD countries. (Cleantech Finland 2010.)

In relation to investments in R&D, Finland invests disproportionately less in the commercialisation of the results of the R&D investments. Finland needs more foreign R&D and cross-border venture capital, which would give Finnish companies global insight, foreign expertise and international networks. (Ministry of Employment and the Economy 2009.) However, a growing trend in the investment of environmental technologies has been apparent in 2007–2009. Eco-IS data shows that the cleantech venture capital investment (per capita) is high in Finland. The peak in 2008 can be explained mainly by a single investment of €120m in WinWind by Masdar Cleantech Fund, which was actually over 83% of the overall investments in Finland (Nordic Cleantech Open 2010).

A very large share of the early stage venture capital has come from public sources in Finland during the recent years. The funding has been typically divided into small portions and distributed to a large number of companies (Ministry of Employment and the Economy 2009). Organisations such as Finnish Industry Investment, Sitra and Veraventure, invest public funds as equity into companies from pre-seed to expansion. They have been involved in at least 50% of the VC private equity deals in Finnish cleantech (clean or environmental technology) companies over the last 4 years. (Nordic Cleantech Open 2010.)

Eco-innovation activities

The eco-innovation activities index is based on the statistics of companies with the EU Eco-Management and Audit Scheme certificates (EMAS) and their innovative performance aimed at material efficiency sourced from the Community Innovation Survey (CIS 2008). In 2007, Finland had 7.8 EMAS-registered organisations per million people. This number is above the EU average, but still much lower than in Austria, where it was 30.4 in 2007. However, according to the Eco-IS, the number of companies with ISO 14001 certifications in Finland is remarkably higher than in the majority of EU Member States.

The share of companies with innovations leading to reduced material use per unit of output is also relatively high in Finland. According to the CIS 2008 data, 32% of the innovative enterprises
interviewed indicated to have implemented material reduction measures. This share has been visibly growing from 2006 onwards.

**Eco-innovation outputs**

Eco-innovation outputs are measured at national level by patenting outputs in pollution abatement and energy efficiency (OECD 2010). Finland is well positioned in the environmental technology area of patenting activity. 24 eco-patents – including patents in pollution abatement, waste management and energy efficiency – were filed in 2007. According to Eco-IS, the number of eco-patents in Finland per million people was above the EU average in 2007. The Finnish environmental technology patenting is spread out across a large number of companies and broad range of industries, but it has concentrated on specific technology areas. For example, water pollution control and solid waste management technologies seem to have slightly larger shares than other technologies. Also renewable energy, biomass and ocean technologies stand out with somewhat higher shares. (ETLA 2010.)

**Environmental outcomes**

Although Finland has been successful in eco-innovation inputs and outputs, the environmental outcomes are notably below the EU average. During the period 1990–2007, the ratio between gross inland energy consumption and GDP in Finland has continuously been one of the highest in contrast to other EU countries. The high energy intensity stems from various structural factors. Large pulp and paper, basic metal and chemical industries consume a lot of energy, cold climate due to northern location increases the need for heating and incoherent regional structure increases the need for transport. The per capita material consumption is high in comparison with other European industries due to high share of heavy industries and high standard of living. Road construction in a sparsely populated country also increases material consumption per capita figures. (SYKE 2009; Ministry of Environment 2011.)

Finland’s share of greenhouse gas (GHG) emissions seems to be small of the overall emissions at the EU level, but GHG emissions per capita in Finland is one of the highest in Europe. The majority of all GHG emissions come from the energy sector. Total GHG emissions in Finland have steadily increased (except for the year 2005). In 2008, GHG emissions have significantly decreased in the energy and transport sectors. (VATT 2009; Statistics Finland 2008.)

The largest amounts of waste in Finland are generated in the construction and forest industries and in agriculture. Agricultural waste in particular exceeds the EU average. On the other hand, the amount of waste generated e.g. by waste collection, treatment, recovery and disposal activities have decreased recently in Finland whereas the EU average has increased. In general, GHG emissions from the waste sector have been reduced significantly, 45% from the 1990 level. Although landfilled wastes still covered ca. 50% of the disposals in 2008, related GHG emissions have reduced due to the landfill gas recovery (Eurostat 2008).

**Socio-economic outcomes**

According to Eco-IS data, Finland scores above the EU average in all three indicators measuring socio-economic outcomes of eco-innovations – exports, turnover and employment in eco-industries. Estimates of the aggregated Finnish environmental business depend on the definition of environmental business and the method of calculation. In 2010, the Finnish Minister of Employment and the Economy gave a recent range of estimates €12-17b which indicates a rapid increase from €4.5b reported in 2007 (Sitra 2007b). Finland has good conditions to increase the size of its environmental business. Finland ranks high in several international indexes describing environmental sustainability, competitiveness, clean water, and innovative solutions (Finnish Environmental Institute 2010). Finland is also well ranked in the Global Competitiveness Reports: in the most recent one (2010) Finland’s position was 7th. However, although Finland has often been rated as one of the world’s leading countries in the environmental sector, it has not been as successful in terms of exports, especially when it comes to small and medium sized businesses (Sitra 2007b).

As to human capital, Finland has a competent and skilled workforce. As a result of a strong focus on education over recent decades, Finland continues to occupy a top position in the higher education and training pillar, one of the 12 pillars of competitiveness (World Economic Forum 2010). According to the Eco-IS data, the number of graduates from eco-industry related fields is also relatively high.
The eco-innovation market in Finland is still medium size compared with the European level. According to a study by Finnish Innovation Fund (SITRA), the Finnish innovation system has enhanced preconditions for technology development and supply rather than creation of market pull and demand (Sitra 2007a). According to the Finnish Cluster of Expertise in Environmental Technology (Cleantech) and the studies carried out by Sitra, the leading eco-innovation areas in Finland can be divided into energy sector (sustainable energy management) and environmental & industrial sectors (sustainable use of resources; forestry, nanotechnology, waste and water treatment and recycling). The eco-innovations that in the 2000s have most successfully penetrated in the market covered these areas. These innovation areas included various types of eco-innovations such as service, processes, operational models as well as marketing eco-innovations. (Sitra 2007a; OSKE 2010a.)

The Finnish Centre of Expertise Programme consists of 13 national competence clusters of which particularly five concern eco-innovative areas: cleantech, energy technology, forest industry future, living business (i.e. housing) and nanotechnology (OSKE 2010a). In this context, an example of a successful eco-innovation is for instance ‘TrumpJet’, chemical mixing system that proportions papermaking chemicals and additives, injects and mixes them quickly and effectively into the stock flow using re-circulated liquid from the main process itself. In addition to the improvement in quality of the production and end product, this process also increases material and energy efficiency. (Sitra 2007a.) Other good practices related to the above classification concern among other things sustainable material use, the enhancement of energy efficiency, the reduction of emissions and waste flows (e.g. through the innovatory recycling of waste materials into the raw materials of design clothes and accessories, new measures of oil spill prevention, or technological innovations in wastewater treatment).

In national studies, different barriers and drivers have been recognised within all phases of the development of eco-innovations from the first idea to R&D, production and marketing. The drivers can be divided into three different categories, which concern demand, supply-orientated technology development, and the operational level of public sector. Firstly, certain changes in the prices of the end products or in the core factors of production have increased the demand for eco-innovations. According to Sitra, this has been the most transparent in the energy sector. On the other hand, also national and international goals concerning energy self-sufficiency have effected on the market pull in the energy sector. (Sitra 2007a.)

However, the market pull resulting from price increase, exists also within other sectors as the customers aim at reducing costs and increasing competitiveness by either intensifying the use of resources or replacing products and processes with new solutions. For instance, recently the markets for equipment and services of oil spill prevention and response have first and foremost grown because of the internal risk and cost management measures of the oil companies. (Sitra 2007a.) On the other hand, also the demand by end-users concerning health requirements and environmental effects of production and expenditure have had an impact on the success of certain eco-innovations. For example, the growing market of textile recycling concept of Globe Hope Ltd. is partially explained by consumer groups that are interested in buying environmentally friendly and sustainably produced design products (Sitra 2007a, see example 3).

Furthermore, technological development as a driver has been recognised in the eco-innovation chain, when eco-innovations are developed in co-operation with a client; and thus the market pull and the technological development have met seamlessly. On the other hand, Sitra also presents cases where successful technological eco-innovations have benefited from developments of parallel technologies. For instance, development of the computational capacity in the IT sector has pushed the process eco-innovation of Fortum Power and Heat Ltd faster to the market. In addition, competing technologies may also act as promoters in growing markets where the end-users are not yet fully convinced of the reliability of a new technological application. (Sitra 2007a.) In some cases, technological push is also
created by ideological or strategic needs of a company; such as the above-mentioned Globe hope Ltd. The funding for companies with eco-innovations has been extensive by the public sector. The major investors in the public sector are Tekes (Finnish Funding Agency for Technology and Innovation), which is the main public funding organisation, and also Sitra, Veraventure, Finnvera and the Academy of Finland.

In addition to funding, other investments by the public sector may support the development of innovations due to the high standard of education in Finland. For instance, Finnish mathematic modelling has enabled the development and production of the combustion technologies of Fortum Power and Heat Ltd. Although the gross domestic expenditure on R&D is high in Finland, it has not removed barriers to internationalisation of eco-innovations. Particularly, the SMEs have lacked of financial methods needed for internalisation and have also had problems with building the marketing and sales networks. In addition, in this context the studies show that lack of risk financiers in creation of demonstration projects for eco-innovations and necessary references has been an evident barrier to Finnish SMEs (Sitra 2007a). Often, the core know-how (such as design, education, development, and coordination of production) has been firmly in the hands of innovators themselves and the sub-suppliers consist of own (domestic) networks. Thus the major problems concerning e.g. technological know-how or quality are considered almost non-existent. (Sitra 2007a.)

**Good practice examples**

**Example 1: Material flow eco-innovation – Sustainable solution to reuse batteries and accumulators**

**Description:**
Within the past few years, AkkuSer Ltd. has created a profitable business from recycling batteries and accumulators used in wireless products, such as digital cameras, video cameras, mobile phones and computers. AkkuSer’s recycling method - **Dry Technology** - is unique in the world. The technology enables the sorting of recycling material into valuable metals suitable for raw material for the electronics industry, and their restoration for reuse. The method allows various new products to be made with the materials used in batteries without a need for chemicals, heat or incineration. (Cleantech Finland 2010; AkkuSer 2010.)

AkkuSer’s recycling plant is located in Nivala, Finland, and it is ISO 14001 and ISO 9001 certified. AkkuSer processes most of the rechargeable batteries and battery waste generated in Finland and Estonia, and half of the waste generated in Norway and Sweden. According to Jarmo Pudas, the Managing Director of AkkuSer, the initial driving force of their product development was the EU recycling directive, which came into effect in Finland in 2008. This directive obligated manufacturers to recycle all their batteries and accumulators, regardless of their shape, size, composition, or intended use. (Cleantech Finland 2010; AkkuSer 2010.)

**Determinants:**
**Barriers:**
- Consumer-orientated business; dependency on people’s will to recycle
- Lack of technology to e.g. recycle disposable alkaline batteries

**Drivers:**
- Increasing demand of wireless devices and rechargeable batteries
- The EU recycling directive
**Sustainability effects:**
The Ministry of the Environment has estimated that 200,000 tons of batteries and accumulators enter the EU markets each year. Some of these batteries and accumulators contain significant quantities of mercury, cadmium, and lead. They also contain materials like zinc, copper, manganese, lithium and nickel. (AkkuSer 2010.)

AkkuSer Ltd. has a sufficient capacity to process and recycle all the batteries and accumulators collected in Finland. They process and restore them for reuse without loading the environment. Over 90% of the recycling material can be reused. No environmentally harmful carbon dioxide emissions or waste are generated during the recycling process. (AkkuSer 2010.)

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**Example 2: Product eco-innovation – Solution to product energy from biomass cleaner and more energy efficiently**

**Description:**
Kemira Plc operates in chemicals industry and is focused on serving customers in water-intensive industries. Their aim is to improve the energy, water and raw material efficiency of their customers via water quality and quantity management. The company developed DesinFix, a complete, chlorine-free disinfection system that disinfects water in ten minutes, and within an hour no active substance can be detected as the compound (DEX-135) breaks down into carbon dioxide and water. DesinFix is based on the combination of formic acid (hydrogen carboxylic acid) and hydrogen peroxide. It is primarily targeted to municipal waste water treatment plants, but the method can be applied also for example to industrial process waters. (Kemira DesinFix 2011.)

Kemira has long roots in the Finnish know-how as it was established already in 1920. The company has a large-scale research and development operations, which expenditure totalled €47m in 2009. The R&D concerns, in addition to drinking and waste water treatment, pulp and paper, oil and mining, and other water intensive customer industries. (Kemira 2011.)

**Determinants:**

**Barriers**
- Not known yet

**Drivers**
- EU bathing water directive
- Increasing demand for water disinfection in water reuse applications
- Low energy consumption & competitive operational costs
- Minimal maintenance requirements, compact size & easy installation
- Lower investment costs (compared with UV-light or ozone disinfection)
- Versatile use of technology

**Sustainability effects:**
DesinFix was invented particularly to meet the increasing demand for waste water disinfection in water reuse applications (such as agricultural and landscape irrigation, industrial applications; disinfection of internal service water), the environmental effects of the innovation concern the sustainable (re)use of water as well as sustainable energy and material consumption. DesinFex has low energy consumption and inexpensive operational costs, which also contributes to the total cost,
which is well below the alternative methods. Thus, in the long run the sustainability effects could also concern cost reduction and market creation through new improved and sustainable water management solutions at both national and the EU/global level.

The DEX-135 compound used in this innovation does not leave any toxic disinfection by-products in water and enables a 99.9999% kill ratio. Thus, the innovation excludes health risks (infections, gastroenteritis cancer etc.) as well as contamination damages of nature. The system can also handle rapidly varying flow rates guaranteeing continuous disinfection even in more demanding environments.

Example 3: Marketing innovation – Waste flows turned into high quality fashion

**Description:**
Globe Hope Ltd. has created a design concept by turning existing (waste) materials into individual design clothes, accessories and textiles, and thus reduces the use of resources. The production relies on sustainable development; hence the aim is to offer ecological and sustainable choices for consumers. Furthermore, the main goal is to design goods that are aesthetic, functional and innovative. The company was established in 2001 and the first collection was launched in 2003. (Globe Hope 2010; Sitra 2007a; 20.)

All the products are made of recycled materials such as hospital & army textiles, worker uniforms, advertisement banners, flags, recycled sails, seatbelts and vintage home textiles (e.g. sheets, curtains, and tablecloths) (Globe Hope 2010.) Globe Hope has managed to develop a green brand for markets by designing fashionable clothes and creating an appealing alternative for fast-paced textile industry with its disposable trends.

**Determinants:**

**Barriers**
- Dependency on the consumers’ will to recycle/think green

**Drivers**
- Interest of the media on environmental issues
- Increasing trend towards more environmentally-friendly attitudes and values

**Sustainability effects:**
Globe Hope reduces material flows by turning waste into new raw materials by design by re-cutting, re-sewing, re-dying and printing. In addition, the production aims at industrial quantities in order to keep the production costs reasonable, which also enables reasonable prices of the end-products for consumers.

Furthermore, since the headquarters are close to the production facilities and factory outlet, also the emissions are kept as minimum as possible.
Part 4. New trends: areas on the rise

Although Finnish environmental know-how has a very high standard and the potential of environmental business and markets has been recognised in Finland in the 2000s, creation of the market is still in its infancy. For instance, half a decade ago, Tekes launched a research programme promoting growth in the environmental business sector. In 2007 ‘cleantech’ was still a rather unusual and exotic concept for most Finnish investors (Tekes 2010; Nordic Cleantech Open 2010). Nonetheless a growing trend in the investment of environmental technologies has been apparent in 2007–2009. However, the high peak in 2008 can be explained by a single investment (€120m) in WinWind by Masdar Cleantech Fund. This investment alone covered 83% of such investments (Nordic Cleantech Open 2010). Despite the extensive funding of the innovation system, the area of eco-innovations is still rather fragmented.

Due to intensive R&D work in the Finnish energy and environmental sector, a few areas have reared their heads. Energy efficiency (particularly waste-to-energy production, power electronics for energy efficiency and smart grid applications) as well as forestry and water treatment (including environmental informatics and environmental monitoring) seem to be the most promising areas for emerging eco-innovations, and have begun to demonstrate auspicious results also in international markets. For instance, in China and India the Finnish solutions for sustainable and ecological construction and water treatment are looking for a foothold (Tekes 2010). This trend can also be seen in the national markets, where more energy effective and sustainable solutions are sought. The ecological solutions, in terms of energy efficiency and environment, have been challenging in Finland, where also the northern location as well as the scenarios of climate change define the starting point. In addition, Finland also has excellent ‘living lab’ environment. For example, the product of Vahanen Ltd. is a good example of the emerging eco-innovations in Finland (see example 1).

In addition to Tekes research programme enhancing cleantech sector, also other institutes in the public sector such as VTT (Technical Research Centre of Finland) and the Ministry of Employment and the Economy has begun to promote the market for green innovations. For instance, VTT has begun to support a specific area of environmental technologies for the market (VTT 2009). For instance, water scarcity is creating a market for water expertise, which growth in Finland can be seen as an establishment of the Centre of Water Efficiency Excellence that aims at developing new environmental technologies, and hence creating new business opportunities (Kemira 2010). Furthermore, although environmental and nanotechnologies have a strong foothold in Finland in terms of know-how, often the solutions cross other areas on the side. The example 2 for instance, concerns not only the area of nanotechnology but also the environmental technologies and new materials.

Example 1: Product eco-innovation – Smart structure insulation system

Description:
Vahanen Ltd. is developing a smart structure insulation system that adjusts thermal insulation by sensors placed on the ceiling or walls. The censors gather information whereby the insulation capacity will be either increased or decreased based on the outer and inner air. Smart structure insulation relates to a method for moving thermal energy and/or moisture in a shell structure of a building. The smart structure adjusts the insulation capacity of a structure according to the outer and inner air conditions. (Kauppalehti 2009.)

The inventor of the system is Ari-Veikko Kettunen, who works for Vahanen Ltd. as a specialist consultant of structural physics. At the
moment, the product is almost ready for marketing. The decrease in energy consumption is intended to gain in both heating and cooling. Energy can be transferred between the different surfaces of the thermal insulation, which will create energy savings. According to the developers, Smart insulation structure is suitable for all types of buildings from small houses to large office buildings. (Vahanen Ltd. 2010.)

**Determinants:**

**Barriers:**
- Creation of new sales networks
- High cost of technology (particularly in LDC countries)

**Drivers:**
- The European Climate Change Programme and European Union environment policies
- National regulations and laws
- Climate change or/and ability to adapt to changes
- Ability to adapt to diverse weather conditions and different types of buildings: global markets

**Sustainability effects:**
The smart structure is designed to radically cut down energy consumption of the building, and thus it would reduce the energy consumption as well as increase cost-efficiency. The innovation reduces GHG emissions, and thus helps achieving the GHG targets as houses consume 40% of all energy. In addition, as the climate changes and as there is uncertainty of the development of the weather conditions in the future, it is essential also to adapt to the changes. These technologies could provide a way for the constructed surroundings to do that. The smart structure insulation system also reduces the need of other heating or cooling systems. In warm countries in the best case scenario, the system may even make buildings independent of any external heating and cooling energy.

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**Example 2: Material flow eco-innovation – Recyclable packaging coating solution**

**Description:**
VTT developed an environment-friendly packaging coating solution, Flexible atomic packaging layer by thin coating, which is suitable e.g. for food and pharmaceuticals. The solution is fully recyclable and based on the Atomic Layer Deposition (ALD) method, which enables excellent gas permeation resistance. (VTT 2010a.)

Originally, the ALD technology was developed in Finland in the 1970s, but so far it has been utilised mainly in microelectronics. Finally, Picosun Ltd. provided the ALD reactor for micro- and nanotechnology applications that also enabled the development of the new solution by VTT (Cleactech Finland 2010).

**Determinants:**

**Barriers**
- High costs of implementing new technology in manufacturing processes

**Drivers**
- Savings in raw materials and transportation
- Waste acts and regulations
Sustainability effects:
The coating offers a new method for manufacturing thinner, lighter and better sealed than traditional barrier materials. Although other thin film methods can also produce thin coating, VTT’s solution has lower gas permeability and the material is less stiff and does not break as easily. As the new material is not only lighter but also fully recyclable, it could significantly save transport costs and raw materials. For example, chocolate wrappers could be manufactured without the aluminium-coated paper if the carton wrap was treated with the ALD coating method. (VTT 2010a.) In addition the ALD technology can improve humidity tolerance and performance of bio-polymers, thus reducing the need for oil-based plastics. The reduced need for oil-based plastics, the decrease of emissions and material consumption would have broad-scale environmental and economic effects, if the ALD coating method was widely implemented in manufacture.

Part 5. Public policy in support of eco-innovation

The studies show that the role of the public sector has been essential part of success for the development of new eco-innovations. In public R&D funding, environmental aspects have been a priority (cross-sectional aspect) since the 1970s (ETAP Roadmap 2005). Financial subsidies related to the public sector (such as R&D funding, investment loans and subsidies) have had a great significance in the success of major innovation processes. Also the increasing amount of national and EU level regulations have had positive impact on the markets and development of eco-innovations. For instance, the regulations for the use of chemicals and hardwood has been a core driver for Stellac Ltd.‘s eco-innovation, since legislation and regulations have underpinned the competitiveness of their new products on the market (Kuitunen et al. 2008).

The government-backed research institutions focus increasingly on funding on research programmes related to environmental technology. For example, Tekes has several active programmes which fund cleantech research, including the BioRefine, Built Environment and Water programmes. (Cleantech Finland 2010.) Tekes is the intermediary organisation under the Ministry of Employment and the Economy and it has a mission to enhance the development of the Finnish industry and the service sector through technology and innovation. (Ministry of Employment and the Economy 2009.)

There are also other important public financing entities in Finland. Sitra is an independent public foundation that operates under the supervision of the parliament and is dedicated to promote the economic prosperity and the future success of Finland. It is an important organisation in the Finnish innovation system and has an important role in policy experimentation. The interviews of companies carried out by Sitra revealed that in most cases the eco-innovation would have left unrealised without external subsidies, particularly at the beginning of the innovation chain (Sitra 2007a). Sitra has been active in environmental issues ever since its foundation. It adds diversity to the innovation system and can help to avoid the risk of too one-sided ideas, policies, and funding opportunities. (Ministry of Employment and the Economy 2009.)

There are several ongoing research projects related to eco-innovations in Finland. For example, Finnish Environment Institute (SYKE) has about 200 ongoing research and development projects. A large part of them are cooperation projects which are carried out together with research institutes and universities in Finland and/or in other countries. (SYKE 2010.) VTT has also several research projects related to eco-innovations. VTT is a part of the Finnish innovation system under the domain of the Ministry of Employment and the Economy. It is a non-profit-making research organisation. (VTT 2010b.)

The development of eco-innovations is more dependent on public sector measures than many other sectors. The public sector has various instruments to support eco-innovations. These instruments can be divided into demand-side and supply-side measures of innovation. The demand-side measures
include for example green taxes and public procurement, whereas the supply-side measures concern the support of specific government and university programmes and grants.

Through public procurement policy governments are able to create markets for innovative products and services. The value of public procurement in Finland is approximately €27b per year. (Ministry of the Environment 2009b.) According to the study performed in 2008 by PricewaterhouseCoopers, approximately 43% of the total procurement value was green procurement, which is slightly below the average of the Green-7 countries (45%). By taking into account environmental criteria in its procurement procedures, contracting authorities can stimulate the supply of 'green' goods and services. In April 2009 the Finnish Government passed a resolution that encourages all public actors – the central government, regional governments and the municipal sector - to adopt sustainable procurement. The Government expects measures from those responsible for public procurement, particularly in the areas of energy, construction and housing, transport, food services, energy-using equipment and services. The Government will support the implementation of the targets by increasing information and advisory services. According to the report, Finland would save approximately EUR 20–30 million at the local level if all municipalities achieved a 9% energy-saving target by 2016. Reaching the same target would mean the savings of €11-13m in the Government. (Ministry of the Environment 2009b.)

The concentrated and appropriate use of environmental taxes could encourage the expansion of widely beneficial green technologies. Environmental taxes are defined as taxes which tax base is a physical unit, or proxy of it, of something that has a proven, specific negative impact on the environment. Environmental tax revenues stem from four types of taxes: energy taxes, transport taxes and pollution and resource taxes. (Eurostat 2010.) If well designed, the taxes can have significant positive effects on consumer and producer behaviours. According to the latest statistics, in Finland the share of environmental taxes in total tax revenues was slightly above the EU average in 2008. (Eurostat 2010.) However, environmental taxes will rise in Finland accordingly to the new green tax reform. Taxation will take account of the energy content, carbon dioxide emissions and emissions into the local environment that has adverse health effects. Energy taxes on fossil heating and power plant fuels and on electricity will be increased by around €700m from the beginning of 2011. Also, the tax base of the waste tax has been extended to private landfill sites and the tax increased by €10 per tonne in 2011 and again in 2013. The objective of the waste tax reform is to promote the utilisation of waste. (Ministry of Finance 2010.)

The successful science and technology policy of Finland has created a basis for many successful industries. Economic policy in Finland has concentrated more on the promotion of new technology development and increased R&D spending. However, a demand-based innovation policy must be strengthened alongside the supply-based, technology-oriented innovation policy. (Ministry of Employment and the Economy 2009.) There are lots of small and medium sized innovative enterprises that have not succeeded in commercialising and internationalising their business. The importance of networking, internationalisation and commercialisation of eco-innovation has already been recognised. For example, the activity of the national cluster of expertise in environmental technology, the Finnish Cleantech Cluster has helped fostering cleantech R&D, innovation and SME development. By building clusters, Finland has coordinated public and private actors to foster internal economic development and attract foreign direct investment to these growing sectors. In early 2010, Finnish Cleantech Cluster was ranked in the top three with the world’s best Green Tech Clusters by the international Cleantech Group (USA). In the cluster, particularly commendable internationalisation projects have been the ones directed to China, Russia and India. (OSKE 2010b.) However, greater attention to fostering the commercialisation of green innovation and developing efficient green markets is still needed in order to accelerate eco-innovation processes.

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1 This report presents the levels and impact of GPP measured in Austria, Denmark, Finland, Germany, The Netherlands, Sweden and the United Kingdom (‘Green-7’) in 2006/2007.
Part 6. Understanding eco-innovation performance

The main barriers for eco-innovations in Finland are:

- The Finnish national innovation policy has been criticised of having a **too strong emphasis on the technical aspects of innovation** as opposed to the commercialisation aspects. There are a good number of small and medium sized innovative enterprises that have not managed to commercialise and internationalise their business (Ministry of Employment and the Economy 2009). However, the importance of networking, internationalisation and commercialisation of eco-innovations has now been recognised. For example, activities of the national cluster of expertise in environmental technology, in the Finnish Cleantech cluster have enhanced fostering the cleantech R&D, innovation and SME development (Cleantech Cluster 2010). According to WEF’s Global Competitiveness Report 2008, the Cluster development level in Finland is at very high rate (World Economic Forum 2010).

- There are significant **overlaps in the financing services offered by public organisations**, and as well as a serious need for streamlining. Especially small businesses and start-ups find the system difficult to use, since within the system appears to be several partially overlapping but not integrated public sources of seed, early stage and growth funding which are provided under numerous headings. The lack of involvement of the Ministry of Finance and less active involvement of the Prime Minister’s Office in coordinating in research and innovation policy formulation is also problematic. Particularly, eco-innovations are not utilised extensively enough nor they replace competing or prior technologies and operations effectively very much due to lack of or weaknesses in the requirements for regulations. In other words, funding directed to eco-innovations also needs stricter legislative directions. (Ministry of Employment and the Economy 2009.)

- The Finnish national innovation system suffers from **scarcity of world class human capital, foreign R&D and cross-border venture capital**. Besides financial support, the international funds could offer young innovative Finnish companies global insight, foreign expertise and international networks. A perceived problem in the Finnish environment has also been the very small number of active venture capital funds that are over €50 million. It can thus be difficult to find funding for the earliest and the riskiest stages of a life-cycle of a young firm. However, there are many on-going and planned developments in the Finnish public service including risk capital provision. (Ministry of Employment and the Economy 2009.)

The main drivers for eco-innovations in Finland are:

- **Extensive public investment in R&D and collaboration between financiers.** Finland is one of the most research-intensive countries in the world, and currently, the national spending on R&D is approximately €6.5b a year (Cleantech Finland 2010). Particularly, the investments in product development have been crucial to the development of new eco-innovations. According to the interviews carried out by Sitra, notably during the R&D process the actors of the public sector (e.g. Tekes, Sitra, Finnvera, Centres for Economic Development, Transport and Environment) has had a crucial role for companies developing eco-innovations. The public funding has also enabled the development e.g. parallel technologies that have boosted the development and utilisation of new eco-innovations. Furthermore, the strong collaboration between the venture capital and public financiers is one the most significant features in the Finnish investment climate.

- **Functionality combined with strong know-how & high standard of education.** Free (higher) education of good quality is connected to the strong know-how, which together are a major driver for eco-innovations. The Finnish national innovation policy may have had a strong emphasis on the technical aspects of innovation, but the strong know-how has been a
key aspect in succeeding in developing eco-innovations. Since the know-how for product development for instance often comes inside the companies and institutions, it is easier to ensure the quality, functionality and competitiveness of the innovations. In addition, the good functionality of Finnish society and corporate responsibility are an essential part of this driver.

- **The strong commitment to both national, global and the EU level policies and environmental thinking.** The Nordic Countries have often been considered a model states e.g. in terms of educational and health care systems. In this respect, Finland has also been seriously committed to environmental policies, rules and regulations both nationally and globally (e.g. climate conventions, green taxes). The political will to act towards cleaner environment through technological as well as operational changes has created a fertile ground for the development and demand of eco-innovations. The Finnish national environmentally-friendly attitudes are also recognised through voluntary energy efficiency agreements between the state and Finnish industry. During 1998–2006 companies voluntarily invested over €360m in energy efficiency.
Bibliography


