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THE ECO-INNOVATION AND THE LISBON STRATEGY

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The eco-innovation and the Lisbon Strategy

Heads of State and Government of the European Union met in Lisbon in 2000 where they decided to make the European Union "the most dynamic and competitive knowledge-based economy in the world" by 2010. The EU' s Lisbon Strategy identified economic and social aspects as key to growth, complemented by the environmental dimension one year later in Gothenburg.

In many ways, innovation and new technologies, such as carbon fuel burning engines and vehicles, have introduced much of the environmental stress the planet is trying to deal with, like global warming, ozone depletion, toxic wastes, loss of biodiversity, natural resource scarcity, air pollution, and acid rain. Ironically, "green technologies" are also seen as the answer to many of these environmental threats. In Europe, despite progress, such technologies are still far from being the norm.

In his report in November 2004 (p. 36) Wim Kok says that "innovations, that lead to less pollution, less resource-intensive products and more efficiently managed resources, support both growth and employment while at the same time offering opportunities to decouple economic growth from resource use and pollution[1]".

In this paper I analyze the multidimensional concept, still extremely vague and problematic to define, of eco-innovation, trying to emphasize that it is not only important for the improvement of the environmental conditions, but that it is also advantageous for the competitiveness of the firms.

The double externality problem of the environmental innovations has been identified as the rationale for the implementation of the environmental policies, that, broadly speaking, can be of two types: regulation or market-based. The different policies adopted are described and their advantages and drawbacks are highlighted in order to identify the best ones.

Finally, the paper presents a review of the main European activities to foster eco-innovation.

[1] Decoupling economic growth from resource use means "tackling rising volumes of traffic, congestion, noise and pollution with full internalisation of social and environmental costs" (W. Kok, 2004, p. 35).

1. Does the trade off between competitiveness and environmental performance really exist?

A growing body of research suggests that economic competitiveness and environmental performance, that measures how successful a firm is in reducing and minimizing its impact on the environment (R. D. Klassen & C. P. McLaughkin, 1996, p. 1199), are compatible, if not mutually reinforcing. In fact there is no evidence that the improvement of environmental quality compromises economic progress.

The only way for Europe to compete in the global economy seems not to be on the basis of low labour costs, but on the provision of more sustainable products (M. Warhurst, 2005, p. 31). In fact low pollution and efficient energy use are a sign of the highly productive use of resources and a source of saving (D. C. Esty, M. E. Porter, 2001, p. 78, 79).

Environmental innovations may be developed with or without the aim of reducing environmental harm. They may also be motivated by typical business objectives such as profitability and the enhancement of product quality (M. Beise, K. Rennings, p. 2).

N. Ashford (2000, p. 2-3) affirmed that “encouraging technological changes for production purposes and for environmental compliance purposes must be seen as interrelated rather than as separate, activities”, while M. Andersen (2004, p. 2) says that environmental activities are increasingly seen as a potential source of competitive advantage, because they offer an element of quality and a source of savings. In fact, by reducing waste, recycling materials and saving energy companies can make large financial gains. Pollution itself can be seen as a manifestation of economic waste and an unproductive resource utilization.

A way to overcome the traditional trade-off between environment and competitiveness seems to be the introduction of a dynamic model based on innovation. Competitive firms are not those seeking for static efficiency and optimization within fixed constraints, but those able to innovate continually thus shifting the constraints. In the theoretical framework of static optimization information is perfect and profitable opportunities have already been discovered, while in a dynamic perspective technological opportunities are always changing, information is incomplete, there are

problems of controls and organizational inertia. The innovations in technology change the old, static approach and assumptions about resource availability and utilization.
Success cannot come from policies aimed at promoting the protection of the environment to the industry's detriment, but it must involve innovation-based solutions fostering both environmentalism and industrial competitiveness, so reducing and not worsening the environment-competitiveness trade-off (M. E. Porter, C. van der Linde, 1995, p. 116).

1.1 Eco-efficiency: the protection of the environment as a business

An evidence of the actual opportunity that a firm can consider the protection of the environment as a resource and not as a burden is the creation of the World Business Council for Sustainable Development (WBCSD), an initiative aiming at the involvement of the private sector in the sustainability issues. It brings together some 180 international companies from more than 30 countries and 20 major industrial sectors in a shared commitment to sustainable development through economic growth, ecological balance and social progress.
In 1992 the WBCSD gave a basic business contribution to sustainable development inventing the term "eco-efficiency".
The WBCSD defines eco-efficiency as being achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality in life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the Earth's estimated carrying capacity[2].
The eco-efficient innovations are an example of the possibility to consider the environment and competitiveness as interrelated. In fact they contribute to raise the company competitiveness by lowering resource costs thanks to greater resource efficiency, marketing the innovation, reducing environmental costs of pollution control and waste management, improving image and stakeholder relations.
The concept of eco-efficiency and cleaner production are almost synonymous. The slight difference between them is that eco-efficiency starts from issues of economic

[2] www.wbcsd.org

efficiency which have positive environmental efficiency (R. Kemp and M. Andersen, 2004, p. 5) say that "eco-efficiency is about value and quality for all actors: to achieve more value with less environmental impact. It is a concept from business, not environmentalist"), while cleaner production starts from issues of environmental efficiency which have positive economic benefits[3].

Eco-efficiency measures the productivity of resource use or pollutant emission in an industry and is defined as the ratio of economic output to environmental pressure. It can be calculated as the quantity of value-added output divided by the physical quantity of resource input or quantity of emissions of pollutant respectively: Eco-efficiency = Output / Environmental pressure.

Its measurement is important because the improvement of eco-efficiency is often the most cost-effective way of reducing environmental pressures and policies to improve eco-efficiency tend to be easier to justify than policies that restrict the level of economic activity.

Eco-efficiency is also defined as 'sustainable development at the company level' (R. R. Helminen, 2000, p. 208), but the concept of eco-efficiency is preferred to the more vague of sustainability (M. Kortelainen, T. Kuosmanen, p. 60).

There are many barriers to eco-efficiency innovation, especially in small and medium-sized companies. These obstacles are related to economic incentives, funds, entrepreneurship, short-term perspectives, competence (R. Kemp, M. Andersen, 2004, p. 1,3).

The underlying determinants of eco-efficiency are the rate of technological progress, the degree of environmental regulation, the extent of competition in product markets and the investment and quality of management or resources by industry itself (Commission of the European Communities, 2002, p.96). Progress in eco-efficiency also needs society, in general, to create an enabling framework that allows individual companies and whole markets to become more eco-efficient (REC, 2004, p. 20), but the political support needed is different from country to country, because every country and every market has its own conditions. Each institutional framework is unique and there is not an "optimal" one (Bleischwitz, 2002/1, p. 8,9).

[3] www.unep.org

According to E. G. Hertwich (2000, p.4) eco-efficiency is divided in five categories: pollution prevention (equipment modernization, maintenance and operation practices improvements, inventory control, input substitution, in-process recycling), cleaner technology (development of clean technologies that replace existing polluting technologies, design for environment (it includes environmental considerations in the regular design process of products and production processes), loop closing (recycling, remanufacturing, industrial ecosystems, product stewardship, design for disassembly, reverse logistics) and environmental management systems (changes in management structure that increase corporate attention in environmental issues and document changes relevant to the environment).

Two different determinants of eco-efficient innovation have been identified: the technology push model where basic scientific R&D is followed by an invention, its development, commercialisation (i.e. innovation) and diffusion; the market pull model in which the stimulous comes from the market needs that leads to technological development and the regulatory support, including existing environmental law, occupational safety and health standards (P. Kivimaa, 2006).

Innovation is different from invention. In an economic sense, an invention becomes an innovation when the improved product or process is first introduced to the market. Inventions often occur in countries other than the country where the innovation is first widely adopted. The third phase is the diffusion phase, when innovation is used and adopted over time (K. Rennings, 2000, p. 322).

In the Oslo Manual (1997) of the OECD three different kind of innovation are identified:

- process innovations, that occur when a given amount of output (goods, services) can be produced with less input;
- product innovations require improvements to existing goods (or services) or the development of new goods;
- organizational innovations include new forms of management.

Finally, it is important to discriminate between radical and incremental innovations. The first ones offer significant and important environmental benefits, while the latter just minor improvements (F. Steward, p.3).

Eco-efficiency should stimulate both the phase of invention, characterized by a strong creativity, and innovation in the search for new ways of doing things.

2. The environmental innovation

The renewal of the Lisbon Strategy highlighted the role of environment in economic growth. In particular eco-innovation seems to have the potential to increase competitiveness and create jobs while protecting the environment[4].

The definition of environmental innovation given by the European Commission is "any innovative product or technology that has less harmful environmental effects than the available alternatives" (P. Kivimaa, 2006).

F. Steward (p. 3) offers a broader concept, saying that it "consist of new or modified processes, techniques, practices, systems and products to avoid or reduce environmental harms".

However all these definition appear to be partial, since eco-innovation does not deal only with technological, but also with organizational, social and institutional changes. Organizational changes are, for example, management instruments at the firm level like eco-audits; while changes of lifestyle and consumer behaviour, who are becoming more environmentally conscious, are often defined as social innovations. Institutional changes are related to the incentives and regulations that have to evolve with technologies and to the creation of local networks and agencies, new regimes of global governance.

The big problem in dealing with eco-innovation is that it is placed at the borderline between two different economic subdisciplines: environmental economics and innovation economics. This is the reason why an interdisciplinary approach seems to be the most adequate, even if it is still hard to find (K. Rennings, p. 322-324). Another important issue not yet solved is the difficulty to measure eco-innovation, due to the difficulty to define it and there are a few statistics and indicators available. This is the reason why a stringent definition and delimitation of eco-innovation is a necessary starting point.

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[4] www.europa.eu.int/comm/environment/lisbon.htm

The identification of indicators to measure eco-innovation is of huge importance, providing new policy signals, incentives and insights.

The indicator of eco-innovation should link competitiveness to environmental performance (M. Andersen, 2005, p. 4, 5, 6).

Environmental innovation research is still in its early phase, and there are worldwide very few actual innovation researcher working with environmental issues.

2.1 The technological dimension of the environmental innovation

The definition of environmental innovation, as already mentioned, is extremely broad and it is characterized by different dimensions. We are going to cope with the analysis of its narrowest definition: environmental technology.

According to the research commissioner Janek Potocnik "environmental technologies are a prime example of how an economy focused on knowledge can retain high environmental standards. It is a good demonstration of how research can contribute to sustainable development" (European Commission, 2005). Examples of them include solar and wind power, water purification technologies, recycling systems for waste water in industrial processes, energy efficient car engines, soil remediation techniques.

The main objective of environmental technologies is to improve the ecological performance of manufacturing processes.

In relation to technological opportunities for environmental improvement, the choice of the company is between control and clean technology. Control technologies are *end of pipe* additions to production processes. They are operations or equipment added in the final step of an existing production process to capture pollutants and wastes before their discharge, thus leaving the original process and product substantially unchanged. A typical example is that of filters to limit the polluting emissions. By contrast, clean technologies reduce the production of pollutants or inputs of energy and materials by taking into consideration and redesigning all the production process. In this case they represent a potential strategic resource able to provide firms with unique advantages at each stage of the value chain (P. Shrivastava, 1995, p. 190). Control technologies does not usually reduce the quantity of harmful pollutants, but the risk associated with them

(R. D. Klassen, D. C. Whybark, 1999, p. 603). Thus, control technologies can be seen as a reactive response to emissions while clean technologies are proactive, because more anticipatory in their nature (A. Gouldson, J. Murphy, 2000, p. 35). According to R. Kemp and A. Arundel (1998) these two broad categories can be divided into six types of environmental innovation:

-pollution control technologies, that prevent the direct release of environmentally hazardous emissions into the air, surface water or soil. They are referred to as end of pipe (or add-on) technologies;

- waste management: handling, treatment, and disposal of waste;

-clean technology: process-integrated changes in production technology that reduce the amount of pollutants and waste material that is generated during production;

- recycling: waste minimisation through the re-use of materials recovered from waste streams;

-clean products: products that give rise to low levels of environmental impact through the entire life cycle of design, production, use and disposal.

- clean-up technology: remediation technologies such as air purifiers and land farming.

The most adopted policies in the 1070s and 1980s were directed to pollution control, while in the last decades government have preferred to focus on pollution prevention. Technologies responses shifted away from pollution control technologies to cleaner production process and recycling that prevent pollution or reuse waste material. Recently cleaner products have an increasing important role (p. 2,3).

The global market for environmental technologies and services is about € 400 billion, of which 50$% is Japanese. It is expected to grow at a rate of 3% annually (J. McGlade, 2005). The turnover is comparable with those for the aerospace and pharmaceutical industries (Network of Heads of European Environment Protection Agency, 2005, p. 3). Moreover, the accession of the new Member States, that are going through a process of modernising their economies and are adapting to EU environmental standards, whose cost of complying is estimated between € 50 and € 80 billions, will create a big market for environmental technology (CEC, 2004, p. 5).

Eco-industries are defined by OECD as “activities which produce goods and services to measure, prevent, limit and minimise or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco-systems. This includes cleaner technologies, products and services that reduce environmental risk and minimise pollution and resource use" (ECOTEC, p.1). In Europe more than 2 millions people are employed in the eco-industry sector and the rate of growth is about 5% per year (European Commission, 2005, p. 3). The eco-industry in the EU comprises: air pollution control, water and waste water treatment, waste management, contaminated land treatment, noise and vibration control, environmental monitoring and environmental consultancy/services (M. Gislev, 2000, p. 2).

Environmental technologies are not only valid in meeting challenges facing the environment, but also represent a potential boon for EU competitiveness as European research is effectively rolled out into new technologies, giving the Union a leadership position in emerging and innovative fields and complementing its Lisbon ambitions.

3. The double externality problem of eco-innovation and the importance of the environmental policy

An important aspect of eco-innovation is that it produces spillovers in both the innovation and diffusion phase. In the former case they appear because of the external benefits to the production of knowledge (S. Martin & J. T. Scott, 2000, p.438), while in the latter because of a smaller amount of external costs compared to competing goods and services on the market. This is called "double externality problem" and it reduces incentives for firms to invest in eco-innovation. As long as markets do not punish environmental harmful impacts, competition between environmental and non environmental innovation is distorted. The take-up and implementation of environmental technology is sometimes held back because they are not well known and they require high initial investments, while the external environmental costs of conventional, generally more polluting, technologies are not accounted for in the price the consumer pays, so there is less incentive for manufacturers to become 'greener'.

This is the reason why regulatory framework and especially environmental policy have a strong impact on eco-innovation (K. Rennings, 2000, p. 325-326).

According to R. Bleischwitz (2002, p. 17) “governments are responsible for setting the framework conditions and organizing a process by which new knowledge on managing the commons can be gained, while markets are responsible for finding and managing solutions”.

In particular environmental innovation for products seems to be mostly driven by the strategic market behaviour of firms, while for process it is more driven by regulation (K. Rennings, 2000, p. 327).

A point widely debated is the degree of regulation necessary. M. E. Porter and C. van der Linde, (1995, p. 98) say that “strict environmental regulations, by stimulating innovation, can actually enhance competitiveness”. This is because the incentive to innovate involves both firms selling environmental solutions and those having to comply. The World Bank and the World Resources Institute are of the same opinion, affirming that there is not an inverse correlation between high environmental standard and international competitiveness (Network of Heads of European Environment Protection Agencies, 2005, p. 5).

“The highly regulated markets and their environmental standards, like the European Union, strongly influence other exporting nations. Global diffusion of best practice in environmental policy has become an important driving force for the diffusion of marketable technical solutions for environmental problems that typically exist on a global scale” (K. Jacob, M. Janicke, p. 36).

The Article 174 of the Treaty provides for Community policy to be based on the ‘polluter pays’ principle. In order to implement this policy, the Community has to use a series of different instruments: regulation, and in particular the adoption of standard, but also voluntary agreements, informational devices or economic instruments such as eco-labels, eco-taxes and tradable permits (European Commission, p. 5).

The first environmental policies were based on regulation, while the other instruments, called New Environmental Policy Instruments (NEPIs) are of more recent adoption (A. Jordan, R. Wurzel, A. Zito, L. Brückner, p. 4).

Government have tended to respond to community demands for better environmental outcomes via regulatory responses, but they often failed in achieving their goals or they were too costly. This is the reason why governments are starting to look for other instruments.

For a number of decades the environment has been regulated through an approach characterised as “command and control” (e.g. through Integrated Pollution Control[5] and Integrated Pollution and Prevention Control[6]), that represented the first attempt to stimulate the development and the adoption of cleaner technologies. These instruments consist in the imposition by law of emissions limits, as well as bans and penalties, and the mandatine of specific technology. They are aimed at the prevention and repression of the polluting activities. Generally the observance of the imposed limits implies the installation of filters for the pulling down of the polluting substances. In fact the regulations just stems a forward problem of the production cycle: this is the reason why they are generally defined as “end of pipe solutions”. The “command and control” instruments are mainly directed to regulate the environmental impact of the activities though they don’t involve all the production cycle e they tend to maintain a kind of continuity with the past. Thus they partially failed their goal to make technological innovations. Moreover the compliance to the restriction of the standards means for the firm to support more costs for the devices required, their maintenance and operation.

Market-based instruments are more and more accepted as important policy instruments for achieving environmental protection goals, because they let achieve efficiency gains compared to traditional regulatory instruments, meeting the different criteria of effectiveness, efficiency and flexibility.

“Market-based instruments are broadly defined as instruments or regulations that encourage behaviour through market signals rather than explicit directives”, so that the achievement of outcomes is based upon the self-interest of individuals and firms and their cost structures are taken into account. On the contrary under a command and control instrument only the achievement of the target is required and there are a few incentives to go beyond the target. Furthermore if the technology to be used is specified there is no incentive to search for cheaper or more effective technologies (D. Collins, M. van Bueren, S. Whitten, 2003 p. 2,3). “Under a market-based policy firms that perform better than required by such regulation face continuous rewards, because their tax payments can be lowered” (H. Vollebergh, 2007, p. 4).

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[5] IPP seeks to minimise environmental degradations of products by looking at all phases of a products’ life-cycle and taking action where it is most effective

[6] IPPC Directive is based on several principle, namely an integrated approach, best available techniques, flexibility and public participation.

In the *voluntary agreements* standards are negotiated between government and industry. Since the late 1980s and early 1990s, industry has taken ever more voluntary initiatives in the field of environmental management. Examples are environmental codes of conduct, publication of environmental reports, design of environmental management systems and establishment of environmental standards (B. Arts, p. 188). They can provide for quick progress due to rapid and cost-effective implementation. They allow for flexible and adjusted adaptation to technological options and market sensitivities.

However self-regulation is not always a feasible option, in particular in sectors where the market is very fragmented. There are also drawbacks: self-regulation is not binding on all industry members (there is the possibility of having "free riders") and cannot, like legislation, be enforced in the courts; compliance consequently cannot be guaranteed.

Informational devices such as eco-labelling provide information about the environmental performance of products and services, allowing consumer to make informed choices in what they buy. In reality eco-labels can be seen as market instruments as well as informational devices. The consumers' sensitiveness to environment is essential for the eco-labelling programs to be effective. The Council of Ministers of the European Community introduced the European eco-label, which is symbolised by a flower, in 1992 (Figure 1). It is a voluntary scheme, like similar state eco-labels, aiming at promoting products that are less damaging to the environment compared to functionally equivalent competing ones. The problem is the co-existence and the competition of different eco-labels at state level, that are an important obstacle to the harmonization of standards within the EU. At global level in recent years we assist to the efforts of international organization to harmonize the initiatives of the Global Eco-labelling Network (GEN), the International Standardization Organization (ISO) and the OECD (Kern, Kissling, Landmann and Mauch, 2001, p. 4, 8, 9). Finally, in eco-labelling programs the use of Life-Cycle Approaches (LCA) is aiming at the evaluation of the overall environmental effects of products in all their life stages (Abe, Higashida, Ishikawa, 2000, p. 3).

Figure 1 here

The expression “environmental technologies” has to be interpreted in a broad view not including only “end of pipe” devices to clean up pollution, but all the technologies that prevent pollutants being generated during the production process, as well as new materials, energy and resource-efficient production processes, environmental know-how, and new ways of working. It is therefore necessary to refer to the environmental technologies throughout the economic system (EuroEnviron, p.6).

Eventually it has been preferred to tend towards economic-fiscal instruments, like taxes and subsidies, able to involve technological innovations aimed at the protection of the environment in all the phases of the production cycle, so that, pushing the reduction of the emissions even beyond the standards, the innovator can have economic benefits, while the polluter is subject to the sanctions provided for by law.

We analyze two kind of economic-fiscal instruments: the *tradeable permits* and the *eco-taxes*.

The idea underlying tradeable permits was stated by Coase forty years ago, but only in the last decade they have been implemented, above all in the US. A tradeable permit can be defined as a transferable right to a common pool resources. When we discuss about environment they are air or water that do not have concentration of substances degrading their quality in some manner (Ellerman D., 2005, p. 123-124).

There seems to be little consensus on what constitutes an eco-tax, so that its definition is somehow difficult and a little bit vague. The basic idea behind eco-taxes is to use our environment paying for it as it was a ‘commodity’ (Diefenbacher H., Teichert V., Wilhelmy S., 2002, p. 11). Current definitions can include one or more of the following: emissions taxes that set their rates according to the amount of emissions and extent of environmental damage known as, ‘Pigouvian taxes’, indirect taxes on production inputs or consumer goods whose use can damage the environment (for example, excise taxes on gasoline), environment-related provisions in other taxes, accelerated depreciation provisions and lower tax rates for equipment and production methods that save energy and reduce pollution.

In figure 2 per capita revenues from environmentally related taxes collected in the EU countries are represented. Environmentally related taxes are any compulsory, unrequited payment to general government levied on tax-bases deemed to be of particular environmental relevance. Taxes are unrequited in the sense that benefits provided by government to taxpayers are not normally in proportion to their payments[7].

Figure 2 here

Figure 3 shows the results for the 2005 Summary Innovation Index (SII). It provides an overview of the relative national innovation performances and it is based on a number of available indicators which can vary from twelve to twenty depending on the country.

Figure 3 here

In both figures 2 and 3 countries that are in the first positions are pretty much the same and are those of Northern Europe. This could mean that more innovative countries take much care of problems related to environment. This consideration is, of course, very partial, because it doesn't take into account all the other instruments, but the taxation, of the environmental policies.

Both taxes and tradable permits require the possibility to measure the emissions. If measurement is not feasible or it is costly, the alternative is to prescribe the appropriate abatement technology or set of practices (Ellerman D., 2005, p. 127-128).

According to N. Lee (1997, p. 253) "regulatory instruments tend to perform relatively better in terms of their administrative feasibility, institutional compatibility, and, in certain cases their environmental efficiency. In contrast, economic instruments have greater potential in terms of cost effectiveness and, in certain cases, economic efficiency". This is the reason why there is a broad consensus that for the environmental policy to be most effective, the best approach is to use a combination of instruments, mixing NEPIs and the traditional command and control approach. The Commission of the European Communities (2006, p. 13) seems to be of the same advise: "the pull of eco-innovation can be enhanced by environmental policy, notably through a well-designed regulation and the development of market-oriented instruments. Eco-

[7] www.oecd.org/env/policies/database

innovation can also be promoted by fostering cooperation between research and enterprises in promising areas, such as construction, water management, bio-industries, carbon capture and storage or recycling".

4. The European Union *Environmental Technologies Action Plan*

On 28 January 2004, the Commission adopted the Environmental Technologies Action Plan (ETAP), a joint initiative between the Directorate General for Research and the Directorate General for the Environment with the aim of stimulating both the development and deployment of technologies which, in the words of the Commission's Communication, "reduce pressures on our natural resources, improve the quality of life of European citizens, and stimulate economic growth".

ETAP seeks to exploit the potential of environmental technologies in order to improve both the environment and competitiveness, thus contributing to growth and possibly creating jobs. Therefore ETAP is one of the elements of the Lisbon Strategy as it aims to improve the environment and the economy at the same time. This was reconfirmed at the European Spring Summit in 2005 where environmental technology as a key to growth was a part of the agenda.

To implement ETAP a number of actions have been highlighted by the European Commission and stakeholders, such as industry and national and regional governments.

Three of these are in the field of research: the strengthening of research on environmental technologies and the dissemination of results, the establishing of technology platforms for complex technologies and the setting up of networks for testing centres. The first action includes support of demonstration and replication of promising techniques, and the co-ordination of EC programmes in this field.

As regards the second point a technology platform is a mechanism that, bringing together all interested stakeholders, increases synergies and innovation efforts to develop and foster a specific technology or solve particular issues (CEC, 2004, p. 10). They should coordinate research and improve partnership and funding more effectively. Four ETAP relevant technology platforms were operating in 2004: hydrogen and fuel cells, photovoltaics, water and steel. These platforms bring together researchers, public and private bodies and financing institutions with a shared interest in the particular technology sector.

The last action aims at building confidence among consumers and industry by validating the performance of new technology. Testing centre networks have been established along sectorial lines, such as soil decontamination and renewable energy.

The other actions that should be undertaken are related to the improvement of market conditions to remove the barriers to a more extensive use of environmental technologies. “These include the lock in to existing technology, price signals that favour less eco-efficient solutions, difficult access to finance and low consumer and purchaser awareness” (CEC, 2004, p. 13). In this perspective ETAP has identified the following actions: to define performance targets, to improve the financing of environmental technologies by introducing enhanced funding and risk-sharing mechanisms, to prepare the future cohesion policy (this includes developing market-based instruments and reviewing state-aid guidelines and environmentally harmful subsidies), to encourage public procurement of environmental technologies, to increase business and consumer awareness, to promote environmental technologies and responsible investments in developing and in transition countries.

The most appropriate way to assist the promotion of environmental technologies has been identified by the Commission in the ‘Open method of coordination’, through the exchange of information on best practice and, where it is possible in the setting of indicators to compare them and of guidelines and timetables for the action programme for all the EU.

To foster experience sharing on eco-innovations and on best practices, the Member States were invited to formalise their national transposition of strategies and action plans towards environmental technologies. The aim of the ETAP roadmaps is to help focus on relevant (to environmental technologies and eco innovations) plans, actions, and achievements.

5. The networking and clusters in the EU

Smaller firms and potential new entrants tended to develop more innovative responses. A possible explanation for this is that incumbent firms, especially the big ones, are vested in old technology, both economically and mentally (R. Kemp, 2000, p. 36), while the small ones are more flexible and receptive to change.

Another competitive advantage for firms is their participation in learning networks. This increase their possibility to adopt eco-innovation because of co-evolution. This is because networking reduces the wastage associated with the assumed "trial and error" nature of eco-innovation" (M. Blum-Kusterer, S. Salman Hussain, 2001, p. 304).

In this perspective the role of clusters is extremely important. They are networks of enterprises, researchers, public authorities and funding organisations with similar interests that cooperate to improve their competitive capacity (A. Honkasalo, 2000, p. 3).

Clusters are recognised as being the most significant and efficient structures for fostering competitiveness at regional, national and international level. Enterprise clusters and networks are considered important platforms for regional development and SME growth; they improve productivity, increase innovation capability, facilitate the commercialisation of innovations, and generate employment.

In the European Union there are more and more initiatives to promote clusters and their connections. We attempt to present here the main European initiatives in this field.

CENCE has been created to establish a cooperative learning platform focussed on knowledge, know-how, and exchange of experience and best practices that facilitated the promotion of entrepreneurial innovation through Connecting Energy Clusters across Europe. The fields investigated are: Renewable Energy Sources, Energy Efficiency and Distributed Energy Resources.

CENCE aims at identifying regional competences through the mapping of energy clusters, analysing success factors and barriers to innovation in the EU Energy clusters, raising awareness of networking Energy Clusters and at laying the foundations for a 'mega-cluster', establishing joint collaborative projects and innovative strategies between participant clusters. With all the information collected policy recommendations to foster the development of Energy Clusters through the EU are provided.

Another initiative worth stressing is that of ‘**Forum: Science and Innovation for Sustainable Development’.** It is a collaborative, virtual effort to draw together emerging ideas, relevant activities, key documents and web sites concerning science and technology for sustainability.

Forum seeks to facilitate information exchange and discussion among the growing and diverse group of individuals, institutions, and networks engaged in the field of science and technology for sustainability. In this spirit, the Network is an effort to help build a community linking disparate scholars, managers, and decision makers, and to promote the sharing of knowledge, ideas, and goals among a community working on science and technology for sustainability.

The **Innovation Research Centres** support innovation and transnational technological co-operation in Europe with a range of specialised business support services. The first ones were established in 1995 with the support of the European Commission. The aim was to create a pan-European platform to stimulate transnational technology transfer and promote innovation services.

IRC services are primarily targeted at technology-oriented small and medium-sized enterprises (SMEs), but are also available to large companies, research institutes, universities, technology centres and innovation agencies. Today there are 71 regional IRCs distributed in 33 countries, that are the EU Member States and Iceland, Israel, Norway, Switzerland, Turkey, Chile.

IRCs collaborate with other networks: Cordis, EBAN, ESA, Eureka, IPR_Helpdesk, IRE, Proton Europe.

CORDIS (Community Research & Development Information Service) is an information space devoted to European research and development (R&D) and innovation activities.

The main aims of CORDIS are: to facilitate the participation in European research and innovation activities, to improve exploitation of research results with an emphasis on sectors crucial to Europe's competitiveness; to promote the diffusion of knowledge fostering the innovation performance of enterprises and the societal acceptance of new technology.

The **European Business Angel Network (EBAN)** gathers at European level national federations of networks and regional networks at with the following objectives: promote the exchange of experiences and good practices, promote the role of business angels and their networks near public authorities, promote codes of conducts and the professionalisation of the industry.

Business angels networks play a crucial role in the matching process between the demand for capital (entrepreneurs) and the offer of capital (business angels). It is a market place for these two economic actors.

Business Angel Networks (BAN) can be active at national level, but in most European countries they are active at regional level. They source business angels and entrepreneurs in their regions, and match their projects with regional capital.

ESA (European Space Agency)'s Technology Transfer and Promotion Office is supported by an international network of companies specializing in brokerage and in the provision of technical and commercial expertise for space technology exploitation. Under the lead of MST Aerospace GmbH (D), the ESA Technology Transfer Network (TTN) members perform the key activities for the Technology Transfer Programme in all ESA member states including Canada.

The members of the Technology Transfer Network include: MST Aerospace GmbH (Germany), JRA Technology Ltd (UK), NODAL Consultants (France), D'Appolonia S.p.A. (Italy), INASMET/TECNALIA (Spain), CREACTION INT. SPRL (Belgium), FSRM (Switzerland), IVF (Sweden), SINTEF (Norway), CRESTech (Canada), EARTO (Belgium) and T4Tech (Italy).

The IPR-Helpdesk provide information on Intellectual Property Rights issues to the potential and current contractors who take part in EC-funded research and technological development projects.

The **Innovating Regions in Europe** (IRE) network is the joint platform for collaboration and exchange of experience for regions that are developing or implementing regional innovation strategies and schemes and it is open to all European regions. The majority of the IRE member regions have undertaken Regional Innovation Strategy projects with support from the European Commission.

ProTon Europe is a pan-European network of Technology Transfer Offices (TOs) and companies affiliated to universities and other Public Research Organisations (PROs).

The purpose of ProTon Europe is to support the professional development of Knowledge Transfer Offices across Europe through networking, the exchange of good practice, staff exchanges and the delivery of appropriate training.

Conclusions: key strategies for eco-innovation

Eco-efficiency is a management philosophy that fits with competitiveness and allows firms to move from prescriptive regulations to greater self-regulation and market-based policies. The main strategies for eco-efficient innovation are: making companies proactive, improving sustainability assessment by companies and customers, improving the system of innovation for eco-innovation, targeted policies for eco-innovations, the use of market based instruments, policy integration. If company self-regulation is to play a major role, regulation and eco-taxation must provide incentives for this (R. Kemp, M. Andersen, 2004, p. 7).

Timo Makela (2006) affirms the necessity to combine different approaches, such as the promotion of R&D in environmental technologies, the verification and labelling of new technologies, the improvement of opportunities for investment and risk capital, better market instruments (i.e. national taxation and reform of state aid) and the greening of public procurement to make environmental technologies and eco-innovation take off .

As concerns R&D there are different policy instruments that can be used to directly stimulate them: patents awarded for new technologies, ex-ante subsidies for R&D through research contracts or research tax credits, prizes awarded ex post for new technologies. The problem is that there is not so much quantitative work on the relative economic efficiency of these policy instruments.

The challenge for policy makers is to combine normative (environmental approvals, integrated pollution prevention control, differentiated enforcement), economic (financial support programs for cleaner technology, EMAS, cleaner products, green taxes on resource consumption and emissions, green public procurement), information (eco-labels and other product declarations, green accounts/environmental reporting) and institutional instruments (self-regulation, ISO, 14001, LCM, eco-design, voluntary agreements, stakeholder participation).

A way to use regulation in a more efficient way is by limiting the period of existence of the standards, so that industry is motivated not only to adopt incremental solutions, but to innovate (Porter M. E. & Van der Linde C., 1995, p. 113).

ETAP stresses the role of several key areas to foster eco-innovations. First of all some market barriers have been identified and have to be overcome if Europe wants to exploit the opportunities of eco-innovation. One of them is the difficulty to have access to finance for the companies that work in the field of eco-innovation. The mobilization of risk funding, with the support of EU financial instruments, in particular for SMEs would be a positive step. At present, investments in eco-efficient innovations have longer risks for investors. The Netherlands offers an example of how Member States can achieve this as it promotes green investments funds, managed by commercial banks, by granting tax reductions to private individuals investing in such a fund. This increases the available capital for companies active in this market. The fact that the Sixth Research Framework Programme (FP) (2000-2005), devoted significant resources to both the development of environmental technologies and on research on socio-economic drivers, external costs and societal attitudes is a good signal, but there is also the potential to further improve the existing funding mechanism, including the European Investment Bank, in key technology areas (CEC, 2004, p. 9). Secondly environmental performance targets should be established for key products, processes and services, allowing producers to innovate and compete on environmental technologies. Finally Member States should set national roadmaps for implementation, with concrete measures and deadlines. National action plans should also be drawn up for green public procurement (European Commission, 27 January 2005).

At a micro level firms' innovation policy can be affected by government regulation, covenants, subsidies in R&D, procurement policies, subsidies given under the conditionality of adopting a particular technology. Unfortunately we don't know so much about the effect of the different policies on environmental innovation and what are the best incentive for the firms (R. Kemp, A. Arundel, 1998 p. 16).

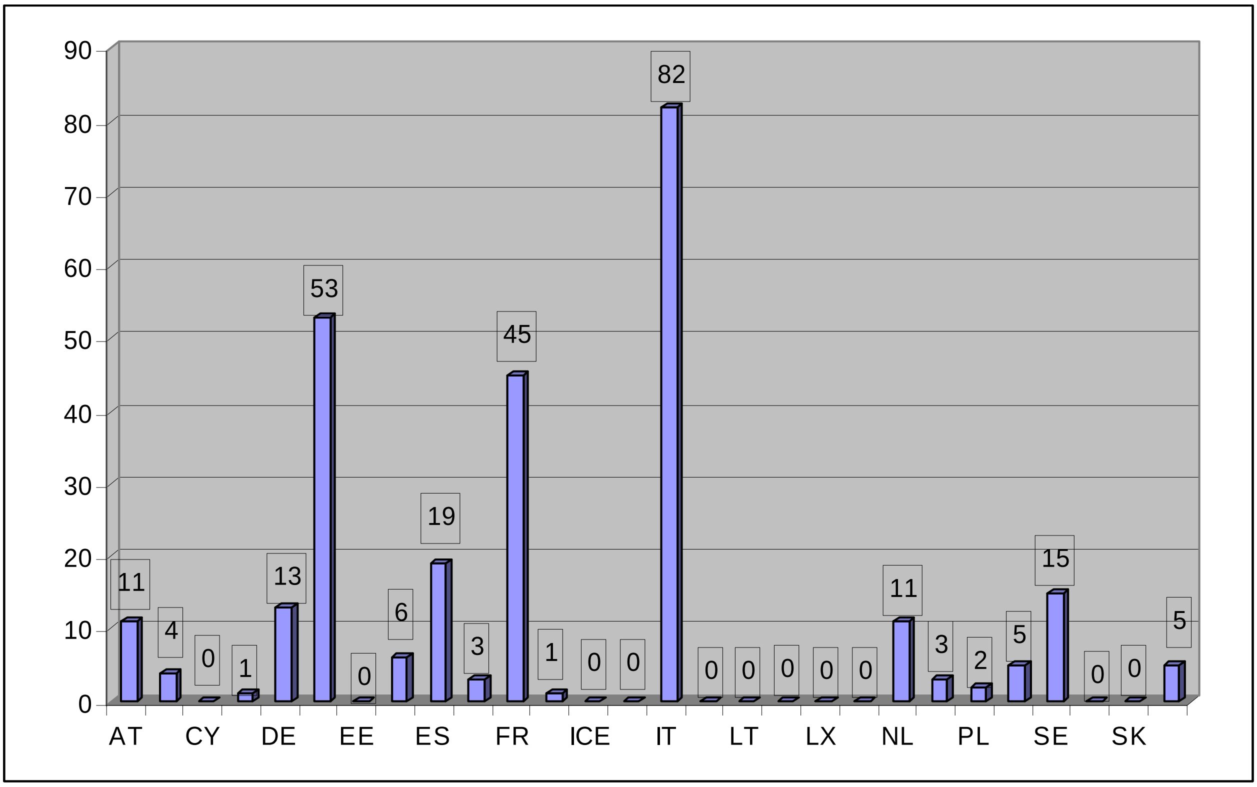
"A public sustainable innovation policy guiding investment and innovation in the direction of cleaner technologies and eco-markets has to include tools that stimulate both the supply and the demand side. On the supply side it is necessary to strengthen the knowledge infrastructure including an appropriate division of labour between the involved actors (firms, universities, and the technological service system). On the demand side it is necessary to create a market for cleaner technologies by for instance public procurement, economic incentives, and financial support" (B. Gregersen, B. Johnson, J. Orozco, A. Remmen, O. Segura, p. 13).

One of the key feature of the knowledge economy is the interaction between industry, government and university (P. Cooke, p.133, 136). "At regional level, particularly when there is a regional governance structure, presence of knowledge centres, finance, and industry clusters, policies are being developed to support clusters by creating 'economic communities' within a multilevel governance structure to develop access to global markets". A better governance structure is necessary to implement policy that promote innovation. "For policy reason both the regional and the national level is important, emphasizing international benchmarking within EU countries" (M. Andersen, 2005, p12).

In this perspective the establishment of strong innovation systems with innovation drivers like education, research, knowledge transfer, entrepreneurship and finance in all the Member States is a priority. The movement from regulation to innovation approaches emphasizes the importance of collaboration networks. The Lisbon Strategy provides a forum for policy discussions and the exchange at EU level of best practices on innovation in the context of the treaty-based multilateral surveillance. Regions should be involved in the preparation and implementation of the National Reform Programmes, because they have the main competence to foster innovation. Another important initiative in this direction is the creation of networks of regions to develop best practices in key areas such as research and innovation (Commission of the European Communities, 2006, p. 15). The Article 16(2) of the IPPC Directive requires the Commission to "organise an exchange of information between Member States and the industries concerned on best available techniques, associated monitoring, and developments in them" and to publish the results of this information exchange.

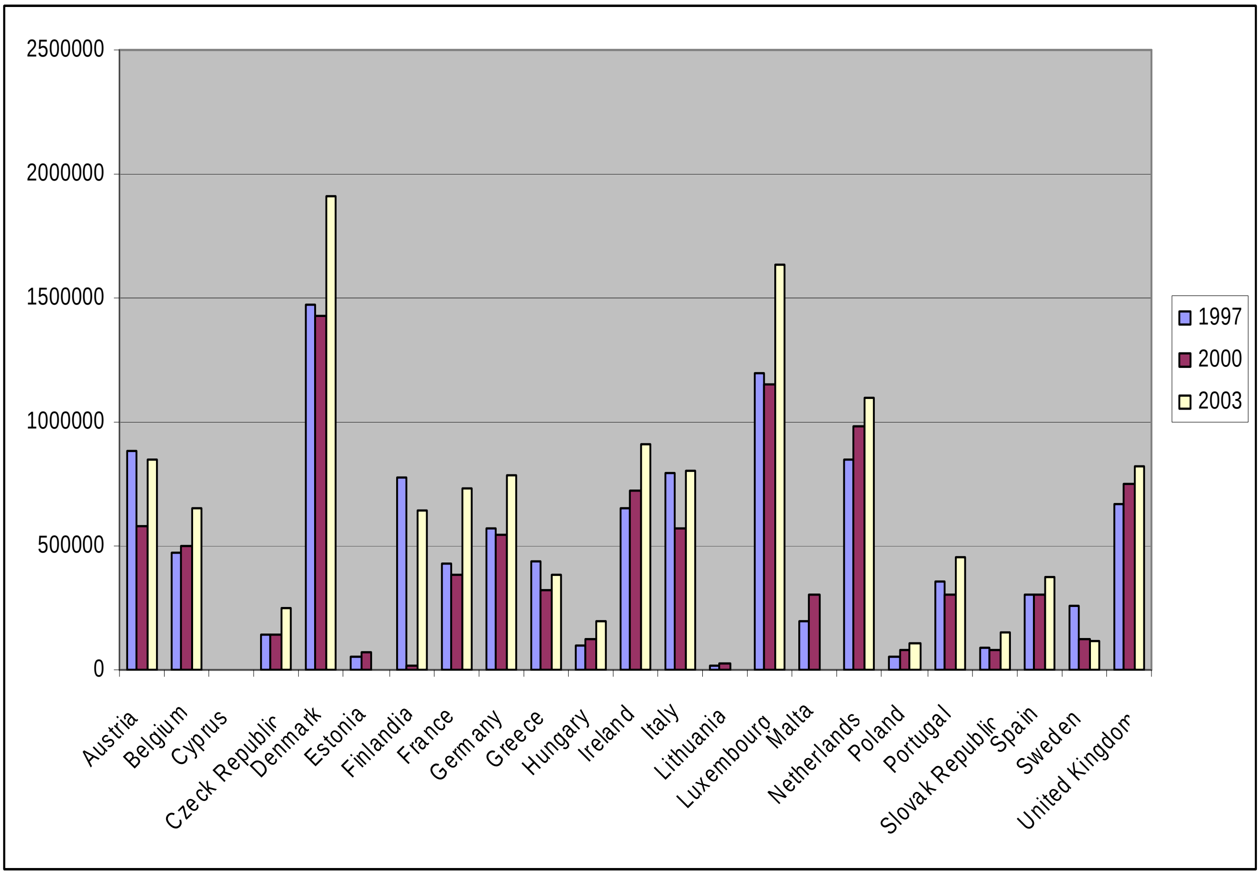
The role of the private sector is of enormous importance. It has to support the action of governments aimed at the diffusion and use of environmental technologies through the international trade (CEC, 2004, p.24, 25) and companies must start to look at the environment not as a burden or as a postponable threat, but as a competitive opportunity.

Figure 1. The companies with the European eco-label by country



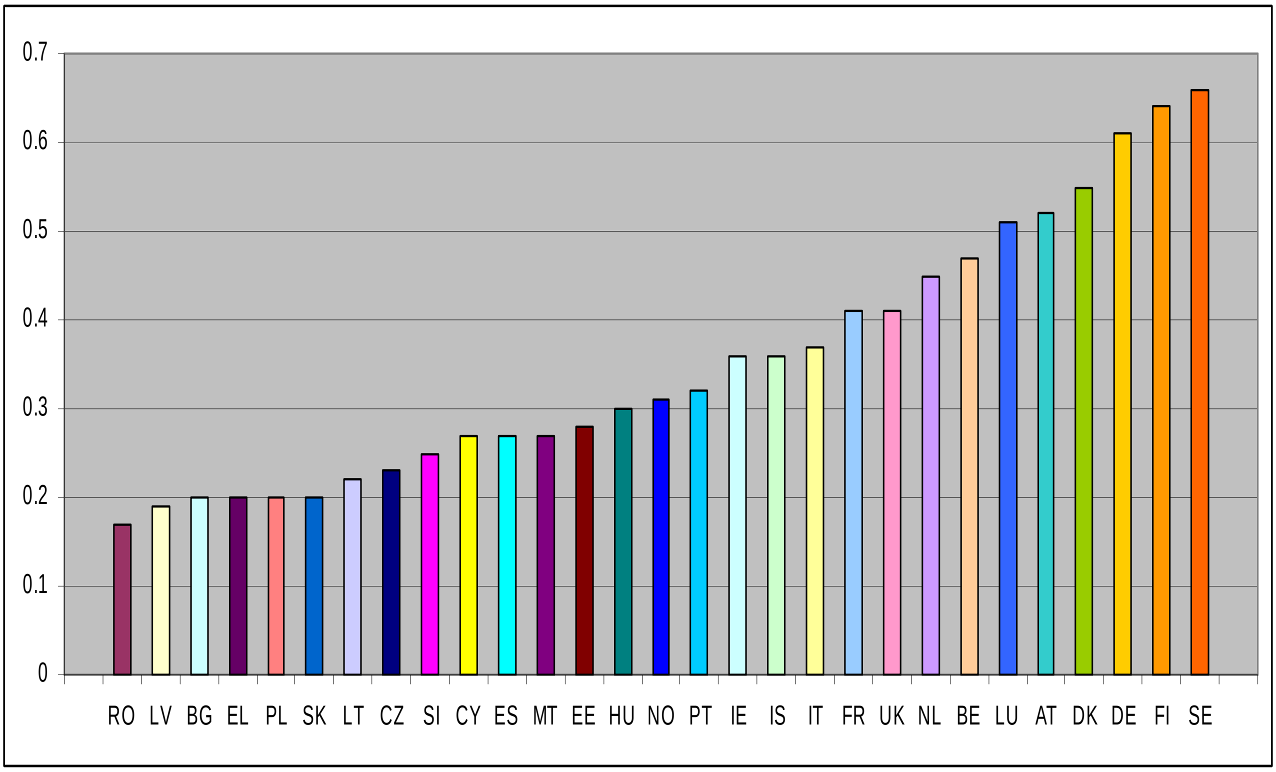
Source: http://ec.europa.eu/environment

Figure 2. Per capita revenues from environmentally related taxes



Source: Author's elaboration on data from EUROSTAT and OECD/EEA database

Figure 3. The 2005 Summary Innovation Index (SII)



Source: http://trendchart.cordis.lu

Bibliography

Abe, K.; Higashida, K.; Ishikawa, J. (2000), Eco-labelling, Environment, and International Trade, work in progress, School of economics, Osaka University, Japan.

Andersen, M. (2004), An innovation system approach to Eco-innovation. Aligning policy rationales. Presented at the conference "The greening of policies-Interlinkages and Policy Integration Conference. 3-4 December 2004, Berlin, Germany.

Andersen, M. (2005), Eco-innovation indicators. Background paper for the workshop on eco-innovation indicators. 29 September, Copenaghen, Denmark

Andersen, M., Kemp R. (2004), Strategies for eco-efficiency innovation. Eco-innovation-making both ends meet. IMR Strategielijnen project voor VROM

Arundel, A., (1998), Survey indicators for environmental innovation. IDEA paper series, Maastricht, The Netherlands

Artis M. J. & Lee N. (Eds). (1997), The economics of the European Union. Policy and Analysis, New York: Oxford University Press

Ashford, N. (2000), An innovation-based strategy for a sustainable environment.

Beise M.; Rennings K., Lead markets and regulation: a framework for analyzing the international diffusion of environmental innovations.

Bleischwitz, R. (2002), Cognitive and Institutional Perspectives of Eco-Efficiency. A new research landscape towards factor four (or more).

Bleischwitz, R. (2002/1), Governance of eco-efficiency in Japan. An institutional approach. *International Quarterly for Asian Studies, 124*

Blum-Kusterer M.; S. Salman Hussain (2001), Innovation and corporate sustainability: an investigation into the process of change in the pharmaceuticals industry. *Business strategy and the environment, 10*, 300-316,

Brückner, L., Jordan, A., Wurzel, R., Zito, A. (2001), The innovation and diffusion of "new" environmental policy instruments (NEPIs) in the European Union and its member states. Presented at the conference "The human dimensions of global environmental change. Global environmental change and the nation state".7-8 December 2001, Berlin, Germany.

Collins, D., van Bueren, M., Whitten S. (2003), An overview of market-based instruments and environmental policy in Australia. Presented at AARES Symposium.

Commission of the European Communities (2002). Sustainable development in the EU manufacturing industry. *European competitiveness report*, p.96.

Commission of the European Communities (2004), Communication from the Commission to the Council and the European Parliament. "Stimulating technologies for sustainable development: an environmental technologies action plan for the European Union".

Commission of the European Communities (2006), Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions. "Putting knowledge into practice: a broad-based innovation strategy for the EU", p. 49.

Cooke, P. (2002), Regional Innovation Systems: General findings and Some New Evidence from Biotechnology Clusters. *Journal of Technology Transfer*, 27, 133-145.

Diefenbacher, H.; Teichert, V.; Wilhelmy S. (2002), Ecological tax reform as an instrument for sustainable development, FEST, Protestant Institute for Interdisciplinary Research, Heidelberg.

ECOTEC Research and Consulting, Analysis of the EU Eco-Industry, their Employment and Export Potential.

Ellerman A. D. (2005), A note on tradable permits, *Environmental & Resource Economics*, 31, 123-131.

Esty, D. C. (2001), Ranking national environment regulation and performance: a leading indicator of future competitiveness?. Harvard: Institute for strategy and competitiveness. Retrieved April 4, 2006 from www.isc.hbs.edu

EuroEnviron (2004), Green Innovation for the Future. Action Plan for the period 2004-2008. Retrieved April 8, 2006, from www.EuroEnviron.com

European Commission (27 January 2005), Environmental Technologies: reinforcing action plan to maximise contribution to Lisbon goals.

European Community (2001), Community Guidelines on state aid for environmental protection. *Official Journal of the European Communities*, *C 37*, 3-15.

Gislev, M. (2000), European innovation and exchange of information about BAT, 6 and 7 April 2000.

Gouldson, A.; Murphy J. (2000), Environmental policy and industrial innovation: integrating environment and economy through ecological modernisation, *Geoforum*, *31*, 33-44

Gregersen, B. Johnson, B., Orozco J., Remmen A., Segura O. (2005), Policies for innovation and sustainable development in central America. SUDESCA Research Papers N. 33, 1-31, Aalborg University, Denmark

Helminen, R. (2000), Developing tangible measures for eco-efficiency: the case of the Finnish and Swedish pulp and paper industry. *Business Strategy and the Environment*, 9, 196-210.

Honkasalo, A. (2000), Environmental cluster research programme. Ecoefficiency, entrepreneurship and co-operation to create and utilise innovations. Workshop on Innovation and the Environment, 19 June 2000.

Jacob, K.; Janicke, M. (2004), Lead markets for environmental innovations: a new role for the nation state. *Global Environmental Politics*, Vol. 4, N. 1 (2004), pp. 29-46

Kemp, R. (2000), Technology and environmental policy: innovation effects of past policies and suggestions for improvement ,paper for OECD workshop on Innovation and Environment, 19 June 2000, Paris, p. 35-62.

Kern, K.; Kissling-Näf , I.; Landmann, U.; Mauch, C. (April 2001), Ecolabelling and Forest Certification as New Environmental Policy Instruments. Factors which Impede and Support Diffusion. ECPR workshop on “The politics of New Environmental Policy Instruments”, Grenoble.

Kivimaa, P. (2006), Is there a role for environmental policies in supporting innovation? Comparing experiences from products and production technologies. Presented at the conference “Innovation pressure”. 15-17th march 2006, Tampere, Finland.

Klassen R. D. & McLaughkin C. P. (1996), The impact of environmental management on firm performance. *Management science*, *42-8*, p. 1199-1214

Klassen R. D. & Whybark D. C. (1999), The impact of environmental technologies on manufacturing performance, *Academy of Management Journal*, *42-6*, p. 599-615.

Koenig-Archibugi, M. & Zurn M. (2006), New modes of governance in the global system. Exploring publicness, delegation and inclusiveness. New York: Palgrave Macmillan

Kok, W. (2004), Facing the challenge. The Lisbon Strategy for growth and employment, Report from the High Level Group

Kortelainen, M.; Kuosmanen T. (2005), Measuring eco-efficiency of production: a frontier approach, *Journal of Industrial Ecology, 9- 4*, p. 59-72.

Kubeczko, K.; Rametsteiner E. (2003), Sectoral issues of integrating environmental policy and innovation policy, Paper for the 5th Blueprint Workshop for the integration of science, technology and environmental policy, Brussels

Makela T. (2006), New generation. The new technological revolution will be led by eco-innovation. *Parliament magazine*. 20 february 2006.

Martin, S. & Scott J.T. (2000), The nature of innovation market failure and the design of public support for private innovation, *Research Policy, 29*, p. 437-447.

McGlade, J. (19 Aprile 2005), Perspectives for business, Europe and the environment. Speech to conference on eco-innovation: Potentials and challenges of tomorrow's technologies. European environment Agency, Copenaghen.

Network of Heads of European Environment Protection Agencies (2005), The contribution of good environmental regulation to competitiveness,

OECD, (1997), Oslo manual. The measurement of scientific and technological activities. Proposed guidelines for collecting and interpreting technological innovation data.

Porter, M. E.; Van der Linde, C. (1995), Toward a new conception of the environment-competitiveness relationship. *The Journal of Economic Perspectives*, Vol. 9, N. 4, pp. 97-118.

REC (Regional Environmental Centre for Central and Eastern Europe) (2004), Environmental policies and legislation and their impact on eco-efficient innovations in Czech Republic, Estonia and Slovenia. A final report to VROM.

Rennings, K. (2000), Redefining innovation – eco-innovation research and the contribution from ecological economics. *Ecological economics, 32*, 319-332.

Shrivastava, P. (1995), Environmental technologies and competitive advantage. *Strategic management Journal*, *16*, 183-200.

Steward, F., Opponent note: eco-innovation, environmental benefits, economic growth and job creation, Green Roads to Growth Forum

Vollebergh, H. (2007), Impacts of environmental policy instruments on technological change, Environment Directorate Centre for Tax Policy and Administration.

Warhurst, M. (2005), Environmental regulation, innovation and competitiveness-making the link, pp. 28-32

Consulted Websites

http://irc.cordis.lu/

http://www.europe-innova.org

http://cordis.europa.eu

http://www.eban.org/

http://www.esa.int

http://www.ipr-helpdesk.org/

http://www.innovating-regions.org/

http://www.oecd.org

http://www.protoneurope.org/

http://www.unep.org/

www.europa.eu.int/comm/environment/

http://ec.europa.eu/research/environment

www.wbcsd.org