Study on the Competitiveness of the EU eco-industry

Within the Framework Contract of Sectoral Competitiveness Studies – ENTR/06/054

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Preface

This report has been produced as part of the "Study on the Competitiveness of the EU eco-industry" commissioned by the European Commission Directorate General for Enterprise and Industry, within the context of the framework contract on Sector Competitiveness Studies (ENTR/06/054).

The report is published in two parts. The first part, which is covered in this document, provides the main results of the analysis for the EU eco-industries as a whole and cross-cutting policy issues, together with the Executive Summary. The second part, covered in a separate document, provides a review of particular eco-industries that have been perceived as core EU eco-industries for this study.

It has been quite a challenge finding appropriate quantitative information on the EU eco-industry. Various sources have been consulted and used bearing in mind their potential and limitations. The most important sources were Eurostat, OECD, and UN Comtrade. Beside literature on the subject, numerous interviews with stakeholders have been done providing valuable qualitative information. The relevant insights have been included in this report to the degree possible and in an independent manner. With respect to the micro economic analysis, substantial efforts have been done to establish representative stratified samples of companies. The help and feed-back of certain stakeholders for the sample composition has been greatly appreciated. Non-EU companies have been identified as well for a comparative analysis. Only the results from sub-sector samples that had a sufficient coverage have been included in this study.

The report has been written in 2009. This implies that much of the economic context was coloured by the economic crisis, the proportions of which became clear mid 2008. To the degree possible the research team took this into account. Especially through qualitative assessments and the interview reports the effects of the financial and economic crisis became apparent. Yet in terms of quantitative information, the crisis has not been reflected adequately, since most data, such as EU level sectoral indicators and harmonized company accounts, come with a substantial delay. Furthermore, at the final stage of the project, leading business indicators still did not show convincing evidence of a sustained recovery, leading to quite some uncertainty about the short to mid-term future economic outlook.

The analysis contained in the Report has been undertaken by a team of consultants from IDEA Consult and ECORYS Netherlands. Specific environmental technical expertise has been provided by a team of specialists from the Flemish Institute for Technological Research VITO. We would like to thank the numerous industry and company representatives who were willing to share their views on the subject. We are also grateful for the reflections of the Commission in the various phases of the project.

Dr. Valentijn Bilsen

Wednesday, 30th of September, 2009

Executive summary

The goal of this study is to perform a competitiveness screening of the EU eco-industries in order to identify factors which need to be addressed in the industrial competitiveness policy for eco-industries based on a quantitative economic foundation. The competitiveness screening should identify those framework conditions and possible market failures that are most important for industrial competitiveness. An important element of the study is the analysis of eco-industry's supply chain.

The European eco-industry has a great potential in contributing towards the goals of the Lisbon Agenda for growth and jobs. Therefore an industrial policy that is focussed at improving the competitiveness of the EU eco-industry, in synergy with other policy decisions and for other sectors, has a vital role in reaching the targets set by the Lisbon Strategy.

Definition

An essential element in the study is the definition of eco-industries. The study uses the OECD – Eurostat definition as a starting point and introduces a distinction between core versus so called connected eco-industries. The core eco-industries are "*those [identifiable] sectors within which the main – or a substantial part of – activities are undertaken with the primary purpose of the production of goods and services to measure, prevent, limit, minimize or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco-systems.*" Activities from the OECD list that do not fit this selection criterion will not be the main focus of this study. For example, 'eco-tourism' whose primary purpose is tourism, will not be included in the main analysis. We call these industries 'connected' eco-industries. Other examples of connected eco-industries are automotive, ICT, paper industry, chemicals. The study focuses on one particular connected industry: eco-construction, quite often labelled as sustainable construction or environmental building.

The study focuses on the following core eco-industries:

- Air pollution control
- Collection and treatment of waste and sewage (NACE 90)
- Renewable energy
- Recycling / recycled materials (NACE 37)

We also distinguish an overarching sector that plays a crucial role for the entire eco-industry: environmental equipment providers. The study does not analyse in a systematic way the sub-sectors noise and vibration control, water supply, and nature protection, although in parts where it is relevant information about these sectors has been included. Two of the core sectors can be identified in the NACE rev. 1.1 classification.

Key characteristics

In comparison to other industries, the major characteristic of the EU eco-industry is undoubtedly its diversity. The type of activities range from high-tech and complex services in e.g. renewable energy and air pollution control to mature and well established applications in recycling and waste treatment. This also implies that the sub-sectors have different innovation and technological potential, and therefore vary in finding and validating new opportunities for creating value added. SMEs are especially present in the so-called 'regulation driven' markets, such as air pollution control and eco-construction. Yet in the older sub-sectors such as waste treatment and collection large and multi-national companies are the major actors. Recycling is a case in particular with large companies at the top of the collection and processing chain and a base of SMEs that collect, sort and process at smaller scale and feed their output into the production of the larger ones.

The size of the EU eco-industry has been estimated using methods which rely strongly on environmental protection expenditure data and which are consistent with the ones of previous studies. This study finds that in 2008 employment reaches approximately 3.4 million. Total turnover is estimated to be more than 300 billion €. While the average growth in nominal terms was about 2% p.a. in previous reports, the current study arrives at a rate of 7% to 8% p.a.

In terms of micro-economic productivity the study found for a representative sample of companies, that on average for the period 2004-2006 the productivity of the EU eco-industry was higher compared to manufacturing and that the growth rates were higher. In this respect one can indeed observe that eco-industries are an important contributor to the Lisbon Agenda for growth and jobs. However, under this aggregate picture differences at sub-sectoral level are hidden. Renewable energy, eco-construction and air pollution control are clearly the sub-sectors that have a relatively higher average productivity than manufacturing, while the other sectors, recycling and waste treatment and collection have lower productivity values. Yet in terms of productivity growth the rates are higher than in manufacturing for all sub-sectors except sanitation and remediation.

One would expect that the relatively better productivity position in comparison to manufacturing would translate in similar profitability outcomes. This is not the case. Only renewable energy has substantial higher average profitability rates than the EU manufacturing industry. The other eco-industry sub-sectors have lower of similar profitability rates, even eco-construction and air pollution control. It has to be noted that these results do not include the effects of the economic and financial crisis which got its full momentum in Autumn 2008.

In terms of exploiting technological opportunities it has been observed that indeed the EU takes a leading role with market shares from 30% to 50% depending on the particular sub-sector. Sub-sectors where the EU is in a leading global position are recycling (50%), water supply (30%) and renewable energy (40%). In other areas such as bio-fuels BRIC countries are in the lead. Also in hybrid car technology, cradle to cradle and eco-design it is felt that the global competitors are in a relatively better position than the EU. Although technological solutions are very important, it has to be indicated that the EU competitiveness and its future relative position will be co-determined by the ability to develop economic feasible solutions.

Competitive position

What becomes clear when analysing the competitiveness of the EU eco-industry is that it is in a state of flux with major and rapid changes in public awareness, policies and regulations, and technologies. Even the definition of the sector is subject to change, as former 'conventional' industries are increasingly focusing on eco-activities, thus becoming eco-industries. Clear examples of this are found in the recycling industries – where former mining companies have refocused on recycling – and in the renewable energy sector, where traditional energy suppliers are increasingly incorporating green energy supply into their business models.

Within Europe, the New Member States are clearly still lagging behind the EU15 in terms of development of the various sub-sectors. But with the adoption of EU legislation, the market in the EU12 is expected to develop strongly and investment opportunities abound.

Our analysis has also illustrated the substantial differences that exist among sub-sectors in terms of their key competitiveness factors and driving forces. While all identified sub-sectors have shown strong development in the EU, globally parts of the waste management sector perform strongest, in addition to a number of sub-segments of the renewable energy sector (notably wind-energy and bio-mass). Key driving factors for the sector include policies and regulations as well as prices and availability of raw materials and fossil fuels. Technological development constitutes another important driver, but plays a more important role in for instance the renewable energy sectors and environmental equipment providers than it does in the waste management and recycling sub-sectors.

With increasing global awareness for environmental issues and the need for energy efficiency and emissions control, it appears increasing public budgets are becoming available for eco-industries worldwide. Particularly in developed countries these public investments are geared towards technological development and specifically R&D. As several sub-sectors are starting to become commercially viable and thus of interest for private investments, private capital appears to become more readily available for the sector. This is a trend which is already longer underway in the US where investments in the sector have until quite recently mostly been inspired by economic and less by ecological considerations. In Japan commercial banks have started playing a more important role in the industry and in the EU green investors are becoming more common and appear to be doing better in the current economic crisis.

As confirmed by many previous studies, the EU eco-industry has a competitive edge globally, in large part due to the early adoption of environmental policies and regulations and the fact that earlier than elsewhere Europe was confronted with the negative effects of environmental pollution. However this competitive position is coming under pressure from emerging countries like China, which have been highly successful in developing high-tech sub-sectors through FDI (e.g. photovoltaic). Furthermore, the micro-economic comparative analysis of the top 250 companies in particular sub-sectors suggested that even before the start of the crisis, companies in the rest of the world sample were able to generate on average a higher profit rate, even when productivity indicators were less favourable compared to the ones of the EU companies.

As internationalisation in many sub-sectors takes place through trade in services and investments as opposed to trade in goods, increasing environmental pressures, emerging legislation, international commitments and existing capacities in BRICs, there are clearly opportunities for EU eco-industries, particularly in the areas of waste management, recycling (integrated chain management) and specific segments of the renewable energy sub-sector.

In developed country markets too, EU eco-industries could potentially play an important role, if they target specific niche markets (e.g. capture of biogas from landfills in the US) and focus on high value added goods and services.

The interlinked nature of the sector implies its competitiveness must be gauged by taking a broader perspective, and there are clearly trends towards the development of partnerships between eco-industries and conventional industries and between the different eco-industries. Especially in international context this could create competitive advantages.

Supply chain

With respect to the EU eco-industry supply chain, the analysis in this study clearly illustrates the complexity of the interactions within and across the supply chains, and the fact that the boundaries between eco-industries and conventional industries are blurring, as both are in a state of flux. There has emerged a strong interdependence between eco- and conventional manufacturing activities. This interdependence is expected to increase, as conventional industries are moving towards green business strategies and implementing environmental technologies, improving resource efficiency and reducing emissions. The potential for contributing to these green business strategies will thus also increase for eco-industries, as they can increasingly add value, and even reduce costs through the integration of for instance on site water purification, energy production and/or heat capture. Further supply chain integration and 'convergence' between eco-industries and conventional industries thus seems to be taking place.

However, some challenges clearly remain, including not least the absence of a strong organising entity (lead firm) in most eco-industry supply chains, as can be found in e.g. the supply chains of the automotives industry, where original equipment manufacturers are strong organisers and integrators of supply chains, retaining control over the processes within it.

In addition there is the challenge of overcoming the various barriers to technology transfer, such as limited adoption and application capacity of environmental technologies in specific supply chains (weak innovation systems, where the technologies are available, but not reaching key clients and end-users) and the need for further development of capital markets for eco-industry or clean tech investments in conventional sectors. Moreover, technology transfer needs to take place between firms but also between countries and in this respect the heterogeneous implementation of the various regulations at Member States' level is a point of attention.

Public policy may have a role to play in mobilising and further integrating the supply chain, due to the specific nature of the sector, and the fact that it lacks strong lead organisers. By focusing on the development of integrated eco-supply chains, market opportunities and enhancement of competitiveness at a global level may be achieved. In addition, the potential for cluster development seems interesting and conducive to technology transfer and the tackling of sustainability issues.

Framework conditions

Looking at the framework conditions, one of the major hurdles the eco-industries has to deal with (especially some of its sub- sectors such as air pollution control and recycling), is the absence of a well functioning single European market. It is felt that there are enough regulations in place to have a good framework for doing business. For example, the Waste Framework Directive provides a sound framework to drive waste management practices in the EU. However, the lack of a uniform implementation and enforcement of all these directives, standards and certification procedures at the level of the Member States creates an uncertain and rather non-transparent business environment, which in turn makes doing business across Europe more costly. This puts a strain on investments and growth of the industry. A long-term stable policy framework with greater harmonization or co-ordination across the Member States, together with simplification of the often highly complex national regulations is therefore a crucial element for the future development of the sector.

Furthermore, there is no single labour market in Europe. Although the barriers to the mobility of people within Europe have been significantly reduced, labour market regulation remains a very complex matter across countries. In the environmental technologies industry, for example, the absence of an open global market for the attraction of non-EU talent is putting pressure on the competitive position of the European companies. Moreover, the technical evolutions and progress in the field of eco-innovation have altered the required labour skills. There is an increased need for new skills and a higher skill-level. Overall it can be indicated that educating and training of the current labour force and a revision of the inflexible labour market regulations are required to stay competitive.

Another important aspect that hinders the future competitive position of the EU eco-industry is limited access to finance in some of the capital intensive sub-sectors. The extent to which access to finance is an issue differs per sub-sector. In the recycling industry, for example, access to finance for innovation is not a real barrier to the sector's development. The main problem in this sub-sector is the fact that collaboration to get the necessary funds is absent. In the environmental technologies industry, however, investments are often considered to be riskier than other technology investments. These perceived risks have a negative influence on capital injections. Besides sub-sector, also the size of the enterprise matters as regards access to finance. Venture capitalists that are active in the market mainly focus on larger companies and projects. SMEs, however, have to rely on traditional local banks for their funding, which are rather risk-averse and are not specialised enough in the technological specifications of eco-industry projects to fully evaluate the risks involved. Furthermore, also the long pay back periods, the relatively high level of uncertainty, and the recent financial crisis have a negative impact on the level of funding-availability. It will therefore be of extreme importance to create an attractive climate for investment in order to persuade new investors. In this respect it has to be mentioned that the determination of policy makers to sustain the environmental goals and commitments in the recent crisis has certainly contributed to a positive investment climate. Also the introduction of sector specific standards and codes of conduct has already increased the confidence for bankers and businesses to invest in innovative products and services.

Policy suggestions

Ten potential areas for policy action have been formulated in this study. Although these suggestions are mainly focussed at the EU policy level, the industry is equally part of the solution, as well as the Member States. The policy recommendations envisaged are:

1. Improve the statistical observation of the EU eco-industry
2. Deepen the Sustainable Consumption and Production and the Sustainable Industrial Policy
3. Improve the functioning of the internal market for the EU eco-industry by harmonizing the implementation of directives, standards and certification procedures
4. Introduce EU-wide functional performance criteria where possible and technical standards where needed
5. Promote environmental skills development and move towards a better integrated internal labour market
6. Reduce asymmetric information between the eco-industry and its clients and suppliers
7. Promote eco-innovation and R&D
8. Provide financial support schemes to support the eco-industry's R&D and innovations that are strategic for the future, yet that cannot be funded by corporate funding due to the financial crisis.
9. Harmonize and promote green procurement
10. Promote open markets at a global scale and the actions that help to create a level playing field.

The first policy action is atypical, yet practical for monitoring the competitiveness of the EU eco-industry. Quantitative information about the EU eco-industry proved to be limited. Although at OECD and EU level a clear definition is available, the 'new' eco-industries such as renewable energy, air pollution control and eco-construction cannot be identified in NACE classification. A better identification of the relevant sub-sectors in a future version of this classification will be helpful for analysis of the EU eco-industry.

A deepening and development of the SCP and SIP Action Plan will be beneficial for the EU eco-industry since it provides a substantial part of the solutions, goods and services that help other industries, consumers as well as authorities comply with the environmental policies. Attention should be paid to avoiding potential distortions between various sectors and to creating a level playing field among the sectors. Also the consistency and interaction with other policy initiatives is important for future policy actions.

One of the most important, and also challenging, policy suggestions is undoubtedly the internal market functioning. The harmonisation of regulations and standards at the

Member States level is critical. It has been stressed by various stakeholders that a strong home market is a key factor for building a strong global position, which makes the internal market a crucial issue for improved global competitiveness. It is felt that at the EU level the necessary regulations are in place. Yet at Member States level the implementation in terms of standards and procedures varies considerably. This creates substantial administrative burden, which is relatively more costly for SMEs, and reduces benefits from scale economies.

For the highly dynamic industries such as renewable energy, environmental technologies, and air pollution control, functional performance standards for the EU as a whole are to be preferred rather than technology-based standardisation. However, it is important to have a 'common language' in terms of technical standards across Europe, especially in new technology applications.

Another important policy area is environmental skills and the EU labour market. The overall positive global competitive position for the EU eco-industry can only be retained if sufficient skilled labour can be attracted. Especially in environmental engineering and technology, skill shortages have been reported. Potential actions include the introduction of specific environmental technology degrees in regular education, job training programmes by the companies itself, and lifelong learning initiatives, and a more flexible policy towards attracting high skilled non-EU talent. Additionally, actions for improving the transparency of the EU job market would certainly help in filling particular and temporal skills shortages in the EU.

Policy actions that help bridging the information shortages between the eco-industry and other industries have important benefits. Inter sectoral co-operation is crucial for developing and valuing new opportunities. Yet due to the complexity and speciality of environmental methods, potential clients are not always aware of applications which might improve their competitiveness, e.g. through higher resource efficiency, moving into the environmental segment of their core market. Forums across industries might be important vehicles for knowledge transfer. Also the initiatives of the Framework Programmes are helpful in this respect.

Eco-innovation and R&D policies are important for the promotion of the EU eco-industry and its relations with the other, connected, industries. Sector initiatives combined with appropriate policy instruments that provide a vehicle to bring companies together are very helpful. Examples of the latter are the Framework Programmes and technology platforms. Also research programmes that are focussed on involving SMEs are beneficial, both at national and EU level. Other funding sources and policy initiatives such as Environment LIFE, the Structural Funds, the Cohesion Fund, and the Competitiveness and Innovation Programme (CIP) are important policy instruments for stimulating eco-innovation and have been well received by the eco-industry sector.

Access to finance is a crucial issue where policy actions can help enhancing the EU eco-industry's competitiveness, especially in times of financial crisis. Although the economic crisis has affected the eco-industry subsectors in different degrees, virtually all sub-sectors witnessed a pressure on the financing of innovation and R&D activities, particularly for SMEs. Getting innovations to the demonstration phase became more difficult. Providing (Member State level) credit guarantee schemes that are in line with EC competition policy has been an important instrument to help SMEs. Also the R&D support initiatives at EU and Member States' level are important instruments to keep the focus on R&D and innovation in times of crisis.

Green procurement can help to sustain the global competitiveness of the EU eco-industry by contributing to the formation of a home market. However in order to have the full benefits of the internal market in this eco-segment, the existing differences at Member States' level in procurement rules should be reduced.

The EU's current position as one of the most competitive regions in eco-industries can be valorised further by promoting open markets (trade policy) and creating a level playing field worldwide. This will enable EU producers and services providers to expand their trade and investments in other markets. Among others, this requires a global comparable certification and labelling development (voluntary) within both eco- and conventional industries. Also the removal of existing trade barriers with the rest of the world allows the EU eco-industry to benefit from its relative comparative advantage.

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List of abbreviations

APC	Air Pollution Control
C2C	Cradle to Cradle
CAPEX	Capital Expenditure
CIP	Competitiveness and Innovation Programme
CIS	Community Innovation Survey
CO_2	Carbon dioxide
CPC	Compound Parabolic Concentrator
CSP	Concentrated Solar Power
CSS	Carbon dioxide Capture and Storage
ECTP	European Construction Technology Platform
EEG	Erneuerbares Energien Gesetz - Germany's Renewable Energy Law
EGEC	European Geothermal Energy Council
EGS	Environmental Goods and Services
EPE	Environmental Protection Expenditures
EWEA	European Wind Energy Association
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GW	Gigawatt (is equal to one billion (short scale)(109) watts)
GWel	Gigawatt electrical energy
GWh	Gigawatt hour
GWth	Gigawatt thermal energy
IEA	International Energy Agency
IPP	Integrated Product Policy
IPPC	Directive on Integrated Pollution Prevention and Control
kW	Kilowatt (is equal to one thousand watts)
LCEGS	Low Carbon and Environmental Goods and Services
MW	Megawatt (is equal to one million (106) watts)
MWe	Megawatt Electrical
MWp	Megawatt Peak
NOx	Nitrogen oxide
ODA	Official Development Assistance
OE	Ocean Energy
OEM	Original Equipment Manufacturer
OPEX	Operating Expenditure
OTEC	Ocean Thermal Energy Conversion
PPP	Public Private Partnerships
PRB	Permeable Reactive Barriers
PV	Photovoltaic
SCP	Sustainable Consumption and Production

SIP	Sustainable Industrial Policy
SO_2	Sulphur dioxide
SOE	State Owned Enterprises
TFP	Total Factor Productivity
TGC	Tradable Green Certificate
TPWind	Technology Platform Wind Energy
UBA	Umweltbundesamt, the Federal Environment Agency of Germany
VOC	Volatile Organic Compounds
WBCSD	World Business Council for Sustainable Development
WSSTP	Water Supply and Sanitation Technology Platform

1 Introduction

The EU eco-industry is a relatively new sector compared to e.g. manufacturing. There is no such sector as ‘eco-industry’ or ‘environmental industries’ in the newly implemented NACE 2 industry classification, albeit that particular activities of the eco-industry can be better identified than in the NACE rev 1.1 classification. Especially in the last decade the environmental toll of global economic growth has become clearer, and quite a number of policies, both governmental and corporate, have been set in place to reduce the environmental footprint of the economy and reduce the use of raw materials. Eco-industries are instrumental in this. This implies that for a market economy, a competitive eco-industry is a prerequisite for sustainable economic growth.

It should not be surprising that the eco-industry is a heterogeneous and relatively complex sector. Therefore it is considered worthwhile starting this report with a chapter on the definition of the sector. It provides an analytical view that is helpful in identifying the various sub-sectors of eco-industry, its sub-markets and business activities. Of particular analytical relevance is also the distinction between core eco-industries on the one hand and the connected industries on the other. This study focuses mainly on the core industries, yet includes also insights on the interrelation with the connected industries and with the rest of the economy.

As a matter of providing introductory context, it is useful presenting the policy rationale for the study. This will be described in Chapter two. Subsequently an overview of the study’s objectives is presented. Chapter four covers the definition of the eco-industry and describes the various groups of activity that can be distinguished according to environmental market and type of business activities. Chapter five presents the key characteristics of the European eco-industry as a whole. An update of the size estimate along the lines of Ecotec (2002) and Ernst & Young (2006) will be presented, as well as the structure, performance and the general trends in technologies. Chapter six presents the various aspects of the competitiveness assessment, focussing on the competitive performance of the EU in comparison to the rest of the world, as well as intra EU competitive performance. Chapter seven presents the findings from the supply chain analysis based on the insights from the stakeholder interviews. Chapter eight focuses on the framework grid of the European eco-industry. The various framework conditions have been systematically reviewed both for the eco-industry and with respect to its relation with the other industries. Chapter nine presents the strategic outlook for the EU eco-industry as a whole over the medium to long term, and provides suggestions for potential policy actions and sector initiatives.

Substantial effort has been done in trying to obtain quantitative data on the various aspects of the EU eco-industry’s key characteristics and competitiveness issues. Data shortcomings posed a serious problem in trying to get a firm analytical grip on the EU eco-industry. The quantitative results presented in this report therefore only depict part of the competitiveness picture. Additional qualitative information, such as stakeholder interviews, and a literature survey, was used to get a deeper and wider view on the topic.

2 Policy rationale

The European eco-industry has a great potential in contributing towards the goals of the Lisbon Agenda for growth and jobs. Hence, in synergy with other policy decisions, industrial policy aimed at improving the competitiveness of the eco-industry has a vital role in reaching the targets set by the Lisbon Strategy.

Adequate industrial policy initiatives for eco-industry require a careful analysis of the eco-industry and the identification of potential obstacles that have negative repercussions on the industry's competitiveness. The competitiveness of the eco-industry is of particular importance since the sector plays a critical role in reaching the environmental targets that have been set at the EU-level. Furthermore, eco-industry has been identified as a sector with a substantial growth potential, which is instrumental in reaching the Lisbon targets.

It is hard to imagine any other industry where the growth, competitiveness and performance are more strongly inter-twinned with the (environmental) policy agenda and the regulatory framework conditions than the eco-industry. Another important driver for the eco-industry is technology. Regulations aimed at internalising the negative environmental and social externalities create business opportunities which can be exploited, provided that the appropriate technologies permit to do so. Increasingly, the scale of the market playing field is getting ever more important. In this respect the EU internal market and the global context matter.

The Spring European Council 2007 set three ambitious targets to be attained by 2020:
- A reduction of at least 20% in greenhouse gasses
- A share of 20% renewable energies in the total EU energy consumption, and
- 20% energy efficiency savings.

It is evident that the eco-industry plays a pivotal role in the realisation of these targets. On November the 22nd 2007 the EU Competitiveness Council endorsed the promotion of the transition to a low carbon economy through a new Sustainable Industrial Policy action plan. This plan has three pillars:
- An integrated product policy fostering the introduction of environmental friendly products on the market,
- A policy for industrial competitiveness for eco-industries, and
- An international response to climate change which aims at global sectoral agreements for energy intensive industries.

So far, the European Commission has not approached the eco-industries as a sector to which it applies the principles of industrial competitiveness. Yet the industry's potential in terms of job creation and contribution to the realisation of environmental policy targets is important. Furthermore, the eco-industry itself has a catalytic effect in promoting the competitiveness of European manufacturing industry and of the economy as a whole e.g. through improving resource efficiency, and providing new opportunities for other industries in the environmental market segments. Therefore the European Commission intends to launch a new competitiveness policy that is specifically geared towards the eco-industry.

3 The objectives

Introduction

The terms of reference for this study recognise that *eco-industries are instrumental in reaching the policy objectives of the European Commission – both in terms of the climate package and the growth and jobs agenda – and have become crucial for the competitiveness of our manufacturing industry and entire economy*. So far, however, the European Commission has not approached eco-industries as a sector to which it applied the principles of industrial competitiveness. Accordingly, to remedy this lack of attention and to contribute to the policy objectives of the European Commission, a competitiveness policy for eco-industries will be launched.

Taking account of the need to provide a solid and systematic analytical foundation to support the formulation of a competitiveness policy for eco-industries, overall task for the study as specified in the terms of reference, is *to perform a competitiveness screening of eco-industries in order to identify those key competitiveness factors which need to be addressed in the industrial competitiveness policy for eco-industries* and, through the successful undertaking of this task, to *provide a comprehensive quantitative/economic foundation of the competitiveness screening exercise*.

Furthermore, the terms of reference also make clear that – within the EU context, where the main role of industrial policy is *to proactively provide the right framework conditions for enterprise development and innovation in order to make the EU an attractive place for industrial investment and job creation, taking account of the fact that most businesses are small and medium-sized enterprises (SMEs)* – the competitiveness screening should identify those framework conditions and possible market failures that are most important for industrial competitiveness.

From the above, and from the specific objectives set out in the terms of reference, we can identify a set of key elements that should be addressed through the competitiveness screening to be undertaken through this study:

- A comprehensive description of the current situation and main developments of the eco-industry and its main sub-sectors.
- A systematic assessment of the competitive performance of the eco-industry in Europe. This assessment will examine both the competitive performance of the eco-industry within the EU and, also, in a global context. In turn, this should enable evidence to be presented on relative competitive performance, positioning and strategies, and of the key drivers of competitiveness within the eco-industry and its main sub-sectors.
- An analysis of the position of eco-industry sectors (and eco-related production activities) within the supply chain. This analysis will examine the inter-linkages

between eco-industry sectors, their suppliers, and their customers. It will aim to identify positive and negative aspects of these inter-linkages for the competitive performance of the eco-industry itself, and for the contribution of the eco-industry to enhancing the competitiveness of client sectors and the economy as a whole.

- A structured analysis of the regulatory and other framework conditions that influence the competitive performance of the eco-industry within the EU. This analysis will evaluate the situation of key framework conditions, and assess their impact on the competitive performance of the eco-industry and its contribution to the competitiveness of client sectors.
- Conclusions concerning the identification of competitiveness factors that are of greatest relevance from an industrial policy perspective, and on possible policy initiatives to enhance their contribution to the competitive performance of the eco-industry and its sub-sectors and, also, their supplier and client sectors.

In the following part we reflect in more depth on some key aspects of the objectives set for the study and their implications for the conduct of the study itself. Many of these issues are raised in the Terms of Reference, and have been further fine tuned on the basis of discussions with the Commission. The objectives relate to the nature of the study, its use, the stakeholders and the nature of the eco-industry.

The nature of the study

The proposed study will focus on the current state of competitiveness of the EU eco-industry. It builds further on the work that has been done in the past on the identification and assessment of the size of the EU eco-industry and on various existing analyses. Particular focus will also be paid to the framework conditions that both determine the cost side of the sector as well as its business opportunities. An important objective in this respect is the detection of the obstacles that impede the full exploitation of the industry's competitiveness.

Unlike traditional sectors, which can be easily identified through one or a few digits in the NACE classification, eco-industries are of a hybrid type in the sense that they cover various NACE sub sectors, often at the 4-digit level. The activities vary considerably. Therefore the study requires the creation of a sound quantitative basis as an input for the competitiveness assessment and provides the factual context for the regulatory and framework analysis. Both the competitiveness assessment and the regulatory and framework assessment are the basis for formulating the strategic outlook of the sector over the medium to long term. The strategic outlook will provide an answer to two important questions:

- Who can do what? A distinction will be made between recommendations to public authorities on the one hand and to recommendations to the eco-industry on the other hand.
- Which tools or policy instruments can be used to remove the impediments that have been identified earlier in the study? And which policy measures can be taken to improve or safeguard the eco-industry's competitiveness? It is important that these policy measures are consistent with the competitiveness policy of other, say more traditional, industrial sectors.

Use of the study

We understand that the request for the present study has been formulated in the context of the new Sustainable Industrial Policy and of the desire to formulate a specific policy for industrial competitiveness for the EU eco-industries. This requires the compilation of an adequate factual basis characterising the eco-industries in its various competitiveness aspects, as well as a thorough insight in the relevant regulatory and framework conditions. Furthermore the relative position of the sector vis-à-vis other sectors of the economy is important.

The Stakeholders

Our approach towards stakeholders can be summarized as “independent but informed”. The study aims at an independent assessment of the EU eco-industry’s competitive position. Yet lots of useful information is not embodied in papers, websites and data. Therefore it has been crucial to involve stakeholders in the study.

We envisaged doing a stakeholders identification and contact at a relatively early stage of the project, so that we got the stakeholders views and opinions relatively quickly. This was helpful for an efficient elaboration of the study and helped us to get quite early a feel and understanding of the various competitiveness issues that are of concern to the stakeholders. A questionnaire template has been developed that covers in terms of content all the stages of the study. This has been used as the basis for the interviews. As such it promoted a certain degree of harmonization across the sub-sectors of the eco-industry, which are quite varied in nature. In close co-operation with the client, each stakeholder has been prioritised with respect to his/her relevance for (a particular part of) the study. This determined the order for the contacts and interviews. As suggested on the kick-off meeting, not only industry associations will be contacted, but also environmental and consumer NGOs and industry associations of associated industries, in due course of the study. Similarly, also key players of the eco-industry have been consulted.

The nature of the industry

Eco-industries are instrumental in reaching the policy objectives of the European Commission. The sector has not been approached by the European Commission as a sector to which it applied the principles of industrial competitiveness. An adequate industrial policy is however essential for the sector’s viability, and for the EU global competitive position in the field of eco-goods and services. Furthermore, due to its potential impact on production processes throughout the entire economy and our daily way of living, eco-industries have a strong potential leverage effect on other sectors of the economy as well. Therefore in the context of sustainable development, decoupling and ever increasing demand for energy, a viable eco-industry contributes to the competitiveness of other industries further up- and downstream. Eco-industry is an important pillar in the realisation of the Lisbon Strategy.

4 Defining the eco-industry

"Eco-industry" is a term covering a wide range of activities that relate to the measurement, prevention or minimization, and correction of environmental damage. It covers activities ranging from equipment and services for pollution and waste management to the development and provision of better technologies. Unlike traditional sectors, which can be easily identified through one or a few digits in the NACE classification, the eco-industry is of a hybrid type in the sense that it covers various NACE sub sectors, often at the 4- or 5-digit level. To be able to start any meaningful analysis on the eco-industry, a clear definition of what the eco-industry exactly comprises in the context of this study is therefore critical.

The aim of this chapter is to summarize our approach to arrive at a working definition of the eco-industry for the purpose of this study. The main goal of the study is to assess the competitiveness of the European eco-industry and the identification of potential barriers that might hamper the competitiveness of the sector in Europe. The study starts with an estimation of the magnitude of the industry in economic terms (turnover, number of employees,…), its recent growth performance and assessing its future growth potential. Where the latter is concerned, the terms of reference requested that our work should build further on what has been done already in other studies. In the following parts of the chapter we will start from this and introduce new elements that are needed to accomplish the particular purpose of this study: the assessment of eco-industry's competitiveness.

4.1 The OECD, Eurostat definition

A sound basis for the classification of the various activities of the eco-industry has been done by the OECD and Eurostat (1999). The manual "The Environmental Goods and Services Industry. Manual for data collection and analysis", defines the eco-industry as "*activities which produce goods and services to measure, prevent, limit, minimize or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco-systems. This includes technologies, products, and services that reduce environmental risk and minimize pollution*[1]." This definition results in the identification of 36 activities that together constitute the eco-industry. These activities range from the provision of services for air pollution control to eco-tourism. We refer to p.12-13 of the OECD, Eurostat document for the complete list of activities.

Within the scope and time of this study, a systematic and in-depth coverage across the whole study of these 36 activities is not possible and, thus, a selection of relevant groups

[1] OECD, Eurostat (1999), p. 9.

of economic activities has to be made. This selection is based on the focus of (primary) activity, on policy relevance and on data availability. An additional criterion in defining the groups will be the homogeneity in terms of the nature of activities[2]. The next paragraphs discuss our methodology in selecting the relevant groups for both purposes of the study in more detail.

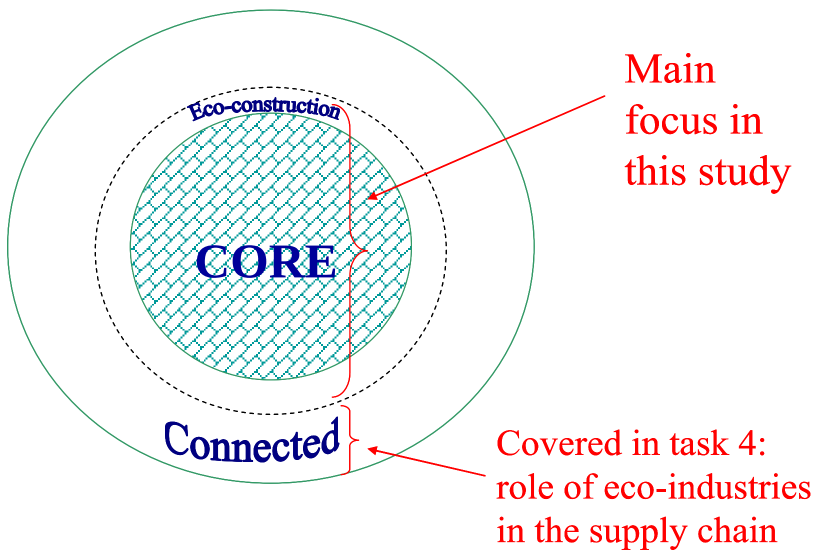
4.2 Core versus connected eco-industries

In this study, the focus will be mainly on the 'core' of the eco-industry, i.e. "*those [identifiable] sectors within which the main – or a substantial part of – activities are undertaken with the primary purpose of the production of goods and services to measure, prevent, limit, minimize or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco-systems.*" Activities from the OECD list that do not fit this selection criterion will not be the main focus of this study. For example, 'eco-tourism' whose primary purpose is tourism, will not be included in the main analysis. We call these industries 'connected' eco-industries.

One connected activity that will be included in the study however is eco-construction. Although this activity does not belong to the 'core' eco-industry according to our definition (i.e. its primary purpose is building houses), we include this activity in the study because of its economic performance, growth potential and policy relevance. In the E&Y study this activity was estimated to generate a turnover of around € 40 billion in 2004. Moreover, this activity has been identified as one of the six highly innovative markets in the Lead Market Initiative for Europe to unlock market potential by lifting obstacles hindering innovation. From a policy perspective, it is therefore highly relevant to include this activity in the study.

[2] Considerable work has already been done in this respect, e.g. the Ecotec study of 2002 for DG Environment "Analysis of the EU Eco-industries, their Employment and Export Potential".

Figure 4.1: Eco-industry - schematic overview



Core eco-industry: e.g. waste water treatment, renewable energy sources

Connected eco-industry: e.g. mechanical engineering, electronic equipment, chemicals, aerospace, automotive industry, steel, metal working industries, ceramics, glass, ICT, paper, ...

Despite the focus of the study on the 'core' eco-industry and the 'connected' eco-construction, many other 'connected' activities depend on the 'core' eco-industry for the supply of specific technologies or may limit the growth of eco-industries. Examples are the development of environmentally friendly cars, mechanical engineering, ICT opportunities for eco-industry and environmental innovation, the relationship between eco-industry and energy intensive industries; the effect of the competitiveness of the energy markets for the renewable energy. Moreover, due to the increased (political) attention for environmental issues, some of these eco-activities in other sectors are often characterized by a high growth potential. Therefore, the link between eco-industries and these non-core segments will be discussed in chapter 6.1 of the study (role of eco-industries in the supply chain).

In order to provide a flavour of the nature of inter-linkages that may occur, the example of the paper industry is presented in the next box.

Box 1 Core versus Connected eco-industries: the example of the paper-industry

> The impact and importance of the connected industries on the competitiveness of the European eco-industry can clearly be illustrated by recent developments in the European paper industry.
>
> The paper industry is characterised as an energy intensive industry, using large quantities of water. According to the Confederation of European Paper Industries, it is one of the most regulated industries in Europe. The capital intensity of the industry and associated scale economies have led to the closing of many smaller pulp and paper mills in recent years. SMEs have a relatively large size compared to the ones in other industries, and the smaller ones often operate in particular niche markets.
>
> Driven by its intense use of energy, the industry became an important contributor to waste treatment in the form of paper recycling (using recycled paper is less energy consuming), generation of renewable energy (currently being the first producer and consumer of bio energy) and carbon storage. Therefore the paper industry can be considered as an important connected EU eco-industry. More than 60 million tons of paper is recycled every year in the EU. The current business models have been challenged. Important technology investments have been made. This lead to a massive energy efficiency increase, with an expected net surplus that can be put on the grid in the future. For the coming years, it is expected that a higher proportion of turnover will come from the production of bio-energy than is currently the case.
>
> The paper industry felt competitive pressure from other industries that deliver substitute products such as plastics or aluminium, especially in packaging. Further improvements regarding energy efficiency and efficiency of raw materials on the one hand, and new market developments through R&D and innovation on the other hand were indispensible to remain competitive.
>
> In this respect, the EU eco-industry techniques and solutions have helped the paper industry, mainly through the increased use of recovered paper and the generation of bio energy. The level of production at the moment would not be possible without using the same fibre several times (in recycling) as there would be no sufficient supply of virgin fibres to support it. Even at the moment, when over half of the fibres are recycled, the virgin fibre supply is considered tight. The same applies to energy: if the EU paper industry would have no bio-energy available, the cost of energy would be unbearable.
>
> However, the current economic and financial crisis has caused a serious downturn in the industry, putting the urgency of new business models in the spotlight. Therefore, besides production of paper, also the indirect production of bio-energy and phyto-chemicals are becoming more and more important.

4.3 Segmentation of eco-industry activities

Within the eco-industry, activities can be categorized alongside two dimensions: so-called environment classes and business activities. This results in the following segmentation grid:

Figure 4.2: Segmentation of the eco-industry

Environment classes / Business activities	Production of equipment and specific materials	Provision of operational services (incl. monitoring)	Provision of management services	Construction and installation of facilities	Innovation and technological development	Provision of environment consulting services	General public administration
A. CORE ECO-INDUSTRY							
1. POLLUTION MANAGEMENT							
Air pollution control							
Waste water treatment							
Solid waste treatment							
Soil & groundwater remediation							
Noise and vibration control							
2. RESOURCE MANAGEMENT							
Recycled materials							
Renewable energy production							
Water supply							
Nature protection							
B. CONNECTED ECO-INDUSTRY							
Eco-construction							

Each cell in the segmentation grid represents a specific business activity within a specific environment class. However, it is beyond the scope of this study to analyze each of the 70 cells in the segmentation grid. Therefore a selection of (groups of) activities has been made. The above segmentation grid together with the list of 10 segments indicated in the terms of reference[3] form the starting point for our selection of groups of activities for further analysis. Figure 4.3 combines both.

Figure 4.3: Specified groups in the Terms of Reference

Environment classes / Business activities	Production of equipment and specific materials	Provision of operational services (incl. monitoring)	Provision of management services	Construction and installation of facilities	Innovation and technological development	Provision of environment consulting services	General public administration
A. CORE ECO-INDUSTRY							
1. POLLUTION MANAGEMENT							
Air pollution control				1			
Waste water treatment							
Solid waste treatment		6	2	5	9	10	
Soil & groundwater remediation				3			
Noise and vibration control				4			
2. RESOURCE MANAGEMENT							
Recycled materials							
Renewable energy production				7			
Water supply							
Nature protection							
B. CONNECTED ECO-INDUSTRY							
Eco-construction				8			

Note: the terms of reference specified the following sectors: 1. Air pollution and control, 2. Waste management, 3. Soil remediation, 4. Noise and vibration control, 5. Waste and waste water treatment, 6. Environmental monitoring, 7. Renewable energy sources, 8. Eco-construction, 9. Clean technologies and processes, and 10. Environmental consulting

The final choice of groups has been determined by data availability and comparability with previous work (especially the ECOTEC study 2002 and the E&Y study 2006), but also policy relevance. As we will argue in the next paragraphs, the selection of groups of activities to be analyzed will be different for the two tasks in this study: the presentation of basic sector 'facts and figures' versus the assessment of the competitiveness.

[3] i.e. 1. Air pollution and control, 2. Waste management, 3. Soil remediation, 4. Noise and vibration control, 5. Waste and waste water treatment, 6. Environmental monitoring, 7. Renewable energy sources, 8. Eco-construction, 9. Clean technologies and processes, 10. Environmental consulting

4.4 Identification of groups of activities for the presentation of basic sector 'facts and figures'

The main objective of the basic sector facts and figures is to obtain an overview of the current market situation, by collecting (the most recently available) data on the structure of the eco-industry (importance in terms of turnover and employment) in the EU-27 and its different Member States. To enable a comparison over time, we will as much as possible make use of the methodology that has been used in the E&Y 2006 study to estimate the eco-industry market.

Making use of the Ernst &Young (2006) approach to estimate the eco-industry, the following groups of activities can be distinguished:

- Air pollution control
- Waste water treatment
- Solid waste management & recycling
- Remediation & clean up of soil & groundwater
- Noise and vibration control
- Recycled materials
- Renewable energy production
- Environmental monitoring and instrumentation
- Eco-construction
- Private Environmental management
- Environmental research & development
- Water supply[4]
- Nature protection[4]
- General public administration[4]

Depending on data availability, starting from this classification sub-sectors or groups will be defined and analyzed. The main source of information for this analysis is the Eurostat Environmental Protection Expenditure (EPE) data. EPE are defined as "*the money spent on all purposeful activities directly aimed at the prevention, reduction and elimination of pollution or any other degradation of the environment*" (Eurostat). EPE data cover the following environmental domains: Air pollution and control, Waste water, Waste, Soil and groundwater, Noise, Nature protection and Others (includes a.o. General public administration and Private environmental management)

The EPE data source is complemented with macro-economic data from Eurostat, business association information and micro-economic data from Amadeus for those groups of activities that are not covered by the EPE data:

- For Recycled materials and Water supply expenditure data from the E&Y study will be updated by applying the growth rate of the production value (extracted from Eurostat's New Cronos database) for the corresponding Eurostat NACE codes of industry (i.e. NACE 37 for Recycled materials and NACE 41 for Water supply).

[4] Although water supply, nature protection and general public administration are not to be considered in the scope of the study, they will be included to calculate the overall size of the eco-industry and its growth over the past years.

- For Renewable energy production (no corresponding NACE code exists) updated expenditures will be derived from the 2004 data from the E&Y study, using a multiplier which corresponds to the sector's growth in Europe since 2004.
- For Environmental monitoring and instrumentation and Eco-construction estimates of the market will be made based on market information of the largest players in the market (through Amadeus) and information from relevant business associations (e.g. FIEC for eco-construction). This methodology is in line with the methodology used in E&Y 2006.

Schematically, the following groups of activities from the segmentation grid will be described in the facts and figures part of the study:

Figure 4.4: Activity groups for the 'facts & figures' analysis

Environment classes / Business activities	Production of equipment and specific materials	Provision of operational services (incl. monitoring)	Provision of management services	Construction and installation of facilities	Innovation and technological development	Provision of environment consulting services	General public administration
A. CORE ECO-INDUSTRY							
1. POLLUTION MANAGEMENT							
Air pollution control							
Waste water treatment							
Solid waste treatment							
Soil & groundwater remediation							
Noise and vibration control							
2. RESOURCE MANAGEMENT							
Recycled materials							
Renewable energy production							
Water supply							
Nature protection							
B. CONNECTED ECO-INDUSTRY							
Eco-construction							

not main focus of study

It is clear from Figure 4.4 that a quantitative analysis of the eco-industry – with the exception of the General public administration, Provision of environment consulting services and Environmental monitoring and instrumentation – is only feasible at the level of the environment classes. The data do not allow any description at the level of the business activities (e.g. provision of services, innovation activities,…). The descriptions of the environment classes aggregate the different business activities within these environment classes. Providing estimates of the share of the production of equipment or installations, or the provision of services in the total environment class was not possible.

4.5 Identification of groups of activity for the competitiveness analysis

Whereas the focus of the first part of the study is on the industry's economic importance, (see section 5.2), the main body of the study will focus on a competitiveness screening of the eco-industry in order to identify potential areas impacting the competitiveness, and to derive useful policy recommendations. As such the study aims providing a comprehensive quantitative/economic foundation for the competitiveness screening exercise, as far as it is feasible given the availability of data. To this end an analysis of groups of activities is both useful from a horizontal perspective (environmental sub-markets, or market niches), and from a vertical perspective (business activities). For example, from a competitiveness point of view it is very important that in the segment of renewable energy production (horizontal perspective) potential barriers that negatively influence the competitiveness of the segment are identified. As this segment is of major importance for the EU to realize the environmental targets that have been set, it is of paramount importance that each of the activities in the life cycle (innovation and technological development, construction of installations, provision of services,…) can optimally work together and interact smoothly. Therefore, a competitiveness screening of this environmental class across all (horizontal) business activities is interesting. On the other hand, also the vertical perspective is important in the competitiveness analysis. The provision of services is very different from the production of equipment and it can be expected that also the competitiveness problems are very different for those business activities.

For this reason, the selection of groups of activities for the purpose of the competitiveness analysis and strategic outlook differs from the selection in the first part that is focused on estimating the eco-industry's economic importance. A mix of both horizontal and vertical groups is identified for the competitiveness analysis. The final choice of the groups of activities for this analysis is mainly based on the availability of quantitative and qualitative information.

Based on a first screening of existing business associations and the list of contacts from the European Commission, we analysed the following groups of activity[5]:

Figure 4.5: Activity groups for the competitiveness analysis

Business activities / Environment classes	Production of equipment and specific materials	Provision of operational services (incl. monitoring)	Provision of management services	Construction and installation of facilities	Innovation and technological development	Provision of environment consulting services	General public administration
A. CORE ECO-INDUSTRY							
1. POLLUTION MANAGEMENT							
Air pollution control			EFCA				
Waste water treatment				EUREAU			
Solid waste treatment			FEAD				
Soil & groundwater remediation							
Noise and vibration control					EUCETSA		
2. RESOURCE MANAGEMENT							
Recycled materials			BIR				
Renewable energy production			EREC				
Water supply							
Nature protection							
B. CONNECTED ECO-INDUSTRY							
Eco-construction			FIEC, ECTP, ACE				

not main focus of study

We proposed contacting the following business associations in an fairly early stage of the project:

- Air pollution and control: European Federation of Clean Air and Environmental Protection Associations (EFCA)
- Waste water treatment: European Federation of National Associations of Water and Waste Water Services (EUREAU)
- Waste management (both solid waste and waste water, soil & groundwater remediation): European Federation of Waste Management and environmental services (FEAD)
- Innovation and technological development: European Committee of Environmental Technology Suppliers Associations (EUCETSA)

[5] We did not make a separate sub-sector report on solid waste treatment and waste water treatment, since these sectors are closely intertwined with recycling and water supply. Furthermore data limitations were important as well.

- Recycled materials: Bureau of International Recycling (BIR)
- Renewable energy production: European Renewable Energy Council (EREC)[6]
- Eco-construction: European Construction Industry Federation (FIEC), European Construction Technology Platform (ECTP) and Architects Council of Europe (ACE)

Apart from the above associations it has been considered useful contacting some leading companies which are active in different business activities in eco-industry. Companies such as SITA or Veolia Environmental Services are major European providers of equipment and services in eco-industry, covering different environment classes such as solid waste treatment, soil and groundwater remediation and recycled materials. These integrated companies provided additional insights in the competitiveness issues of the industry. Ample attention has also been paid to the SMEs through the representative organisations of various sectors.

In the following parts of the study is referred to the NACE sectors and non-NACE sectors. The so-called NACE sectors are NACE 37: recycling, NACE 90.01 collection and treatment of sewage (e.g. waste water from households and industry, cleaning and maintenance of sewers and drains, treatment of waste water), NACE 90.02: collection and treatment of other waste (e.g. from households and enterprises, incineration, composting), NACE 90.03: sanitation, remediation and similar activities (e.g. decontamination of soils and groundwater at the place of pollution, cleaning of oil spills, collection of refuse in litter bins in public places, outdoor sweeping and watering of streets…). Statistical coverage for the NACE sectors is reasonably well. The non-NACE sectors are more challenging in this respect.

In relation to the latter it has to be mentioned that during the course of the study, Eurostat published the "Data Collection Handbook on Environmental Goods and Services Sector"[7]. The definition used in this study is consistent with that of Eurostat. It has been indicated that Eurostat plans to collect data autumn 2009. It is expected that this will certainly help to get a comprehensive view of the EU eco-industries, including the sub-sectors that have not been the focus of the current competitiveness study.

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[6] EREC is the umbrella organisation of the European renewable energy industry, trade and research associations active in the sectors of bio energy (EUBIA, AEBIOM, eBIO), geothermal (EGEC), ocean (EU-OEA), small hydropower (ESHA), solar electricity (ESTELA), solar thermal (ESTIF) and wind energy (EWEA).

[7] European Commission – Eurostat (2009)

5 Key characteristics of the European eco-industry

5.1 Introduction

This chapter aims to provide a concise overview of the key characteristics of the European eco-industry as a whole. Details for the main sub-sectors are presented in the second report. Since there has been a lot of debate and uncertainty on the size of the total eco-industry, which undoubtedly finds its roots in the various interpretations on the definition of the sector and lack of comparable data, we first present our estimates of the size of the sector. These are based on the methodology developed earlier by Ecotec (2002) and Ernst & Young (2006).

Subsequently we focus on the relative importance of the eco-industry's sub-sectors and their relative importance compared to sub-sectors in other industries. In particular we make a concise comparison with industrial cleaning, architectural engineering & technical consulting, and computer & related activities.

The third part of this chapter focuses on the structure of the eco-industry as a whole. This is followed by analyses of performance, in terms of profitability, productivity, skill profiles, and the distribution of employment and production across sub-sectors and the main member states. The last section gives a concise overview of the general trends in technologies per sub-sector characteristics of eco-industries.

5.2 The size of the EU eco-industry

A substantial amount of research has been undertaken to determine the size and structure of the eco-industry in the European Union. A working definition by the OECD and Eurostat confines eco-industries to "*activities which produce goods and services to measure, prevent, limit, minimize or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco-systems. This includes technologies, products and services that reduce environmental risk and minimize pollution and resources*". However, trans-national comparability is still hampered by problems of methodological classification. One note of caution has to be made within this whole chapter: eco-construction is a connected industry and is therefore not included within the size of the eco-industry[8].

[8] In this we follow other studies such as Ernst &Young (2006) that do not take eco-construction into consideration either.

Estimating the size of the eco-industry is a difficult task depending highly on the definition used and data availability. In this section we have made an attempt to use the same definition and data as Ernst & Young in their report in 2006 (hereafter referred to as Ernst &Young 2006). The size of the eco-industry is measured by the turnover, which is equal to the environmental protection expenditures (EPE) [9] according to Ernst & Young (2006). They have estimates for the years 1999-2004 with €227 billion in 2004. This section will analyze the size of the eco-industry for the years 1999-2008.

An important recent development is that Eurostat (unit E3 – Environmental Statistics) published in March 2009 a data collection handbook on 'the Environmental Goods and Services Sector'. This handbook explains how to collect, interpret and present data on environmental goods and services. It provides a complete reference tool for developing a new data collection system on the environmental sector at national level. Eurostat has planned the collection of data Autumn 2009, so we cannot use this information for this study.

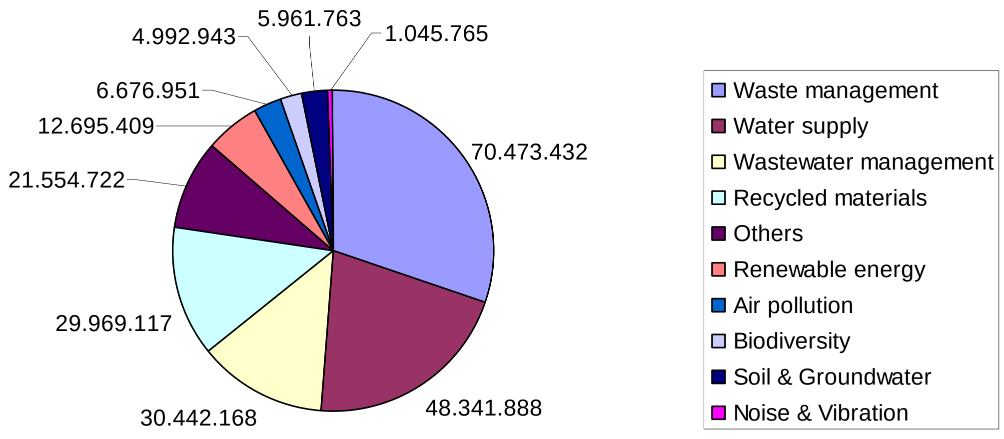
Falling back on the current data, we had to use intra- and extrapolations as quite some data were missing and several data series only go until 2005. More information on how we processed is given in annex.

5.2.1 Turnover

The eco-industry of the EU27 had a turnover of €232 billion (2.2% of GDP) in 2004 and €319 billion (2.5% of GDP) in 2008 (at current prices), which translates to compound annual growth rate in nominal terms of 8.3%. Corrected for inflation, the annual growth rate is 5.9%. As can been seen in Figure 5.1, the four largest sub-sectors take up to roughly three quarters of the total eco-industry with waste management (30%) as the largest one followed by water supply (21%), wastewater management (13%), and recycled materials (13%).

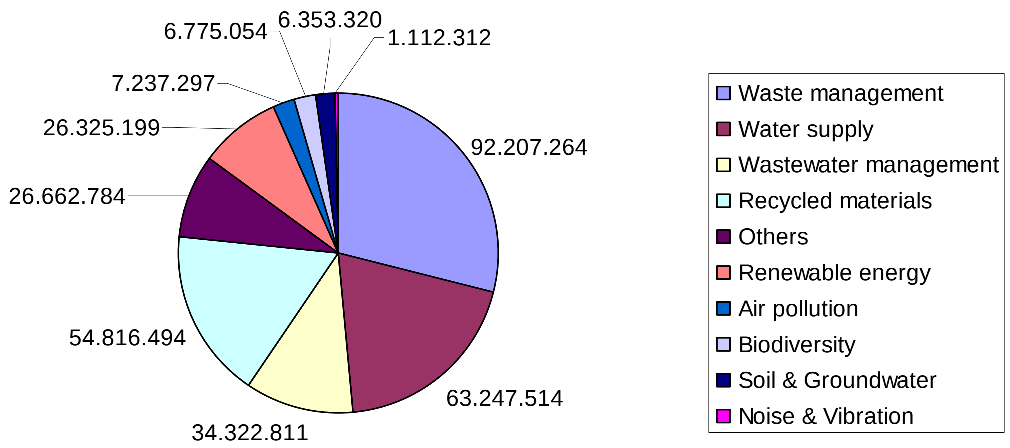
9 Environmental protection expenditures are (according to Eurostat's definition) expenditures related to technologies and products of both a preventive or remedial nature for the prevention, reduction, elimination and treatment of air emissions, waste and wastewater, soil and groundwater contamination, noise and vibration as well as radiation, the prevention, reduction and elimination of soil erosion and salinity as well as other kinds of degradation, the prevention of biodiversity and landscapes as well as monitoring and control of the quality of the environmental media and waste. This definition is thus more restricted than E&Y's and our definition of eco-industries where we e.g. also include renewable energies.

Figure 5.1 The sizes of the various sub-sectors within the eco-industry in 2004



Source: own calculations based on Eurostat data (in line with E&Y (2006) calculations)

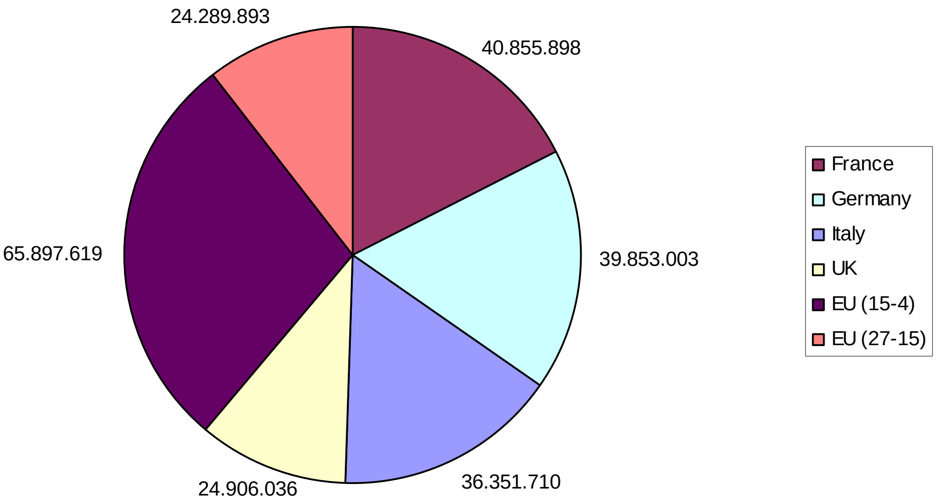
Figure 5.2 The sizes of the various sub-sectors within the eco-industry: estimates for 2008



Source: own calculations partly based on Eurostat data

Comparing figures 5.1 and 5.2, recycled materials grew more than the other three largest sub-sectors, although their overall share still represents roughly three quarters of the total, as in 2004. Renewable energy has the highest growth rate of all sub-sectors within the eco-industry: 107% over 4 years. Given the information we received from EREC (the European Renewable Energy Council), this is even an underestimation as the latest turnover figure for 2008 which EREC published, is 45 billion euro. Thus virtually twice as high as the amount estimated for 2008 which was calculated using the same growth rate as in the E&Y 2006 report.

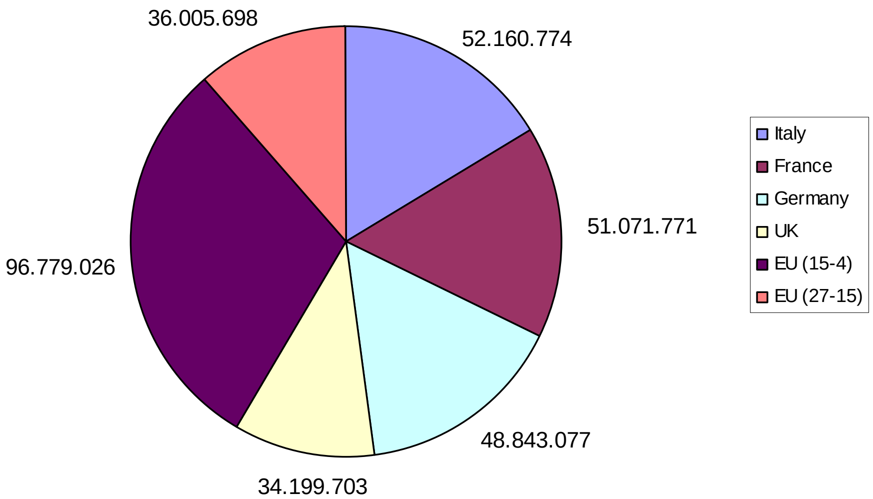
Figure 5.3 The distribution of turnover among the four largest countries, EU (15-4), and NMS in 2004



Source: own calculations based on Eurostat data

Figure 5.3 and Figure 5.4 show the EPE of each country and each sub-sector in 2004 and 2008. The four largest countries in term of EPE are France, Germany, Italy and the UK who contribute 61% in 2004 and 58% in 2008 to the total EPE of the EU27. In 2008 the distribution of turnover among the four largest countries has changed, with the UK and Italy being the most outstanding ones with annual growth rates of respectively 9% and 8%. Furthermore, the New Member States (EU27-15) have the highest annual growth rate: 10%.

Figure 5.4 The distribution of turnover among the four largest countries, EU (15-4), and NMS in 2008



Source: own calculations based on Eurostat data

5.2.2 Employment

The direct-employment (hereafter referred to as employment) of the total EU eco-industry in EU27 is estimated at about 2.8 million and 3.4 million in respectively 2004 and 2008. The estimation methodology is explained in annex.

Table 5.1 and table 5.2 show that employment has an annual growth rate of 7.0% over the years 2000-2008 (6.7% in real terms). Furthermore, it has to be noticed that the ratio between the EPE and employment is not a constant one. As Table 5.2 indicates, the ratio between the growth rates of the EPE and employment differ among the sub-sectors due to specific sector- and/or country-related wages, operating expenditure ratio, and the percentage of labour costs to expenditures. This is best illustrated in the sub-sector air pollution, which has a positive growth of the EPE, but a negative growth of the employment. This could indicate a significant increase of the wage in this specific sub-sector or a relatively high increase of air pollution EPE in high-wage countries.

Table 5.1 The employment of the eco-industry in EU27

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Employment ('000s)	2.006	2.389	2.427	2.506	2.754	2.913	3.057	3.232	3.441

Source: Eurostat, Ecotec and own calculations

The growth rates given in Table 5.2 are also a reasonable approximation of the predicted growth rate for the coming years. However, it should be mentioned that these rates are corrected for inflation with an average rate of 2%. It can be seen that renewable energy and recycled materials are the fastest growing sub-sectors with respectively 13% and 18% in real terms.

Table 5.2 Employment of the various EU eco-industry sub-sectors and the growth rates of employment and EPE (corrected for inflation)

	employment (2000)	employment (2008)	Employment: annual growth rate	EPE: annual growth rate corrected for inflation
Waste management	844.766	1.466.673	7,14%	5,89%
Water supply	417.763	703.758	6,74%	4,04%
Wastewater management	253.554	302.958	2,25%	3,62%
Recycled materials	229.286	512.337	10,57%	13,12%
Others	129.313	193.854	5,19%	6,23%
Renewable energy	49.756	167.283	16,37%	17,65%
Air pollution	22.600	19.067	-2,10%	3,10%
Biodiversity	39.667	49.196	2,73%	5,29%
Soil & Groundwater	14.882	18.412	2,70%	3,02%
Noise % Vibration	4.176	7.565	7,71%	7,76%
Total	*2.005.764*	*3.441.102*	*6,98%*	*6,69%*

Source: Eurostat, Ecotec and own calculations

5.2.3 Comparison across various studies

Turnover

The Ernst &Young study described the EU 25 eco-industry as a sector with a 227 billion € turnover or 2.2% of EU GDP in 2004. However, the overall turnover has been drawn into question by more recent research. A German study argues that the size of the eco-industry is routinely underestimated and that the "statistical defined part of environmental industry" represents "at least 2.6% GDP in the EU and at least 4% in Germany" (Jänicke and Zieschank 2008). It should be noted that Jänicke and Zieschank include "satellite areas" into their assessment of the EU eco-industries, such as eco-tourism, and tangential economic sector not covered in this study. Furthermore, Jänicke and Zieschank include wider ranging areas of economic activities not covered by the Ernst & Young and Eurostat definition. Such new additions would be "cleaner technology" as a subsection of resource management and a revised classification would "include all integrated environmental technologies into the sub-class of resource management". As such, the sometimes stark differences observed with the Ernst &Young report seem to stem from a methodological difference in classification rather than fundamental under appreciations. It should be noted that existing problems of statistical classification of the industry are sometimes reflected in substantial differences between national turnover figures. While the Ernst & Young study gives a turnover figure of 21.5 billion € for the UK eco-industry in 2004, a similar study by DTI and DEFRA estimates the size of the industry at 35 billion € in 2005 (DTI and DEFRA 2006). Differences concerning the turnover of Germany's eco-industry are even more remarkable. Ernst & Young estimate 66.2 billion € in turnover for 2004. In contrast to that, a survey based study undertaken by Roland Berger puts the number to 150 billion € for the year 2005 (BMU 2007).

Another recent study covering seven OECD countries using a classification broadly comparable to the pollution and resource management categories comes to the conclusion that "cleaner production" ,which reduces pollution at the source, has a larger market share than the "end-of-pipe" sub-group, the ad-hoc add on technologies which reduce pollution, (Frondel et al. 2007).

Employment

The Ernst & Young study estimated EU 25 eco-industry employment in 2004 at 3.4 million full time job equivalents or 1.4% of total paid employment in 2004. This figure includes direct and indirect employment related to eco-industries, which is in contrast to the data presented in this section which only included direct employment. As concerns geographical dispersion, Germany (24%), France (20%) and the UK (17%) have the highest number of eco-industry jobs (WIFO 2006). A recent study by Germany's Environmental Agency (UBA) estimates that 1.8 million employees were working in Germany's environmental sector in 2006, representing 4.5% of the total workforce (UBA 2008). On the whole, the literature on EU eco-industries show that "eco-industries account for around 1 to 2% of GDP and a similar percentage of jobs in the economy" (GHK 2007).

The data presented of the turnover and employment in this chapter is not the same as in an earlier report of ECORYS (2008), which is due to the fact that the data presented in this section is taken from Eurostat and the data of the earlier report has been taken from

GHK (2007). An overview of several different reports is given in Table 5.3. All reports took (most of) their data from Eurostat and filled the gaps with their own estimation method e.g. GHK (2007) used the E3ME model of Cambridge Econometrics. However, it has to be noticed that the reports are difficult to compare due to different geographical coverage, different years and different price bases. Although this comparison has its flaws, it can be concluded that the data presented in this report is in line with the data found in earlier reports.

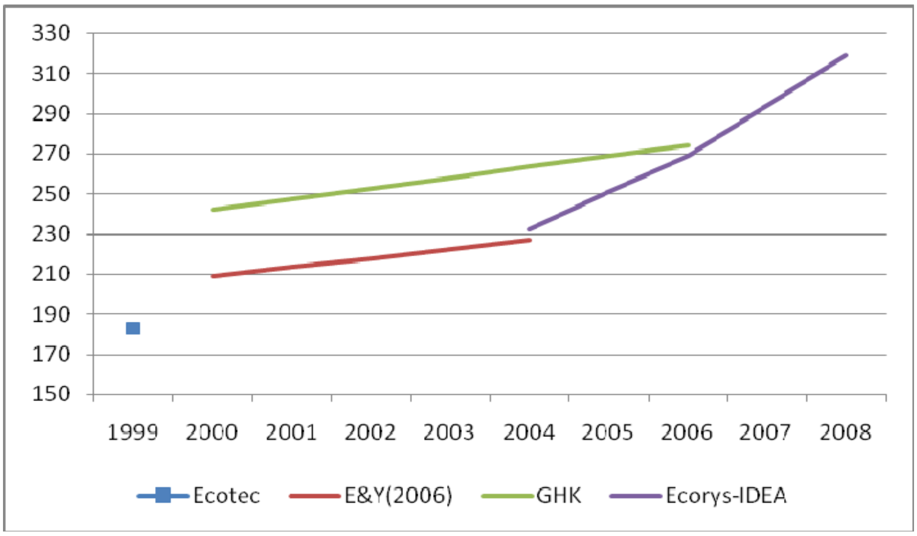
Table 5.3 Comparison between different reports on turnover and employment

	Ecotec report (EU-15) 2002	E&Y report (EU-25) 2006[10]		GHK report (EU27) 2007		This report (EU-27) 2009		
Year of data	1999		2004	2000		2004	2006	2008
Employment ('000s)	2.086		2.445	2.364		2.754	3.057	3.441
Price base	1999	2000	2004	2000	2006	2004	2006	2008
Turnover (Bil €)	183	209	227	242	274	232	269	319

Source: Ecotec, E&Y, GHK and own calculations

The next figure summarizes the results of the various studies. While the average growth in nominal terms was about 2% p.a. in previous reports, the current study arrives at a rate of 7% to 8% p.a. Note that the size estimates are relatively close to the Ernst & Young (2006) results for the year 2004 and the GHK results for 2006. Our estimates imply that the average turnover per employee vary from 84,241 € in 2004 to 92,706 € in 2008, which is still in the range used in previous studies.

Figure 5.5 Comparison of various turnover estimates for the EU eco-industry



Source: own calculations

[10] For comparison reasons only the direct employment of the E&Y report has been taken into consideration. And for renewable energy no reliable data was found.

5.3 Comparison of the EU eco-industry sub-sectors with other industry related service sectors

In order to put the sub-sectors of the eco-industry in perspective they are compared with three other industry related sub-sectors of the services: Industrial cleaning, Architectural Engineering & Technical Consulting, and Computer & related activities. The choice of these sectors is based on availability of information[11] and on the strong inter-relation between services and industry.

Table 5.4 gives an overview of the main characteristics of the various sub-sectors of both industries. Note that the sub-sectors of the service-industry are all larger than the sub-sectors of the eco-industry. Waste management is clearly the largest sub-sector. Yet taken as a whole, the total EU eco-industry is comparable with the other sub-sector of the service industry. The relative measures (share of labour in production and turnover/employment) are comparable.

The labour productivity, which is approximated by turnover over employment, is relatively low for industrial cleaning and waste management while it's rather high for air pollution and soil & groundwater. These differences are mainly due to the labour-intensity of the specific sub-sector. Furthermore the similarities of waste management and industrial cleaning are not surprising as these sub-sectors are characterized by the same kind of work. The large differences in the turnover/employment ratio can also be explained by the fact that the price effects across sub-sectors have not been taken into consideration. Furthermore, other production factors such as capital and labour determine the ratio as well. Sub-sectors with relatively high input of capital and/or energy costs show high turnover/employment ratios.

[11] Study on Industrial Policy and Services Within the Framework Contract of Sectoral Competitiveness Studies – ENTR/06/054

Table 5.4 Overview of the various sub-sectors of the eco-industry and the service-industry[12]

2005	Sub-sectors of the eco-industry										Sub-sectors of the service-industry		
	Waste management	Water supply	Recycled materials	Wastewater management	Others	Renewable energy	Air pollution	Biodiversity	Soil & Groundwater	Noise & Vibration	Industrial cleaning	Architectural, Engineering & Technical Consulting	Computer & related activities
Turnover in billion €	74	51	35	32	22	15	7	5	6	1	66	248	331
Employment ('000s)	1.293	540	368	335	181	106	20	44	19	7	2960	2580	2640
share of labour in production (%)	60%	n.a.	n.a.	40%	44%	n.a.	15%	n.a.	20%	65%	59%	32%	38%
Turnover / employment ('000s)	58	95	94	96	123	144	341	120	305	146	22	96	126

[12] Data from the eco-industry is for EU27 (with missing values) and the data of the service-industry is for EU 27 (-Malta and Czech Republic + Norway)

5.4 The structure of the EU eco-industry

The eco-industry is a heterogeneous industry which makes it difficult to draw general conclusions. However, there are some general trends found in various reports (Ernst & Young 2006, WIFO 2006, Köppl 2006). They note that concentration is a notable trend in the industry in the EU, in the waste management sector in particular. Other sub-sectors tending towards higher concentration are soil remediation, wind power and renewable energy in general. The driving factors behind concentration trends in the eco-industry lie in the desire for firms to extend geographic coverage, increase business activities, and reach critical mass for bearing the upfront cost of R&D.

5.4.1 Company size

The most competitive eco-industry firms in the EU are concentrated in France, Germany the UK and the Netherlands. The eco-industry in the EU is mostly made up of small and medium enterprises. For instance in Germany, the EU's largest eco-industry national market, 10,000 firms are active market players. The active firms in the Austrian market stood at 315 in 2005 (WIFO 2006). The greatest market concentration in Austria can be found in the domain of waste disposal and air technologies. This tendency is also confirmed by other studies on Austria (Köppl 2006).

The literature on the structure of the EU eco-industry highlights that new "regulation driven" markets are usually made up of SMEs (<500 employees), while in older and established eco-industry markets (e.g. waste management, water supply) firms tends to be larger and international. As the new markets grow, firm size also increases and concentration trends appear over time (Ernst & Young 2006). A short overview of the different sub-sectors is given in Table 5.5.

Table 5.5 Industry structure of various sub-sectors

Sub-sector	Industry structure
Air pollution	Flue gas treatment: small and medium-sized e.g. LAB (france) and large international e.g. Lurgi (Germany), Alstom (France) Catalytic converters: Big groups e.g. Coming GmbH (Germany), Delphi (Luxembourg), Rhodia (France) and special medium-size e.g. Ibiden (Germany) and Johnson Matthey PLC (UK)
Waste management	EU15 has a mature market and EU (27-15) is developing. An oligopoly with the large actors accounting for 80% and the remaining 20% is for the local companies
Soil & Groundwater	Two types: small specialized firms and construction companies
Wastewater management & Water supply	Wastewater management & water supply are often done by the same actors who are usually local small specialized companies who are often part of a few major actors e.g. Veolia (France), RWE (Germany), Thames Water (RWE) (UK).
Renewable Energy	Hydropower: 90-100 small and large companies Photovoltaic energy: 40-50 large companies

Sub-sector	Industry structure
	Geothermal: hundreds of small companies Solar thermal energy: small sector dominated by SMEs Wind power: a fast growing market all sort of actors
Others	Public administration: each country has at least one department or ministry Private environmental management: activities are part of total activities within a company
Biodiversity	Eco-tourism: plenty of national parks, eco-museums, etc…

Source: Ernst & Young (2006)

5.4.2 Market activity and integration in the EU eco-industry

The 2006 Ernst & Young report found that the integration of activities of a firm depends on its size. Large waste management groups for instance, tend to integrate all activities within the firm with little or no external suppliers or subcontractors. Conversely, in environmental monitoring activities, components from external suppliers may be used for equipment and thus a supply chain for the end product can be mapped within a market segment.

The report also notes that "*the geographic location of eco-industry firms and their range of operations are linked. Residential eco-construction is performed by small, local companies, for example*". Thus the scale of activities in the EU eco-industry are often geographically constrained, even in sectors dominated by large international firms, such as the waste management. However, there are groups operating on a global scale, and which are not constrained by the local nature of the needed resources. These tend to be air pollution control, consolidated water supply and waste water treatment groups.

5.4.3 Concentration and distribution per size category

A preliminary analysis of the micro-economic sample[13] indicated that the eco-industry is a well concentrated industry with 10% of the companies responsible for almost 80% of the operating revenue/turnover. In the large sub-sectors, solid waste management is less concentrated than recycling and waste water treatment.

The identified companies in micro sample were classified in size categories based on the number of employees from the European SME definition. For large and very large companies the threshold was put at 250 and 1.000 employees respectively.

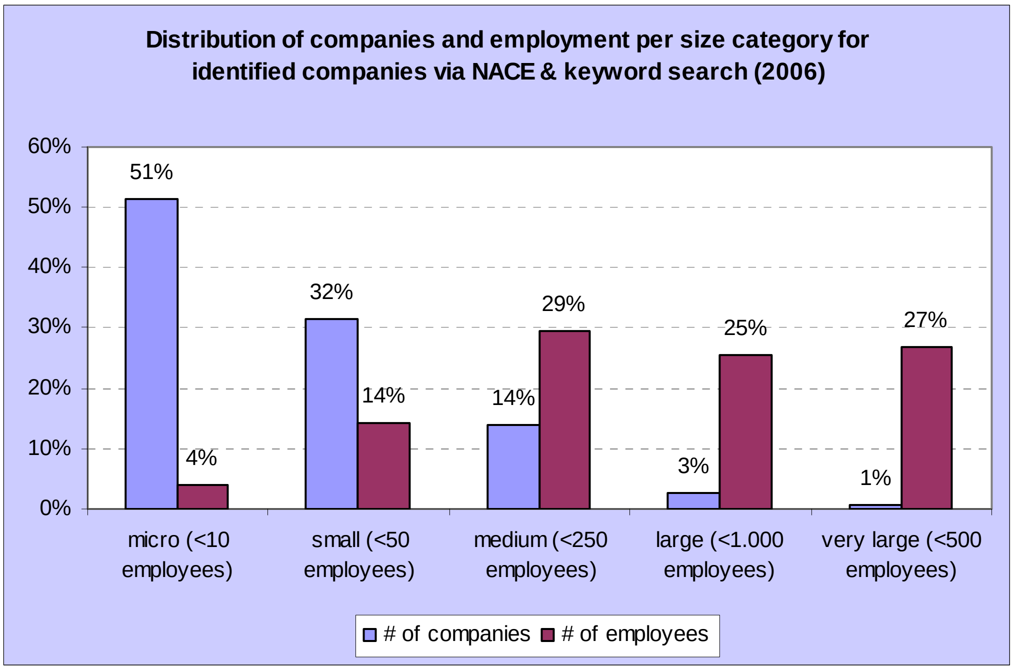
In order to make a distinction between companies identified by the top down approach (NACE-classification) and the bottom-up approach (keywords) and to check whether this affects the size distribution, distribution figures were calculated for a all identified

[13] The selection of companies is explained in annex I.

companies (by NACE and keyword search) and only for companies identified by NACE classification[14].

In both cases almost all identified companies are SME's (97% via NACE & keyword search and 98% via NACE search) but they only account for half of the number of employees (47% via NACE & keyword search and 53% via NACE search). The difference in the percentage of employees indicates that in the eco-industry the chance of identifying larger companies is bigger when a search is made by keywords. In both cases the category of medium sized companies (between 50 and 249 employees) is generating most jobs.

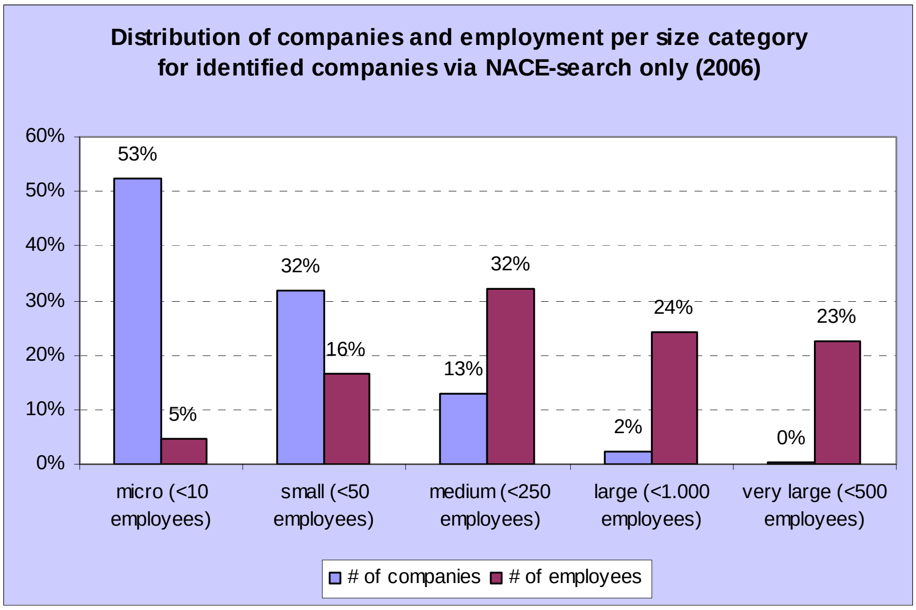
Figure 5.6: Distribution of companies and employment in the EU eco-industry by size category for identified companies through NACE & keyword search (2006)



Source: Own calculations on the base of Amadeus data

[14] NACE 37 (recycling), NACE 90.01 (waste water treatment), NACE 90.02 (solid waste management) and NACE 90.03 (soil and groundwater remediation) as main activity code.

Figure 5.7: Distribution of companies and employment in the EU eco-industry by size category for identified companies in NACE defined sectors only (2006)



Source: Own calculations on the base of Amadeus data

5.5 The micro-economic performance of the EU eco-industry

Based on the sample of eco-industry companies that have been identified for the EU-27 in the Amadeus database, productivity and profitability for recent years have been analyzed in comparison with a representative sample of the EU manufacturing sector[15]. The sample for the non-NACE sub-sectors of the EU eco-industry has been compiled using information from the representative organizations, specialized networks and web searches. These sectors are renewable energy, air pollution control and eco-construction. The NACE Rev 1.1 sectors are recycling (37), collection and treatment of sewage (90.01), collection and treatment of other waste (90.02) and sanitation, remediation and similar activities (90.03). The EU manufacturing sector is represented by NACE categories 15 to 37.

It has to be indicated that NACE sub-sectors are the ones with relative mature technologies, although still important opportunities can be identified, see section 5.9. Given the results of the analysis in previous sections of this chapter it is expected that certain non-NACE sectors such as renewable energy and air pollution control will have different micro-economic performance patterns.

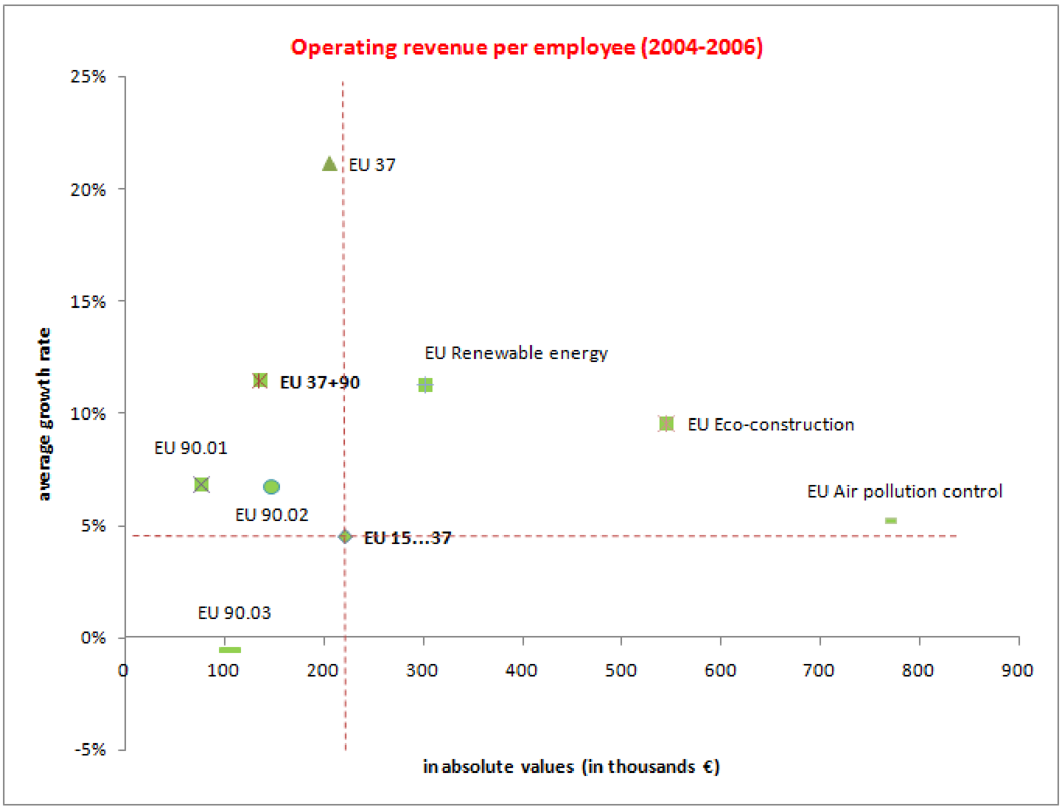
The period investigated is 2004 – 2006. This implies that the effects of the crisis, which got its full swing from mid 2008 onwards, are not reflected yet in these performance

[15] The sample of companies for the EU manufacturing NACE 15 to 37 categories contains 1.014.973 companies. This corresponds to a coverage of 44 % in terms of number of companies.

numbers. From this point of view these results need rather be interpreted as an indication of the position in which the various sub-sectors started the current crisis.

5.5.1 Productivity indicators

Figure 5.8: Operating revenue per employee 2004-2006 (in thousands €)



Source: Own calculations on the base of Amadeus data, sector inquiries, and web-searches

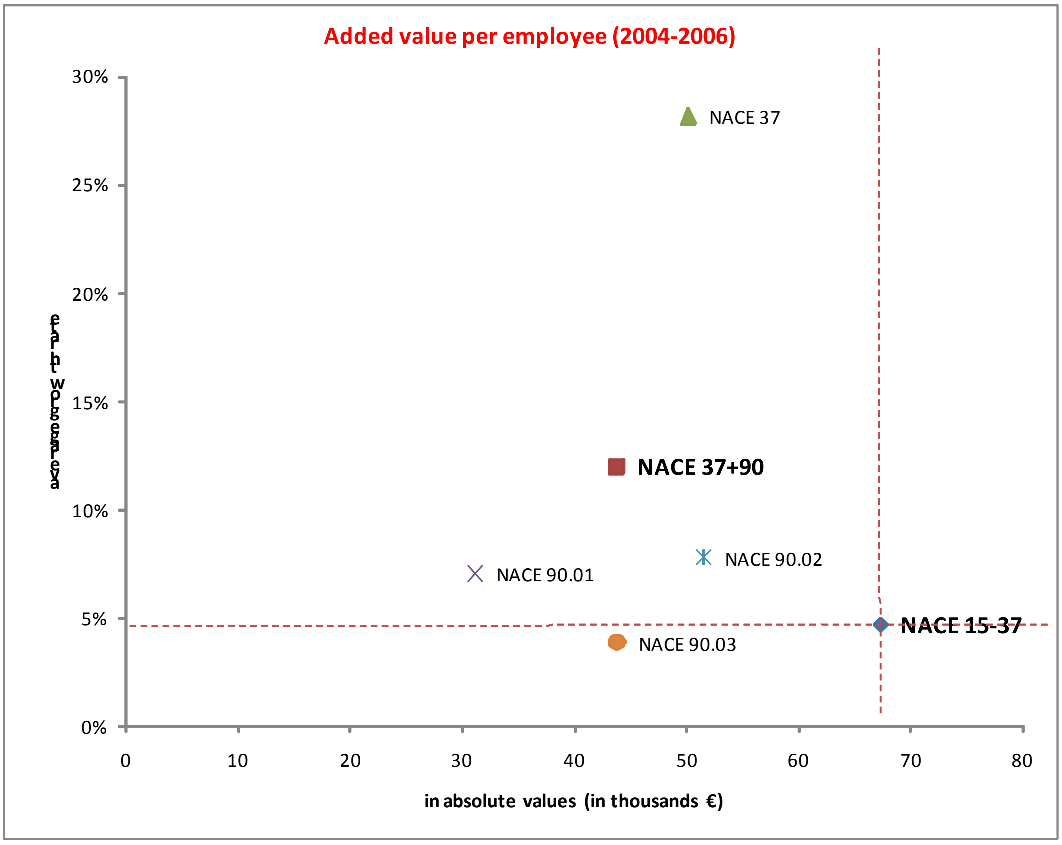
EU 37: recycling; EU 90.01: collection and treatment of sewage; EU 90.02: collection and treatment of other waste; EU 90.03: sanitation, remediation and similar activities; EU 15…37: manufacturing

Overall productivity for the sample of companies in the NACE eco-industries, expressed by operating revenue per employee, increased by 11% in nominal terms annually between 2004 and 2006, while for the manufacturing sector, the growth was around 5%. Manufacturing has higher operating revenue per employee than all of the NACE eco-industries. Recycling performs best in the sense that it comes closest to the overall manufacturing average with an operating revenue of 205700€ per employee, yet with a significant higher average growth rate of 21%. The latter may be due to the steady increase in raw materials in that period, and therefore the value of recyclates. Sanitation, remediation and similar activities show a negative growth and relative low operating revenue per employee.

The relatively younger eco-industries have substantially higher average operating revenue per employee rates than manufacturing and in the case of renewable energy and eco-construction substantially higher growth rates as well. The average operating revenue per employee of air pollution control is virtually 3.5 times larger than the average of the manufacturing sample. This might be due to the increased demand for climate change services over the course of the years.

We did not have data for the value added per employee for renewable energy, eco-construction and air pollution control. Yet given that the added value per employee shows similar patterns as the operating revenue per employee for the NACE eco-industries, namely higher growth rates but lower value added per employee, the expectation is that a similar pattern as the operating revenue per employee would be observed.

Figure 5.9: Added value per employee 2004-2006



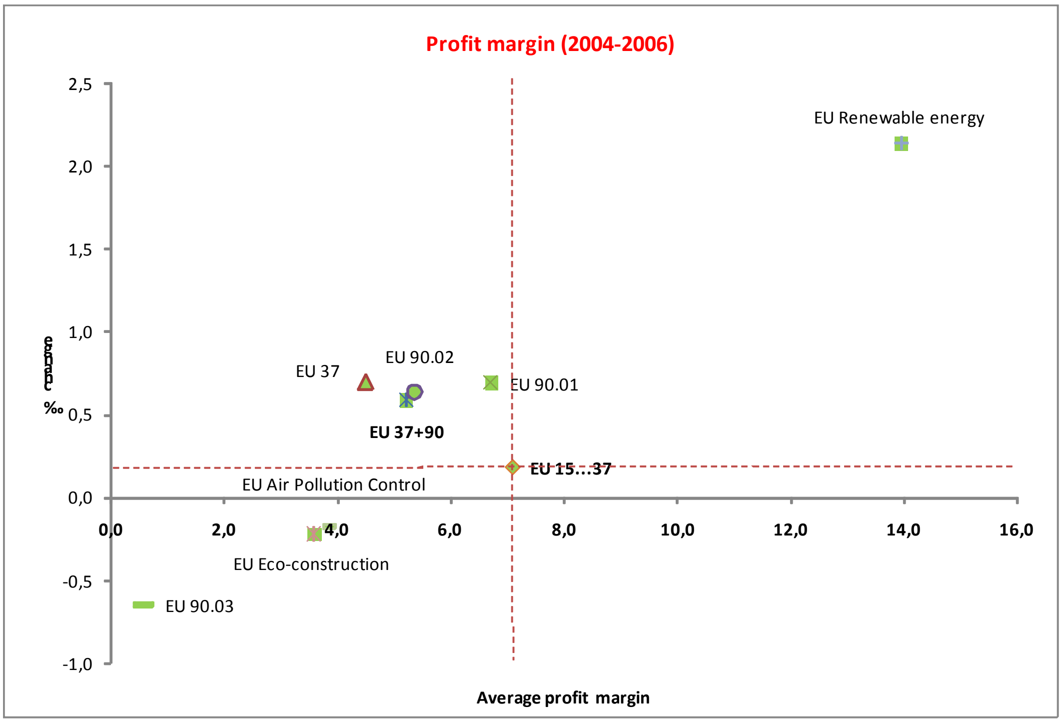
Source: Own calculations on the base of Amadeus data, sector inquiries, and web-searches

EU 90.01: collection and treatment of sewage; EU 90.02: collection and treatment of other waste; EU 90.03: sanitation, remediation and similar activities; EU 15-37: manufacturing

5.5.2 Profitability

With the exception of renewable energy, the average profit margin in the period 2004 – 2006 for the eco-industries was lower than that for the manufacturing industry as a whole. Furthermore, the sub-sectors air pollution control, eco-construction and “sanitation, remediation and others” depict on average a declining profit rate. Only NACE 90.01 “collection and treatment of sewage” approaches the average of the manufacturing sector. In comparison to the sample of EU manufacturing companies, the average increase of the profitability has been more outspoken in renewable energy as well as the recycling, waste collection and sanitation sectors.

Figure 5.10: Average profit margin 2004-2006 (in %)



Source: Own calculations on the base of Amadeus data, sector inquiries, and web-searches

EU 90.01: collection and treatment of sewage; EU 90.02: collection and treatment of other waste; EU 90.03: sanitation, remediation and similar activities; EU 15…37: manufacturing

It is quite remarkable that companies in the sample for eco-construction and air pollution control show relatively low average profit margins in the period 2004-2006, while they have relatively high rates of operational revenue per employee, as in renewable energy. Assuming that there are little or no average wage differentials between these sub-sectors[16], this suggests that air pollution control and eco-construction are faced with relatively more important cost factors, other than wages, in comparison to renewable energy. These cost factors might be due to the application of new technologies and scale economies, yet also to fragmented markets and administrative burdens.

5.6 The distribution of production and employment within EU Member States

Distribution of turnover

The shares of the different sub-sectors of the whole eco-industry differ per country. Figure 5.11 gives an overview of the four largest countries in terms of EPE, the other countries of the EU15 (EU15-4), and the New Member States (EU27-15). The most important observations are:

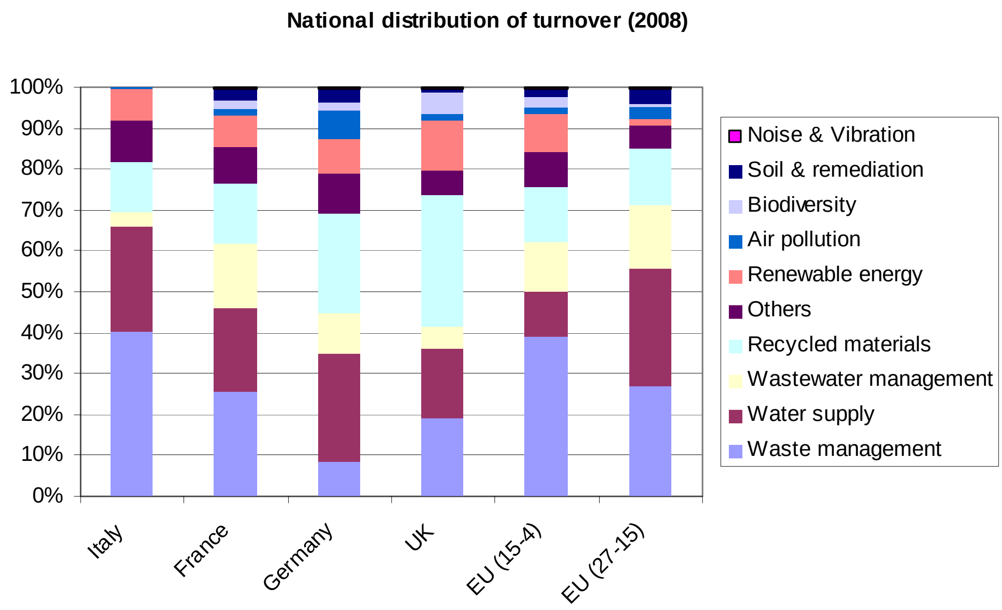
- Waste management is especially large in Italy (40%[17]) in comparison to the UK and Germany where in attributes less than 15% of the total eco-industry.

[16] From operational point of view these services all rely substantially on engineering.

[17] No data were found for Noise & Vibration, Soil & Remediation and Biodiversity for Italy

- Recycled materials is relatively large (30%) in the UK while in the other countries/areas it contributes less than 25% of the total eco-industry
- Also the shares of the third largest eco sub-sector, Water supply, vary greatly among the countries/areas.

Figure 5.11: National distribution of turnover (2008)

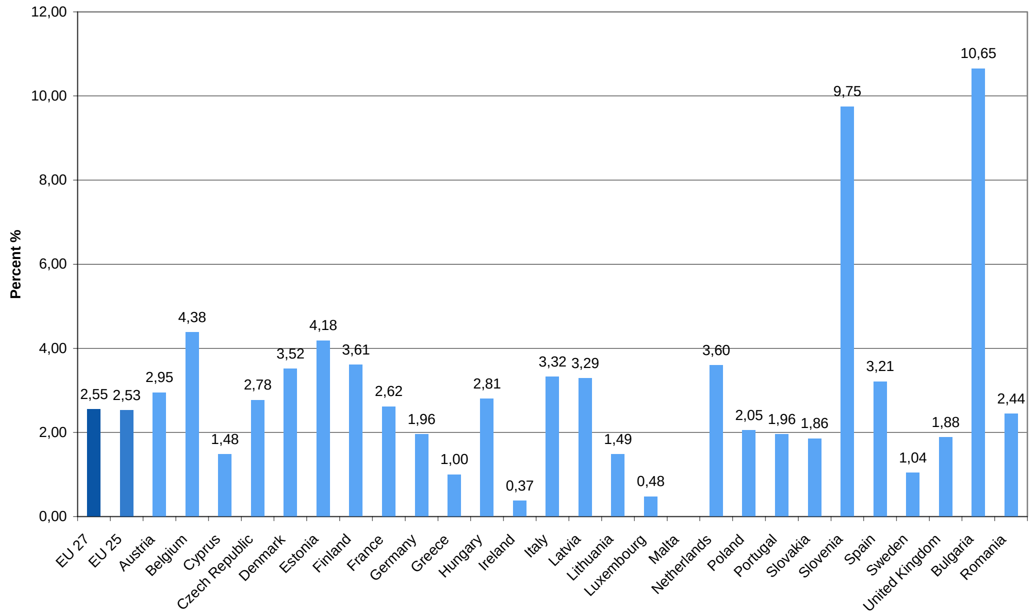


Source: Own calculations on the base of Eurostat, and Ecotec (2002) data

Looking at the total EPE turnover in relation to GDP for each of the Member States in 2008 (Figure 5.12), one can see that there is quite some variation around the mean value of the EU-27. The New Member States show relatively high percentages on average, indicating the importance of EPE for their new market economies. Exceptionally high are the percentages in Slovenia and Bulgaria[18]. No information was available for Malta.

[18] In order to control for year specific effects in Bulgaria and Slovenia, we have analysed the same percentages for the years 2004 and 2006. In both years, the figures display a similar picture as for 2008, indicating that the relatively high percentages have a more structural nature, either in terms of statistical measurement or in terms of economic activity. .

Figure 5.12 EU-27 ECO-Industry turnover as a percentage of total GDP in 2008



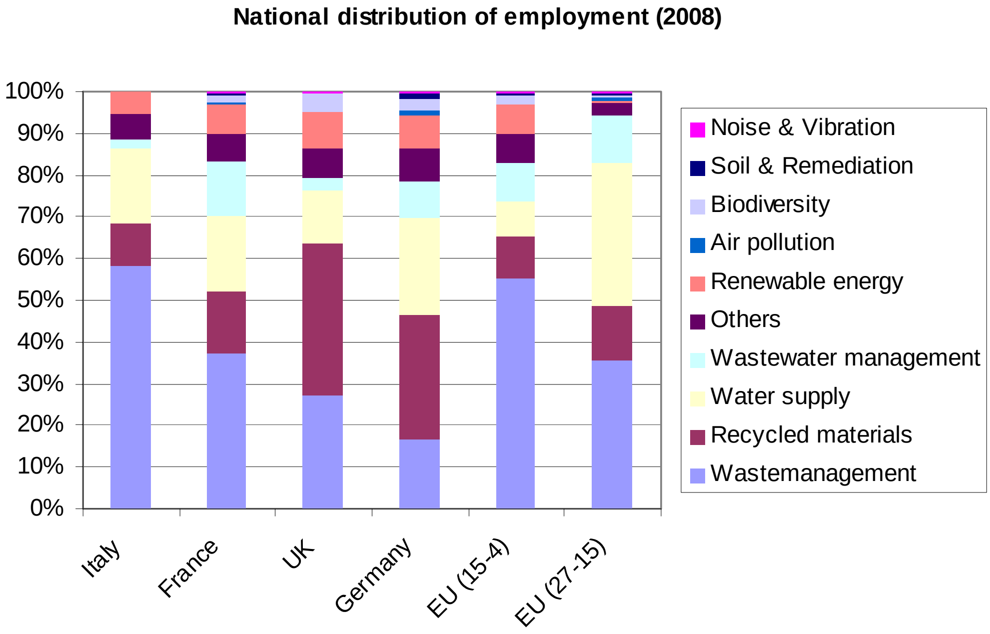
Source: Own calculations on the base of Eurostat data

Employment

Figure 5.13 shows a similar distribution as Figure 5.11 with respect to employment. The shares of the various sub-sectors are slightly different but the same main conclusions can be drawn as in the case of the turnover.

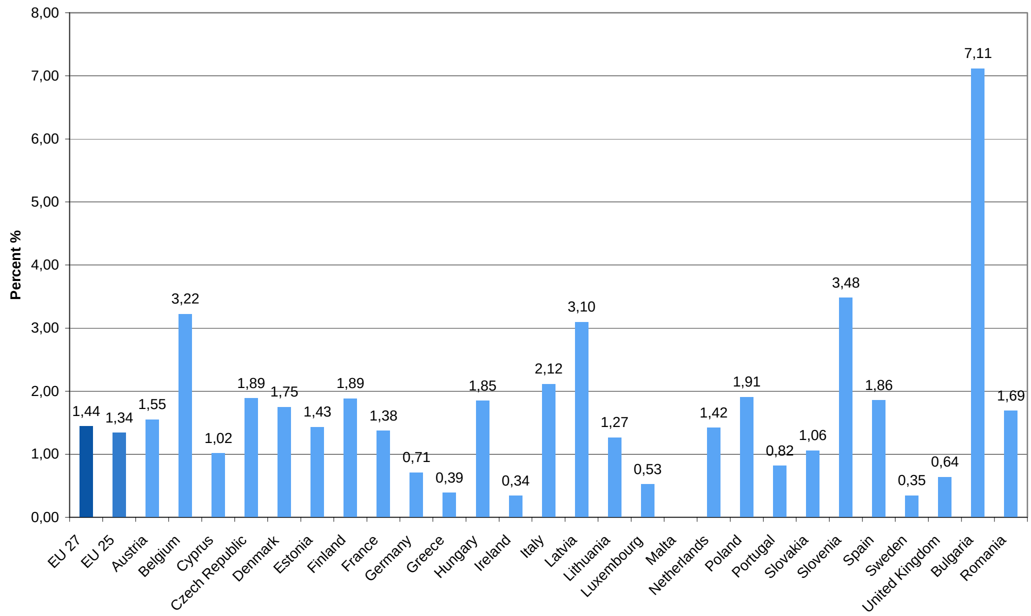
Figure 5.14 depicts the employment in each of the EU-27 Member States as a percentage of the total workforce in 2008. Again one can perceive a large variation around the EU-27 mean. The New Member States have, on average, a relatively higher percentage of the workforce in eco-industries than the other Member States. No information was been available for Malta. The percentage of employment in Bulgaria is exceptionally high.

Figure 5.13 National distribution of employment in 2008 in the four largest EU Member States, EU (15-4) and EU (27-15)[19]



Source: Own calculations on the base of Eurostat, and Ecotec (2002) data

Figure 5.14 EU-27 ECO-Industry employment as a percentage of total workforce in 2008



Source: Own calculations on the base of Eurostat data

[19] No data were found for Noise & Vibration, Soil & Remediation and Biodiversity for Italy

5.7 Skill profile of employment in the eco-industrial sub-sectors

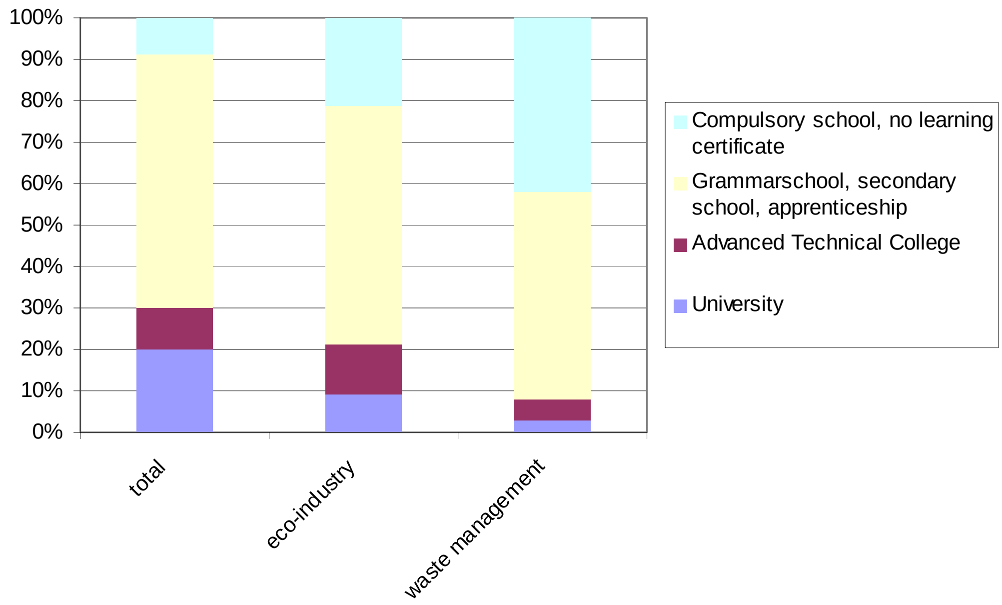
Besides the number of employees, also the skill profile of the employees is important to describe the employment development in an industry. More and betters kills are needed to improve an industry in terms of technology, productivity and attracting investment (ECORYS, 2008).

The skill profile of the eco-industry is a debated one. According to the OECD[20] the skill profile of the eco-industry is quite diverse and they are traditional qualifications applied to environmental issues e.g. chemists working in waste management. However, the Austrian Institut fur Wirthschaft und Umwelt argues that the qualification requirements of the eco-industry are not different from others sectors. Furthermore, other experts argue that there are specific eco-industry skills like knowledge about sustainable development, “Carbon foot printing” skills, environmental impact assessment skills and good understanding of the “sound” sciences.[21]

Data on skills profiles

As data was already scarce in the eco-industry as such, data about the skill profiles is even more difficult to find. However, the OECD[22] has done a study about the environment and employment, which did provide us with some data.

Figure 5.15 Employment by educational background EU-25 (2000)



Source: OECD (2004), Environment and Employment: An Assessment

[20] OECD SEMINAR SOCIAL AND ENVIRONMENT INTERFACE PROCEEDINGS (1999)
http://www.oecd.org/dataoecd/51/15/33848718.pdf

[21] ECORYS (2008, Environment and labour force skills

[22] OECD (2004), Environment and Employment: An Assessment

Figure 5.15 above shows the educational background of the labour force of the whole industry, the eco-industry (excl waste management) and the waste management. Waste management has been taken separately as this is the largest sub-sector and their skill profile is quite different than the skill profiles of the rest of the eco-industry. For all the three industries most employees have graduated from grammar school, secondary school or an apprenticeship (between 49% and 58%). Furthermore it can be seen that the share of employees who graduated from university is lower in the eco-industry (and especially in the waste management sector) than in other industries, which indicates that there are many relative less complex jobs in these sectors. This can also be concluded from the share of employees who only went to compulsory school or do not have a learning certificate (Eco industry 21% and waste management 42%). Especially in the waste management sector, most work can be done by relatively low-skilled workers.

Future of skill profiles

The demand and supply of skills will mainly be affected by globalisation, technological and demographical change (including ageing and migration). According to Skillsnet[23] the eco-industry will requirement employees with new skills and with a higher skill-level. Subsequently, they argue that there will be a shortage of skilled employees[24]. Furthermore, numerous existing skills will become obsolete and therefore educating the current labour force is required to maintain competitive. However, low skilled people will always be needed for some sub-sectors within the eco-industry.

5.8 Innovation expenditures in recycling and water supply

The Community Innovation Survey (CIS) provides information about the innovation expenditures in various sectors. Two sectors of importance to this study could be identified: water supply (DN37) and recycling (E41). In Figure 5.16 below the information about the innovation expenditures expressed in percentages of total turnover is presented for 23 of the 27 EU countries[25]. An arithmetic average is given which shows that the innovation expenditures are relatively higher in the sub-sectors water supply (5.1%) and recycling (4.3%) than in the other industries (2.9%). This trend is also visible on country-level with some notable exceptions (Germany, Sweden for recycling and France for water supply). Looking at the countries for which data are available, innovation expenditure as a percentage of total turnover is relatively higher in the New Member States. This might reflect the catching-up in terms of water and waste services with the rest of the EU.

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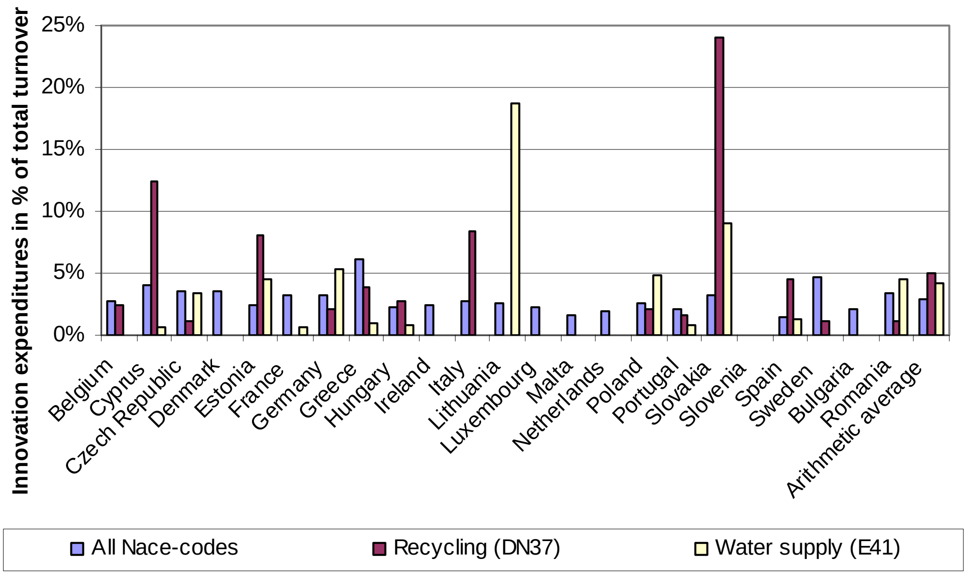
23 The early identification of skill needs network of Cedefop.

24 Strietska-Illina (2008), Skills net, Enterprise surveys as a tool for skill needs analysis, http://agora.cedefop.europa.eu/skillsnet2008innet/UsersFiles/sa/documents/Presentetion2/12_Strietska.ppt#273,3

25 Data for Austria, Finland, Latvia and the UK are missing.

Figure 5.16 Innovation expenditures in % of total turnover for the sectors: water supply and recycling of 2004



Source: own calculations based on Eurostat, CIS

5.9 General trends in technologies per eco-industrial sub-sector

In general there is a trend of increased importance of technology in the eco-industry. This is due to an increased demand of eco-efficiency. The term eco-efficiency is based on the concept of "creating more goods and services while using fewer resources and creating less waste and pollution" according to the WBCSD. This section will discuss the most important technological trends per (group of) sub-sector(s) as defined in chapter 4.

5.9.1 Pollution management

Pollution management technologies will avoid or reduce the introduction of contaminants into the environment. Generally it considers end-of-pipe techniques which are placed at the end of an industrial process. End-of-pipe technologies are understood to be control technologies that help companies to meet permit requirements or to reduce the taxes to be paid for emitting pollutants.

It is generally considered that investments in pollution management technologies are not particularly interesting from an economic/financial perspective. Generally they consume both energy and raw materials without producing added value. Therefore, the industry is shifting away from the end-of-pipe approach towards more process-integrated solutions. The aim of process-integrated solutions is to prevent the production of pollutants, but also to lower the use of raw materials and energy.

Despite this clear shift from end-of-pipe control techniques towards the process-integrated approach still some different technology development in the pollution management sub-sectors could be identified. However, in the case of waste water treatment these new end-of-pipe measures could also be seen as process-integrated measures since they allow the reuse of the cleaned water and the removed substances.

Air pollution control

Most of the stationary air pollution sources have to meet strict environmental legislation (e.g. IPPC Directive on Industrial Pollution Prevention and Control) for their emissions of air pollutants such as SO_2, NOx, VOC [26] and dust. The technologies to reduce these pollutants are already at a mature level and include air/gas filtration systems, scrubbers, gas treatment plants (denitrification, desulphurization,…), dust collectors and others.

In the future more efforts are expected to reduce the pollution from mobile sources in air, road and sea transportation. Technological developments can be expected in the downscaling of the technologies already applied in stationary sources.

Recent research is focusing on the abatement of greenhouse gases. Carbon dioxide capture and storage (CCS) is considered as one of the options for reducing atmospheric emissions of CO_2 from human activities. CCS involves the use of technology, first to collect and concentrate the CO_2 produced in industrial and energy related sources, then the transport to a suitable storage location, and then finally store it away from the atmosphere for a long period of time. (IPCC, 2005) The different components of a CCS system are all well known and developed. However, the CCS is not yet a fully commercial technology and only some pilot plants are currently under construction. Although the enabling technologies are well known, their optimal mounting at the level of a large-scale power plant still involves uncertainties regarding technical performance and cost. In addition, uncertainties also exist regarding the infrastructure of transportation and storage. Reaching maturity of CCS technology can be accelerated if there is confidence about the prospects of a large-scale deployment of CCS applications in the future. (Capros et al., 2007)

Solid waste treatment

New technologies in solid waste treatment focus on the recovery of energy in the form of electricity and/or heat. Such technologies reduce or eliminate waste that is traditionally streamed to a “greenhouse gas” emitting landfill or consume waste materials from existing landfills. Either the waste can be directly combusted to produce energy or the waste material can be modified into a combustible fuel such as methane, methanol, ethanol or synthetic fuels. (Fuji-Keizai USA, Inc., 2008)

A lot of research is going on in this field of producing fuels from waste. These technologies have the potential to produce more electric power from the same amount of fuel than would be possible by direct combustion. This is mainly due to the separation of corrosive components (ash) from the converted fuel, thereby allowing higher combustion temperatures in e.g. boilers, gas turbines, internal combustion engines, and fuel cells (Fuji-Keizai USA, Inc., 2008). Some life cycle assessment analysis suggest that in some cases it is, from an environmental point of view, more interesting to recover energy from waste than to recycle it (especially when the recycling process is energy consuming) or re-use it as compost (organic waste). (VITO, 2009)

[26] VOC: Volatile Organic Compounds

A new trend in waste management and recycled materials is "cradle-to-cradle" (C2C)[27], which implies a biomimetic approach to the design of systems i.e. designing a product that is waste-free, where all inputs of a product can be re-used for other products. However, this concept is mainly applicable in the design phase of products. Also the waste treatment is becoming inspired by the idea of waste being a valuable resource. Ideas exist to start with the 'mining' of historical landfills including energy and material recovery.

A report of Berger (2007) stated that in 2005 €30 billion worldwide has been invested in environmental technologies in the sub-sector waste management and recycling. The EU takes a leading role with a market share of 50%.

Waste water treatment

Most of the primary[28] and secondary[29] waste water treatment technologies are mature and prevalent. Also tertiary[30] waste water treatment technologies are already refined, but they are not prevalent, while the investment and operation costs are high. Tertiary technologies can become interesting, when there is a stricter legislation, taxes on discharge are higher or the price on clean water is higher than recycling waste water.

Most important developments are situated in the membrane technology. The main principle of the membrane technology is quite simple. A membrane could be considered as a filter that is designed to catch very specific substances while allowing the water molecules to flow through. Different types of membrane filtration are available. Depending on the size of the substance that is trapped, different filtration methods are identified such as microfiltration (macro-molecules), ultrafiltration (molecules), nanofiltration and reversed osmosis (ions). Research in this field focuses on the development of cheaper, dedicated and more resistant membranes that can produce water of drinking quality and concentrate the raw materials to make them available for re-use. (VITO, 2009)

Next to the stand-alone applications, membranes are also applied in the relative new "membrane bioreactor" (MBR) plants. The first European MBR pilot plant was built in 1996. The technology used in a MBR, is the combination of activated sludge treatment together with a separation of the biological sludge by micro- or ultra-filtration membranes with pore size of typically 10 nm to 0.5 µm to produce the particle-free effluent. By 2006, around 100 municipal full-scale plants with a capacity >500 p.e. were in operation in Europe and around 300 large industrial plants with a capacity >20 m^3/d. The development and successful commercialization of the technology in the past few years has led to a significant decrease in capital and operating costs. However, the delineation between

[27] McDonough, W and Braungart, M. (2002), *Cradle to Cradle: Remaking the Way we Make Things.* New York: North Point Press.

[28] primary waste water treatment technologies: sieve and raw filtration techniques to remove (raw) materials.

[29] secondary waste water treatment technologies: (bio)chemical techniques to remove (partially) heavy metals and (easy degraded) organic mater to acceptable levels for discharge the water. (When the waste water contains difficult degrading organic substances or specific metals, their emission concentration are not always acceptable for environmental authorities).

[30] tertiary waste water treatment technologies: techniques which eliminate "rest" pollutants, and produce water of drinking quality.

municipal and industrial systems shows that the technology remains especially competitive for industrial applications. In the municipal sector, it is now considered that for a green field and for a given treatment quality the capital cost of MBR plants is comparable to a conventional scheme. However, the energy costs remain 30 to 50% higher. Should this discrepancy be reduced in the coming years, the MBR technology would become a State-of-the-Art process for the municipal sector. (mbr-network, 2009)

Another promising membrane-based technology is the electrodialysis. This technology is used to remove salts (ions) from water streams through the combination of an applied electric potential and ion-exchange membranes. (VITO, 2009)

Soil- and groundwater remediation

Within the soil- and groundwater remediation two main groups of technologies can be identified: in situ and ex-situ technologies. In situ remediation refers to the cleaning of the soil or groundwater by stimulating the natural processes in the soil through the injection of air, nutrients and/or dedicated micro-organisms. For ex-situ remediation the soil is excavated (or the groundwater pumped) before treatment.

The ex-situ remediation technologies for groundwater are comparable to the general waste water treatment technologies.

Most of the in-situ technologies are based on the *biochemical removal* of organic contamination, where groups of bacteria are converting the contaminant to CO_2 and water. New technology developments focus on new methods to inject air in the soil (to stimulate microbial activity). One of the more recent technologies are the Permeable Reactive Barriers, PRBs, which are more economically viable compared to the expensive and energy consuming ‘pump-and-treat’ methodology. Downstream a permeable barrier containing reactive elements is placed in the soil. When the polluted groundwater passes this barrier it makes contact with the reactive elements. Because of fysical, chemical or biochemical processes the pollutants will then become immobilized or break down to less harmful components. The most common used reactive material is iron, which is very effective for the treatment of chlorinated solvents. Further development in this technology is expected, including the use of biological reactive elements. Research is focusing on developing these reactive elements in function of the pollutant and the biochemical and geophysical conditions. (VITO, 2009)

Also new technology developments are expected in the field of measurement methods such as the analysis of contaminated soil samples with laser-spectroscopic procedures.

Noise and vibration control

Despite existing EU and national legislation targeted at controlling noise pollution, public concern and anxiety about noise remain high. For the European Union (not taking into account the 10 new member states) it has been estimated that about 80 million people are exposed to noise levels considered unacceptable. (CALM-network, 2004)

Transportation is the main contributor to environmental noise pollution. According to the CALM-network (2004) the main research topics in this field are:
Road traffic noise:

- Quiet road surfaces: (R&D up to 2010, implementation up to 2020)
- Low-noise tyres (R&D up to 2010, implementation up to 2020)
- Vehicle engine (R&D up to 2015, implementation up to 2020)
- Traffic flow management (R&D up to 2012, implementation up to 2018

Railway noise:

- Rolling noise arising from wheel and rail roughness (R&D up to 2010, implementation up to 2020)
- Traction noise (R&D up to 2009, implementation up to 2020)
- Aero-dynamic noise (R&D up to 2010, implementation up to 2020)

Air traffic noise:

- low noise design for the engine
- low noise design with optimized power plant integration
- improved aircraft aerodynamics
- application of advanced active control technologies

Noise and vibration control technologies are further optimized and specifically tested in the energy production. In the energy sector noise and vibration control is especially an issue for the building of onshore wind turbines which are placed closely to habitation areas.

5.9.2 Resource management

Not only from an environmental point of view, but also due to economical reality resource management is gaining more and more importance. Raw materials, fresh water and fossil fuels are becoming less available and therefore more expensive. The growing demand for resource management technologies explains the amount of research activities in these eco-industry sub-sectors.

Recycled material

A lot of recycling techniques are state of the art, but the implementation is depending on the price of raw materials. A report of Berger (2007) estimated that the total amounts invested in waste management and recycling in 2005 were €30 billion, and indicated that the EU takes a leading role with a market share of 50%.

Renewable energy production

Renewable sources of energy – wind power, solar power (thermal, photovoltaic), hydro-electric power, tidal power, geothermal energy and biomass – are essential alternatives to fossil fuels. Their use reduces our greenhouse gas emissions, diversifies our energy supply and reduces our dependence on unreliable and volatile fossil fuel markets (in particular oil and gas). The growth of renewable energy sources also stimulates employment in Europe, as well as the creation of new technologies and improves our trade balance. The new Directive on renewable energy sets ambitious targets for all Member States, so that the EU will reach a 20% share of energy from renewable sources by 2020 and a 10% share of renewable energy specifically in the transport sector. (European Commission DG Energy, 2009). The global clean-energy projected growth for bio fuels, wind power and solar power is about 200% in the period 2008-2018 (2008: 115,9 billion $, 2018: 325.1 billion $). This growth is expected to be equally spread over the different energy sources (bio fuels, wind power, solar). (CleanEdge, 2009)

The subsector renewable energy is the fastest growing sector (the 20% in this report is most likely to be an underestimation) and it heavily relies on technological progress. In 2005 close to €600 billion worldwide is invested in environmental technologies (Berger, 2007), which makes it the largest sub-sector with respect to technological investment. Europe is taking the lead with a market share of around 35% (Berger, 2007).

On overall it can be said that there are public and private incentives for industries to invest in technology. However, the markets need more guidance and incentives to avoid underinvestment in R&D according to Berger. This is in line with the ambitious goals of the EU in the Lisbon Agenda to increase the competitiveness of EU business and intensify investment in research and education.

This paragraph will only focus on the production of renewable energy. Of course also a lot of research is going on in the fields of energy infrastructure (e.g. smart-grid systems), energy storage, heat storage, energy efficiency, (e.g. organic LED in lightning), energy efficient vehicles, etc. However these research topics are generally dealt with in the traditional industries. Therefore these will not be further discussed in this chapter.

Wind energy:
A common misunderstanding is to consider wind energy as a mature technology, which could lead to a reduced R&D effort. In addition, the European 20% target for the promotion of energy production from renewable sources poses new challenges. In its recently published Strategic Research Agenda, the European Technology Platform for Wind Energy, TPWind (www.windplatform.eu), proposes an ambitious vision for Europe. In this vision, 300 GW of wind energy capacity is implemented by 2030, representing up to 28% of EU electricity consumption (in 2008 this is about 4%). Moreover, the TPWind vision includes a sub-objective on offshore wind energy, which should represent some 10% of EU electricity consumption by 2030. An intermediate step is the implementation of 40 GW by 2020, compared to the 1 GW installed today. (EWEA, 2008)

The wind turbine technology has developed extremely fast, best evidenced by the increase in commercial turbine size by a factor of around 100 in 20 years. In 1985 the maximum rotor diameter of a commercial wind turbine was 15m (0.05 MW). In 2005 this was already 112m (5 MW). By 2012 this is expected to be 150m (7.5 MW) and by 2020 it might be possible that 10-20 MW turbines will be build. (EWEA, 2008)

These ‘mega-turbines’ are being developed for the large offshore projects planned in many European countries. These offshore projects also induce research projects regarding large distance electricity transport. Next to the large turbines, further research is going on for the micro turbines for decentralized energy production. Also the implementation of non-traditional concepts, such as small vertical axis wind turbines is part of this ongoing research.

Solar/photovoltaic

A variety of other photovoltaic technologies and conversion concepts are the subject of research in and outside Europe. They are all aimed at low cost and high efficiency or a combination of the two. New technologies are at various stages of development: from proof-of-principle to pilot production. Most still require fundamental research to show the basic potential for commercial use. A key factor in reducing of the cost of modules is connected with the manufacturing processes used. In this context there is considerable interest in replacing single crystalline and polycrystalline semiconductor layers by nano-structured layers, which may be deposited very cheaply, using experience from other sectors. (PV TRAC, 2005)

New technologies can be categorised as:

- Options primarily aimed at very low cost (while optimising efficiency)
    - sensitised oxide cells
    - organic solar cells
    - other nano-structured materials.
- Options primarily aimed at very high efficiency (while optimising cost)
    - multi-junction cells for use in concentrators
    - novel conversion concepts.

Some technologies, such as sensitized oxide and multi junction cells, are more mature and are gradually moving out of the laboratory phase while others are still in the early stages of development. Organic (or "plastic") PV is often considered a high-risk, high-potential option. Working devices have been demonstrated, but efficiencies are still low and sufficient stability has yet to be proven. Finally, novel conversion concepts will be based on a variety of principles, and can be considered to be at the fundamental research stage. (PV TRAC, 2005)

Solar/thermal

The solar thermal energy can be applied in many ways:

- electricity generation using concentrated solar power (thermal collectors);
- electricity generation by heating trapped air which rotates turbines in a solar updraft tower;
- direct heating of buildings;
- direct heating of water or air for domestic hot water and space heating (solar-thermal panels);
- use of solar heat in cooling systems.

Solar Thermal Energy is an important alternative to fossil fuels with a huge potential. In 2005 approximately 10 GWth of solar thermal capacity was in operation in Europe. This capacity could well be increased to at least 200 GWth by 2030, when solar thermal energy will be used in the majority of European buildings. The typical share of solar thermal energy in meeting the heating and cooling demands of a single building will be increased dramatically to more than 50%, and up to 100%. And new applications will be developed, e.g. solar thermal systems that provide process heat for industrial use. Although matured solar thermal technologies are available already, there are further developments needed to provide adjusted products and applications, reduce the costs of the systems and increase market deployment. (ESTTP, 2006)

Research in this sector is focused on the further development of solar thermal collectors. High-temperature collectors will be developed alongside large-scale collector modules, façade-integrated modules and very inexpensive low temperature collectors. To address the segments in the temperature range of 80°C to 250°C, collectors must be developed that can reach these temperatures at a high level of efficiency. Appropriate technology concepts already exist, for example flat-plate collectors with multiple glazing and anti-reflective coating, stationary CPC (compound parabolic concentrator) collectors or small parabolic collectors. High temperature collectors can also be used for refrigeration services required in industrial processes. Further great potential for improvement is seen in the use of new materials and production technologies in order to reduce production costs, e.g. with full through-flow volumetric absorbers and frames suitable for industrial production. (ESTTP, 2006)

In the future, a large proportion of solar thermal collectors will remain separate from the storage medium and will still require a heat transfer circulation loop. The development of new types of heat transfer media, e.g. ionic fluids, and collector loop materials, e.g. metalized plastic pipes, could improve system output and reduce costs. New pumps especially developed for the solar heat circuit are already reducing the electricity demand by more than 80%. These pumps, together with additional functionality such as measurement of the pressure within the loop, will become standard within the next years. In addition thermally driven pumps will be developed. Expansion tanks and vessels, overpressure valves, heat exchangers and other system components will be further integrated and developed, e.g. to resist high temperatures. (ESTTP, 2006)

Thermally driven cooling systems can use any type of heat source that provides adequate temperatures. They are especially suitable for use with solar thermal energy because of the correlation between the level of solar irradiation and the cooling services required. Currently, the air-conditioning world market is dominated by decentralized room air-conditioners, e.g. split and multi-split systems. Moreover, these systems are habitually less efficient than larger centralized technologies; they cause a tremendous impact on the electricity requirements in terms of energy and power. This underlines the need for the development of small-scale solar thermal driven cooling machines in the range of 2-5 kW units. Solar cooling and air-conditioning is still in the early stages of development. (ESTTP, 2006)

Bio-energy

Plants use energy to produce biomass. This biomass can be used directly as a fuel or to produce bio-fuels. The first bio-energy application made use of the so-called 'first-generation bio fuels' which are bio fuels made from sugar, vegetable oil, animal fats,… Because of the competition of these types of bio fuels with food supply and other limitations (e.g. not competitive with fossil fuels, low environmental gain) further research has been undertaken in the field of second-generation bio fuels. Second generation bio fuels are produces from waste or rest products (the non-food parts of crops, such as fibres) as well as from crops that are not used for food purposes such as grasses, jatropha and wood. (VITO, 2009)

The focus in the bio-energy markets is on the production of bio fuels. According to the Bio fuels Research Advisory Council of the European Commission (2006) Large-scale deployment of bio fuels can be expected by 2020-2030. Three main phases in the technology development are to be considered:

- Phase I Short term (until 2010)
  - Improving existing technologies;
  - R&D into 2nd generation bio fuels (from lignocellulosic biomass). First 2nd generation bio fuels demonstration plants;
  - R&D into the bio refinery[31] concept.
- Phase II Medium term (2010 - 2020)
  - Deployment of 2nd generation bio fuel production
  - Demonstration of bio refinery concept; continued R&D to improve lignocellulosic biofuel; and integrated bio refinery processes;
  - Development of options for energy crops and sustainable agriculture.
- Phase III Long term (beyond 2020)
  - Large-scale production of 2nd generation
  - Bio fuels; deployment of integrated bio refining complexes

Liquid bio fuels, which are compatible with current technology, offer the highest potential for fast introduction of bio fuel on a large scale. The preference for liquid fuels from biomass does, however, not mean that there is no place for gaseous fuels in this strategy. Biogas (methane) is likely to replace an increasing share of the CNG in automotive fuel market. (Bio fuels Research Advisory Council, 2006)

Hydroelectric power

The technology is mature and most potential sites in Europe have been fully developed. Only at the level of the small hydroelectric power stations further technology development is expected on the improvement of the energy efficiency of these installations.

Ocean energy

Ocean Energy (OE) involves the generation of electricity from the waves, the tides, the currents, the salinity gradient, and the thermal gradient of the sea or the ocean.Globally, the theoretical potential of OE has been estimated over 100.000 TWh/year (as a reference, the world's electricity consumption is around 16.000 TWh/year). The global technical resource exploitable with today technology is estimated to be in the order of 45.000 TWh/year for wave energy; tidal current energy is in the order of 2.200 TWh/year, salinity gradient energy in the order of 20.000 TWh/year, and of OTEC in the order of 33.000 TWh/year. (EU-OEA, 2009)

The technologies that recover energy from the ocean are generally not at the same commercial level production of energy (electricity) from solar, wind and bio-mass. Installations exist at pilot scale. The technologies used are generally derived from other renewable energy technologies such as turbine technology from wind power for the

[31] Bio refinery is the co-production of a spectrum of bio-based products (food, feed, materials, chemicals) and energy (fuels, power, heat) from biomass

conversion of wave energy and traditional hydroelectric technologies for the conversion of tidal energy. (EU-OEA, 2009)

Geothermal

Geothermal energy is the exploration of the heat of the earth itself. Sometimes this heat is available very close to the earth's crust but mostly it has to be tapped from kilometers deep. Strictly seen this is not a renewable source of energy (there is no continuous heat transfer to the earth's core).

In the EU at total of approximately 2.5 Mtoe (Million Tons of Oil equivalent) has been supplied for heating and the installed geothermal electricity capacity is about 1GW, 10% of the world geothermal installations. The 2020 targets, set by the European Geothermal Energy Council (EGEC, 2008) are:

- Heat production for all Europe: 11 Mtoe
- Electricty production for all Europe: between 40.000 and 80.000 GWh/y

Therefore, R&D has to focus on following topics (EGEC, 2008):

- R&D for heating & cooling
  - Increasing the knowledge about the usable geothermal potential
  - Improving plant efficiency,
  - Decreasing installation and operation cost
  - Geothermal heat pumps (efficiency improvement)
- R&D for electricity:
  - Develop enabling technologies for the exploitation of geothermal resources
  - Prove the sustainability of Enhanced Geothermal Systems (EGS) technology
  - Develop enabling technologies and demonstrators for the microgeneration and co-generation with low temperature water (<120°C), also in hybrid plants (e.g. biomass and geothermal)

Water supply

There will be severe problems of water supply in the near future according to the UN World Water Development Report (2006). Water scarcity could lead to an enormous movement of populations to other parts of the world. This shortage of water supply demands a high technological progress. According to Berger (2007) over €190 billion (of €1000 billion in total) in 2005 worldwide has been invested in R&D in the sub-sector sustainable water management, which indicates a high priority of this sub-sector. The EU takes a leading role with a market share of 30%.

This reality shows that water in the future is not a consumable or utility anymore, but regarded as a highly valuable asset. At the moment the European water sector is already a major economic player (1% of GDP) with a turnover in the EU of about 80 billion Euro and average growth rate of 5% per year. (WSSTP, 2005)

Technology development is focussing on two aspects of the water supply problem:

- water saving technologies and management
- technologies that enables the use of new and alternative resources of water.

In the industry the tendency is to work with closed water cycles or even zero water use processes. In the closed water cycles the use of membrane systems is playing an important role to ensure the required water quality needed and the recovery of usable products from the water streams. Since agriculture is a large consumer of freshwater further developments in intelligent irrigation systems and integrated water management methods are ongoing. On the longer term research in groundwater management is a major issue in sustainable water management.

Alternative resources of freshwater include brackish water, karstic water and seawater, wastewater (grey or black) and rainwater (including runoff from hard surfaces and from agricultural fields). Cheaper and smarter technologies are needed to treat these sources to appropriate standards. Advances in membrane technology are expected to have a major role in the development of new methods of water treatment, leading to an increased knowledge of water quality requirements for all applications and purposes. (WSSTP, 2006)

Nature protection

In the field of nature protection tools to follow the evolution of the quality and quantity of nature are developed. One of those tools is remote sensing: by use of satellites, airplanes and helicopters builds are made of the earth. Those builds are analyzed and problems can be detected.

Examples:

- quality and quantity of north and south pole ice;
- accidental and illegal forest fire;
- illegal chop of forest;
- evolution in erosion,
- evolution in desertification,
- drying of rivers, inland seas;
- illness of forest,
- oil on seas,…

Current systems allow for detection when damage to nature has already taken place. Researchers are looking for systems to predict problems and make real-time early warning systems.

Therefore there is need for:

- looking for special unmanned planes (UAV), that can control big areas in a continues way. Because those planes had to operate continues, they had to work on solar energy, and therefore they must be very light.
- new sensors to detect specific situations (e.g. special to look for oil on seas, special to look for ill forest, …). Those new sensors had to be very light and very economically;
- the pictures of the sensors are send to data centres, to analyze. To make a real early warning systems; there is need for new software to computerize the pictures into alert signals.

Beside the control systems for nature protection, research is done on local scale for specific problems.

Examples:

- Protecting special eco-systems of the rising of the sea level
- Protection of glaciers,…

But this research is focused on a local situation and mostly linked on a local nature reserve.

5.9.3 Eco-construction

Eco-construction is about building structures that are non-harmful or even beneficial to the environment. This means that these buildings are efficient in the use of (renewable) materials and the energy required to build it. Even more important is the impact of the building during its lifetime , including: energy demand (e.g. insulation, passive buildings), energy production (e.g. solar panels, solar thermal,…) and water usage (e.g. re-use of rain water,…). Eco-construction thereby covers a large field of the eco-industry topics such as recycled materials, renewable energy production and water usage.

Eco-construction is a part of the whole concept of sustainable construction and living. The European Construction Technology Platform (ECTP, 2005) sees three strategic research themes to move on to sustainable construction and living: materials and technology, industry transformation and service:

Materials and technology

Small improvements in eco-efficiency (energy and raw material consumption) would generate big savings due to the large volumes involved. New analytical and development opportunities are evolving, for example from the application of nanotechnology, which can lead to breakthroughs in the functionality and sustainability of building materials, as well as in building energy performance improvement.

R&D in this context will typically involve the development of:

- Client-driven platform construction and the industrialization of construction (including underground), allowing for drastically reduced construction costs and time, in turn giving rise to architecturally rich communities
- New materials, and construction, maintenance and demolition techniques, which reduce consumption of natural resources and allow recycling and reuse of materials

Efficient materials and technologies for safeguarding our cultural heritage

- Methods of inspection, maintenance, repairs and renewals of infrastructure at minimal cost and with minimum disruption.
- Nano- , bio- and information technology as drivers of change in the construction industry and the built environment.

Industry transformation

This theme concerns the management of construction, with the objective of improving the competitiveness and productivity of the European construction sector and creating new business opportunities. An important task is to turn the sector around to becoming knowledge based.

This approach also includes refocusing from the purely technical to include the human element. Today, increasingly advanced technology is being developed but human behaviour essentially remains the same – we are not inherently interested in learning the details of the technologies available. It is important that technologies, buildings and cities are developed with human behaviour and needs constantly in mind. This approach will yield hospital designs that facilitate recovery, roads that limit the inherent risks for drivers, building plans that reduce fire evacuation times for all, etc.

R&D typically performed within this approach will:
- Link the value and supply chains in construction together, including bridging the gap between "knowledge production" and "knowledge use"
- Re-engineer construction into a safe, knowledge-based and high-tech industrialized process, producing highly customized, low environmental impact products
- Develop new sustainable models, design and building techniques, materials and ICT that increase design possibilities, efficiency and safety, and reduce risks from hazards
- Develop standards that are performance-based and inherently open to innovation
- Develop tools for transforming research into economic activity
- Develop tools for improving the general public's and particularly young people's perceptions of the construction sector, by dialogue and communication
- Build a more human-friendly construction work environment
- Address the mechanisms of change needed for business procedures
- Develop "human science tools" in construction, while adopting holistic approaches and integration for improving dialogue, communication and decision-making, as well as obtaining better value definitions for customer and user
- Develop the architectural knowledge-base and its implementation in construction
- Develop robust technologies that connect human behaviour and requirements for safety, energy-efficiency, etc.

Service
The cultural heritage of the existing built environment enriches the identity, the collective memory and the quality of our daily life. Cities, towns and villages, each in their unique territorial setting, represent an essential part of our universal heritage, and should be seen holistically, with structures, spaces and human factors normally in a state of continuous evolution and change. This involves all sectors of the population, and requires integrated design and planning processes across a wider range of different activities. Conservation deals with ensembles of buildings, infrastructure and open spaces and includes intangible as well as economic values.
R&D typically performed within this approach will develop:
- Methods for management, life-extension, assessment, monitoring, diagnosis, improving energy performance, shortening payback time and reducing the environmental impact of infrastructure, networks and buildings
- Specific methods and materials to preserve and rehabilitate existing building of various types, and transport and services infrastructure.
- Ways to integrate buildings and networks in the urban and natural environment (including social innovation and risk-sharing)
- Methods for incorporating alternative energy resources into the built environment.

6 Competitive position of the European eco-industry

6.1 Introduction

In its Mid-term review of Industrial Policy, the Commission states that based on available evidence:

> "[the] (European industry) is (…) well placed to grasp the opportunities of the emergence of environmental industries. Environmental industries in Europe are at the global forefront on technologies generating a turnover of approximately 2.2% of EU GDP, and employing 3.4 million people."

The purpose of this chapter is to deepen the understanding on these competitiveness issues and to assess to which extent such statements need to be qualified. It investigates available data and literature, considering the determinants of competitiveness, so as to provide some insights in how these opportunities may indeed be grasped. Therefore in this chapter we scope out and identify the key (sub-) sectoral issues which influence the competitiveness position of the EU eco-industry. In addition the EU eco-industry sector will be put in to context within the wider global market.

We start with a consideration of the internal competitiveness dynamics of the industry in the EU-27 and the different sub-sectors within it and subsequently turn to the position of the EU eco-industry in the world and particularly vis-à-vis the main other key players in this industry. Obviously the intra-EU and extra-EU levels are interrelated, as we will highlight where relevant. Subsequently we briefly consider some important developments in the connected industries and other parts of the value chains in which eco-industries operate, which (potentially) have an impact on the competitiveness of the eco-industries. These issues will be elaborated on further in the following chapter.

We conclude with some summary observations on the competitiveness of the EU eco-industry and the main drivers behind this competitiveness. These observations will be taken up further in the strategic outlook and the dynamic SWOT analysis in chapter 9.

6.2 The eco-industry in the EU-27

6.2.1 Intra-EU Trade and investment patterns

Through an analysis of available trade data we have investigated the developments in intra-EU trade and the revealed comparative advantage (RCA) of individual member states, providing further insights into the intra-EU differences and gaps that have been noted in various sources[32].

Trade patterns – methodological notes

These analyses draw on official trade statistics ("trade code" data) provided by EUROSTAT for the period 2000 to 2007. Gaps and limitations of the available data have been addressed by using a similar approach to that adopted in the earlier studies by ECOTEC (2002) and Ernst & Young (2006).[33]

However, certain limitations remain. Due to the fact that the sub-sectors selected for this study are not captured in trade data as separate categories as such, means we have had to rely on trade data of recognisable eco-industry products, which are then considered a reflection on the industry as a whole, and specific sub-sectors of which the products may form a part. It should thus be noted that goods covered by the trade codes used include only a small proportion of the total trade in environmental goods and services. Another important limitation is formed buy the fact that the figures capture *products only, and not services.* Therefore, while the analysis is relatively robust for the trade in goods covered, it is estimated to represent only around 20 percent of total trade in environmental goods and services (ECOTEC, 2002). This claim is strengthened by the E&Y report, which makes similar assumptions. An additional disadvantage is that due to various issues (see annex II), intra EU exports and imports do not add up to the same total. Although import data seem to be the most accurate, export data are most interesting from the perspective of considering the competitive advantage of a sub-sector in a country. We thus present export data as derived from import statistics.

For our analysis, seven different eco industrial sectors have been identified in the Eurostat Comext trade database, including (1) Air Pollution Control, (2) Hydropower, (3) Monitoring equipment, (4) Other Environmental Equipment, (5) Photovoltaic, (6) Waste Disposal and (7) Water Pollution Control. This implies that virtually all sub-sectors that have been identified earlier are covered. The notable exception is recycled materials, while renewable energy is only partially covered. The specific codes under these eight sub-sectors are provided in the methodological annex II, 14.2.

Trade analysis per sub-sector

Intra EU-27 trade has been growing for the sub-sector other environmental equipment, photovoltaic and solar thermal. However, the bulk of this trade takes place within the EU15, illustrating the large gap that still exists between these old member states and the New Member States (EU12). Air pollution control imports show a declining trend in the EU15 area, while the exports from this area show a slight increase. It is likely that some of this is destined for the New Member States, which have seen an increase in imports of air pollution control products. These findings in part confirm the findings from earlier studies.[34]

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[32] The available data for intra-EU trade do not follow the same sub-sector delineations as the sub-sectors in this study. Nevertheless they may provide useful insights.

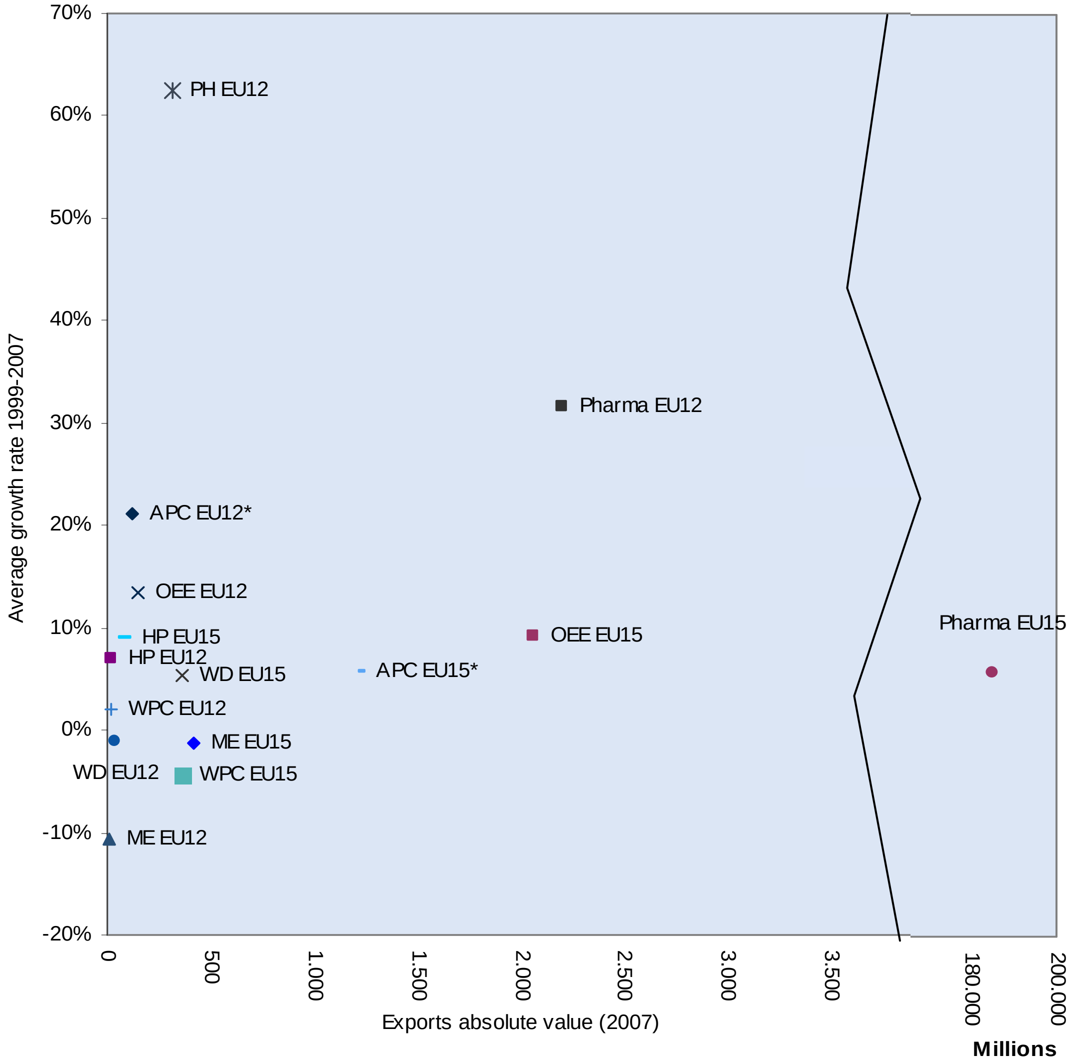
[33] For details see the methodological annex II, point 1.

[34] The 2002 ECOTEC study identified air pollution control, water pollution control and "other environmental equipment" as growing export markets. In their analysis, no renewable energy codes were taken into account. The 2006 E&Y study

Clearly the 'new' eco-industries such as photovoltaic, monitoring and other environmental equipment are showing bigger increases in trade – both in the EU15 and EU12 – than the more traditional eco-industries such as hydropower,[35] waste disposal and water pollution control.

Figure 6.1 provides an illustration of the Export values and average growth rates for intra-EU exports from the EU15 and the EU12, specified by sub-sector. As a reference, the figures are presented for intra EU trade in pharmaceuticals, generally considered as one of the most competitive industries in the EU.

Figure 6.1 Intra-EU exports by eco-industry sub-sector (1999-2007)



APC Air Pollution Control OEE Other Environmental Equipm. WD Waste Disposal

identified monitoring equipment and solar thermal as the largest subsectors for export (intra and extra EU). The photovoltaic was identified as the largest and fasted growing import category.

[35] In 2006, hydro supplied 9.2% of electricity in the EU27 and as such was by far the biggest renewable source of electricity today. However, hydropower is not expected to increase significantly due to environmental concerns and a lack of suitable sites, particularly within the EU.

HP	Hydropower	PH	Photovoltaic	WPC	Water Pollution Control
ME	Monitoring Equipment	Pharma	Pharmaceutical		

Notes:

- APC growth rates for 1999-2005 and export value for 2005
- Pharma growth rates for 2005-2007

Source: Eurostat (2009) and author's calculations

Table 6.1 below presents total percentage change in imports and exports between 2000 and 2007 for the various sub-sectors.

Table 6.1 Developments in intra EU-27 Trade patterns – percentage changes in imports and exports: 2000 - 2007

Type	AREA	Air Pollution Control[1]	Hydro-power	Monitoring equipment	Other Environm. Equipm.[2]	Photo-voltaic	Solar thermal	Waste Disposal[3]	Water Pollution Control
IMPORT	EU15	-34%	24%	-33%	97%	571%	87%	38%	-43%
	EU12	86%	26%	-49%	-46%	87%	582%	28%	59%
EXPORT	EU15	79%	92%	1%	267%	547%	91%	183%	-37%
	EU12	-2%	-21%	41%	505%	118%	2,951%	-60%	61%

[1]. Growth Export Air Pollution Control based on 2000 till 2005; no data for 2007

[2]. Growth Import Other Environmental Equipment based on 2000 till 2005; no data for 2007

[3]. Growth Import Waste Disposal based on 2000 till 2005; no data for 2007

Source: Eurostat (2009) and author's calculations

From the table it becomes clear that solar thermal trade in the EU12, exhibits substantially higher growth rates than in the EU15. Although total trade for the EU-12 is still limited (base values are low), these growth rates could hint at a catching up of the EU-12 to the EU-15 performance.

At individual country level, by 2007 Germany was by far the largest exporter of eco-industry goods, specializing mainly in solar thermal and other environmental products. Other major players include Spain, Great Britain, France and the Netherlands, which all show rather mixed patterns in terms of products exported. These main exporters in the EU also are among the main importers of eco-industry goods. (see annex III for more detailed trade data per country).

A more complete way of assessing competitiveness on the basis of trade performance is to also include investments and to consider the revealed comparative advantage of EU member states in their intra-EU trade.

Intra-EU investment patterns

Although no statistical data are available on intra-EU investment flows in eco-industry sectors, some trends in different sub-sectors can be observed suggesting an increased interest from established EU-15 producers in investing in the New Member States. As these countries are integrating further into the EU, they are also increasingly adopting and implementing EU environmental regulations and standards, while generally these markets are still fairly undeveloped. The required adjustment processes to implement the new regulations with regards to waste, recycling, renewable energy, etc. provides opportunity for the established players in the market. Several companies and industry representative organisations indicated the substantial investment opportunities and market potential of the New Member States during interviews.

Due to the nature of many eco-industry goods and services (locally based), and the fact that environmental legislation and standards are still predominantly national, FDI flows mostly relate to establishing in national markets to serve that market (i.e. market access). Although some of the largest players in e.g. waste and recycling management by now have investments across Europe, it appears these are relatively un-integrated units.

Revealed Comparative Advantage

Although the trade data and patterns illustrated above already provide an indication of the strongest players in the eco industry within the EU, a more refined way of analyzing the actual competitiveness is by measuring the so-called revealed comparative advantage (RCA) of a country in a specific sector or sub-sector. The RCA compares the structure of specialisation in trade *vis-à-vis* other countries – in our case the level of trade specialization of each EU member state for each sub-sector *vis-à-vis* the EU27 average. While there are various ways to measure the RCA, we have chosen the simple Balassa index (Balassa 1965). More detailed information on this index is given in Annex IV. The usual caution is required when interpreting the results given the limited coverage of available trade data (see methodological notes).

Basically, if the RCA for a country is bigger than one, this indicates relative trade specialization and a country is said to have a comparative advantage in this specific sub-sector. Without presenting all results from our calculations we present here some of the main findings.

- Contrary to what one might expect, our analysis revealed a strong comparative advantage in a number of New Member States for the Hydropower sub-sector. However, this advantage is decreasing, probably due to the fact that the growth potential in this sub-sector – despite being the biggest in terms of renewable energy production – is only limited. It may also be an indication of more diversification towards other sectors. Overall there is a high degree of volatility of RCAs in this sub-sector, which could be related to changing oil and gas prices.
- No strong comparative advantage in Air Pollution Control (APC) products,[36] emerged for any individual country, although Latvia and Portugal seem to have a slight edge over other countries. It has been noted (see APC sector report) that this sub-sector is expected to develop strongly in the New Member States in particular (e.g. incinerator flue gas treatment).
- For Monitoring and Equipment Spain and Finland were found to have the strongest positions, which also show an increasing trend.
- In Other Environmental Equipment products Latvia shows the strongest comparative advantage, both in terms of the value of its RCA in 2007 and the growth of this value (i.e. the gaining in strength of its comparative advantage) between 1999 and 2007. Considering low base values and the absence market

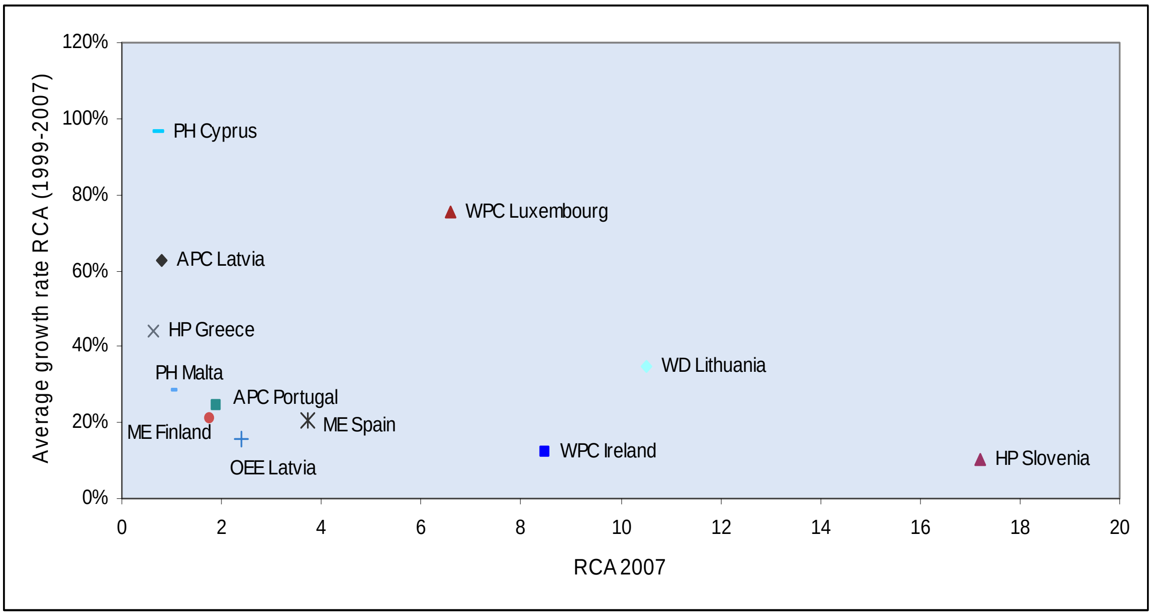
[36] It should be noted that for APC, data is available only until 2005.

leaders in eco-industries in this country, this result must be interpreted with some caution.

- No country appears to have a clear advantage in the photovoltaic subsector, although Malta and Cyprus show a surprising (slight) advantage in this sub-sector. Traditional strong players in this industry such as the Netherlands have seen their position deteriorate somewhat. This could also imply that the industry is becoming more pan-European though mergers and acquisitions / investments. However, the RCA does not incorporate these kind of data.
- Similarly Waste Disposal seems to be rather dispersed, with quite a few countries showing RCAs greater than one. The strongest performer in terms of RCA score and growth in this subsector was found to be Lithuania.
- For Water Pollution Control products Ireland, and Luxembourg are the strongest performers, with Ireland having the highest level of trade specialization and Luxembourg showing the strongest average growth rate of its RCA.

These findings are summarized in Figure 6.2, which presents EU countries with the highest score on the value of their RCA in 2007 and the growth rate of their RCAs for the period 1999-2007 per sub-sector. In some cases (e.g. waste disposal) a country scores highest on both, while in other cases (e.g. water pollution control) highest absolute values and highest percentage average growth rates are achieved by different countries.

Figure 6.2 RCAs by country and sub-sector (1999-2007)



APC	Air Pollution Control	OEE	Other Environmental Equipm.	WD	Waste Disposal
HP	Hydropower	PH	Photovoltaic	WPC	Water Pollution Control
ME	Monitoring Equipment				

Note: Air pollution Control based on 2005 data.

Source: Eurostat (2009) and author's calculations

What is surprising about these outcomes is the fact that the 'traditional' eco-industry countries, often identified as the strongest players in the sector (e.g. Germany, Denmark, France, Netherlands, UK and Austria) do not feature among the countries scoring high in terms of trade specialisation. As such, it may be questioned whether trade specialisation is an adequate indicator of competitiveness. As the RCAs calculated here do not capture investments and services, it favours countries involved mainly in the supply of goods. As in many other industries, most Northern European countries have shifted towards higher value added goods and related services, implying also a shift from the trading of goods to the trading of services and related investments as the main mode of internationalisation. Competitiveness thus seems to be increasingly derived from higher value added and investment strategies.

6.2.2 Profitability developments

Profitability is an indicator that can be used to assess the competitive performance of an industry or sector, provided that the sector operates in an (reasonably) open market. In such cases it indicates the reward for product and process innovativeness, scale economies, successful market development and exploitation, etc. Thus, profitability is not simply a direct indicator of competitiveness and this holds true in particular for eco-industry sub-sectors, as these often see substantial public involvement or are influenced by specific external factors. Here we therefore try to shed some light on the main determinants of profitability, thus trying to gauge the extent to which profitability really indicates competitiveness.

In the previous chapter we considered the profitability developments of the EU eco-industries based on micro-level data from the Amadeus database. It was demonstrated that overall profit margin in the NACE eco-industries was lower than that of the manufacturing sector as a whole, yet with a higher average yearly increase in profitability[37]. Quite different renewable energy showed average profit rates that were virtually twice those of the manufacturing sector and with relatively high annual growth rates.

Public goods and utilities

In some countries particular sub-sectors are still largely run by Government due to (perceived) limited profitability / commercial viability of these sub-sectors and/or the public goods argument. This concerns notably the waste management, water supply and waste water treatment sub-sectors. The price-point for the products and services delivered by these sub-sectors, are in many cases determined through regulation and policy, not market forces.

In some countries, e.g. the Netherlands, privatisation of water supply companies has demonstrated that these can be run profitably and that this enhances substantially the efficiency and financial sustainability of the sub-sector. Subsequently this 'business model' – more efficient water supply management systems – has been used by several companies for successfully bidding for water management contracts in other (especially developing) countries, implying it has become a competitive advantage.

[37] With the notable exception of "sanitation, remediation and similar activities"

Even in these cases profitability is still often limited by the principle of affordability to pay. Although consumers may be willing to pay more, prices are set by a regulator at levels that assure full cost recovery for the water supplier (i.e. coverage of operational costs, financing costs and reserves for (re)investments).

Thus the level of sustainability and the extent to which the water suppliers are able to 'export' their services and approaches are a better indication of competitiveness than profitability per se for many of the eco-industries operating in the public or semi-public sectors.

Prices of alternative goods and changing consumer awareness and preferences

Profitability in several sub-sectors depends heavily on external factors, such as global commodity and energy prices. High prices for these make alternatives, such as recycling and development of renewable energy sources more viable and lucrative, as suppliers can raise their price points upwards as well, with the increased prices of alternatives. Similarly, when commodity prices fall, this can put significant pressures on specific eco-industry sub-sectors. For instance, over the last few months many commodity prices have seen a significant price fall, linked with the worldwide financial crisis. Thus prices for aluminium have dropped from over $3,000/mt to around $ 1,800/mt between April and October 2008. This unprecedented volatility has confronted the recycling industry with a high level of uncertainty and business risk. As prices for raw materials have collapsed, the economic benefits for customers of using recyclate materials have dropped significantly as well. This makes that demand for many recyclate materials has strongly decreased over the last few months. Despite these events, the expected long term trend is still that of increasing prices of energy and raw materials, and prices of several raw materials such as zinc and copper are already o the rise again.

Increased consumer awareness of environmental issues and according changes in consumer preferences, imply that they have been, in recent years, willing to pay premiums for certain eco-industry products, such as green energy and eco-friendly buildings. Some evidence for this was found in the eco-construction sector in the US for instance, where eco-buildings were able to command higher sales and rental prices. This has implied that certain eco-industries have been able to be profitable, despite higher costs and according higher market prices. Although the first signs of recovery start to appear, it remains to be seen if this will still be the case if the current economic downturn would take longer, and when consumers re-assess their budgets and expenditures.

Public investments

Within sub-sectors, profitability also often differs per sub-*segment* in the production and distribution chain. Thus in renewable energy, the different elements of the production chain vary considerably in terms of profitability, which is reflected in the level of public spending in the sub-segments. Heavy public spending might indicate that (expected) profits will not outweigh the investment costs and defined as such (net) profitability is low. From this point of view, the sources of funding give an indication of expected profitability. Although the core eco-industries may not be highly profitable, the connected industries that supply to these industries often are. Thus structural and civil engineering companies that supply services and/or capital goods for water treatment and supply systems, eco-construction materials or energy companies, tend to be quite profitable.

One should bear in mind that when one looks at profitability alone as an indicator of competitiveness, the large public involvement in many of the eco-industry sub-sectors, makes gauging the sectors competitiveness a tricky exercise.

6.2.3 Entry, growth and exit rates of EU eco-industry

High entry and exit of firms and firm growth are often associated with dynamic and innovative processes in a sector – or more broadly speaking the process of creative destruction. However, some structural elements of a sector may lead to differences in these rates. For instance highly capital intensive sub-sectors of segments within these sub-sectors, in which sunk costs are high and plant size usually large, are less likely to show high rates of entry and exit. This holds true for sub-sectors such as water treatment and supply, parts of the recycling and solid waste sub-sectors (especially the actual treatment facilities) and suppliers of renewable energy.

Eurostat provides exit and entry statistics for a number of sectors at NACE2 level. Unfortunately no entry and exit data are available for the eco-industry and its sub-sectors.

Firm growth rates have been demonstrated by several authors to be higher for young firms, although these firms also exhibit greater volatility. Again, no reliable data at sub-sector or overall level are available to make a clear assessment of this. Based on the turnover and employee growth figures presented in the previous chapters, some general trends with regards to sector growth can be made. Sector growth can be seen as the sum of net entry and firm growth, although the relative contributions cannot be ascertained.

With regard to entry, exit and growth, some observations can be made at level of the different sub-sectors:
- The biggest growth sub-sectors are the recycled materials sector and the renewable energy sector, both in terms of turnover and employment;
- Productivity as measured in terms of turnover per employee – an admittedly very crude measure of productivity – also shows increases in these two sub-sectors;
- Both these sub-sectors have been strongly encouraged by both policy measures and developments in global markets, notably increases in commodity and energy prices, thus both can be seen as new growth industries;
- It is likely that firm entry in these two sub-sectors have been high, although only for specific parts of these sectors (e.g. in the case of recycling mostly upstream segments of collection and sorting), where investment and sunk costs were relatively low.
- Entry and exit for the more mature and specifically the semi-public or public sub-sectors are likely to have been quite low (e.g. wastewater and waste treatment as well as water supply);

- In several sub-sectors, entry did not necessarily involve only new players, but rather traditional players that transformed their business models or added eco-activities, which eventually grew to be their core business. This is for instance the case in eco-construction, but also in renewable energy, where the major energy companies have started to supply 'green' energy, or in the recycling sector, where former suppliers of raw materials have become (increasingly) involved in recycling.

In terms of data availability, at sub-sector level there are only data for net increases in number of companies in the recycling sector between 2001 and 2006. This increase was 2,000 firms in total, representing a 15 percent increase. Unfortunately net increases over such a period of time say little about general entry and exit dynamics, i.e. the level of churning.

6.2.4 Presence of sunk costs and regulatory barriers

Sunk costs

Sunk costs are substantial in some of the eco-industry sub-sectors, as they involve large capital investments with a long economic lifetime. Many of the structures and equipment installed in e.g. water treatment and supply plants, waste disposal plants, etc. involve purpose built facilities. In other words, a water treatment plant is not easily transformed into something else (as e.g. a factory hall could be) and the capital goods not easily divested and put to use elsewhere.

Part of the substantial public involvement lies specifically in these high sunk costs, which pose too high a risk for private investors, considering they are also often not able to determine the prices of their outputs. Examples of this can be found at the downstream end of some waste management / recycling chain, where large energy plants can cost up to € 200 million to build.

High sunk costs deter both entry and exit rates, as seems to be the case for all but the recycling and environmental technologies sub-sectors and possibly the eco-construction sub-sector.

Regulatory barriers

Above we already noted the role of the public sector (rules and regulations) in price forming for many sub-sectors which are considered as lying in the public goods domain. In addition several investment and trade barriers (non-tariff) still appear to exist in relation to certain sector (e.g. energy) and in relation to procurement and subsidies. There have been initiatives to address these barriers at EU level, e.g. within the Renewable Energy Sources Directive and through the EU Energy policy, which recognise the fact that such barriers may reduce opportunities for increasing productivity, developing new technologies with high market potential, etc.

The further development of capacity for the private sector to bid for projects in areas such as utility management for both private and public sectors will determine dynamism and competitiveness of the sector in the years to come, especially for SMEs.

National regulatory measures and completion of internal market legislation still pose challenges to the eco-industry. The problem lies in the different implementation and enforcement of the EU-regulations in the different Member States that still exist. From this point of view there is no single market yet. This issue was raised by several stakeholders from various sub-sectors and obviously seen as a key barrier across the board.

Where EU standards and regulations are more stringent, they may prove to be barriers to competitiveness vis-à-vis other countries. These effects will differ strongly per sub-sector and play a more substantial role in the connected industries than in the core industries (in fact it may drive competitiveness in some core industries). Yet even for the core industries it could eventually lead to loss of competitiveness, for instance in case major industrial suppliers of recyclates, move their main activities abroad due to the high costs of compliance with EU regulations, this also implies reduced availability (and thus higher prices) of inputs for the recycling sector.

Particularly for those sub-sectors highly dependent on high skilled, technically strong personnel (e.g. environmental technologies, renewable energy), access to a highly skilled pool of human resources is crucial for retaining competitiveness. To be able to perform highly innovate research and develop state-of-the-art new environmental technologies for instance, the best brains from all over the world are often needed. At this moment however, the EU labour market lacks the necessary flexibility to address this problem and attract knowledge workers from abroad. Thus labour and migration regulations may seriously hamper the industry's competitive potential. At the same time, as mentioned in one of the interviews with industry representatives, the share of technically educated people in the EU is decreasing.

Despite the regulatory barriers, it must be noted that the regulatory environment also plays a big role in enhancing the competitiveness of the eco-industry sector. For instance, Wagner (2003) highlighted a range of conditions he identified in the existing literature that make a positive relationship between environmental regulation and competitiveness more likely, such as the use of economically efficient types of regulation, in particular tradable permits and a favourable market structure, in particular demand for environmentally differentiated goods by a sufficiently high number of consumers

A 2008 Centre for European Economic Research (ZEW) report that European regulations are a central pillar for fostering innovation in the EU eco-industry. The report notes that "firms from the eco-innovation sector rank meeting regulation most often as a highly important effect of their innovation activities […] This indicates that the general importance of regulation as a barrier appears to be low. The general perception of regulation as a barrier for innovation seems to be rather subordinate. Particularly those barriers that focus on the financing of the innovation process receive a considerably higher importance."

Examples of specific regulations affecting specific sub-sectors positively include the WEEE Directive for the recycling sector and the EU bio fuels directive directly for suppliers of renewable energy. The existence and growing importance of the APC sector can to a large extent by attributed to policies and regulations

However, Wagner (2003) also identified challenges related to the role of the eco-industry *within* the regulatory process. As regards interest representation, he argues, eco-industry should be seen as an independent player with an incentive structure potentially at odds with that of its client industries. As such a closer look at the connected industries and other players in the value chain is warranted.

Finally the European Commission is looking at removing certain regulatory barriers to market development through international agreements, or perhaps more accurately formulated, by agreeing on international standards they are looking to assist with the creation of market opportunities:

> "Faster uptake of environmental technologies and standards for more sustainable technologies, products and services in the EU can pave the way to the development of international standards which better integrate environmental aspects, taking a life-cycle approach. This can give European companies "first-mover" advantages in global competition. International sectoral agreements for energy intensive industries hold out a significant potential to set global benchmarks for energy and resource efficiency and foster technologies that are meeting these benchmarks. Such sectoral agreements, which must comply with competition rules and environmental objectives, should help create export markets for leading European technologies, services and products. They can be complemented through international or bilateral agreements on the diffusion and use of environmental technologies, by facilitating the use of the Kyoto flexible instruments and through trade and development policy." EC, Mid-term Review of Industrial Policy, (2007)

A more elaborate assessment of the regulatory and policy environment may be found in chapter 8 and in the sub-sector reports of the draft final report – part 2.

6.2.5 Investment developments and ownership

As mentioned in the previous sections, investments play an important role in the industry next to trade. In addition there is still substantial involvement of the public sector in several sub-sectors, but there is an overall trend of increased private involvement and consequently investments.

Although some data exist on capital expenditures for certain eco-industries (Eurostat CAPEX statistics), these are somewhat outdated (running up till 2005) and pertain to different subsectors than defined in our study. Moreover, data are lacking for some of the main players in the sector, such as Denmark and Germany. As such they are of limited relevance to the current study.

Although we are thus not able to provide detailed quantitative data on investment developments in the eco-industries, based on interviews with key stakeholders, the literature review and sub-sector studies, the following observations can be made:

- Investments tend to be geared towards technological development, yet in several sub-sector it is recognised that the technologies and techniques are there, but their wider application / adoption has not been achieved yet. In part this is a matter of commercial viability, but the lack of a level playing field plays a part as well.
- With increasing pressures on the environment and the development of more stringent regulations in external markets (notably China), these are increasingly viewed as potential investment locations; such investments will also depend on

the existence of a level playing field in the markets in question, which in some cases (e.g. for recycling in China) is not yet present.

- In some sub-sectors consolidation is taking place leading to larger firm size and capacity to invest and attract funding; for instance in the wind and solar energy segments of the renewables sub-sector, companies are merging and a growing number of companies is listed on the stock exchange. This larger size and access to capital should give companies a competitive edge over external competitors, as capital needs are substantial and investments crucial to its further development.
- In several markets, especially New Member States, investments are triggered predominantly by the need to comply with (new) regulations; this provides opportunities for established players in the old member states.
- In the recycling and waste management sub-sectors there is a shift towards private ownership and involvement, while PPP are also becoming more prevalent. Private involvement in utilities such as water treatment and supply is also increasing.
- Investment opportunities seen as major driving force for expansion and internationalisation of the sector; the development of a level playing field – both within the EU and in outside markets - is seen as a crucial condition for this potential to be realised.

6.2.6 Access to finance

Access to finance is crucial for the capacity of a sector or industry to obtain capital, make investments and trade. Generally speaking, financing for the eco-industry depends heavily on both private and public funding, as many sub-sectors lie in the public goods domain, while the spearheading of environmental policy has made public investments in environmentally friendly technologies and practices a common phenomenon in the EU.

Private funds

The extent to which access to finance is an issue differs per sub-sector. For instance, our analysis shows that in the recycling industry access to finance for innovation does not seem to pose a real problem or barrier to the sector’s development. However, in many cases obtaining funds requires cooperation among different players and this does seem to present a problem, as collaboration in the area of R&D is not common.

On the other hand, access to finance appears to still be a barrier for innovation in the environmental technologies industry. As FUNDETEC research highlights[38]:

> “The financing difficulties are perceived to be much more salient regarding environmental technologies, which are often considered riskier than other technology investments, and as they are more subject to regulatory risk, and experience greater competitive disadvantages within current market structures”.

The research found that problems of access to finance mainly relate to two aspects:

1) an expectation gap between technology developers, private investors and policy makers,

[38] FUNDETEC (February 2008), “Funding environmental technologies – final report”

2) an existing gap between early-stage innovation and commercialisation leading to the so-called "valley of death".

Although there are venture capitalists active in the market, they mainly focus on the larger companies and projects, leaving most SMEs reliant on traditional local banks for their funding. Traditional banks are not specialised enough in the technological specifications of innovation projects in eco-industries to be able to fully evaluate the risks involved. Moreover, traditional banks mostly have a rather risk averse profile, making it difficult for environmental technology suppliers to get the funds needed. Especially for larger projects involving higher investments (often already in the demonstration phase), it is difficult to find enough financial means.

In recent years, companies in several sub-sectors (e.g. waste management and established renewable energy companies) have also been able to attract venture capital and obtain stock listings. With the emergence and development of eco-industries, there is also increasing interest on the part of venture capitalists, who actively seek opportunities in the sector, although it must be noted the availability of venture capital for green investments seems more prominent in the US and even China[39] than in the EU – an example of such VC in the US include Google Ventures, which looks to finance start-ups in the green-tech sector.

Public funding

The pool of public funds for environmental protection and development of environmentally friendly alternatives has increased in recent years, partially as a result of increased environmental taxes (although this contribution should not be overstated, with a nominal annual growth rate of 3 percent). The development of environmental tax revenues is illustrated in the table below.

Table 6.2 Environmental tax revenues in million EUR and growth rates (%) (2000 – 2008)

Year / Country	2001	2002	2003	2004	2005	2006	2007*	2000	2008*	growth rate**
Austria	5,572	5,844	6,126	6,339	6,435	6,391	6,708	5,011	7,041	4.96%
Belgium	5,856	5,919	6,224	6,852	7,091	6,857	7,013	5,721	7,173	2.28%
Cyprus	320	328	442	507	480	482	537	269	599	11.43%
Czech Rep.	1,760	1,977	2,066	2,333	2,699	2,939	3,259	1,527	3,614	10.90%
Denmark	9,216	9,768	9,664	10,857	12,131	13,205	14,012	8,991	14,869	6.11%
Estonia	146	153	164	203	255	293	346	103	408	18.13%
Finland	4,118	4,369	4,615	4,884	4,823	4,951	5,073	4,129	5,197	2.46%
France	35,227	38,869	38,754	40,407	40,401	41,306	41,939	35,952	42,582	1.53%
Germany	53,256	53,989	57,349	56,011	55,139	55,670	57,231	49,041	58,836	2.80%
Greece	3,731	3,600	3,723	3,993	4,081	4,198	4,287	3,223	4,378	2.12%
Hungary	1,694	1,997	1,982	2,301	2,488	2,575	2,774	1,553	2,988	7.71%
Ireland	2,725	3,012	3,206	3,661	4,004	4,314	4,614	3,013	4,936	6.97%
Italy	37,816	37,409	40,060	39,292	40,078	40,836	41,055	37,810	41,276	0.54%

[39] In 2006, China overtook Europe as the second-largest destination for venture capital in greentech (source: Dow Jones VentureOne and Ernst & Young)

Latvia	202	228	249	291	346	385	434	204	489	12.62%
Lithuania	259	315	344	365	396	433	474	225	519	9.40%
Luxembourg	637	664	718	839	892	894	956	611	1,022	6.95%
Malta	158	155	151	138	159	172	176	156	179	2.10%
Netherlands	16,839	16,898	17,666	18,863	20,176	21,887	23,061	16,246	24,298	5.36%
Poland	4,394	5,024	4,708	5,285	6,483	7,501	8,444	3,889	9,506	12.58%
Portugal	3,844	4,266	4,306	4,479	4,558	4,576	4,686	3,343	4,800	2.42%
Slovakia	457	612	771	910	984	1,085	1,260	487	1,463	16.10%
Slovenia	738	800	850	900	920	934	1,041	632	1,160	11.44%
Spain	14,155	15,148	16,071	16,831	17,606	18,287	19,117	13,780	19,985	4.54%
Sweden	6,978	7,530	7,883	8,054	8,348	8,532	8,811	7,303	9,098	3.26%
UK	45,357	45,877	43,083	45,451	45,102	45,876	46,206	47,849	46,539	0.72%
Bulgaria	424	377	537	672	672	784	902	338	1,038	15.07%
Romania	n.a.	1,033	1,289	1,468	1,607	1,884	2,189	n.a.	2,543	16.19%
EU-25	*255,454*	*264,753*	*271,174*	*280,048*	*286,075*	*294,580*	*302,734*	*251,067*	*311,114*	*2.77%*
EU-27	*n.a.*	*266,163*	*273,000*	*282,189*	*288,353*	*297,247*	*305,570*	*n.a.*	*314,125*	*2.80%*

* Estimates

** Based on period between 1999 and 2008

Source: OECD Environmental Data: Environmental Expenditure and Taxes

It is clear from the table that although environmental taxes are highest in the old member states, the highest increases in such taxes are found in the New Member States, reflecting a catch up of these countries and a harmonisation with EU legislation and tax systems.

It must be noted though that in most countries environmental tax receipts are not specifically allocated to environmental R&D funding (i.e. hypothecation). Thus these tax receipts are not the best indicator for availability of public funds.

Table 6.3 provides an overview of the magnitude of funding for environmental R&D purposes.

Notable in the table are the substantial amounts of public budgets for environmental R&D in France, Germany, Italy, Spain and the UK. Only Germany gets up to the same level as the US though. Some adjustments should obviously be made for the relative size of these economies, but the shares of environmental R&D funding in total R&D funding already give some more relative indication. Notable when considering both absolute and relative numbers is the decline in public funding for R&D in the Netherlands and Denmark, often considered as fore-runners in competitiveness of eco-industries. Unfortunately it is not possible to assess whether this drop in public funding has been compensated by an increase in private funding for research.

Table 6.3 Public R&D budgets for control and care of the environment (a), selected countries, 1990-2005

Country	Million USD at 2000 price levels and PPPs/ 1990	1995	2000	2002	2003	2004	2005		as % of total R&D budget appropriations/ 1990	1995	2000	2002	2003	2004	2005
Austria	18,2	32,1	21,5	20,3	25,2	23,7	30,3	+	1.9	2.5	1.5	1.3	1.7	1.6	1.9
Belgium	11,5	21,4	51,1	45,0	36,2	27,7	40,5	+	1.0	1.7	3.3	2.7	2.1	1.6	2.3
Czech Rep.	..	..	..	31,5	35,3	36,2	29,6	-	..	..	..	4.0	4.1	4.1	2.9
Denmark	32,6	38,5	31,1	26,4	21,4	21,9	20,2	-	3.8	4.4	2.7	2.3	1.9	1.9	1.7
Finland	12,7	26,4	30,0	29,9	27,9	29,1	28,8	+	1.4	2.5	2.3	2.2	2.0	1.9	1.8
France	115,8	293,0	263,0	471,9	507,4	487,4	433,2	+	0.7	1.9	1.7	2.9	3.1	3.0	2.7
Germany	545,4	596,9	552,2	510,5	556,8	570,4	574,1	+	3.5	3.6	3.3	3.1	3.3	3.5	3.4
Greece	8,9	15,7	30,4	18,6	24,0	29,4	27,7	+	2.8	3.6	5.0	3.3	3.9	4.3	4.0
Hungary	..	..	..	..	..	..	55,7		..	..	..	..	..	..	9.7
Ireland	1,8	3,0	4,8	9,9	9,0	4,2	5,3	+	1.2	1.4	1.4	2.4	2.1	0.7	0.9
Italy	200,4	181,8	213,1	..	..	..	279,3	+	2.2	2.4	2.3	..	..	..	2.7
Netherlands	114,7	115,3	127,0	101,8	95,6	64,4	41,0	-	3.3	3.7	3.6	3.0	2.8	1.9	1.2
Poland	..	..	..	..	..	1,2	33,7	+	..	..	..	..	..	0.1	2.4
Portugal	15,3	29,0	48,2	45,5	39,1	46,2	50,3	+	3.2	4.4	4.4	3.5	3.3	3.7	3.5
Slovak Rep.	..	3,7	2,8	5,3	3,2	5,7	2,1	-	..	2.0	1.3	2.7	1.6	2.7	1.0
Spain	140,2	87,0	205,3	115,1	128,5	211,6	252,7	+	4.3	2.6	4.0	1.7	1.9	2.8	3.0
Sweden	73,4	52,8	23,5	22,2	36,3	42,7	52,9	-	3.2	2.3	1.4	1.0	1.5	1.8	2.2
UK	149,1	235,7	238,8	189,7	218,2	210,6	219,3	+	1.4	2.3	2.3	1.6	1.8	1.8	1.8
Non-EU															
Iceland	..	2,3	0,6	0,6	0,6	0,5	0,6	=	..	3.4	0.6	0.6	0.4	0.4	0.4
Norway	27,8	26,6	29,8	31,7	30,9	28,6	27,8	=	3.2	2.8	2.8	2.6	2.4	2.2	2.1
Switzerland	24,1	..	2,6	5,2	..	2,5		-	2.3	..	0.2	0.3	..	0.1	..
Canada	70,3	152,1	206,7	249,8	267,7	250,3	254,8	+	1.7	3.7	4.5	4.6	4.8	4.4	4.4
USA	482,8	596,1	536,8	568,0	532,9	604,8	507,5	+	0.6	0.8	0.6	0.6	0.5	0.5	0.4
Japan	59,6	87,3	169,4	203,3	210,7	213,2	201,9	+	0.5	0.6	0.8	0.9	0.9	0.9	0.8

Source: OECD Environmental Data: Environmental Expenditure and Taxes

In many sub-sectors public funding is mostly focused on pre-market research, not so much on later stages. However, finding enough funding to finance the demonstration phase and market introduction is as crucial for environmental technology firms. Financing these phases mostly happens through corporate funding or own funding.

Another, more indirect source of public funding, which provides several sub-sectors of the eco-industry with additional market opportunities is formed by the Official Development Assistance (ODA) budgets in many EU countries and at the EU level, available for environmental goods.

ODA is provided for technical assistance (capital goods and advisory services) to developing countries in e.g. waste water treatment and water supply systems, renewable energy development, etc. To the extent that this still concerns tied aid, the contracts for implementation are often awarded to EU eco-industries, essentially providing a stimulus to such industries by expanding markets and allowing for higher returns on investment. As can be seen from the table below, the amounts involved differ per country, but can be substantial.

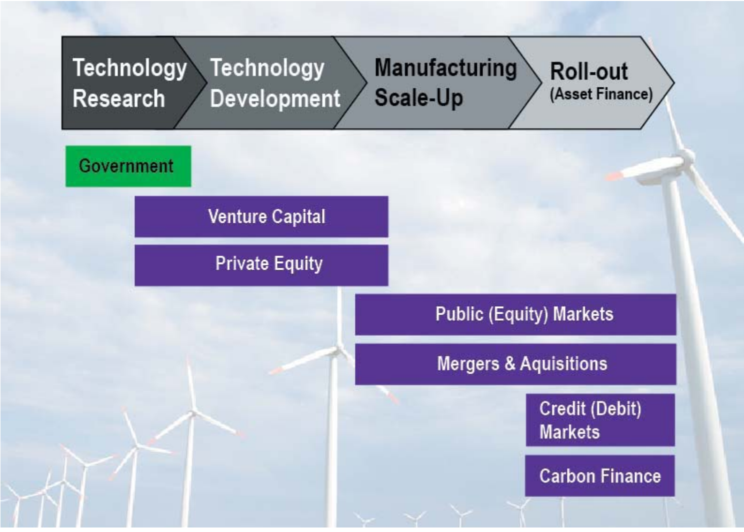
Table 6.4 Aid in support of environment, selected countries, 2004

	Environment as principal objective	Environment as significant objective	Environment as % of total sector-allocatable aid	Covera-ge ratio	Sector-allocable aid	Total official development assistance
EU	Million USD	Million USD	%	%	Mln USD	Million USD
Austria	16	33	25	100	202	678
Belgium	16	68	22	53	714	1,463
Denmark	93	417	44	97	1,196	2,037
Finland	29	64	33	97	289	680
Germany	584	841	52	65	4,220	7,534
Greece	9	6	7	100	222	321
Netherlands	275	154	21	100	2,054	4,204
Portugal	3	1	2	100	174	1,031
Sweden	216	397	59	100	1,033	2,722
UK	120	228	12	97	3,001	7,883
Eur. Comm.	495	483	16	96	6,544	8,704

Source: OECD Environmental Data: Environmental Expenditure and Taxes

Generally speaking access to finance will differ per activity involved, as is clearly illustrated in Figure 6.3 below, which illustrates funding sources for the renewable energy sub-sector.

Figure 6.3 Financing in the finance renewable energy sub-sector



Source: SEFI, New Energy Finance

6.2.7 Productivity developments in the eco-industry

An important aspect of competitiveness concerns productivity and productivity development. This can be measured in both labour productivity and, more broadly speaking total factor productivity (TFP). In addition, through economies of scale companies may achieve efficiency gains that will provide them with a competitive advantage. It has been argued that particularly an efficiently operating internal market can contribute to such economies of scale – a point we will return to when discussing the institutional framework for the eco-industry.

Labour productivity

It must be noted here that data limitations make it impossible to present labour productivity and TFP statistics outright.

In terms of labour productivity we can compare employment growth rates in the various sub-sectors with turnover growth rates (as expressed in terms of EPE growth rates, see previous chapter). If the latter is higher than the first, this can be interpreted as a rough estimate of productivity increases (see Table 6.5 below). Obviously these numbers and indications should be considered with extreme caution.

Table 6.5 Proxies for productivity development by sub-sector

Sub-sector	Employment growth rate corrected for wage changes	EPE growth rate corrected for inflation	Labour productivity
Waste	7.1%	5.9%	decreased
Water supply	6.7%	4.0%	decreased
Wastewater	2.3%	3.6%	increased
Recycle	10.6%	13.1%	increased

Sub-sector	Employment growth rate corrected for wage changes	EPE growth rate corrected for inflation	Labour productivity
Others	5.2%	6.2%	increased
Energy	16.3%	17.7%	increased
Air	-2.1%	3.1%	increased
Biodiversity	2.7%	5.3%	increased
Soil	2.7%	3.0%	increased
Noise	7.7%	7.8%	increased
Total	**7.0%**	**6.7%**	**decreased**

Overall the numbers in the table above suggest a slight decrease in labour productivity. This is attributable to two sub-sectors: waste water treatment and water supply.

As there are no data available on value added for the eco-industry and employment figures were estimated, it is also not possible to calculate labour productivity for the sector. Very rough estimations do seem to suggest that especially in the New Member States productivity levels in the eco-industry have increased substantially. This would suggest a catching up of these countries and a closing of the gap between the eco-industry in the old and New Member States, as was observed in the previous studies.

For the recycled materials sub-sector some data exist, although it is not possible to consider these as representative for the entire eco-industry. The detailed results are discussed in the sub-sector case study. In summary, for recycled materials the average gross value added per person employed amounted to €50,200 in 2006. This is a significant increase since 2001, when gross value added per person employed was only €35,400. Substantial differences in labour productivity exist across the EU Member States, with average gross value added per person employed ranging from only €7,100 thousand in Romania to €130,000 in Finland. With the exception of Denmark and Portugal, all countries with a lower than average labour productivity, are New Member States.

Total factor productivity

TFP figures are not available and it is not possible to estimate it with the available data. We therefore limit this section to some more general remarks on issues affecting TFP in the eco-industries.

In the Mid-term review of Industrial Policy (2007) the EC comments:

> "Rapid advances in science and technology create opportunities for manufacturers to adapt and exploit new technical possibilities. However, EU manufacturing remains specialised in medium-tech sectors and has not taken advantage of the fast growth of certain high tech sectors, nor has it fully exploited the potential of ICT uptake."

This weakness has been noted frequently by policy makers and researchers alike and may also pose a challenge to the more capital intensive, technology driven eco-industry sub-sectors, as it reduces the possibilities for productivity growth. Thus, especially in the 'newer' and more technologically advanced eco-industries TFP is likely to be strongly influenced by the capacity to uptake ICT technologies (e.g. air pollution control). As such stronger linkages between ICT sectors and eco-industries could enhance the competitiveness of both sectors.

Economies of scale are important particularly to the more capital intensive sub-sectors and can be encouraged through further deepening of the internal market and e.g. through the development of new markets overseas.

6.3 The EU eco-industry in the world

6.3.1 Developments in the global market and position of the EU eco-industry

Global market for eco-industry

According to the literature consulted, the global market – as expressed in annual turnover – for eco-industries is estimated to stand at roughly €600 billion a year, with over one third of this stemming from the EU. The US and Japan account for a large part of the remaining global turnover for eco-industries. The EU's comparative advantage and niche markets are seen to lie in renewable power generation technologies (over 40 percent of global market shares) and waste management and recycling technologies (50 percent of global market shares). Although it is an established market player in certain segments, the EU eco-industry is coming under increasing pressure from Japanese, Taiwanese and Chinese competition in a range of market segments. The US is also a competitor of the EU in the area of bio plastics (the environmental technology with the highest projected growth rate between 2005 and 2020) and bio fuel technologies.

The 2006 WIFO scoping paper divides the global market for eco-industries into two broad segments:

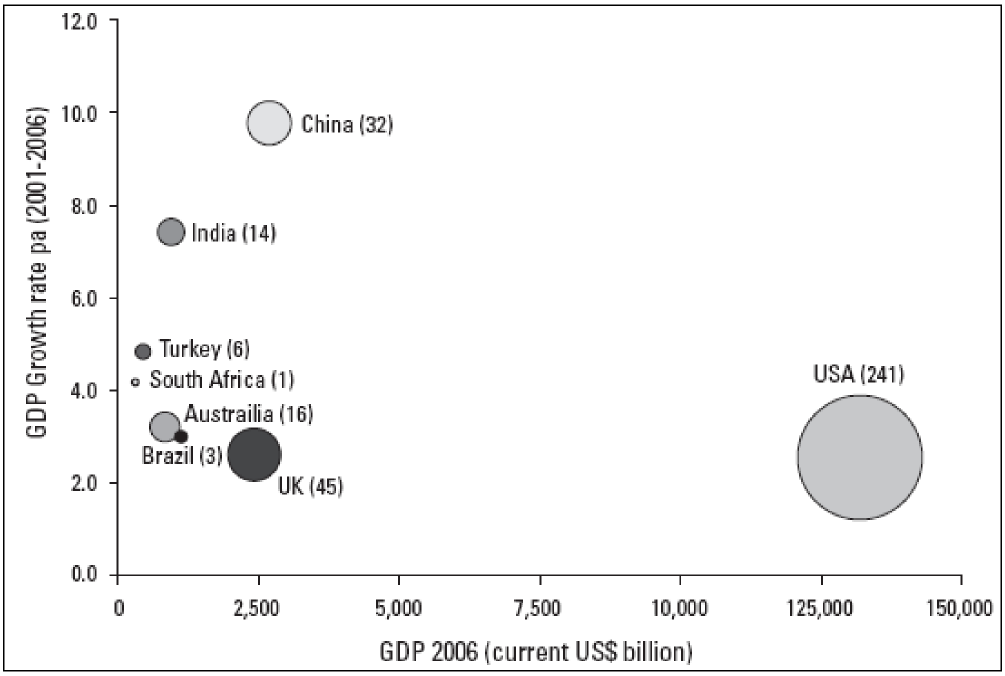
1. The market in developing countries, where demand for clean water supply and waste-water treatment are the bulk of the industry, constituting no more than one percent of GDP;
2. The market in developed countries where more sophisticated and expensive goods and services are provided.

The global market for eco-industries is expected to grow further in the future. A 2008 report by the UK government on international eco-industry markets confirmed that the increasing importance of resource and energy efficiency, alongside tighter environmental regulations in developed and developing countries (China, India, Brazil, USA) drive the expansion of eco-industries globally. For instance, the California Zero Emissions Vehicle Program[40] is largely credited for stimulating and ultimately sparking the commercialisation of fuel cells, key components of electric vehicles, and the introduction of super clean vehicles. This is an example of an initially regulation driven market for low and zero emission vehicles, which over time (starting in 1990) has stimulated innovation both inside the United States and globally (DEFRA, DTI 2006).

[40] http://www.arb.ca.gov/msprog/zevprog/zevprog.htm

Figure 6.4 provides an overview of the size of the global market relative to GDP and GDP growth in each market. The size of the bubbles depicts the estimated scale of the market for EGS in each of the countries around 2005 in USD billion.

Figure 6.4 GDP, GDP growth and the market for environmental goods and services

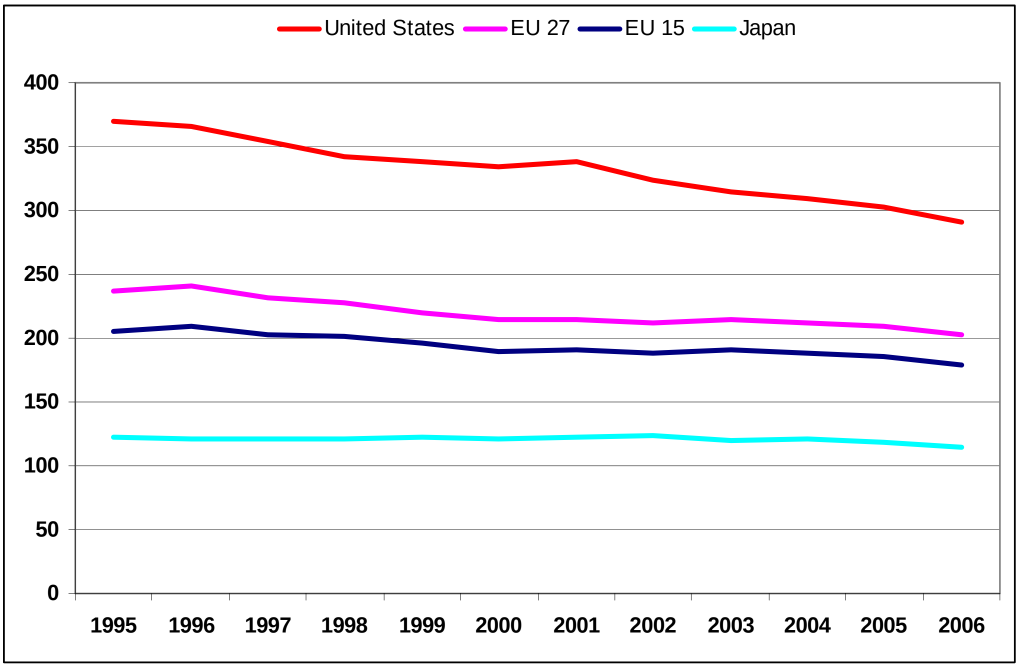


Source: UK Trade and Industry (2008)

In developing and emerging economies the sector – in an international context often referred to as the Environmental Goods and Services or EGS sector – is also expected to grow as new environmental policies and regulations are being introduced and the increased participation of the private sector encouraged. Many countries' environmental laws and standards, often introduced in the 1990s, need strengthening in an emerging international context that focuses increasingly on tackling climate change and other environmental issues at the international level, suggesting new opportunities for EG&S markets in the future. (OECD, 2004)

As in Europe, an important driver for the development of eco-industries and particularly certain sub-segments globally, is formed by the increased costs of energy and the increasing recognition within countries and globally, of the need for energy efficiency to combat both environmental pollution and resource depletion. Many eco-industry innovations and technological changes have thus targeted the reduction of energy use (energy intensity) and this is reflected in the energy intensity developments in the main energy consuming regions, as depicted in the figure below. Particularly the US has been very successful in reducing its energy intensity, although it must be noted that it comes from (and remains at) a very high level.

Figure 6.5 Energy intensity* in the EU, US and Japan (1995-2006)



* Gross inland consumption of energy divided by GDP, in kilogram of oil equivalent per 1.000 Euros

Source: Eurostat

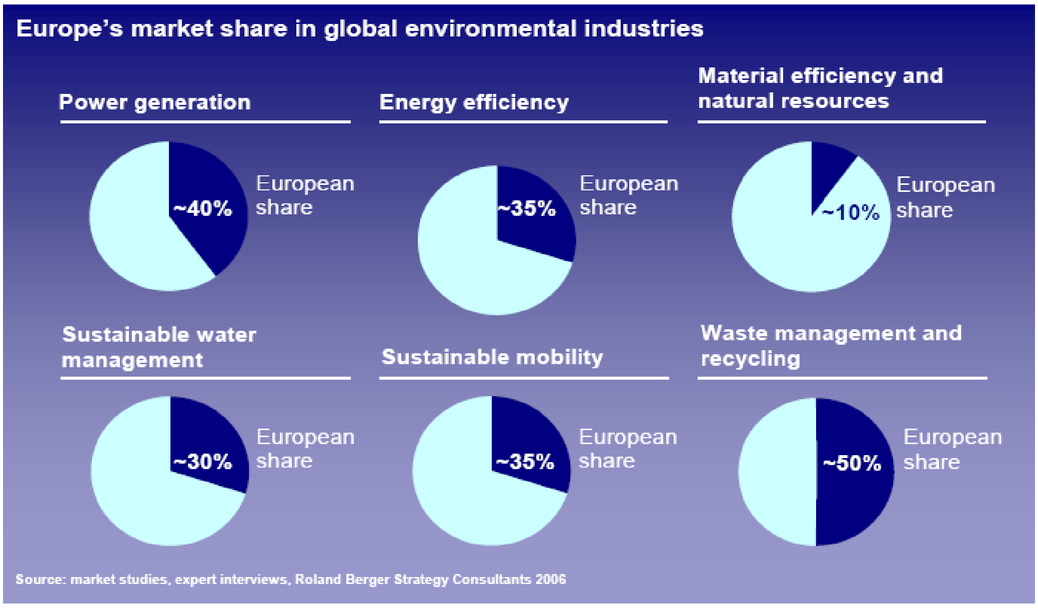
The figure shows that the energy intensity of the three biggest economies has improved over the last decade. However, notable differences remain and a gap persists between the EU 27 and the EU15. The overall trend in the EU15 points to the introduction of more energy efficient technologies and production methods, energy saving incentives and increased prices of energy, but it may also be partially influenced by a tertiarisation of the economies in question.

Position of the EU in global markets

A 2006 report by DTI and DEFRA[41] classifies the UK, USA, Japan, Germany, France, the Netherlands and Scandinavia according to academic publications and citations with regard to the eco-industry. According to the classification used in the report the UK and the Netherlands are ranked the highest consistently, while Japan was ranked lowest, and the remaining countries placed in the middle with no obvious differentiation among them. These findings point to a clear inventive and innovative thrust stemming from the EU in eco-industry markets, an observation further underpinned by the number of patents stemming from the EU with regards to the eco-industry. However, it appears there are differences in terms of sub-sectors or even segments in which the main players specialise and market shares vary accordingly, as is illustrated in Figure 6.6.

[41] DTI and DEFRA (2006) Bridging the gap between environmental necessity and economic opportunity. Environmental Innovation. First Report of the Environmental Innovations Advisory Group, London.

Figure 6.6 Europe's market share in global environmental industries



Source: Roland Berger (2006)

A 2008 report for the European Commission analysed data at the EU level with regards to patent application in the thematic area of eco-innovation as these are seen as a useful tool for understanding innovative and inventive activity within a certain market. The report identifies Germany as one of the top three leading innovation markets in eco-technologies in the world, leading innovations thrusts in noise protection ahead of the US and Japan (Oltra 2008).

The EGS industries in the United States, Germany, Japan, and elsewhere don't just compete with one another in their own markets, they also compete in third markets, particularly developing countries. The competition in the EGS market is in effect a three-way race between the three largest market shareholders. However, more recently some Asian countries have been able to find niche markets and are performing well by way of exports, with China even become market leader is certain segments of the industry (e.g. solar cells).

6.3.2 Trade and FDI patterns

A typical characteristic for many eco-industries is that at least part of the production and distribution chains are location bound. This is most clear with services such as electricity supply (related to renewable energy), waste management (particularly collection), water supply services, etc. This makes them harder to trade, or rather trade takes different forms, specifically it takes place through investments and services trade, which are not adequately captured by the available trade data for eco-industry – as was already indicated in section. In addition several sub-sectors still have substantial public sector involvement, implying opportunities for private and foreign investments may be more limited.

Official trade data may not capture these dimensions, as was explained in the first part of this chapter and in the annex with methodological notes. The figures in the table below therefore merely represent an indication of overall direction and magnitude of trade.

Table 6.6 Trade flows for 2007 between selected countries (in mln €)

Exporter	Importer							
	Brazil	China	EU-27	India	Japan	Russian Fed.	USA	World total
Brazil*	0,18	48,86	202,30	2,10	49,27	-	137,80	
China*	32,04	544,51	1.467,09	12,89	2.073,06	0,79	496,26	
EU-27	30,16	3.720,76	-	205,43	2.508,47	18,14	1.955,58	
India	0,19	158,49	485,62	-	45,47	1,23	81,01	
Japan	0,20	585,32	398,18	2,61	-	0,41	556,10	
Russian Fed.	0,21	64,29	992,71	4,28	22,87	-	150,89	
USA	21,26	920,38	1.919,04	51,71	1.274,75	1,85	-	

Source: Comtrade and Eurostat databases

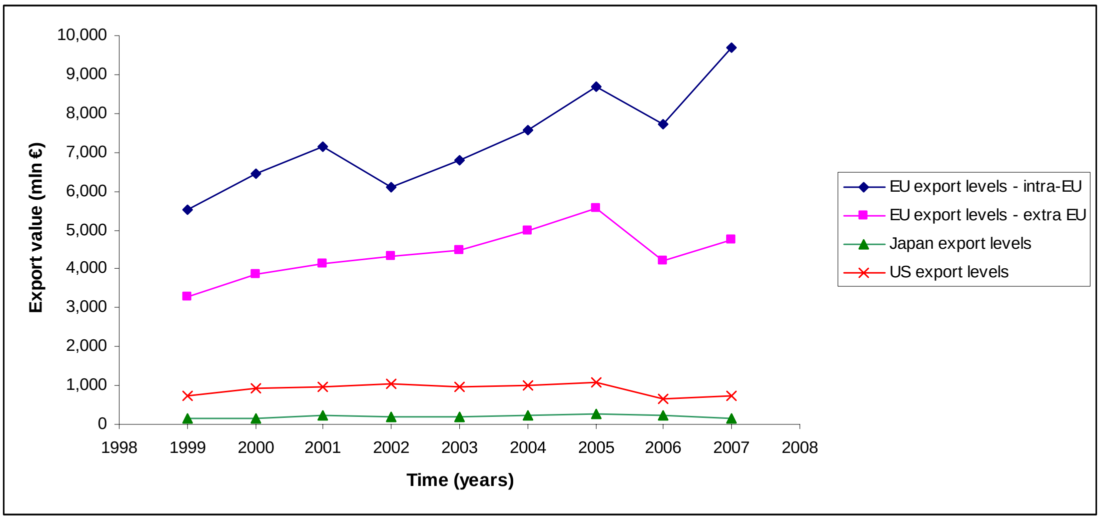
Note: trade flows include the following product categories: air pollution control, hydropower, monitoring equipment, other environmental equipment, photovoltaic, waste disposal and water pollution control

Clearly the EU is the dominant exporter of environmental goods in all markets, keeping in mind the caveats indicated above. Striking are also the large trade flows from China to Japan. These may mirror investments from Japan in China in specific sub-sectors, where products produced are subsequently exported back to Japan, which is also a net importer of resources (as the EU is).

EU eco-industry imports come mostly from China an the US, involving lower value added products in the case of China, while likely to involve more high-tech and advanced technology imports from the US.

Unfortunately the above table provides only a snapshot and reveals little in terms of dynamic trade patterns. Figure 6.7 therefore provides an overview of changes in the levels of exports of the EU, US and Japan.

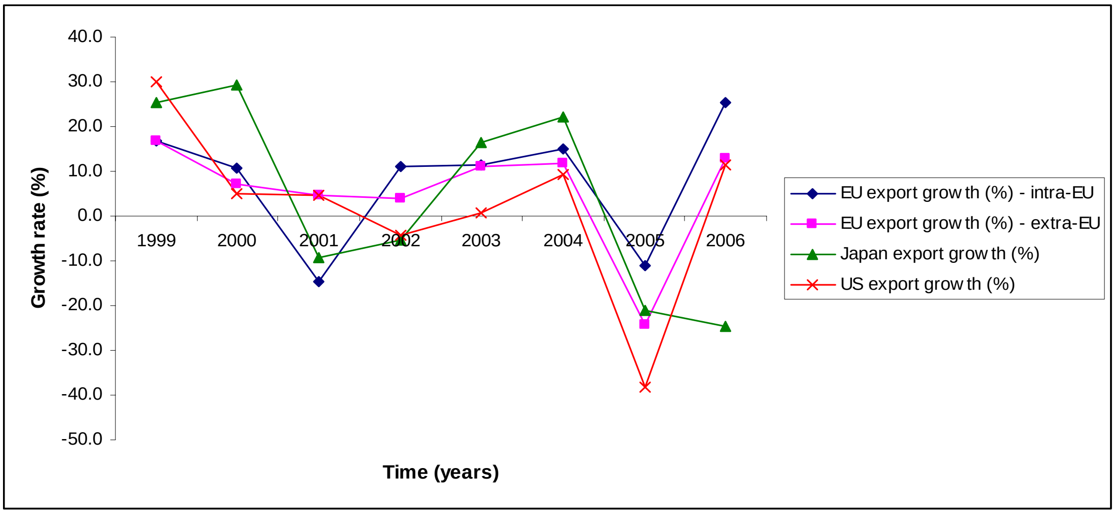
Figure 6.7 Eco-industry export levels for the EU, Japan and US (1999-2007)



Source: Comtrade and Eurostat databases

Moreover, when we extend our analysis to include growth rates, we find that in general, EU exports to other member states in eco-industries have increased by 75 percent, while EU exports outside the EU have increased by 44 percent between 1999 and 2007. In that same period US and Japanese exports have increased (overall) by four percent and 18 percent respectively. Clearly EU export growth has outpaced growth in exports of the main competitors, suggesting it has strengthened its global position and market share.

Figure 6.8 Eco-industry export growth rates for the EU, Japan and US (1999-2007)



Source: Comtrade and Eurostat databases

In view of the large size of the EU market, exports and investments by US firms are still modest. The strong competitive position of EU eco-industries within their domestic markets, may explain this. Other important export markets for the US are in Latin America and China.

Japan's main export markets are in Asia, although it is also an important exporter of environmental technology to the EU and US.

In terms of trade balances, the EU has a trade surplus with most external markets, although in several sub-sectors it displays a trade deficit with Japan in particular and with the US to a lesser extent. This pertains to for instance to photovoltaic goods and monitoring equipment for Japan and other environmental equipment for the US.

China has in recent years emerged as a major producer in the photovoltaic industry and is by now the biggest producer of solar cells, which it mostly exports (approximately 98 percent of production); exports are mainly destined for the EU.[42]

Revealed Comparative Advantage EU 27

Based on the same methodology as applied for the intra-EU RCAs, we have calculated the RCAs for the EU27 vis-à-vis other global players. The usual limitations apply.

In our assessment of the performance of eco-industries trade, no bilateral trade flows of EU member states have been taken into account, but only the comprehensive trade flow of the EU-27 towards six major world players: Brazil, China, India, Japan, the Russian Federation and the United States. The data used for the analysis range from 2002 to 2007.

The figures below (Figure 6.9) give an impression of the relative position of the EU27 vis-à-vis its main global competitors in terms of trade specialization for each sub-sector.

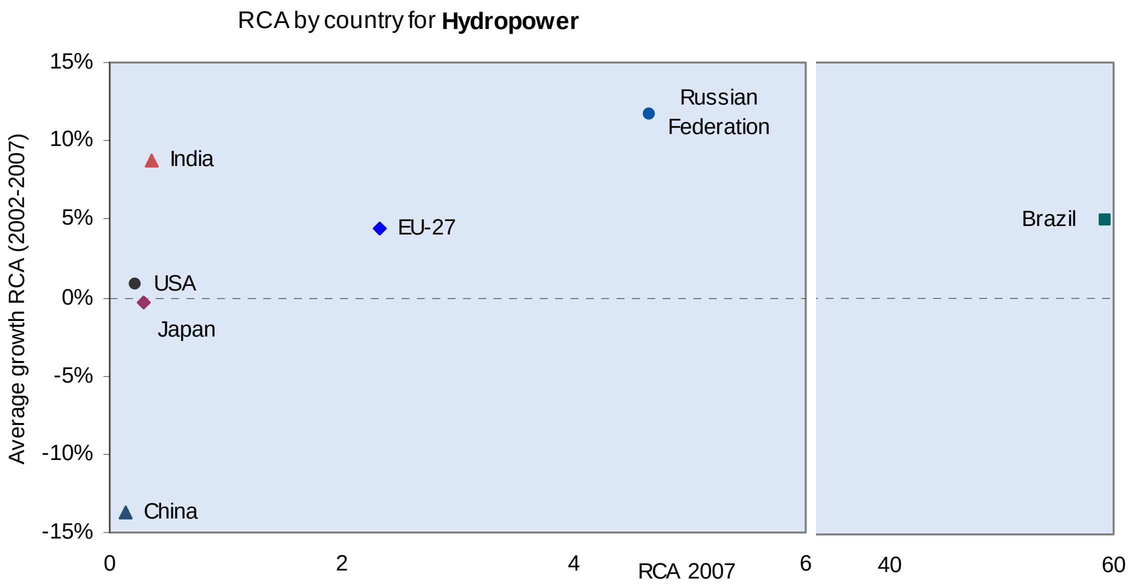
From the figures some general trends can be discerned:

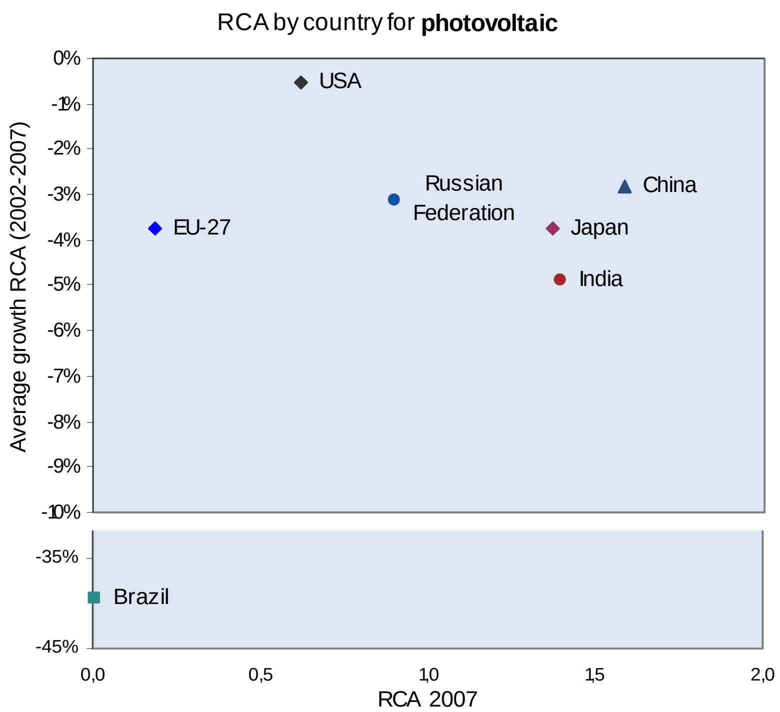
- Europe seems to perform well overall, being the only region with a trade specialization (revealed comparative advantage) in six out of seven sectors - the exception is photovoltaic, in which the Asian countries are more specialized.
- In Hydropower the EU holds a middle position, with Brazil and Russia ahead of the EU both in terms of the value of their RCA and the growth rate. Brazil is clearly by far the most specialized country in this sub-sector
- In the photovoltaic subsector the EU is one of the least specialized and Asia's comparative advantage is clearly strongest. Generally, however, growth rates of RCAs have been negative for all countries under consideration, suggesting this market is increasingly becoming one with global competition and no clear advantage for one specific country.
- In air pollution control the EU still has the strongest position measured by RCA. However, Japan and Brazil show stronger growth rates, thus putting pressure on the EU's position. This sub-sector is clearly of lesser importance in the emerging economies of Russia, China and India.
- In Monitoring equipment the RCA of the EU is only surpassed by the US. The growth rate of the latter, but also of Brazil's RCA is higher than the EU, suggesting a possible loss of comparative advantage of the EU, as other countries catch up.

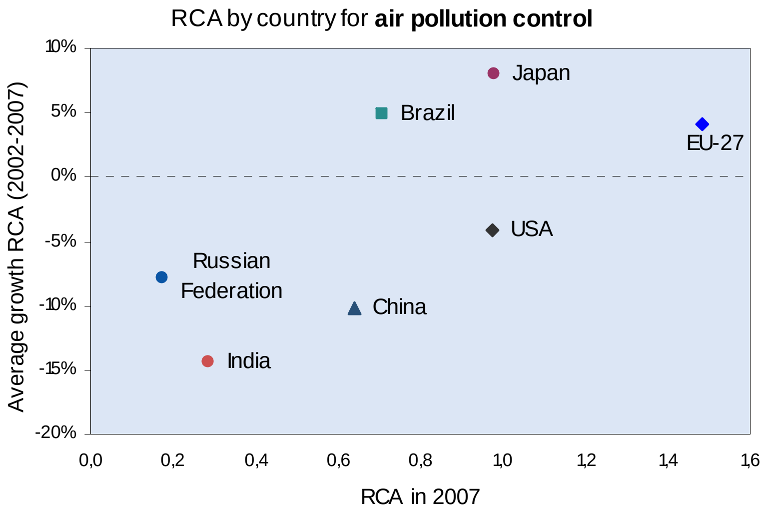
[42] GreenTech, made in Germany 2.0. Umwelttechnologie-Atlas für Deutschland (2009) Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit.

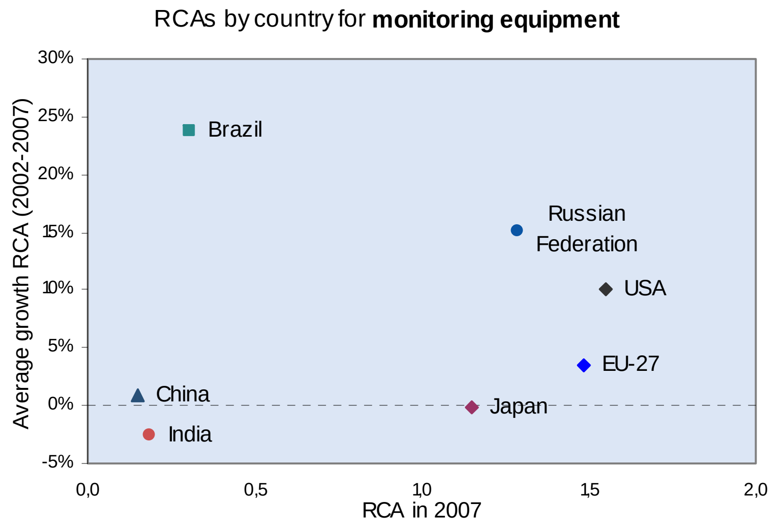
- For other environmental equipment the US is clearly the most specialized, followed by the EU. Growth rates for the RCAs of these two countries are roughly the same, suggesting they are surging ahead of the other countries under consideration.
- Finally, in terms of waste disposal the EU clearly has the strongest level of trade specialization. Growth rates in Russia, India and China are high though, suggesting these countries are catching up as population growth, urbanization and economic growth are placing increasing demands on waste management services.

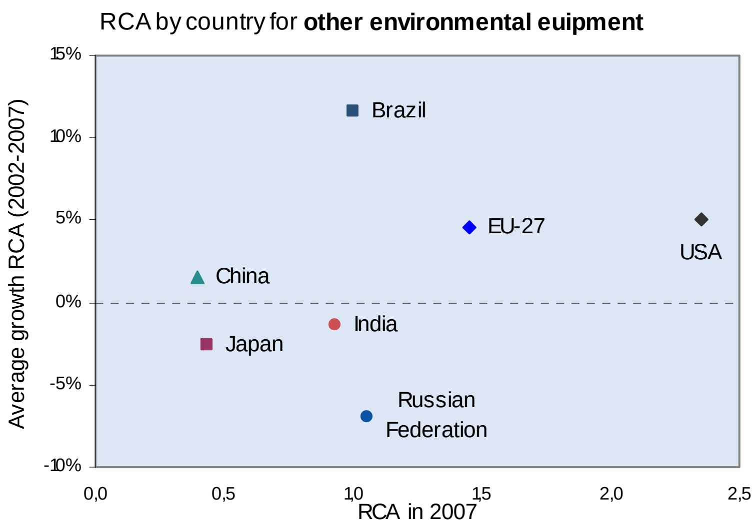
Figure 6.9 RCA's by country for 7 sub-sectors (2002-2007)

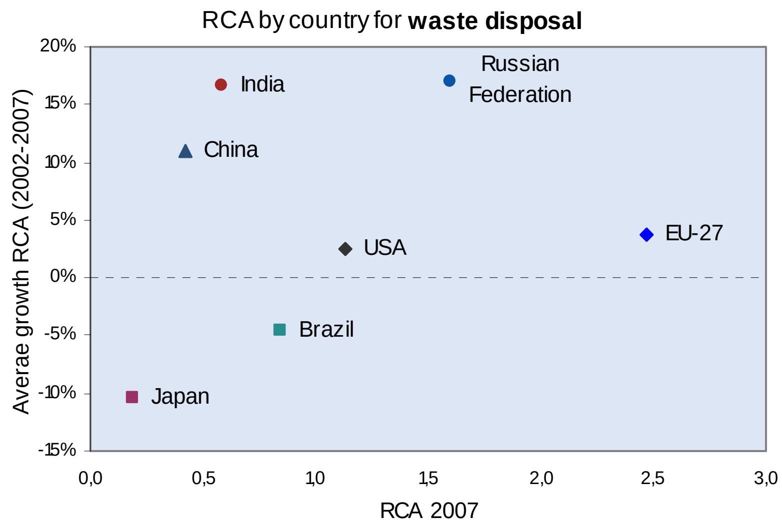












Source: Eurostat & Comtrade; author's own calculations

Overall, there appears to be a link between the level of maturity of technologies and RCA's. More mature technologies are increasingly provided by 'low cost' countries. Less mature (and more sophisticated) technologies are where EU (also US, Japan) still has a RCA. The exception being China's penetration of the photovoltaic market, where it has shown explosive growth and the EU seems to be losing ground.

The EU thus appears to have a relatively strong comparative advantage in most sub-sectors, but it is clear that the emerging economies are becoming increasingly important players in the global markets and competitive pressures on the EU industry is thus likely to increase.

FDI trends

Adequate data on FDI at eco-industry sub-sector, or even sector level, are not available.[43] Quantitative analysis of extra EU FDI patterns is thus, at this stage, not possible. Some observations can be made based on interviews and analysis of the literature though, while even trade patterns give some insights into FDI flows, as trade and investment are often complementary.

In terms of FDI inflows in eco-industries, the high standards and levels of regulations in the EU market acts as a so-called non-tariff barriers, as they make it harder for foreign operators to operate in EU markets. Although EU producers also have to comply with these, they are more used to it and have had to do so from an early stage. The information advantage they have makes this barrier relatively less for them.

Nonetheless, in recent years, there appears to be more interest from US companies in particular in trade and investment opportunities in the EU. As the US is a sizeable market in its own right, up until more recently, US players have tended to focus on their domestic markets or have ventured out into the Latin American region.

As with many aspects of the eco-industry competitiveness, differences exist per sub-sector, with some being more open to investments, while other – particularly those in the public goods realm – tend to be more closed to outside investments. It must be noted that this often applies to investors from elsewhere in the EU as it does for outside investors.[44]

With the rapid emergence of the China and India, these countries have started venturing outside their domestic markets as well, as is best illustrated by the acquisition of one of the largest German wind power installations builder, Repower by an Indian company, Suzlon.[45]

With regard to FDI outflows, there seems to be an increasing interest among EU companies to venture into foreign markets, driven by the opportunities that increased environmental pressures and awareness as well as stricter regulations create in these

[43] The UNDP FDI statistics database only provides figures at aggregate level, at which it is impossible to properly define the sector. All other databases (Worldbank, Eurostat etc.) describe FDI flows at national level.

[44] For instance, in April 2009 the Province of Brabant (Netherlands) as a major shareholder in Dutch energy company Essent, opposed a buyout of this energy supplier by the German RWE energy company.

[45] GreenTech, made in Germany 2.0. Umwelttechnologie-Atlas für Deutschland (2009) Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit.

markets. The focus in this respect is clearly on Asia, with China being a preferred location. The fact that particularly the Chinese welcome such investments due to the interest in technology transfer makes this market also more open to investments. However, it has also been remarked that IPR issues, the fact that technology transfer is often enforced and the lack of a reliable and level playing field in local markets still make EU operators in specific (especially more high tech) sub-sectors hesitant to invest here. India is still viewed at a lower level of development and does not yet feature prominently as an investment location.

In for instance the recycling sub-sector these investment involve mostly the outsourcing of basic activities, while the higher value added and knowledge based activities are retained in the EU. In addition investments are made to access markets.

In a recent report on Market Opportunities in Environmental Goods and Services, Renewable Energy, Carbon Finance and CATs, published by UK Trade & Investment, several countries emerging as major sources and markets for environmental technologies were identified. These included Australia, Brazil, China, India, the Gulf Region, South Africa, Turkey and the USA. Clearly most of these markets are considered as investment location for the access of their domestic markets.

Up till now there appear to be relatively limited investments in the US, which could be due to the presence of a strong domestic sector, but may also be attributable to specific non-tariff barriers to trade and investments, e.g. in government procurement. With a renewed interest in environmental protection and climate change issues, the US market is, however, likely to expand and this may provide opportunities for EU companies as well, given their advanced experience in many sub-sectors.

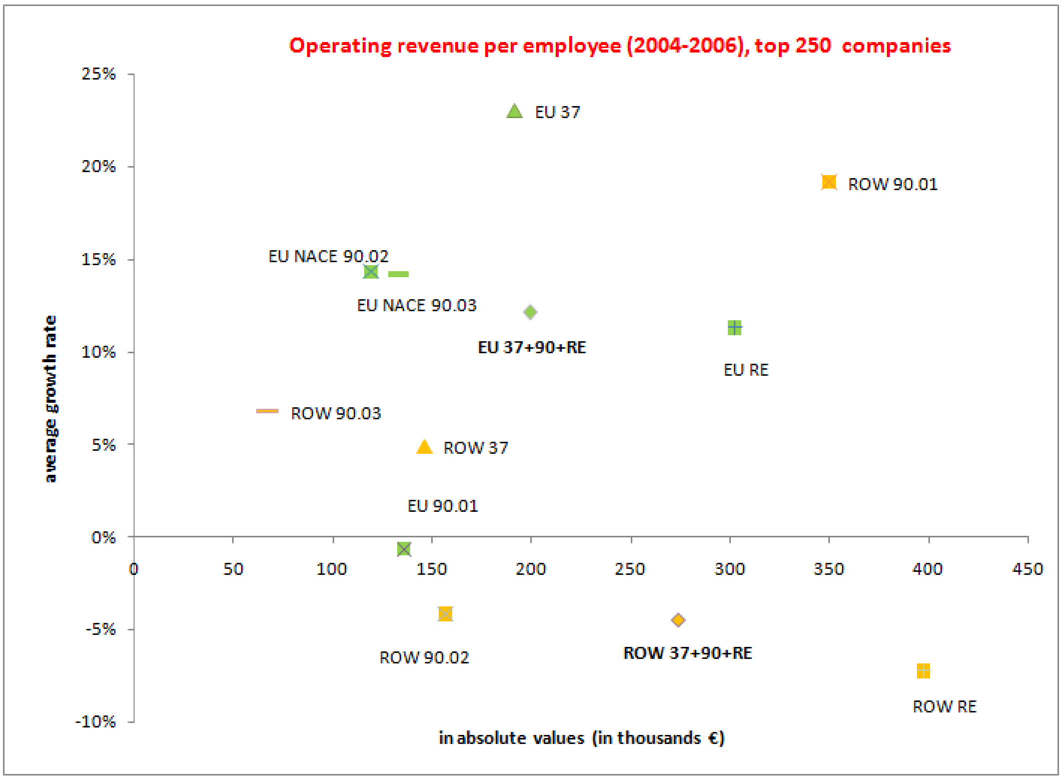
6.3.3 The micro-economic performance of the EU eco-industry compared to that of the rest of the world

Using the same approach as the one used for the micro-economic analysis of the EU eco-industry in part 5.5 of this report, a comparative analysis was made for productivity and profitability. We focussed on the top-250 companies in each of the sub-sectors in the EU and the rest of the world that we were able to cover. The ranking was based on turnover. The period covered is 2004-2006, which implies that the consequences of the current crisis cannot be present in the numbers. The analysis includes the NACE sectors recycling (NACE 37) and waste collection and treatment (NACE 90), as well as renewable energy.

Operating revenue per employee (2004-2006)
Looking at all eco-industries that are covered, the average operating revenue per employee for the rest of the world was 38 % higher in the period 2004-2006 than for the set of EU companies. Yet the latter showed strong average growth rates of more than 10% p.a., while the companies in the sample for the rest of the world depicted on average a decline of 5% p.a.

At sub-sector level substantial differences can be observed, although similarities as well. Starting with the latter one perceives that renewable energy has in both samples the highest operating revenue per employee. The only difference is that in case of the EU the top 250 companies in renewable energy show on average a substantial growth in the operating revenue per employee, while for the companies in the rest of the world, a decline. The other sub-sectors have similar levels of operating revenue per employee for the EU and rest of the world samples, with the notable exception of collection and treatment of sewage, which seems to generate a marked higher turnover per employee in the rest of the world than in the EU.

Figure 6.10 Operating revenue per employee by sub-sector for the EU and rest of the world, top 250 companies 2004 - 2006 (in thousands €)



Source: Own calculations on the base of Amadeus and Orbis data, sector inquiries, and web-searches

37: recycling; 90.01: collection and treatment of sewage; 90.02: collection and treatment of other waste; 90.03: sanitation, remediation and similar activities; RE: renewable energy;

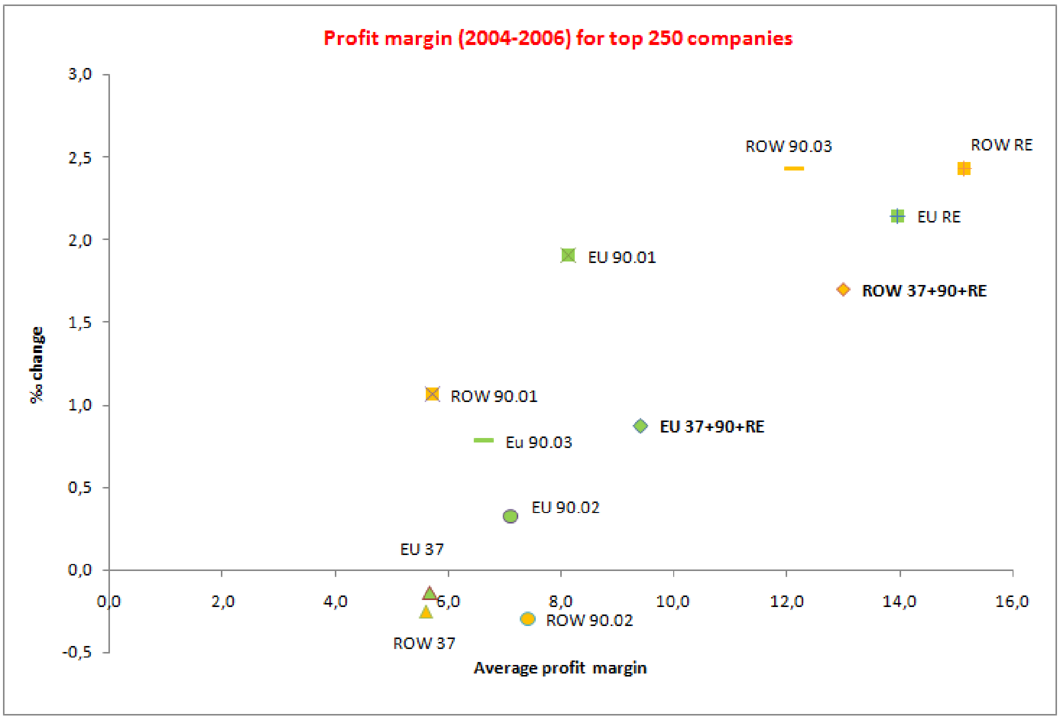
Note: each sub-sector's sample consists of the top 250 firms in that particular sub-sector ranked by turnover.

Profit margin

The next figure shows the average profit margins for the NACE sub-sectors and renewable energy for the period 2004 – 2006 and the average rate of change over these years. The profitability of the companies in the sample of the rest of the world is on average 3.6% higher than for the firms in the EU sample. Furthermore, the annual increase in profitability has been more outspoken in the sample for the rest of the world than for the EU. It is quite logic that an increasing operating revenue per employee leads, ceteris paribus, to increasing profit margins, as is shown for the EU companies (EU 37+90+RE). Yet the observation for the rest of the world is quite different. The operating revenue per employee declined over the years, while the profitability increased, and even more than for the sample of EU companies. This indicates that the costs per employee for these firms must have declined at an ever higher rate than the operating revenue.

Consistent with the operating revenue per employee numbers, the sub-sector renewable energy shows the highest profit rates of 14% and more. Yet here also one observes that where the growth rate of the operating revenue per employee decreased for the companies in the rest of the world sample, their profit margin increased substantially. This implies that over the years the companies in the rest of the world sample reduced their costs, either in terms of wages or other, considerably.

Figure 6.11 Average profit margin by sub-sector for the EU and rest of the world, top 250 companies, 2004 - 2006 (in %)



Source: Own calculations on the base of Amadeus and Orbis data, sector inquiries, and web-searches

37: recycling; 90.01: collection and treatment of sewage; 90.02: collection and treatment of other waste; 90.03: sanitation, remediation and similar activities; RE: renewable energy;

Note: each sub-sector's sample consists of the top 250 firms in that particular sub-sector ranked by turnover.

6.3.4 Access to private and public funding

While in the EU the sector has been strongly driven by subsidies and public financing, as a clear strategy to encourage a more sustainable society, in the main competitor markets such as the US and Japan, economic considerations have been more prominent and public funds have been geared more towards the financing of investment proposals, although the number of technology development programmes and public funds connected to them in the US and particularly Japan have been substantial.

The substantial public involvement in eco-industries in the EU has given eco-industry companies a competitive edge vis-à-vis their competitors outside the EU. However, particularly in the US many high-performing private companies are active in the industry as well – especially focusing on renewable energy. Until now the environmental technologies industry in the US has not been supported as much as the European by public authorities (although in several US States many initiatives have been taken), but indications appear that this may change with the new presidency.

In the US in particular private investments and venture capital have shown increasing interest in the sector and in Japan there are an increasing number of organizations serving as intermediaries between institutional investors and financial institutions on the one hand and environmental technology firms on the other, in order to develop capital markets for green technologies.

Based on data from the Dow Jones Venture Database, Ernst & Young recently estimated that total US and EU venture capital in clean technology was almost USD 3 billion in 2007. The majority of this capital was invested in the US (80 percent). Although this is still a very modest amount in comparison to total venture capital investments (5.4 percent of total US venture capital investments and 4.4 percent of EU venture capital investments) this share is increasing.[46]

In any case public expenditures on R&D in environmental technologies is substantial in most other markets as well, as is clearly illustrated in Table 6.7. The amounts are similar to the expenditures of EU countries such as Germany, France, the UK and Spain, although as a share of total R&D budget they are much lower. The exception being Canada which spent up to 4.4 percent of all public funding for R&D on environmental R&D.

Table 6.7 Public R&D budgets for control and care of the environment in selected countries, 1990-2005

	Million USD at 2000 price levels and PPPs/							as % of total R&D budget appropriations/						
Country	1990	1995	2000	2002	2003	2004	2005	1990	1995	2000	2002	2003	2004	2005
Iceland	..	2,3	0,6	0,6	0,6	0,5	0,6	..	3.4	0.6	0.6	0.4	0.4	0.4
Norway	27,8	26,6	29,8	31,7	30,9	28,6	27,8	3.2	2.8	2.8	2.6	2.4	2.2	2.1
Switzerland	24,1	..	2,6	5,2	..	2,5		2.3	..	0.2	0.3	..	0.1	..
Canada	70,3	152,1	206,7	249,8	267,7	250,3	254,8	1.7	3.7	4.5	4.6	4.8	4.4	**4.4**
USA	482,8	596,1	536,8	568,0	532,9	604,8	507,5	0.6	0.8	0.6	0.6	0.5	0.5	0.4
Japan	59,6	87,3	169,4	203,3	210,7	213,2	201,9	0.5	0.6	0.8	0.9	0.9	0.9	0.8

Emerging players such as China and to a lesser extent India are more likely to uses public funding for eco-industries development, as particularly China is acutely faced with the consequences of environmental pollution and has made political commitments to fight this pollution. The rapid economic growth and industrialisation experienced by China has resulted in severe environmental degradation with unsustainable natural resource consumption and massive pollution of air, water and land. China's outdated infrastructure

[46] Ernst & Young (2008) "Comparative Advantage and Green Business." BERR, URN 08/1036

and use of environmentally unfriendly technologies has also contributed further to environmental degradation. This has resulted in recent efforts by the Chinese government to introduce and enforce environmental legislation as well as plans by the Chinese government to invest US160 billion up to 2010 to reduce pollution and improve environmental performance. As a result, the EGS sector is expected to see annual growth rates of approximately 16 percent (UK Trade and Investment, 2008).

6.3.5 Environmental policies and regulations in main competitor markets

It is estimated that developed countries all spend roughly the same level of GDP (2 percent) on environmental protection. This is the case for the EU, Japan and the United States. Furthermore, levels of environmental protection are similar in developed countries. For instance, air quality values of pollutants like carbon monoxide, ozone and particulate matter are the same in the EU and the US, although standards for heavy-duty vehicles are more stringent in the US.

The main difference lies in the more specific directives at EU level, with the WEEE and IPPC as clear examples. In Japan and Canada only recently ‘take-back’ legislation has been introduced, and this is still not widespread (e.g. in Canada it has only been adopted in several provinces).

An additional difference lies in the mode of implementation and enforcement, where in the US, Canada and Japan these are much more based on voluntary standards and commitments, as well as incentive structures and programmes.

USA

In the US, the *Energy Policy Act* (2005) is the guiding policy framework that influences eco-industries. Under it several initiatives and legislation has been developed including funding and credit facilities for the encouragement of new technologies, development of standards (“Energy Star” products), subsidies for the installation of solar cells in households, eco-construction standards for public buildings, and a funding programme to accelerate the adoption of solar technology. Energy efficiency and a focus on renewables is not just seen as a matter of environmental principle, it is also a matter of national security, as the 2007 Energy Independence and Security Act (EISA) clearly illustrates. This is likely to be a powerful driver for the development of the renewable energy sector.

Despite recent commitments and further emphasis on environmental issues, this has not (yet) resulted in requirement regarding for instance the use of renewables sources of energy by the main energy suppliers, although in the summer of 2008 the first binding commitments were made for CO2 reduction goals in “America’s Climate Change Security Act” implying the market for eco-industries are likely to grow, while the likelihood of commitments in shares of green energy has also increased with the current Administration in place. Moreover, an increasing number of States – with the Pacific States leading the pack – are making individual commitments and developing State level legislation.

Japan

Energy and resource security plays an even bigger role for Japan, which is highly dependent on imports of fossil fuel and raw materials. The focus of Japanese policies is – as it has been with other sectors and as has been the mainstay of its economic development success – on technological development and substantial investments in applied research and R&D. Since the first oil crisis in 1973, Japan has made impressive strides towards reducing its dependence on oil imports, through the use of coal, gas and nuclear energy, and hydropower. Not surprisingly, therefore, particularly the market for renewable energy has been strongly encouraged in Japanese policies. In 1994 the Japanese Government for the first time set concrete goals towards the adoption of renewable energy. In 1997 these were subsequently included in the New Energy Law.

In the global arena Japan has also been a frontrunner in the move to reduce GHG emissions and use of non-renewable energy sources. The International Energy Agency has lauded Japan as a world leader in progressing energy and environmental policy. Despite this strong international role, concrete commitments towards emissions reductions have taken a while to evolve.

Most Japanese measures take the form of stimulus packages and programmes, for which both domestic and foreign investors are eligible. Japan has dedicated the largest amount of public funds to the energy sector among all developed countries, of which a substantial part is dedicated to the development of the renewable energy sector.

Brazil

Brazil has taken a lead role among developing and emerging economies in the area of climate change policies, as the country itself is clearly and directly affected by the consequences of climate change, while due mainly to deforestation it is the sixth largest emitter of CO_2 in the world. With the National Plan on Climate Change (2008) Brazil is the first emerging economy that has made quantitative commitments for the reduction of GHG emissions.

Brazil's environmental laws are based on the general principles of sustainable development (a balance needs to be struck between social, economic and ecological considerations), cooperation (between the state and society, public, private and NGO actors), prevention and 'polluter pays'.

Brazil's National Environmental Policy (NEP) has been in force since 1981, and includes instruments such as the definition of standards, licensing, environmental impact assessments, special areas for preservation, incentives for cleaner production, and environmental zoning. More recently a life cycle strategy has become increasingly important and is being integrated into the NEP. Various legal regulations already implemented in Brazil and involving Integrated Product Policy (IPP) concepts cover cell batteries, tires and pesticide packaging.[47]

[47] A.R. Ometto, A. Guelere Filho and M.P. Souza (2006) "Implementation of life cycle thinking in Brazil's Environmental Policy." Environmental Science & Policy, Volume 9, Issue 6, October 2006, Pages 587-592

Many programmes have also been developed for the development and improvement of energy efficiency and renewable energy.

Russian Federation
In the Russian Federation detailed environmental legislation is in force, but it primarily focuses on the use of natural resources and not on environment protection. The country has signed the Kyoto protocol, but this seems more inspired by external factors (e.g. WTO accession) than based on ecological considerations. Both in terms of policies and the position of eco-industries in the world (see next section) Russia is still in its infancy. This is probably in part due to its extensive oil and gas resources, which have made resource issues as faced in the EU and Japan less pressing.

In 2003 the Russian Government presented the National Energy Strategy; however, it contained few concrete measures in the area of renewable energy. Next to this strategy the Federal programme for an energy efficient economy was introduced, which ran from 2002-2006 and was extended till 2015. The focus of this programme was on more efficient extraction and use of energy, while renewable energy is not an explicit part of the programme. With increasing attention for the issue of energy efficiency measures such as the required energy audits for State Owned Enterprises (SOEs) were introduced, but it wasn’t till November 2008 that a more comprehensive Law was proposed for energy saving and increasing of energy efficiency, which includes the encouragement of alternative forms of energy and the development and adoption of energy efficient technologies.

India
India introduced its National Environment Policy in 2006. The policy builds on the existing policies (e.g. National Forest Policy, 1988; National Conservation Strategy and Policy Statement on Environment and Development, 1992; and the Policy Statement on Abatement of Pollution,1992; National Agriculture Policy, 2000; National Population Policy, 2000; National Water Policy, 2002 etc) and was intended as a guide for action in the areas of regulatory reform; programmes and projects for environmental conservation; review and enactment of legislations by Central, State and Local Government, etc..[48]

Although India has not committed itself to reductions of CO2 emissions under the Kyoto Protocol on grounds of its development status, the Indian Government has taken measures to reduce emissions, as India is experiencing firsthand the consequences of climate change and wants to take an active role in addressing the issue. Although the country sources much of its energy from hydropower, it is still highly dependent on fossil fuels and with its increasing energy demand due to strong economic growth, is showing increasing interest in renewable energy development and energy efficiency measures. In 2001 the Indian Government introduced the Energy Conservation Act, which encouraged energy efficiency and expansion of renewable energy use in electricity generation. Other recent initiatives include the Indian Industry Programme for Energy Conservation (IIPEC) of 2005 and the National Action Plan on Climate Change.

[48] http://www.envfor.nic.in/nep/nep2006.html

China

The Chinese policy and legal framework for environmental protection and resource efficiency is in a state of development, but it is clear that the Government has placed a high priority on environmental protection. It is more inclined to use restrictive measures next to incentives, although it has been argued that economic considerations (notably employment creation) are still given priority in the end. In addition the issue of enforcement still remains and this creates uncertainties for eco-industry companies interested in investing.

Faced with serious environmental challenges as a consequence of its rapid industrial and economic development, awareness on the need to address pollution,[49] climate change and energy efficiency has increased drastically in recent years. Although China has not made any quantitative commitments under the Kyoto protocol, it has taken numerous measures to address climate change and other environmental issues. As a consequence, China currently has the most modern environmental policy in the world, at least on paper. However, its practical implementation still lags behind its ambitions.

In June 2007 China introduced the National Climate Change Program, with the aim of reducing GHG emissions. This is to be achieved mainly through the encouragement of environmental technologies and improvement of energy efficiency. No targets for CO2 reduction were set in the Plan. In the context of the 11th five year plan several targets were set, including a reduction of the energy intensity of the Chinese economy by 20 percent in 2010 and a share of at least 15 percent of renewable energy in total energy use – currently China depends predominantly on the use of coal for its energy production, although the increase of renewables in the national energy mix over the past few years has been substantial. As in other countries, next to environmental considerations, energy autonomy is also an important driving force behind these initiatives.

The Chinese Government also uses fiscal stimuli and regulation to encourage energy efficiency in the biggest industrial enterprises in China, through introduction of audit systems and investments in energy saving technologies.

6.3.6 Key strengths other global players

USA

The EGS sector in the US is made up of a few large firms, and a large number of small- or medium-sized enterprises. The US market has long been rather self-sufficient, but U.S. firms are facing increasing competition from foreign investment, technology, and expertise. The U.S. domestic market for environmental technologies is very big so only a few firms are engaged in exporting internationally. According to an OECD study, competitive advantage in the EGS industry is based on four factors: technological innovation, quality and service performance, marketing and export strategies, and flexibility in production. According to a recent report by the '*Bundesministerium für*

[49] Pollution is no longer just a matter of environmental quality, but directly affect public health, while in some cases the costs of cleaning pollution are surpassing the benefits derived from economic growth.

Umwelt, Naturschutz und Reaktorsicherheit' in Germany,[50] US companies specialize in the production of energy efficient white goods and wind power plants, while there is increasing demand for renewable energy sources, particularly for bio fuels based on ethanol and solar energy. In addition eco-construction (sustainable construction) is on the rise, particularly driven by the US policy to make all public building sustainable – from 2013 public procurement regulation for public buildings will require that companies have an energy star certificate.

Two of the biggest white goods producers in the world, Whirlpool and General Electric (GE) are American companies and both have focused strongly on the development of more energy efficient products. GE moreover has become one of the world leaders in wind energy technology and the company is increasingly concentrating, as part of its overall business model, on energy efficient products and services, while it is venturing out into areas such as CO2 sequestration.

Japan

Due to its early confrontation with the dangers of import dependence on fossil fuels, Japan has developed from an early stage onwards a clear strategy towards energy efficiency and alternative energy sources. In addition it has encouraged particularly technological development. As a consequence, the Japanese eco-industry focuses predominantly on high-tech products and is a world leader in the photovoltaic and solar thermal sub-sectors. Other renewable technologies in which Japan has a strong position include the geothermal and biogas sub-segments. In addition it has a strong position in energy efficiency increases through conventional energy supply, such as batteries, which has enabled it to take the lead in the production of hybrid cars. Production of more energy efficient white goods is also a competitive strength of the Japanese EGS sector.

Both Japan and the US seem to focus more on hardware (technology for products) and eco-design (cradle to cradle) while the EU is more focused on pollution abatement, waste management and integrated chain management. In this respect there are opportunities for all three countries in one another's markets.

Brazil

One of Brazil's main competitive strength, clearly reflected in its RCA, lies in hydropower, while bio fuels production based on ethanol is also widespread. In many other sub-sectors the country has not developed any outstanding competencies yet, b ut overall the sector seems in development.

Russian Federation

As mentioned, Russia is in many ways still a relatively undeveloped player in the global market for EGS and has not reached levels of being able to seriously compete globally. However, certain sub-sectors are emerging, including for instance insulation technology, geothermal and photovoltaic.

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[50] GreenTech, made in Germany 2.0. Umwelttechnologie-Atlas für Deutschland (2009) Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit.

India
India has developed into an important player in the global wind-energy sector, as the recent acquisition by Indian company Suzlon of one of the biggest companies in Germany (REpower) clearly illustrates. With a more limited domestic market than e.g. China, generally speaking Indian companies are more prone to venture into international markets through major acquisitions than do their Chinese counterparts (e.g. the sale of Dutch Hoogovens to Tata Steel). This pattern seems to be discernable in eco-industries as well.

In terms of installed capacity, India is world leader in terms of renewable energy in its energy mix. However, this comes predominantly from the hydropower sector. India is an emerging player in solar energy production, with cash rich companies the likes of Tata venturing into this market.

China
China has emerged in recent years a dominant player in some sub-sectors of the EGS sector and has done so in a relatively short period of time. China now belongs to one of the world leaders in the photovoltaic, solar thermal and wind-energy sectors. In the case of photovoltaic, this process has been strongly driven by FDI and the sector is estimated to export up to 98 percent of total production. Wind-energy production on the other hand is much more driven by domestic demand.

With increasingly stringent regulations opportunities for pollution control technologies and services as well as waste management and recycling are likely to continue to increase and several EU companies have already invested in these sub-sectors in China.

Other
For the materials recycling sub-sector in particular, competition from developing countries in both Asia and Africa poses a challenge to EU companies and more general in terms of sustainability issues. Often, the dismantling of electronics, and other products can be done more cheaply in these countries and therefore the products are exported instead of ending up with EU recyclers. Although this is in principle a matter of economics, it has been argued that dismantling in these countries is often done illegally, less efficiently (lower recovery percentage) and/or with less regards for health and safety standards and little insight into where the end-of-life product ends up.

6.3.7 EU's relative position in technology and innovation

Technology, R&D and innovation are important enablers for the EU eco-industry to meet the future environmental challenges and to valorise the business opportunities that go together with it. This section discusses the relative technology and innovation position for the main EU eco-industry subsectors in the medium and long term. The same eco-industry classification is used as in chapter 4.

Air pollution control
The total funding available for CO2 capture and storage technologies has been increasing in the US, Japan and Europe since 2000. Before 2000, funding for the technology, especially in the US and Europe, was quite insignificant: however as governments across the world increasingly recognise the importance of reducing environmental emissions,

technologies such as CO_2 capture and storage are gaining prominence. Europe and Japan have the lead over the US in terms of funding available for CO_2 capture and storage technologies. In Europe (EU + Norway) the total annual funding before 2006 was more than 80 M€. This was slightly higher than Japan (72 M€) and the USA (54,6 M€ in 2006). Within Europe, the UK, Germany, France and Norway are the key nations investing in the technology. (European commission DG Research, 2006)

Waste water treatment
Since the development of the submerged MBR technology, and its commercial deployment in the first years of the new millennium, the European MBR market has witnessed a growth rate greater than 10% per annum. This growth was driven essentially by the municipal sector and in particular by the construction of the larger plants with an installed capacity above 5,000 m3/d. In contrast, the industrial market is very mature and competitive, and exhibits a constant market volume with about 65 new plants being constructed per year in the past 5 years. The MBR technology is now a cost competitive option for industrial wastewater treatment, or for municipal projects with exceptional specifications such as enhanced water quality (for bathing water, water reuse), reduced footprint or upgrade of existing plants. Following the observed trend in countries such as Spain, Italy, or Cyprus, the technology is expected to be embraced in the coming years by new countries facing water-scarcity such as Greece, Croatia, Turkey etc. (Huisjes et al., 2009)

Renewable energy: wind
According to the WWEA (2009) the wind energy market is still growing rapidly. In 2008 the wind energy capacity reached more than 120 GW of which 27 GW was added in 2008. For the first time in more than a decade, the USA took over the number one position from Germany in terms of total installation. North America and Asia catch up in terms of new installations with Europe which shows stagnation. Based on the experience and growth rates of the past years, WWEA expects that wind energy will continue its dynamic development also in the coming years. Although the impacts of the current financial crisis makes short-term predictions rather difficult, it can be expected that in the mid-term wind energy will rather attract more investors due to its low-risk character and the need for clean and reliable energy sources. Based on accelerated development and further improved policies, a global capacity of more than 1’500’000 MW is possible by the year 2020. The most optimistic scenarios expect that by the year 2025 it is even likely to have 7'500’000 MW installed worldwide producing 16’400 TWh.

Europe lost its dominating role as new market, but kept its leading position in terms of total installation with 66’160 MW. Germany and Spain maintained as leading markets, both showing stable growth. The most dynamic European markets were Ireland (adding 440 MW, 55 % growth) and Poland (196 MW added, 71 % growth), the first Eastern European country with a substantial wind deployment. All in all, the European wind sector showed almost stagnation with a very small increase in added capacity from 8’607 MW to 8’928 MW. The biggest market Germany is expected, after the amendment of the renewable energy law EEG, to show bigger market growth in 2009. An encouraging change happened in the UK where the government announced the introduction of a feed-in tariff for community based renewable energy projects. However, the cap of 5 MW represents a major hurdle so that the UK wind market will still grow at moderate rates.

However, without additional incentives for wind power in more EU member states, such as improved feed-in legislation, the European Union may not be able to achieve its 2020 targets for renewable energy. (WWEA, 2009)

Renewable energy: solar/photovoltaic
Europe's photovoltaic industry competes with companies from Asia, the USA and other parts of the world. Two of these countries have instituted programmes to support their domestic PV industry – Japan and China. The effectiveness of the programme sponsored by Japan's Ministry of Economy, Trade and Industry, METI, is already apparent. Due to long term planning, support schemes, investment security, and a substantial domestic market, the Japanese PV industry has around 50% of the world market share in PV products. China is the second country with an industrial strategy geared towards building up a highly competitive PV industry. China wants to cover the whole value chain from silicon feedstock to complete systems. The fruits of this relatively new strategy are already visible. Chinese cell and module manufacturers are rapidly establishing a significant share of the world market and their production capacity increases are unrivalled. If Europe does not react to this challenge, there is the danger that PV production will move to China, in common with many other manufacturing technologies. So far, Europe still has a competitive edge due to the excellent knowledge base of its researchers and engineers. However, without steady and reliable R&D funding and support from the public purse, this advantage could be eroded in a short time. More support for innovation and clearer long-term strategies are needed for the European PV industry to continue to invest in Europe and to ensure that European companies increase their market shares and become world leaders. (EU PV technology platform, 2007)

Renewable energy: solar/thermal
The large majority of the systems sold in Europe are manufactured within the EU or its Mediterranean neighbours. Imports from Asia are limited mainly to components such as evacuated glass tubes. For European manufacturers, exports outside the EU are becoming a growing market. The main selling point is their high quality and reliability. In most renewables, Europe is leading both in technology and in the market volumes. However, the latter is not the case for solar thermal, where the Chinese market alone is seven times bigger than the EU market. The European industry is the worldwide technological leader in solar thermal. However, given the price levels, European manufacturers cannot easily compete in markets like China, India and Turkey. If the EU does not catch up soon with a substantial growth in the domestic market, the European industry will face a hard task in maintaining its technological leadership. (ESTIF, 2007)

Renewable energy: bio-energy
In the period 2000-2004 the average annual funding for research in bio-energy was 103 M€. In comparison in the US and Japan this was respectively about 70 M€ and 28 M€. But both countries have been increasing this budget since (e.g. Japan 64 M€ in 2006). The significant distinction between the RTD portfolios of the EC and the US can be seen in the degree of integration of technology research into one coherent concept, thereby focusing funding on the related technological and socio-economical RTD requirements. As Japan is not an agriculture-intensive country, Japan is concentrating on technologies related to the utilization of organic waste such as fluidized bed combustion, co-firing, pyrolysis, etc. (European Commission DG Research, 2006)

Renewable energy: ocean energy

By the end of 2007 more than 25 countries are involved in developing relevant conversion technologies for harnessing ocean renewable resources for electricity generation and/or other purposes. Europe (UK) is leading in the research on ocean energy with more than 60 projects. Also in the US there are several ocean energy projects initiated[51].

Renewable energy: geothermal

The European technological focus on Enhanced Geothermal Systems is comparable with what strategy of the main competitor, the US, though the breakdown of research objectives is more detailed than in the EC work programme. US activities are differentiated between Technology Development, including resource development, EGS and systems development, and Technology Application activities such as technology verification and deployment. Japan, as a volcanic country, has favourable conditions for geothermal applications. The total installed capacity of geothermal power generation in Japan is more than 535 MW. Existing geothermal research in Japan focuses on studies of those areas in Japan likely to hold geothermal resources but that have not yet been subject to development surveys.

Overall view across sub-sectors

In almost all fields of the eco-industry, research activities are ongoing in the European Union. The global need for renewable energy production due to climate change issues and the run-out of fossil fuels combined with the strive of Europe for becoming more energy independent explains why most of the efforts are taking place in the sub-sector of renewable energy production. Close to €600 billion in 2005 worldwide has been invested in environmental technologies (Berger, 2007), which makes it the largest sub-sector with respect to technological investment. Europe is taking the lead with a market share of around 35% (Berger, 2007). The global clean-energy projected growth for bio fuels, wind power and solar power is about 200% in the period 2008-2018 (2008: 115,9 billion $, 2018: 325.1 billion $). This growth is expected to be equally spread over the different energy sources (bio fuels, wind power, solar) [52].

At the global level the sufficient supply of clean water is also one of the major challenges for the future. Also here the EU is taking a leading role with a market share of 30%. A lot of the technology development in this sector is built on the research for wastewater treatment. It is seen in most of the pollution management sectors that research activities are moving towards process-integrated solutions rather than on end-of-pipe technology development. Major exemptions on this are the large research projects on Carbon Capture and Storage (CCS).

The EU eco-industry will benefit from research activities on renewable energy and water supply since these are next to energy efficiency of houses and the use of environmentally friendly materials the major topics of this industry.

[51] IEA, 2008

[52] CleanEdge, 2009

6.4 Evolutions in sectors that have a significant impact on the eco-industry

Although the current study focuses on the 'core' eco-industries and only one of the 'connected' industries (eco-construction), many other 'connected' activities depend on the 'core' eco-industry for the supply of specific technologies or vice-versa may provide these industries with necessary inputs (materials, technology). Examples are the development of environmentally friendly cars and other transportation vehicles such as air planes; mechanical engineering; ICT opportunities for eco-industry and environmental innovation; the relationship between eco-industry and energy intensive industries and the effect of the competitiveness of the energy markets for the renewable energy. Moreover, due to the increased (political) attention for environmental issues, some of these eco-industry activities and eco-innovations in other sectors are often characterized by a high growth potential.

Without going into detail (the following chapter will elaborate on the connections and relations between the various down- and upstream industries in the eco-industry supply chain), below we highlight briefly some important developments in a number of key sectors[53]: Automotive and transport sectors, energy intensive industries, electronics industry, chemicals sector and the energy supply sector (energy markets).

Automotive and transport sectors

Addressing environmental pollution and climate change problems has been a major concern for both policy makers and the wider public (i.e. consumers) in the EU and a diverse range of policies and legislative measures have been put in place and are being developed to address these concerns. The EU automotives industry has therefore been under increasing pressure from regulations and standards regarding the cars they manufacture and the plants they operate. In addition there have been pressures from legislation related to recycling.

At the same time consumer awareness and rising fuel prices have created market opportunities for energy efficient and low emissions cars and for cars made with more sustainable and lighter weight materials (e.g. Ultra-light, high-strength steel products, special energy saving tires, etc.) and processes (more energy efficient and sustainable plants). Besides pressures, environmental concerns thus also pose substantial opportunities for the industry.

These developments have been strong drivers for a number of eco-industry sub-sectors, including notably the environmental technology, recycling and renewable energy sub-sectors (e.g. changing the energy mix of car engines). In addition, the increasing tendency for automotive producers to adopt a life-cycle approach has meant a greater role for the recycling industry.

[53] Please note this is a selection highlighting some important and relevant examples. The list could be extended, but many of the developments in the selected sectors would apply to the other possible sectors as well. The sections thus provides a more or less comprehensive overview of the main developments.

Energy intensive industries
Examples of energy intensive industries include the steel sector, non-ferrous metal sector, paper and paperboard production, glass and ceramics, etc.. These industries have been under pressure from various sources to invest in and apply environmental technologies for their products and production processes.

As a consequence of on the one hand EU standards and regulations (e.g. the Emissions Trading Scheme) with regards to emissions and on the other hand due to increasing energy prices and competition for resources (especially raw materials), investments in technologies and applications for more efficient resource use and for reduction of emissions have been high on the agenda of many of these industries. Various so called eco-innovations have therefore been developed within them, including e.g. alternative iron-making processes, increased use of recycled inputs, investments in pollution control technologies, waste treatment, etc. The results have been impressive.

The links to the various eco-industries are abundant. Increased emphasis on eco-innovations in the iron and steel sector also applies to the products made, which serve as inputs for other industries under pressure from environmental requirements and regulations. The industry has for instance engaged in development of ultra-light, high-strength steels for automobiles, representing a more durable and energy efficient raw material for the latter.

Electronics industry
While not contributing to the same extent to CO2 emissions as the automotives, transport, or energy intensive industries, the electronics industry is also responsible for a large share of global energy consumption. In addition, increasing consumption of electronics has created an increasing problem in terms of waste generation. This trend has not only been driven by growing demand for various consumer electronics and appliances, but also as a result of electronics being increasingly embedded in the production of other goods (e.g. automotives). Such trends make recycling an important linked sector to the industry, especially with increasingly comprehensive EU legislation related to recycling. Before that start of the financial crisis, the recycling of electronics appliances had become a profitable business, as prices for the raw materials incorporated in the appliances (e.g. copper) increased

Besides the production, distribution and cleaning up of electronics products, the industry also makes use of eco innovations for the development and application of energy savings technologies in the products themselves. Examples of such applications can be found in e.g. environmental friendly data centres, development of air-conditioning units and auto switch off mechanisms in computers.

Energy sector
The energy sector has a major and very direct impact on eco-industries. Energy security issues in the sector have encouraged the development of alternative energy sources, including renewables. This trend was further encouraged by EU legislation on bio-fuels (for details see the sub-sector case study on renewable energy in part II of this report).

Energy sectors have in turn been influenced by developments in energy markets, with increasing scope for supply of ‘green energy.’

As the bio-fuels debate in the EU has extended to the question of sustainability of first generation bio-fuels, there is increasing demand for the development of second generation bio-fuels and other renewable alternatives, which have implications for the renewable energy development sub-sector.

As for the most recent development, plunging oil and gas prices have made renewable energy sources relatively less cost-effective, while thinner profit margins have prompted big industrial users of power to tighten their budgets for sustainable energy programs. The low carbon and crude oil prices may be an incentive for energy producers in the EU to pay for emissions permits rather than invest in renewables or other technologies that reduce emissions.

6.5 Strategic responses and initiatives of EU eco-industry companies

Strategic responses and initiatives by EU eco-industry companies obviously vary substantially by sub-sector. Here we will highlight some common and some more specific strategies that can be observed:

- Focus on markets with increasing resource pressures and regulation. Investment opportunities are increasingly sought outside the EU, lead by market access considerations; in this respect there appears to be a strong focus on Asia.
- Development of strategic partnerships with other sector players (e.g. recycling with automotives, chemicals with eco-construction, etc.)
- As a consequence of the crisis large cash rich incumbents in e.g. the energy or recycling sectors may buy up cash-strapped SMEs in project development, to gain control over technology (development).
- In most sub-sectors there is a clear focus on creating higher value added, either by focusing on higher-end products (e.g. recycling of precious metals as opposed to basic metals) or providing additional services to clients and suppliers (see also the next chapter on the supply chain).
- Forming preferred partnership networks with suppliers (to ensure steady supply of materials, while at the same time by selling recycled metals back to supplier reducing volatility of input prices for these partners).
- A focus on the policy arena, engaging in the lobbying of policy makers at the start of the policy process and so as to anticipate upcoming policies and legislation, which is useful for strategy development.
- In the waste management and recycling industry in particular, companies are increasingly positioning themselves as catalysts for integrated chains, providing the end and start of such chains and contributing in close cooperation with suppliers and buyers for more efficient chain management.
- Moving away from the end of the pipeline (e.g. cleaning up pollution) and becoming more involved at the start of the chain.

Although by no means an exhaustive overview, it does provides some insights into the possible future development of the eco-industries, a point we will return to in our strategic outlook for the sector.

6.6 Key drivers of competitiveness of the EU eco-industry

Our analysis has provided some insights into the key drivers of competitiveness in the industry and its sub-sectors. Overall, the four key drivers of competitiveness for the EU eco-industry that can be identified include: 1) Technological change and innovation, including clusters; 2) Policy and regulations at international and EU levels; 3) Globalisation and international competition; and 4) Access to finance and related to this market organization. In general it should be stressed that the drivers are interrelated and cover a number of processes that take place simultaneously and interactively. Moreover, competitiveness of the industry is to a large extent driven by connected industries, as we have explained briefly in the previous section and will elaborate on in more detail in the following chapter.

Below we summarise how these four key drivers affect competitiveness developments in the EU eco-industries.

Technological change and innovation
Technological change and innovation are crucial to the development of the eco-industry and in many cases it is the industry's core business. Connected industries too have contributed to technological innovation, sometimes in cooperation with environmental technology firms, but also often in-house.

Technology is an elemental building block for sectors like renewable energy (e.g. second generation bio fuels development), air pollution control and passive buildings. The following issues at sub-sector level should be noted as regards the link between technology and competitiveness:

- Solid waste management's competitiveness is contingent upon the development and implementation of recognition and auto-sorting technology that will reduce costs through the production chain and avoid outsourcing outside of the EU;
- Peak technology, innovation capacity as well as providing small scale solutions are "critical competitiveness factors" for air pollution control;
- Alternative technology development in water supply will determine the competitiveness of this sector to meet high quality requirements;
- Carbon capture and storage (CCS), second generation biofuels, biomass, thermal heating, passive housing technology and hydropower still have room to improve in the market given the right technology input.

The 2007 Roland Berger report notes that alongside eco-technology, providing eco-efficient solutions will become a compelling determinant of the competitiveness of the EU eco-industry, asserting that "*given the scarcity of natural resources, eco efficiency will become a major characteristic of all industrial goods and services […] Future competition will not be over novelty, price, quality and design; it will also be over eco-efficiency*."[54]

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[54] Insert reference

The role of eco-efficient solutions in underpinning the competitiveness of the EU eco-industry is highlighted by the following trends identified in the Roland Berger study:

- The 20-20-20 targets set by the European commission will provide continued pressure for reducing GHG emissions and provide opportunities to drive eco-innovation and eco-technology development;
- Rising energy and other resource prices will sustain the need for improving the energy efficiency of both the broader economy and the eco-industry;

A 2008 report for the European Commission delved into data analysis at the EU level with regards to patent application in the thematic area of eco-innovation. Patent data in the EU is a useful tool for understanding innovative and inventive activity within a certain market. The report identifies Germany as one of the top three leading innovation markets in eco-technologies in the world, leading innovations thrusts in noise protection ahead of the US and Japan (Oltra 2008). A 2008 Centre for European Economic Research (ZEW) report notes that grants, subsidies, tax credits and R&D allowances are seen as driving factors in promoting eco-innovation in Europe.

Considering the importance of technology and innovations for the eco-industry and its various sub-sectors, retaining and strengthening the competitive position of the industry is strongly dependent on the extent to which technological developments are taking place and being taken up. In this respect stronger integration of ICT applications within the eco-industries provides promising opportunities for improvement of efficiency and services within eco-industries and for their linkages with other sectors. Examples are integrated sustainability management solutions for enterprise resource planning, customer relation management and supply chain management systems.

International and EU Policy and Regulations

Public policy has undoubtedly played an important role in generating demand for abatement technologies and eco-efficient products and services (see for example Ernst & Young 2006, DEFRA 2007, Cleff et al. 2008 and Jänicke and Zieschank 2008). In this context, most attention is usually given to environmental regulation (e.g. emission standards, recycling requirements, cap and trade systems for greenhouse gas, etc.). However, many recent contributions adopt the position that a policy approach heavily focused on the demand side may have reached its limits and that "in future the twin effects of global competition and adoption of green products and services beyond first mover markets today may make the support of supply side factors dominant over demand side" (Ernst & Young 2008). The study finds that the key supply side success factors are not specific to the sector but “broadly generic factors which can be applied to all successful businesses.” A survey of environmental businesses in the UK revealed that public procurement, access to finance, and testing and certification are seen as the main barriers to environmental innovation by companies in the sector. According to this survey, environmental regulation is also important but less significant (DTI and DEFRA 2006).

Recent publications also stress the importance of seizing global market opportunities (UK Trade and Investment, 2008a, Ernst & Young, 2008; EC, Mid-term review of Industrial Policy, 2007). Especially in the emerging markets, rapid industrialisation, urbanisation and a growing population are leading to growing demand for environmental goods and services (UK Trade and Investment 2008b). Therefore, the international competitiveness of the EU eco-industry will be dependent on avoiding the fragmentation of markets by ensuring that environmental regulation does not lock the EU eco-industry in the domestic market. This argument is supported by a recent article by Johnstone and Hascic (2008) who argue that a flexible environmental policy regime is more likely to induce innovations which are able to find markets overseas. Therefore, "any policy which focuses on the environmental 'bad', rather than mandating a particular means of reducing its impact, will provide potential innovators with the flexibility to identify the optimal means of its mitigation."

International agreements and an overall increase in global awareness of environmental issues and willingness to address these issues at a global level, may further encourage opportunities for the EU eco-industry to exploit its current competitive advantage in specific sub-sectors.

In the sub-sector reports we address more specifically the various policy intervention options and rationale for such interventions (see report number two). According to a number of recent studies, public policy should increasingly focus on:

- Facilitating access to international markets and promote the capability of the EU eco-industry domestically and internationally;
- Supporting networking between businesses and thereby help building value chains within the EU and internationally;
- Working with industries / economic sectors where resource management issues are critical to competitiveness and sustainability;
- Positioning the EU eco-industry as a commercial cornerstone for the broader economy by ensuring that domestic regulation does not hinder international market success.

Another way of viewing the role of environmental regulations and their effects on competitiveness, follows the Porter hypothesis. In short, Porter argued that environmental regulation providing economic incentives for firms to innovate may eventually increase a firm's competitiveness and outweigh the short-run costs imposed on the firm. This argument challenges the established notion that environmental regulation necessarily leads to private costs that harm the competitiveness of a country's industry. For many eco-industries this is an indirect effect, however, as they are often suppliers to the industries that are most directly affected, enabling them to meet more stringent standards or regulations. As Rennings (1998) argued: "innovations are in most cases not developed by the polluting firm but by specialized firms in the eco-industry." From that insight he concludes that "the eco-industry wants to maximize profits and turnover and may be interested in stricter regulation, while the polluting firm wants to reduce avoidance costs and tends to oppose stricter regulation."

Globalisation and international competition

Several aspects of globalisation impact on and drive competitiveness in the eco-industries (i.e. the different sub-sectors). First of all, competition for resources globally has been a strong driver for the development of alternatives and increasing efficiency of products and processes. In addition, global market prices for commodities and fossil fuels determine in part the competitiveness of e.g. renewable energies and recycling vis-à-vis traditional sources.

With its relatively high population density and resource dependency, Europe has been confronted, earlier than many other regions with the impacts of environmental pollution, increased prices of resources and has had to adjust at an earlier stage accordingly. This has given many EU eco-industry sub-sectors a first mover advantage. As the issues become more globalised and awareness is increasing even in emerging and developing economies, these first mover advantages are seen to give the EU a strong position in the global market. The extent to which these can be exploited also depends on the extent to which further trade and investment liberalisation in the environmental goods sector within the WTO can be achieved.

Access to finance and market organization

Considering the high perceived risks of investments in several of the eco-industry sub-sectors, and unfamiliarity of traditional banks with these sectors, access to finance is a major issue for some sub-sectors, such as environmental technologies, renewable energy development, etc. In other words, the capital intensive sectors of the eco-industry are at particular risk in terms of their access to finance, given the low level of availability of funds (long pay back periods, low rate of return, uncertainty). Those sectors most affected by poor access to finance are the following:

- Water supply and waste water treatment facilities;
- Air pollution control equipment;
- Waste treatment facilities;
- Renewable energy sectors.

With regards to market organisation, the emergence of public-private partnerships (PPP) in the EU eco-industries as well as privatization thrusts have to some extent been able to render the market competitive and well calibrated to adapt both to new regulation and market pressures. The balance between the role of public and private sectors varies between old member states (with a public sector often able to meet investment needs) and New Member States (where the private sector supplants the public sector role for certain investment needs). Developing the capacity for the private sector to bid for projects in areas such as utility management for both the private and public sector will determine the dynamism and competitiveness of the sector in the years to come. Access to such projects for SMEs is important. Information campaigns and an enabling bidding system are two key components.

Finally, there are ample opportunities for increased profitability and productivity in sub-sectors of the eco-industry often associated with public goods, through the introduction of more private involvement and market driven price-setting mechanisms.

6.7 Conclusions

This chapter has provided an overview of the main competitiveness contours of the EU eco-industry, both from the internal EU perspective and from a global perspective. What becomes clear when analysing this sector is that it is in a state of flux with major and rapid changes in public awareness, policies and regulations, and technologies. Even the definition of the sector is subject to change, as former 'conventional' industries are increasingly focusing on eco-activities, thus becoming eco-industries. Clear examples of this are found in the recycling industries – where former mining companies have refocused on recycling – and in the renewable energy sector, where traditional energy suppliers are increasingly incorporating green energy supply into their business models.

Many of the developments identified and described should therefore be seen as ongoing processes, driven by a number of policy and market factors. A key aspect of these factors is that there is a high level of uncertainty over their future development. Oil and raw materials prices have proven to be volatile and environmental policies and regulations implemented at an increasing rate.

Within Europe, the New Member States are clearly still lagging behind the EU15 in terms of development of the various sub-sectors, but with the adoption of EU legislation, the market in the EU12 is expected to develop strongly and investment opportunities abound.

Our analysis has also illustrated the substantial differences that exist per sub-sector in terms of their key competitiveness factors and driving forces behind them. While all identified sub-sectors have shown strong development in the EU, globally the recycling and waste management sectors perform strongest, in addition to a number of sub-segments of the renewable energy sector (notably wind-energy and bio-mass). Key driving factors for the sector include policies and regulations as well as prices and availability of raw materials and fossil fuels. Technological development constitutes another important driver, but plays a more important role in for instance the renewable energy sectors than it does in the waste management sub-sector.

With increasing global awareness for environmental issues and the need for energy efficiency and emissions control, it appears increasing public budgets are becoming available for eco-industries worldwide. Particularly in developed countries these public investments are geared towards technological development and specifically R&D. As several sub-sectors are starting to become commercially viable and thus interesting for private investments, private capital appears to become more readily available for the sector. A trend which is already longer underway in the US, where investments in the sector have up till quite recently mostly been inspired by economic and less by ecological considerations. In Japan commercial banks have started playing a more important role in the industry and in the EU green investors are becoming more common and appear to be doing better in the current economic crisis.

As confirmed by many previous studies, the EU eco-industry has a competitive edge globally, in large part due to the early adoption of environmental policies and regulations and the fact that earlier than elsewhere Europe was confronted with the negative effects of environmental pollution. However this competitive position is coming under pressure from emerging countries like China, which have been highly successful in developing high-tech sub-sectors through FDI (e.g. photovoltaic).

As internationalisation in many sub-sectors takes place through trade in services and investments as opposed to trade in goods, increasing environmental pressures, emerging legislation, international commitments and existing capacities in BRICs, there are clearly opportunities for EU eco-industries, particularly in the areas of waste management, recycling (integrated chain management) and specific segments of the renewable energy sub-sector.

In developed country markets too, EU eco-industries could potentially play an important role, if they target specific niche markets (e.g. capture of biogas from landfills in the US) and focus on high value added goods and services.

Finally, the interlinked nature of the sector implies its competitiveness must be gauged by taking a broader perspective, and there are clearly trends towards the development of partnerships between eco-industries and conventional industries and between the different eco-industries. Especially in international context this could create competitive advantages, an issue we will turn to in more detail in the next chapter.

7 The EU eco-industry and the supply chain

7.1 Introduction

As indicated earlier and especially in section 6.4, the competitiveness of the eco-industry depends critically on the conditions and developments in other industries. In turn, eco-industries may provide positive contributions to the competitiveness of other sectors in the economy.

The aim of the analysis of the supply chain in this chapter is to identify:

- Which industries are the major suppliers for the eco-industries; which are the major customers for the eco-industries?
- What is the growth potential for these industries and their likely demand for eco-industries products?
- What are the barriers for technology transfer from eco-industries to customers?
- What are the competitiveness factors upstream or downstream affecting the competitiveness of eco-industries?

The analysis of the dynamics in the supply chain of the eco-industries will thus focus on suppliers and clients of the sector.

Defining the eco-industry supply chain

As indicated at the start of this study, we distinguish between core eco-industries and connected sectors and focused our analysis on the former, with the notable exception of the eco-construction sector. In principle the eco-industry supply chain comprises all these connected sectors. In a recent study (2009) by the UK Department for Business Enterprises and Regulatory Reform (BERR) a comprehensive assessment was made of the Low Carbon and Environmental Goods and Services (LCEGS) sector, which included the following definition:

> "In addition to these more traditional **Environmental** activities, [the EGS sector] now includes a range of rapidly growing **Renewable Energy** technologies (such as hydro, wave and tidal power, geothermal, wind and biomass), as well as a number of other **Emerging Low Carbon** activities (such as reduced emissions from within the transport and construction sectors, nuclear energy, energy management, carbon capture and storage and carbon finance)." (BERR, 2009)

In its assessment of the sector it essentially included the entire supply chain of the sector, by distinguishing between those companies whose main business is purely in the LCEGS market (specialist) and those who supply into LCEGS markets but are classified in other sectors such as engineering (supply chain). For example, in the Wind Energy sub-sector, manufacturers of wind turbines would be classed as specialist wind energy companies, whilst manufacturers of the gearboxes that go in to the turbines are classified as engineering, but in reality are part of the wind energy supply chain.

It concluded that "approximately half of the value of the overall LCEGS sector (48%) lies in the extended value and supply chain activities," which include design and development; manufacture; supply; distribution; installation; maintenance; operations; R&D; consultancy; support services and retail. The study thus systematically mapped the supply chain of each sector.

In this chapter we will use a similar approach, although we will clearly not be able to delve into as much detail as the BERR study does, which drew on over 720 sources.

7.2 Main suppliers and customers

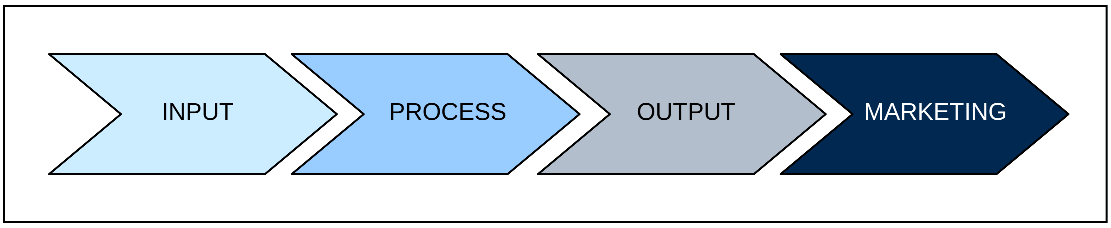
7.2.1 Introduction

The literature on supply chain issues within the eco-industry context is quite limited, although green supply chain practices and management (i.e. cooperation between companies so as to close material loops and to avoid environmental damage across the value chain) have received considerable attention over recent years. In addition studies have been conducted on green business, which covers all sectors and activities that contribute to a 'greener', i.e. low carbon, more resource efficient economy.[55] Much less has been written on the overall dynamics of the supply chain of eco-industry, with the notable exception of the above mentioned BERR study.

In our assessment we should also make a distinction between the production chain and the supply chain. The production chain concerns the processes that take place in a specific sub-sector that result in a final product, while the supply chain considers the different inputs and where they originate from, as well as the end-users of the products.

In Figure 7.1. the framework for a supply chain focus is shown.

Figure 7.1 Supply chain framework for green business



[55] See for instance a recent study commissioned by the BERR and conducted by Ernst & Young (2008) "Comparative Advantage and Green Business."

Based on this principle we have traced backward and forward all major supplying and client sectors for the eco-industries. The table below provides a non-exhaustive overview of the eco-industry materials supply chain for the main sub-sectors identified in this study and provides a first assessment of the competitiveness aspects that are involved. What has not been included in the table are all the activities that are part of the supply chain, nor have we at this point elaborated on providers of specialised services (consultancy, engineering, research institutions, etc.)

Table 7.1 Identification of the eco-industry supply chain and competitiveness aspects

Upstream: supplying sectors	Core eco-industry	Downstream: client sectors	Competitiveness aspects
Steel, Glass, Textiles & clothing, ICT (hardware), electronic equipment, Automotive, Publishing and printing / paper, Petro-chemicals / plastics, chemical,	Recovery and Recycling	Steel, Glass, Textiles, ICT (hardware), electronic equipment, Automotive, Publishing and printing / paper production, Petro-chemicals / plastics, packaging industry, chemicals, special alloys.	• Consumer demand / awareness • Global competition for materials and prices of commodities in world markets • Policy / regulations; International and EU (e.g. REACH, WEEE, life cycle strategies, etc.) • Competition from developing countries in dismantling activities.
Innovation & Technology Raw materials supply for equipment	Air pollution control	Steel and other energy intensive industries, automotive, aerospace, chemistry, cement, offices, hospitals, households	• Innovation, ability to provide small scale solutions (nano-technology), transfer of knowledge,
Suppliers of wind, solar, heat, and other technologies & equipment. Bio-fuels supplying sectors, e.g. agriculture (sugar, wheat, maize, rape-seed) Mechanical engineering services	Renewable energy production	Energy intensive industries, Automotive, Transportation, Aerospace, Households, public sector, eco-buildings	• Policy / regulations (EU and international agreements) • Global competition for resources • Access to finance • Technology • Energy prices
Mechanical engineering Machinery and equipment	Waste water treatment and water supply	all industries households public sector	• Consumer demand basic commodities and services • Industry standards • New investment opportunities
Building materials (wood, cement, glass) Plastics (bioplastics) Chemicals (insulation materials) Electronics sector	Eco-construction	Real estate developers, institutional investors, commissioners of public buildings construction.	• Access to finance • Green procurement policies • Divergence of regulation and standards (internal market)

Upstream: supplying sectors	Core eco-industry	Downstream: client sectors	Competitiveness aspects
Energy saving lighting producers Climate control equipment (heat and energy saving) Renewable energy sector			
Households, public sector, services sector (e.g. retailing) and industry	Waste management	Industry, renewable energy sector and energy suppliers.	Industry standards, regulations, renewable energy (bio-mass)

In addition there are so called cross-cutting /enabling sectors, such as ICT, environmental technologies, engineering, consultancy, finance, etc., which play an important role in managing and organising supply chains.

Below we present more detailed (again, not exhaustive) descriptions of the eco-industry supply chains by sub-sector.

Recovery and recycling

The Materials recycling and recovery sector is part of a supply chains that links to a whole range of different industries. It is quickly becoming the most integrated of chains, with the recycling industry taking a lead role in trying to position itself as a key catalyst for this integration. Interests between the recycling and manufacturing industries are highly intertwined and have become even more so with the WEEE, which has shifted the responsibility of end-of life product to the producer.

Main suppliers of materials include households, construction sector and manufacturing industries ranging from textiles to metals, while for the actual installations a host of different suppliers are involved including construction, engineering, and installation of smelters and other plants.

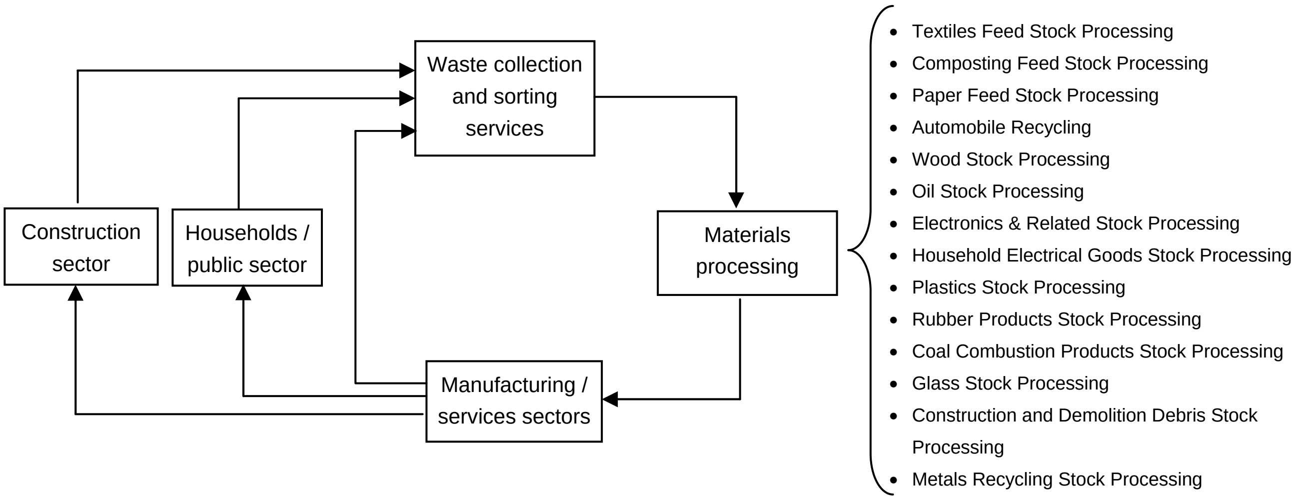
Main customers include industries such as steel, metal, glass, textiles (fibres), electronic and office equipment, automotive, publishing and printing / paper production, petro-chemicals / plastics, packaging industry, catalytic converter producers, but also services providers (e.g. precious metals such as gold for banks).

Through these manufacturing and services industries, recycled materials end up with final consumers again, such as households, the public sector and construction sector. The latter form the end of the chain, until they consider the product to have reached the end of its lifetime, after which it may end up in the recycling chain again. Specifically for materials such as glass this process is virtually endless. For other materials it is more limited, as the quality of the materials are likely to decrease (e.g. plastics) with continued recycling up until a point at which they can no longer be used as inputs.

Once again, the WEEE directive requires that producers of a good take responsibility for its recycling at the end of the products useful lifetime. Thus in principle the flow of raw materials into the recycling industry increasingly goes through the producers, not final consumers.

Figure 7.2 provides a (simplified) schematic illustration of the recovery and recycling supply chain as described above.

Figure 7.2 Schematic presentation materials recovery and recycling sub-sector supply chain



Air Pollution Control

The air pollution control sector provides products, offers process improvement and other services such as measuring and monitoring for the removal of air pollutants. Its material inputs thus consist mainly of equipment used in filters and screening processes usually developed in-house (many companies design their own systems, which in some cases become patented technologies) and ICT technology, and it depends highly on innovations and knowledge development.

Main suppliers thus include manufacturers of material inputs used in e.g. filters, which could range from plastics to metals and chemicals applications as well as providers of ICT solutions, which can be tailored for measuring and monitoring.

Main customers include notably energy intensive industries with relatively high emission levels, the transport and energy sectors as well as public sector customers such as municipalities, hospitals, and other public agencies with an obligation to monitor air pollution or engagement in the incineration of waste.

Although not a common part of the air pollution control chain at this point, an evolving activity in the sector concerns carbon capture, which holds great promise for future development.

Renewable energy production

The renewable energy supply chain is complex and diverse, as it comprises many different sources of supply and processes (for an overview, see the sub-sector report on renewable energy in the second report).

The sub-sector comprises:

- Hydropower,
- Biomass including bio fuels,
- Wind energy,
- Geothermal energy,

- Solar power,
- Solar thermal, and
- Ocean (tidal & wave) energy.

Main suppliers include producers of inputs for components and technology, such as:
- Engineering companies and manufacturers of e.g. gearboxes, pumps, etc.;
- Chemicals industry, which provides inputs for e.g. solar cells;
- Steel and non-ferrous metal sectors for installations in e.g. wind energy, solar power and hydropower production;
- Building materials sector for installations in e.g. hydropower sector and for geothermal.

In addition **providers of material inputs** for biomass include the agricultural and food processing sectors, the forestry sector, and waste management sectors, which supply the biodegradable fraction of municipal and industrial waste.

Main customers include energy companies, industrial users, as well as public sector and household level users, e.g. solar panels for households and or public buildings, or geothermal systems in sustainable housing developments. Interesting in the latter cases is the link of the renewable energy sub-sector with eco-construction, or rather sustainable building, where there is a trend towards developing housing and public buildings that are built sustainably and (in part) self-sufficient in terms of energy creation.

Other connected sectors include e.g. consultancy and research institutions.

Waste Water Treatment and Water Supply

The waste water treatment and water supply sector is one of the traditional environmental goods sub-sectors, with an established supply chain that connects to various manufacturing and services industries.

Main suppliers include:
- Engineering companies and manufacturers of pumps, filters and other equipment;
- Chemicals sector for supply of chemicals for treatment;
- Building materials and steel sector for installations, transmission pipes, etc.;
- Machinery manufacturers for supply of generators;
- Possibly municipalities for supply of raw water.

Main customers include public sector clients, private households and industry, while **other connected sectors** include engineering consultancy firms and waste management sector for processing of e.g. sludge.

Waste management

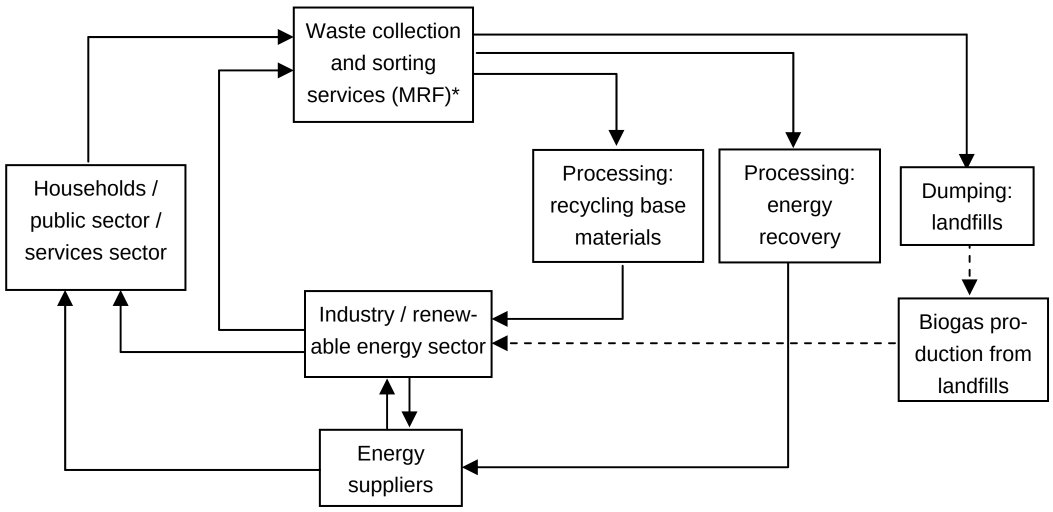
The waste management supply chain is again a diverse and complex chain with a wide range of different sectors involved. Just like the recycling supply chain it is potentially an integrated chain, with waste management services closing the chain.

Main suppliers of material inputs (waste) include households, industry and services sectors, while for the actual installations a host of different suppliers are involved including construction and engineering companies, builders of incinerators, etc.

Depending on the mode of processing the **main customers** for the outputs produced in the waste management sector include the renewable energy sector (biomass), energy suppliers (energy recovery), industry (base materials such as plastics, glass, metals, etc.). In case the final products cannot be re-used, they will be dumped in landfills. However, even here there are possibilities for energy recovery through the production of biogas from these landfills (capture of methane). This can be used by the renewable energy sector. Finally products and services provided by these sectors will end up at final consumers and (in part) eventually as waste again.

The figure below provides a schematic illustration of this supply chain.

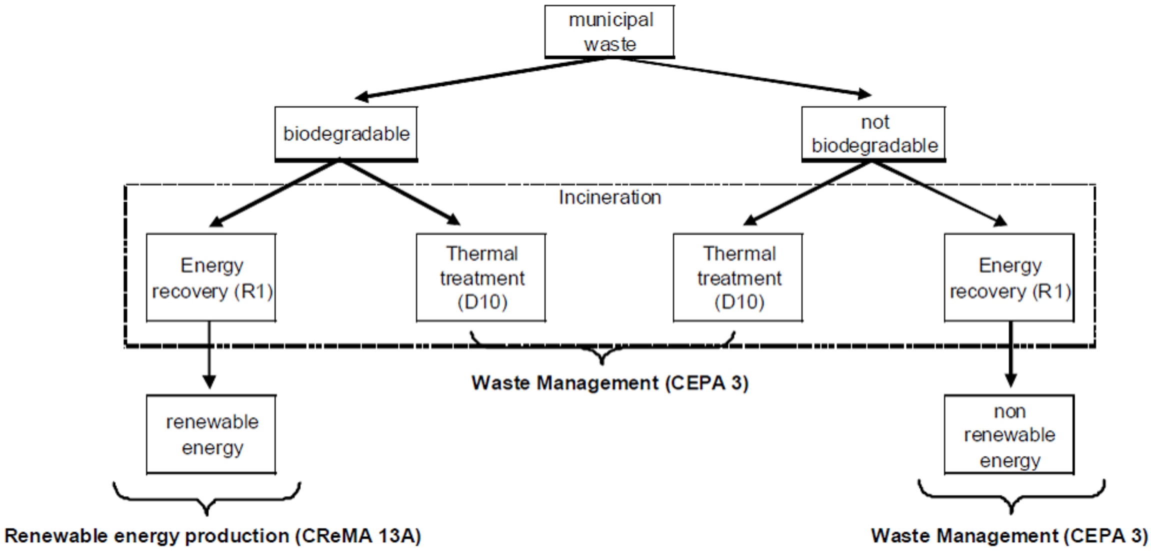
Figure 7.3 Schematic presentation waste management sub-sector supply chain



* MRF = Materials Recovery Facility, which sort mingled waste streams

As for the energy recovery process, this may be done in different ways and from different sources through incineration and heat capture, as is depicted in Figure 7.4.

Figure 7.4 Incineration activities: waste management and production of renewable energy



Source: European Commission – Eurostat, 2009, p.56

Eco-construction

The eco-construction or sustainable construction sector has already been identified as a connected sector and as such is a customer of other eco-industries. However, the eco-construction sector is also connected to a large number of other sectors.

Main suppliers include a wide range of producers of building materials and fixtures, all with a focus on sustainability. Some of these may focus entirely on eco-products, others only for a certain percentage of their business. For instance suppliers of:

- Building materials (wood, cement, glass) or intermediates (specialized door and windows)
- Plastics (bio plastics)
- Chemicals (insulation materials)
- Electronics
- Energy saving lighting producers
- Climate control equipment (heat and energy saving);
- Renewable energy sector.

Main customers include the public sector (through green procurement for public buildings for instance), property developers or even individual households (when refurbishing their houses for instance).

An important aspect of the eco-construction supply chain is the management of the actual building site and the building process, so as to ensure this is done sustainably as well, i.e. with regard for the environment, as well as public health and safety. Here the services of specialized consultancy firms for environmental impact assessments can play an important role. Similarly, cooperation with research institutions and eco-design companies often plays a role.

Cross-linkages
As the above descriptions illustrate, there are in fact many cross-linkages between the supply chains of different eco-industries and their customers and suppliers. Similarly, though not reflected in the above, cross-linkages can be found between different conventional industries aimed at eco-activities, e.g. the chemicals and the car industry, which are part of each other's supply chain and are increasingly cooperating to develop eco-friendly solutions for their products and processes.

7.3 Trends in customer and supplier markets affecting eco-industries

The major trend in almost all sectors of the economy in the EU is one of increasing awareness and integration in business models of sustainability issues, specifically resource and energy efficiency. The boundaries between the traditional eco-industries (EGS sector) and connected sectors are therefore becoming increasingly blurred, as conventional sectors are developing eco-goods and services. As several studies have highlighted, growth potential therefore lies in those areas where synergies and existing competitive advantages are strongest.

The trend towards 'green business' is driven by policies, regulations, resource scarcity and prices, as well as changing consumer preferences where 'being green' can act as a marketing strategy.

7.3.1 Changes in demand and growth potential

The main customers of eco-industry products and services can be found in both the private and public sectors. Overall it can be expected that demand from the private sector will increase relative to the public sector (which has always played a big role in demand through regulation, subsidies and procurement policies), as eco-industries mature and become more integrated in the general business practices of conventional industries and sectors (implying a broadening of the definition of eco-industries is also necessary).

Crucial in this respect is the development of financial markets for eco-investments, an area in which the EU currently still lags behind notably the US, where venture capital investments in clean tech are considerably higher.[56]

Trends in customer markets are expected to differ somewhat per sub-sector, with differing effects on the competitiveness of these sub-sectors.

Growing demand and market potential
As confirmed by several earlier studies and by global trends, the strongest growth is expected in the markets for renewable energy, where all categories of customers are expected to increase their use of clean energy in the energy mix. It must be noted, however, that in some customer sectors, especially energy intensive sectors with a need

[56] See e.g. Ernst & Young (2009) pp.9-11

for a steady and reliable energy supply base, there are currently limits to the extent to which they can replace fossil fuel energy with renewables. Their increased use will thus depend on the further development and technological innovations in the renewables energy sector.

As the renewable energy sector is expected to increase worldwide, increased competition in both home country an third markets may also be expected; increasingly renewables are expected to become commercially viable alternatives to fossil fuels and already big customers (e.g. energy suppliers) are integrating backwards, including project developers and thus the technologies into their organizations. As such the renewable energy supply chain is one that is still very much evolving.

A second sector that is expected to experience increased demand, at least in the medium terms is the recycling sector, as integrated chain management becomes more prominent among suppliers and customers of the recycling industry – especially with the WEEE Directive in place – and raw materials extraction is becoming increasingly un-economical vis-à-vis the recycling option. For instance, already recycling aluminium makes more economic sense than the recovery of many other materials as re-melting requires only five percent of the energy required to make aluminium from the ore. Not just from a material efficiency, but also from energy efficiency viewpoint, recycling thus makes sense.
Technological advances in recycling are also expected to allow the inclusion of a wider scope of products e.g. in the plastics industry, thus expanding its markets.

On the other hand, for some sectors recycling is still not easily done. For instance in the chemicals sector, recycling still faces major hurdles because of transport limitations while substance regulations also make recycling difficult – just the smallest trace of a substance can mean the product is not allowed and it is hard to keep products 'pure' in recycling.

In the waste management sector demand from customers and the customer base is also expected to increase. With its strong competitive position and advanced levels of development (outside the UK, the vast majority of waste in the EU-15 does not end up in landfills). Demand for the services and outputs from this sub-sector are expected to come on the one hand from new markets in e.g. the EU12 and outside of Europe – contingent on increasing environmental pressures and evolving regulation – and on the other hand from the development of notably the demand for renewable energy sources, which the waste management sub-sector can accommodate through energy recovery. Particularly the capture of biogas from landfills in markets where these are still most common could provide interesting growth markets for the sector.

Steady or mixed demand patterns and growth potential
In the pollution control supply chains, improvements in production processes and quality of inputs (e.g. renewable energy sources) of client industries are likely to reduce the levels of pollution in final output. Although certain emissions of pollutants will likely remain, the expectation is that this market will not grow significantly in the EU15. As customer demand in this market is highly driven by best value at best cost options, the sector will have to focus even more strongly on technological development an innovation to be able to compete with emerging economies that have a cost advantage. On the other hand, growth potential may be apparent in the EU12 and in emerging economies, as

legislation there becomes stricter and emissions targets and CO2 commitments are increasingly quantified.

Similar observations can be made for the water supply sector. As resource efficiency among users, particularly industrial users, further increases, demand for water in eth EU15 is not expected to increase significantly. However, implementation of the EU water directive and substantial investment programmes for the water sector in the new member states and developing countries may provide further opportunities for EU water supply companies. To the extent that privatisation in this sector continues, at least in the form of PPP, there are also interesting opportunities for the supply of water supply management and consultancy services by existing or new suppliers, which may improve the water supply services and sector as a whole in the EU12 in particular, as well as in developing countries.

Eco- or sustainable construction has taken a pretty hard hit from the economic crisis, which has hit particularly the construction and real estate sectors. However, demand from the public sector may still increase. In this respect policies and initiatives such as green procurement, sustained implementation of regulations such as the Directive for energy savings in building, form a good basis for further growth, while tax incentives for households have also been used to stimulate the incorporation of more energy efficient measures in existing buildings (e.g. solar panels).

Further growth potential for eco-industry through customer markets
For all sectors it appears that regulatory and standards convergence, further progress in internal market process and increased market access in international markets will enlarge the customer base and thus demand for EU eco-industry goods and services, allowing them to benefit from economies of scale. It must be noted that the creation and further development of a level playing field within and outside the EU will also imply increased competition, and a lesser scope for purely policy driven markets.

Finally, the development of veritable eco-supply chains could create increased demand for eco-industry goods and services throughout existing chains. In a recent study commissioned by the BERR a methodology is developed to consider more closely the different parts of the supply chain and identifying where room for further application of green technologies, and eco-industry products and services lie. Such a methodology could be applied in PPP to assist in further developing the competitiveness of the broader supply chains of which the eco0-industries are now part.[57]

7.3.2 Competitiveness factors upstream / downstream and effect on eco-industries

As our overall study and the analysis in this chapter in particular have shown, EU eco-industries are strongly interlinked with their supplying and client industries and often interdependent. Thus competitiveness issues in these downstream and upstream sectors also impinge on the eco-industries.

[57] See Ernst & Young (2008), pp.6-8

The increasing competitive pressures on the various EU manufacturing industries and specific sub-sectors in particular are by now well recorded. The intensification of global competition in this sector and emergence of industrial powerhouses such as China and India against the back-drop of a changing society in Europe, have forced substantial restructuring in most manufacturing industries. Although the EU has managed to retain its role as world leader in specific sectors such as chemicals, pharmaceuticals, food processing and petrochemical industries through a strong focus on higher value added and technologically advanced products and processes, the dominance of its global position in most of these sectors has declined. In recent years the added pressures from rising costs of resource prices have been strongly felt and manufacturing industries have responded in various ways, with different effects on eco-industries. Overall these pressures, together with regulations, are seen as the main contributors to demand for eco-industry goods and services that improve energy and resource efficiency. But other forces are at play as well.

Resources competition
One of the competitiveness issues that should be noted in this context is the effect of growing demands for renewable energy (bio fuels) and biomass in particular on sectors that traditionally depend on renewable raw materials, such as the chemistry sector. An increasing competition for these raw materials may drive up prices and policies should be mindful of these cross-sectoral price elasticities.

Value added creation
As EU manufacturing industries increasingly look for value added as a base for competitiveness, demand for environmental goods and services increasingly hinges on the question whether eco-industries can add value to products, processes or brands. Where they are seen exclusively as necessitated by regulations and as adding costs, demand for such goods and services will be strongly based on cost considerations and lower cost competitors with similar technologies (e.g. from China) may well be chosen over European producers.

Leakage
Similarly there is a continued debate on the costs of environmental regulations and policies such as notably the ETS between EU manufacturing industries and policy makers, as the former argue that unless a level playing field in terms of such regulations is created at a global level, such measures put EU manufacturers at a competitive disadvantage. As a consequence, they warn, 'leakage' may occur, where production of especially energy intensive industries increasingly takes place in countries with less strict regulations, defeating the whole purpose of the ETS. Whether or not these effects will really occur is not yet clear, but if they do, the secondary effect on EU eco-industries may be that these follow manufacturing activities, which form essentially their main customer base. A similar fear of leakage mechanisms can be discerned for the supplier industries of the recycling supply chain. As producers of recyclable materials are held responsible for the recycling of these materials (and thus face additional costs) they may opt for exporting them to developing countries, where dismantling may be done at a fraction of the cost due to lower labour costs, but also due to lower compliance costs with environmental and public health and safety regulations – often absent in these countries. This deprives EU recycling industries of key inputs, while it has been argued that the

recovery rate in these countries is often much lower and it is not always clear where the residual materials end up.

Longer term effects of the economic crisis

Although the longer term effects of the economic crisis are hard to predict, some trends are already discernable. One of the hardest hit sectors is the automotives industry and as it is generally accepted that substantial overcapacity exists in the sector, it is likely that the crisis will trigger a worldwide reduction in productive capacity. At the same time the crisis seems to have accelerated demand for and development of more energy efficient and eco-friendly cars and therein lay potential further opportunities for specific eco-industry sub-sectors. It must be noted, however, that in terms of hybrid technology in particular, the Japanese seems to be far ahead. Strong collaborative arrangements between EU car manufacturers and developers of applied environmental technologies could enhance the competitiveness of both sectors.

Technological limitations

The competitiveness of energy intensive sectors such as the steel and non-ferrous metals depends heavily on stable energy supply and prices. Currently energy supply from renewables is not able to provide the kind of steady supply needed and the scope for switching entirely to renewables is therefore still limited in these industries.

Similarly the chemicals sector needs high quality and very pure inputs for certain products and processes. Currently the recycling sector is not yet able to ensure this kind of quality to allow for a substantial increase in recycled materials in chemical products. The main focus is therefore on how to reduce energy consumption, as in the words of CEFIC (European Chemical Industry Council) “it is better to use fossil fuels for high value added applications than it is to burn it.”

7.4 Barriers for technology transfer within eco-industry supply chains

7.4.1 Characteristics of eco-industry supply chain organisation

A report by the Environmental Innovation Advisory Group (2006) highlights the absence of an established supply chain in the eco-industry sector. This is mostly due to the heterogeneity of the sector and a lack of forces mobilising and organising the supply chain. In other industries this mobilising role is typically played by OEM’s (Original Equipment Manufacturers) and distributors.

The report states that “in the car industry there is a pathway that carries new ideas through SME’s, Tier 2/3 companies, Tier one integrators, OEM’s and distributors and hence into the market. In key environment sectors these supply chains are either absent, dysfunctional or badly damaged.” Due to these weak linkages up and down the supply chain, the report argues, eco innovation with great market potential frequently reaches the market with a delay or totally fails to reach the market. In this context, public policy has the special responsibility to provide the appropriate framework for developing the intelligent supply chain management required by the sector, due to its dominant influence on the development of the environmental industries and the public's interest in environmental goods.

This situation is exacerbated by the fact that technology developers (e.g. engineering companies and research institutions) and companies specialising in managing the industrialised production of innovative products are frequently located in different European countries and insufficiently aware of each other's capabilities (Krüger, 2007). Finally, there is insufficient awareness of the market potential of eco-industrial products and services in different European countries and overseas.

Information asymmetry
Do potential clients know which technologies exist and which applications might bring an increase in competitiveness? Due to the diversity of applications in the eco-industry and the relatively high level of technical complexity, it is not always known which technologies are in reach of the company to increase competitiveness and how this practically has to be applied. Especially for SMEs, for which the cost factor of the investment gets an important weight, particularly in times of economic crises, the search and investment costs for applying the appropriate environmental technologies might overweight the longer term but relatively uncertain benefits. This equally applies to eco-construction where the client is basically the private owner of the building, often households. Yet in this case the passive house or sustainable building networks fulfil a crucial role. For SMEs a catalytic role can be played in this respect by eco-industrial parks (see boxes 7.1 – 7.3).

Differing standards and legislation
Technology transfer needs to take place between firms but also between countries and in this respect the heterogeneous implementation of the various regulations at member state level seems to be hindering efficient and effective technology transfer. In this respect particularly the development of a more coherent intellectual property rights (IPR) policy and legal framework is crucial, not just at intra-EU, but also at international level.

Evolving partnerships
Despite these apparent barriers to efficient and effective functioning of the value chains in which many eco-industries operate, more recent developments in the formation of strategic partnerships between the different players in these chains provide positive examples of how further synergies can be created.

Examples of such partnerships include waste management and recycling companies with automotive and airplane manufacturers to develop closed chain management. Core eco-industry companies are often much more aware and tuned into evolving policies and legislation, e.g. in the field of recycling. As such they may advice client industries on strategies to prepare for upcoming regulations, so they may already improve their products from the onset. Examples of this can be found in materials recycling, where the latter provide advisory services to clients in e.g. the electronics or ICT sectors.

In addition partnerships are evolving between conventional industries aimed specifically at tackling environmental issues. Thus the chemicals industry may work together with the car industry to develop new paints that are sustainable or with the building materials industry to develop solutions for sustainable buildings.

Finally some interesting examples can be found of emerging eco-clusters, which bring together partnerships in a specific geographic area. The following section provides a few examples of such clusters.

7.4.2 The potential of eco-industry clusters

As has been argued by the High level Group on the Competitiveness of the European Chemicals Industry (2009), there is potential for further improvement in the use of natural resources through geographically integrated supply chains or clusters.

Clusters are generally seen to foster technology and knowledge transfer among industry players and their suppliers and clients, thus contributing to competitiveness of a sector. In the context of sustainability, geographically concentrated clusters may have added advantages in terms of more efficient use of resources and reduction in emissions due to reduced transportation needs.

Clusters are generally seen to evolve through private initiative, but there are also numerous examples of policy induced clusters or public private partnerships. In any case, public policy may provide an enabling environment, which further strengthens the cluster and the competitiveness of companies within it.

Below we present three examples of successful eco-clusters, which include both eco-industries and connected industries and institutions. Two are located in Denmark, while one is situated in the US. The driving forces behind their emergence differ between the three, one being driven by the public sector, one through PPP and one by private initiative.

Box 7.1 Kalundborg eco-industrial park

Eco-industrial parks share some characteristics with their larger cousin, the industrial cluster. Close geographical proximity, social networks, and an understanding of how co-operation can co-exist with competition are all important. In the case of eco-industrial parks, these relationships are formed primarily to take advantage of other's waste materials. For example, a wastewater treatment plant provides cooling water for a power station, which in turn supplies steam to provide power for an industrial user. One companies waste can be another's resource.

Unlike an industrial cluster, the connection between organisations is not along a traditional value chain. Organisations within the cluster are not working with complementary products, but rather, complementary *waste* products. Members of the cluster are part of an ecological chain rather than a value chain.

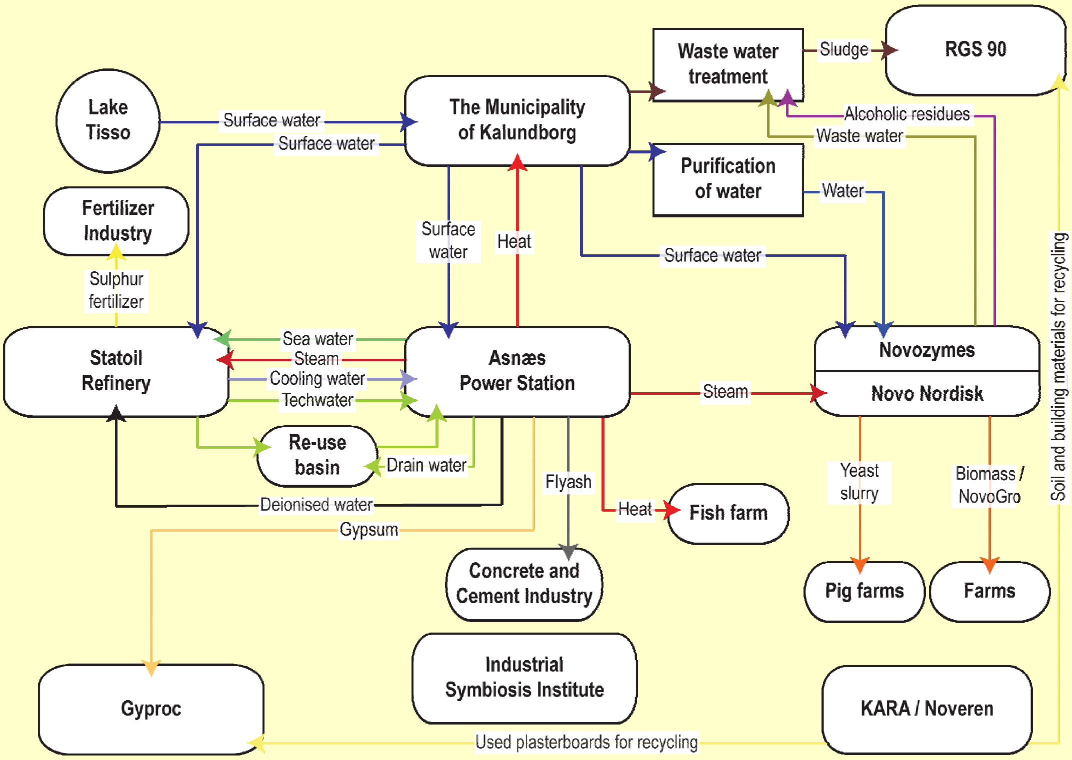
One of the most actively described and successful eco-industrial parks is located in Kalundborg, Denmark. The members of the network include:

- a power station (Asnæs)
- an oil refinery (Statoil A/S)
- a waste collection company (Kara / Noveren)

- a biotech and pharmaceutical company (Novo Group)
- a plasterboard manufacturer (Gyproc Nordic East)
- a soil remediation company (Soilrem A/S)
- a local fish farm
- the local municipality

Waste is just one of the resources in this interdependent system. The refinery's waste and cooling water are reused by the power plant. The cooling water is used as input during desulfurization, which in turn produces industrial gypsum that can be used for plasterboard production at the Gyproc factory. The diagram below shows more of the relationships between the various organisations and resources.

Figure 7.5 Schematic overview Kalundborg Industrial Park



Source. Adapted from http://www.symbiosis.dk/industrial-symbiosis.aspx

The Kalundborg example is also evidence that clusters can and do develop without much interaction from government actors. This eco-park developed slowly based on a series of bilateral agreements between parties looking for economic advantages to their co-location.

Box 7.2 The Risø National Laboratory: Catalyst for a wind energy cluster in Denmark

Renewable energy became a political priority in Denmark in the 1970s, and the seeds for an industrial cluster were planted late in this decade. Many researchers focus on the role of government-set minimum prices for wind energy as well as other state-aid schemes in the industry's growth. However, the growth of a successful cluster in the area owes credit to the creation of a machine testing programme at the Risø National Laboratory in 1978.

The testing programme—with a certification element added a year later—was initially intended to support the

Danish strategy to establish a "safe technical path" for wind energy, looking for gradual improvements on existing technologies rather than huge, ground-breaking leaps. The marketing strategy played into this approach, establishing market credibility with Danish technology that was reliable.

Companies were understandably hesitant about sharing their knowledge with government testers; however, a government incentive offering a 30% reimbursement on the purchase price for any turbine tested at the facility helped break down any resistance. This testing and certification had an important secondary effect. It helped to initiate the knowledge sharing and networks that are so key to any industrial cluster. Today, the Risø National Laboratory is considered a critical component in research and development of new wind technologies.

Western Denmark is now home to some of the leading firms designing wind turbines, namely Vestas Wind Systems A/S (in Randers) and Siemens Wind Power A/S (in Brande), who lay approximately 100km from each other. Foreign firms like Gamesa (Spain) and Suzlon (India) also have offices that conduct research and development. In addition to the facility at Risø, Aalborg University and Aarhus University have become leading centres of innovation in the field of wind technology.

The wind cluster—and energy exports in general—are an important component of the Danish economy. Exports of energy technology and equipment grew to DKK 51.8 billion in 2007 (from DKK 45.9 billion in 2006). Exports of energy products and equipment, including especially wind turbines, make up an ever increasing percentage share of Denmark's overall exports of goods. This percentage grew to 9.2 percent in 2007 from 8.4 percent the year before. The industry holds 40 percent share of the global market and employs more than 20,000 people.

Box 7.3 Portland's Green Building cluster

In 1999, the U.S. Green Building Council (USGBC) created the Leadership in Energy and Environmental Design (LEED) rating system. This programme measures design, construction, and operation of building construction, and was meant to encourage the adoption of sustainable designs. This rating system has come to dominate the commercial green building field in the United States.

Portland, Oregon—on the west coast of the United States—has the highest concentration of LEED certified buildings in the country. Some of this development can be attributed to public policy, with the adoption of the Green Building Action Plan. Its goals were to expand the market by educating industry professionals and the public while reducing regulatory and financial barriers to adopting. The first programme, called G/Rated, focussed on four areas:

- Organisation and policy development;
- Demonstration projects;
- Technical assistance and outreach; and,
- Incentives.

What remains important in this programme in terms of cluster development is the combination of information and resources. While the Portland programmes fail to support any more direct networking policy tools, the use of training, conferences, and other advisory programmes provides indirect networking support.

The government has also been mindful to the importance of education, and how it supports industry—both as a provider of knowledge, an educated workforce, and important research. The state legislature funded the Oregon Built Environment and Sustainable Technologies Research Centre, with additional support from the Oregon University System and the Meyer Memorial Trust. The partners for this institute included the important higher-education facilities of the state: Oregon State University, Oregon Institute of Technology, Portland State University, and the University of Oregon. Their mission is to grow and focus a shared, state-wide *network* of university researchers, laboratories, and equipment in the following two strategic areas:

- Green Building Products and Services;
- Renewable Energy Generation.

More recently, the green building industry has been targeted by a "cluster" programme, though the methods and policies remain very similar to initial initiatives. The Green Development cluster, sponsored by the State of Oregon: Oregon Economic & Community Development Department, began operation in 2007. Cluster initiatives focussed primarily on demand:

- Create an ecosystems services marketplace (will help rural communities, agriculture and forestry industry, environment) and Encourage more developers to be ecosystems-neutral;
- Fast track permitting for green building;
- Develop climate friendly mortgage, appraisal, and insurance products;
- Commercial forum—Create a "commercial support forum"— an entity (physical & on-line) that will entertain inquiries regarding opportunities to fill market demands/create new businesses.

7.5 Conclusions

In this chapter we have outlined the main characteristics and trends in EU eco-industry supply chains, so as to assess the impact of eco-industries on the competitiveness of supplier and customer sectors and vice-versa.

Our analysis clearly illustrates the complexity of the interactions within and across the supply chains and the fact that the boundaries between eco-industries and conventional industries are blurring, as both are in a state of flux. There has emerged a strong interdependence between eco- and conventional manufacturing activities and this interdependence is expected to increase, as conventional industries are moving towards green business strategies and implementing environmental technologies, improving resource efficiency and reducing emissions. The potential for contributing to these green business strategies will thus also increase for eco-industries, as they can increasingly add value, and even reduce costs through the integration of for instance on site water purification, energy production and/or heat capture. Further supply chain integration and 'convergence' between eco-industries and conventional industries thus seems to be taking place.

However, some challenges clearly remain, including not least the absence of a strong organising entity (lead firm) in most eco-industry supply chain, as can be found in e.g. the supply chains of the automotives industry, where OEMs are strong organisers and integrators of supply chains, retaining control over the processes within it.

In addition there is the challenge of overcoming the various barriers to technology transfer, such as limited adoption and application capacity of environmental technologies in specific supply chains (weak innovation systems, where the technologies are available, but not reaching key clients and end-users) and the need for further development of capital markets for eco-industry or clean tech investments in conventional sectors. Moreover, technology transfer needs to take place between firms but also between countries and in this respect the heterogeneous implementation of the various regulations at MS level is a point of attention.

Public policy may have a role to play in mobilising and further integrating the supply chain, due to the specific nature of the sector, and the fact that it lacks strong lead organisers. By focusing on the development of integrated eco-supply chains, market opportunities and enhancement of competitiveness at a global level may be achieved. In addition, the potential for cluster development seems interesting and conducive to technology transfer and the tackling of sustainability issues.

8 Framework conditions

8.1 Introduction

The goal of this chapter is twofold:

- To identify the key sectoral issues of the regulatory environment and the framework conditions which:
    a. influence the sectoral performance and the competitive position of the European eco-industry (as a whole and of its sub-sectors).
    b. determine the use and application of eco-industry services and goods that may contribute to the other sector's competitiveness.
- To provide a comprehensive and structural assessment of the relevant regulatory conditions and framework conditions that determine
    a. the growth and competitive position of the eco-industry,
    b. the interaction between the EU eco-industry and other client and supplier industries.

Thus, the analysis of the framework conditions will provide an overview of the relevant conditions affecting the competitiveness of the eco-industry on the one hand and of the interaction with the other industries on the other hand. Following the same approach as for the other sectoral competitiveness studies, first a framework grid has been developed, the results of which are shown in annex V. The subsequent step after this initial analysis has been the matching of these results with the ones of the competitiveness analysis. This indicates which of the potential effects that have been identified from a regulatory and framework perspective have further consequences in the field of competitiveness. In the following part the main conclusions from the framework grid are presented. Subsequently the results from the competitiveness grid are documented.

8.2 Conclusions from the framework grid

Based on a systematic screening of the framework conditions, as reported in the framework grid, we identified the key issues for the EU eco-industries in general and for its different sub-sectors. Key issues having an impact on most eco-industries are:

- Environmental regulations;
- National regulatory measures;
- Completion of internal market legislation
- Knowledge and innovation;
- Access to finance;
- Socio-economic developments (ecological awareness), and
- Economic crisis

In the following section we present shortly our main conclusions for each part of the framework grid. Hereby, we focus on the relative importance of each part and describe the key issues having a potential impact on the competitive position of the EU eco-industries.

Regulatory conditions

- Environmental regulations: direct impact on the demand for services and know-how of the eco-industries
- National regulatory measures and completion of internal market legislation: problem of different implementation and enforcement of the EU-regulations in the different Member States. From this point of view there is no single market yet.

Other framework conditions

- Knowledge and innovation: innovation is a critical factor in the context of connecting sustainability and economic growth. The focus of eco-innovation is on improving resource productivity and reducing environmental impact. Eco-efficiency can therefore be seen as a yardstick for eco-innovation. The climate change, the reduced availability of resources and raw materials and the increased international competition are the main drivers of the demand for eco-efficiency and therefore the demand for eco-innovation.
- Access to finance: some of the eco-industries are very capital intensive. However, there is a low level funding-availability due to the long pay back periods, low rate of return, uncertainty, and in addition the recent financial crisis. Therefore, additional support from the public sector (local, national and supranational) will be an important factor for the future competitiveness of the EU eco-industries.

Exogenous conditions

- Socio-economic developments and ecological awareness;
- Economic crisis: risk and uncertainty increased due to price collapsing of raw materials (such as aluminium and copper), which is a hampering factor for the competitiveness in the recycling industries. But also the capital intensive eco-industries are hit by the financial and economic crisis due to a diminished access to finance.

8.3 The effects of the framework conditions on the competitive position

8.3.1 Competitiveness grid

The competitiveness grid is drawn to present potential impacts of the framework conditions on the economic and competitive position of the eco-industries in the EU. These impacts are indicated by means of light or dark blue crossings between the condition and the indicator in question (depending on the intensity of the effect). For each shadowed crossings, the direction of the effect (+ or -) and the source through which we have identified the effect[58] is given.

First, the regulatory conditions are shown, followed by the grid of the other framework conditions and the exogenous conditions. After presenting the competitiveness grid as a whole we focus in more detail on the effects that each individual competitiveness indicator encounters through the framework conditions.

[58] This indication is consistent with the one in the framework grid and is thus defined as [1]: effects that are found in empirical literature and validated interviews; [2]: the effects that are described as 'potential' in literature and the validated interviews; and [3]: the effects that on the base of our own assessments have a potential impact.

Regulatory conditions:

Eco industries

	Indicators	EU Environmental regulation	EU Labour market and migration regulations	Knowledge: IPR-legislation	Sector specific standards and codes of conduct	National regulatory measures and completion of internal market legislation	Competition policy issues
Outcomes	Production and Value added	[+/-] [2-3]		[+] [3]	[+] [2-3]		
	Employment	[+] [2-3]	[-] [3]				
	Productivity		[-] [3]				
	Profitability			[+/-] [3]	[+] [1]	[3]	
	Exports and Trade	[+/-][11-2]		[+] [3]	[?] [3]		
Processes	Intra- and inter-industry relations	[1]					[3]
	Production processes	[+] [2]			[-] [3]		
	Organisation			[-] [3]	[+] [3]	[-] [3]	
Structure	Industrial structure	[1]	[1-3]		[3]	[3]	[3]
	Size of enterprises			[+] [3]			[3]
	Segmentation	[+] [1-3]					
	Level of specialisation	[+] [1-3]		[+] [3]			
Inputs	Labour (skills)		[-] [1]				
	Capital				[+] [3]		
	Intermediate goods & services						
	Knowledge & technology	[+] [3]		[+/-] [2-3]	[-] [2]		

Framework conditions — Regulatory conditions

Other framework conditions:

	Indicators	Access to finance	Knowledge base development and innovation	Market access: openness of international markets	Structural change: process of desindustrialisation	Climate change: sustainability in production process	Market organisation	Labour force, knowledge and skills
Outcomes	Production and Value added	[-] [3]	[+] [3]		[-] [2-3]	[+] [1]		
	Employment	[-] [3]		[-] [3]	[-] [3]	[+] [3]		
	Productivity							[-] [3]
	Profitability		[+] [3]				[+] [1]	
	Exports and Trade	[-] [1-3]		[-] [1]				[-] [3]
Processes	Intra- and inter-industry relations	[-] [3]	[+] [3]	[-] [3]	[-] [1]	[3]		
	Production processes		[+] [3]			[+] [3]		
	Organisation				[1-3]		[+] [1]	
Structure	Industrial structure	[3]	[3]	[3]	[3]			[3]
	Size of enterprises							
	Segmentation		[3]				[+] [1-2]	
	Level of specialisation		[3]					
Inputs	Labour (skills)		[+] [3]	[-] [1]				[-] [2]
	Capital	[-] [1-3]	[-] [1-3]					
	Intermediate goods & services		[+] [2]			[-] [1]		
	Knowledge & technology	[-] [3]	[+] [2]			[+] [2]		

Eco industries — ***Framework conditions*** — Other framework conditions

Exogenous conditions:

	Eco industries *Indicators*	Technological change	Socio-economic developments	Global competition	Economic/financial crisis
Outcomes	Production and Value added		[+] [3]		[-] [3]
	Employment	[-] [3]			[-] [3]
	Productivity	[+] [3]		[+] [3]	
	Profitability	[+] [3]	[+] [3]		
	Exports and Trade		[+] [3]	[?] [3]	[?] [3]
Processes	Intra- and inter-industry relations		[3]		[?] [3]
	Production processes	[+] [3]			
	Organisation				
Structure	Industrial structure	[3]			[?] [3]
	Size of enterprises			[?]	[?] [3]
	Segmentation		[+] [3]		
	Level of specialisation				
Inputs	Labour (skills)	[+] [3]		[3]	
	Capital	[+] [3]			[-] [3]
	Intermediate goods & services	[3]		[-] [2]	[-] [3]
	Knowledge & technology	[+] [3]		[+] [2]	
	Framework conditions				
		Exogenous conditions			

8.3.2 Main findings from the competitiveness grid

OUTCOMES

Production and value added

Looking at production in quantitative terms, the enforcement of the **EU environmental regulations** has been a key driving factor for some sub-sectors, such as the recycling (positively affected by e.g. the WEEE Directive and the End of Waste Directive), the waste management sectors and a number of sub-segments of the renewable energy sector (notably wind-energy and bio-mass). With increasingly stringent regulations worldwide (e.g. in China,...), new opportunities for pollution control technologies and services as well as waste management and recycling are likely to emerge. The environmental regulations will, therefore, most likely have a positive influence on the production of eco-products and services in the future. Nevertheless, the international competitiveness of the EU eco-industry will depend on avoiding the fragmentation of markets by ensuring that environmental regulation does not lock the EU eco-industry in the domestic market.

Together with the **sector specific standards and codes of conduct** (such as the Environmental verification systems applied in the environmental technology industry), the environmental regulations tend to foster innovation and consequently the value added and quality of the environmental goods and services. EU producers have become increasingly specialized, with a sound knowledge base, giving them a competitive advantage in this respect. The eco-companies, especially SME's, can fortify this competitive advantage by protecting knowledge and specific know-how using **IPR-legislation**. An important condition in the longer term, however, is to create an environmental policy regime that is consistent with an industrial policy focusing on innovations with sufficiently large international selling opportunities.

Looking at the non-regulatory conditions, production is positively influenced by the increased **ecological awareness** as a consequence of the changing climate. In this respect, also the role of green public procurement has to be mentioned, being an important driver of demand for e.g. renewable energy and recycling technologies. The sustainable use of resources, the development of life-cycle thinking in waste management and the diminishing supply of raw materials encourage the introduction of more sustainable alternatives. In order to comply with the increasing demand, and the unsaturated supply, production is expected to increase in the coming years. For example, demand for services and outputs of the waste management sector is expected to come from new markets, such as from the new member states, on the one hand and from the increased demand for renewable energy sources on the other hand.

Limited **access to finance** and the current **economic and financial crisis**, however, have a negative impact on the production level. Especially the demand in the eco-construction sector has been hit by the economic crisis.

Employment

Employment is negatively affected in a direct way by the **process of deindustrialization** and the inflexibilities with respect to **labour market regulations**. Manufacturing industries, important customers of the recycling industry, are increasingly moving away from Europe. It is therefore expected that over time recycling companies will reorganize their value chain and relocate parts outside of Europe, having a negative impact on employment.

Also **wage differences** across countries and subsectors might explain future changes in the employment level. Companies in labour intensive segments are stimulated to relocate their business, or parts of it, to low labour cost regions/countries. Low skilled people will always be needed for some subsectors within the eco-industry.

It is expected that the eco-industry will also require employees with **new skills** and a **higher skill-level**. The supply of skills within a region/country will mainly be affected by globalisation and demographical change (including ageing and migration). However, in order to remain competitive and to keep the business inside Europe, the EU can react proactively by investing in education and training and take measures to stimulate employment conditions in the sector.

Conditions influencing the **demand** of environmental goods and services (e.g. access to finance, climate change and ecological awareness, financial crisis,…) influence employment in the same direction as the production level, but mostly with some delay.

The **automation** of the production process (such as the auto-sorting technology in the solid waste management sector) has a negative impact on employment due to capital labour substitution: less labour is needed to produce the same output.

Productivity

Though low skilled people will always be needed for some sub-sectors within the eco-industry, the eco-industry will, according to Skillsnet, require employees with new skills and with a higher skill-level. They argue, however, that there will be a shortage of skilled employees, especially in the environmental technologies and air pollution control industries. The absence of a **single labour market** in Europe and the inflexibility of labour market regulations discourage the attraction of high skilled workers from all over the world. This shortage of skilled workers undermines the level of productivity that would otherwise be feasible. Furthermore, numerous existing skills will become obsolete and therefore educating the current labour force is required to maintain competitiveness.

On the contrary, **globalization** and increased **competition** stimulate innovation and technology. Both are important drivers of economic efficiency and productivity. Examples of innovative and technological improvements that led to an enhanced productivity level are the implementation of more automated sorting systems in the recycling industry and the introduction of ICT systems in the water and waste industry.

Further, other industries, mainly the **connected industries**, are stimulated by both economic and legislative motives to adopt cost reducing and energy efficient technologies from the eco-industry suppliers in order to reduce their environmental impact (compliance with environmental legislation). In this respect, other industries (up- and downstream) serve as an indirect, retroactive driver of the productivity in the eco-industry.

Profitability

The profitability of the EU eco-industry is mainly influence by its cost structure. The **decrease of bureaucracy** and **cost inefficiencies** resulting from the introduction of sector specific standards and codes of conduct (compared to stand-alone norms) lead in the longer term to cost decreases, and therefore to profit gains. The administrative burden in compliance with the IPR-system, however, may have a negative influence on the profitability of EU producers, especially for SMEs who have less organizational capacity.

Other factors that might possibly hamper future profitability are **efficiency losses** in the production process due to a lack of skilled workers, the effects of economic and financial crisis and the high labour costs compared to low-wage countries.

The emergence of **public-private partnership**s (PPP) as well as **privatization thrusts** has to some extent been able to render the market competitive and well calibrated to adapt both to new regulation and market pressures.

Beside these elements, the profitability of eco-commodities and services is also strongly co-determined by the prices of energy, raw materials and alternative goods.

Exports and Trade

The **absence of international level playing field** with respect to various regulations and standards might negatively affect the competitive position vis-à-vis non-EU countries. A flexible environmental policy regime is more likely to induce innovations which are able to find markets overseas.

The impact of the **financial crisis** is still uncertain, but it is expected that it will have a decreasing effect on export in the coming months/years. Also having a negative impact on export volumes are the existing **trade barriers** that hinder access to customers and thus hinder free supply and demand (for example, export tariffs on raw materials in the recycling industry in e.g. Russia and Ukraine, often for protective reasons). In the renewable energy industry, neither trade barriers nor intellectual copy right issues are considered as an important impediment to the exploration of international markets.

Conversely, the production of eco-efficient goods is beneficial to the EU-companies, creating a **comparative advantage** on the world market regarding quality. This advantage is even fortified by the increased **ecological awareness and policy pressure**. Therefore, also conditions that have an influence on the **value added** of the EU production may increase export volumes.

The impact of the increased **global competition** on export depends on the competitive position of the EU-producers and their ability to keep non-EU competitors at a certain distance. Currently, the EU is the main exporter of environmental goods in nearly all markets, and has a relatively strong comparative advantage in most subsectors. For the environmental technology suppliers, especially the BRIC countries are considered as very promising markets. In this subsector, European companies do not encounter problems yet in doing business outside Europe. Still, the emerging economies (e.g. China, India, Brazil) are becoming increasingly important players in the global market, putting serious competitive pressure on the EU industry. In the renewable energy industry, for example, the potential for cheap mass production in China and India is seen as a major challenge to European companies.

PROCESSES

Inter-industry relations

The inter industry relations are mainly affected by the need for potential client industries to find "eco-solutions". Important suppliers of the eco-industry are situated in various sectors of the economy, such as the automotive and transport sectors, steel sector (energy intensive industries), electronics industry and the energy supply sector (energy markets). The motives behind the increased dependence on eco-industry technologies are quite diverse ranging from the compliance with **environmental legislation**, to the need for increased **energy efficiency**, and serving as a response to increased **consumers' awareness** and **policy pressure.** For a more extensive description of the relationship between the eco-industry and the connected industries, we refer to the previous chapter.

Production processes

One of the biggest comparative advantages of the EU-eco industries vis-à-vis their non-EU competitors is the progress in the field of **eco-innovation** which makes the production process more cost efficient, and consequently the EU eco-producers more competitive. The ability of European companies to alter their processes and products according to a changing **technological** (e.g. introduction of the auto-sorting technology in the solid waste management sector) and **economical environment** is therefore one of the critical factors that determine competitiveness of the industry is.

The strict **standards** for environmental quality and the enforced **environmental regulations** are an important driver of the innovative production process.

On the contrary, the difficulties to get **access to finance** for innovative investments, fortified by the current financial crisis, have a restraining effect on the further developing of the production process of the eco industries (especially in the environmental technology industries).

Organization

In order to remain competitive, the EU eco-industry companies have to continuously adapt their processes to the changing environment, and to constantly optimize time and costs. There are different kinds of organisational changes. A first type of organisational changes can be attributed to changes and developments, intrinsic to the (evolution of the) sector. An example of this type within the eco-industries, is the emergence of **public-private partnerships** (PPP) and **privatization thrusts** and the further development in areas such as **utility management** implying changes with respect to the organisation of the business process, especially for SMEs. Another example, is the increased need for interactive, complementary collaborating teams in the sustainable building industry, demanding an extremely different organisational structure, compared to the traditional building industry. Thus, also changes in the production process and product range may imply organisational changes.

A second type of organisational changes can be attributed to changed external conditions, such as newly enforced regulations that involve high **administrative burdens**. Examples of these conditions are the further completion of the **internal market legislation** and the further enforcement of **IPR-legislation**. The introduction of sector **specific standards** and **codes of conduct**, however, decrease the administrative bureaucracy in comparison to stand-alone norms. But also non-regulatory extrnal factors may imply organisational adaptations. For some companies, the **relocation** of parts outside of Europe due to a too high **labour cost disadvantage** vis-à-vis non-EU regions, will involve serious reorganizations.

STRUCTURE

Industrial structure

The EU **environmental regulations** have been an important driving force behind the new so called ‘regulation driven sectors’. On the one hand they created new eco-industry markets. On the other hand, they have an influence on how the industry itself is doing business. At the moment, there are - in theory - enough regulations in place to have a good framework for doing business. For example, the Waste Framework Directive provided a sound framework to drive waste management practices in the EU. However, the implementation and enforcement of all this legislation is still problematic. A long-term stable policy framework is a crucial element for the future development of the sector. Greater harmonization across the Member States and a simplification of the often highly complex national regulations are considered to be of major importance.

Next to regulation, also **standards and codes of conducts** are important elements in shaping the industry. They are seen as important instruments in the development of the single market, and to some extent considered as a requisite to earn the confidence from customers, bankers, investors. However, in the environmental technology industry, the strictness of standards is seen as a barrier to innovation, seriously decreasing the flexibility to deploy new technologies and causing delays at the moment of market introduction.

Another important evolution within Europe which affects the eco-industry, more in particular the recycling industry, is the process of **deindustrialisation**. The manufacturing industry, an important customer for the recycling industry, is moving away from Europe, with a declining impact on demand for EU recycling services. It is therefore expected that European recycling companies will reorganise their value chain in the future and relocate parts outside Europe. This will negatively affect the competitive position of the EU recycling industry in the future.

Previous issues have a rather direct impact on the industrial structure. Besides, conditions influencing the inputs, processes and outcomes of the eco-industry often affect the industrial structure of the sector in an indirect way. Developments with regard to the **inter-industry relations** between the EU eco-industry and the connected industries will have an influence on the industrial structure of the eco-industry itself (see 'inter-industry relations', above). Evolutions in required **skills**, wage differences and conditions of employment, will affect a company's choice of business' location (see 'employment' and 'labour'). Limited **access to finance** and conditions with an impact on the investment climate (e.g. the current financial crisis) might create strategic boundaries and hinder essential progress in the field of **innovation** and technology, jeopardizing the competitive position of the European companies (see 'capital', below). These issues are discussed more in-depth under the specific indicator in this chapter.

Size of enterprises

The average size of an eco-industry organization strongly depends on the sub-sector in which it operates. The older and **established subsectors** such as the waste management and water supply sectors are more concentrated and active on a more international scale compared to the new regulation-driven markets that are usually made up of SMEs. As new markets grow, firm size and concentration rate increase. The eco-industry as a whole therefore shows indications of being an endogenous sunk cost industry, characterized by a high level of investments in **R&D** and **innovation**, with a positive lower bound to concentration as the market grows infinitely, as described by Sutton[59].

Competition policy is the main regulatory condition mitigating the level of concentration, and consequently the size of the enterprises, at least in the large size class.

Segmentation

Segmentation, or the division of a market into distinct groups of buyers on the basis of needs, characteristics or behaviour, is mainly driven by the **environmental regulations**, creating new segments of customers and downstream industries to focus on. In addition, segmentation is closely related to the increasing level of eco-innovation, making it possible to broaden the global market and to enter into new submarkets. Besides, changes in the market organization and increased global competition enhance segmentation.

In the recycling industry, a tendency of deliverance to fiercely growing non-EU markets (e.g. BRIC countries) is taking place (geographic segmentation). However, the process of de-industrialization in Europe and increased energy costs, stimulate European recycling companies not only to shift their consumer-focus outside Europe, but also urges them to move their business towards emerging countries with lower energy costs and a better legislative framework. This is putting serious pressure on the competitive position of the European recycling industry.

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[59] Sutton (1991) predicts a positive lower bound to concentration, as market goes to infinity, for industries with high level of investments in R&D (endogenous sunk cost industries), such as the banking industry, but a lower bound of zero for sectors characterized by low investments in R&D (exogenous sunk cost industries), such as the sugar industry.

Level of specialization

The increased ecological awareness and the maintenance of green culture are important drivers of specialization as a reaction to the **fiercer global competition**, especially from producers in low-wage countries. Differentiation can allow EU producers to remain profitable. However, a prerequisite for profitability of high levels of specialization is the protection of a company's innovative investment which might imply the enforcement of the **IPR-legislation**. Thus, an evolution regarding the extent to which organizations can safeguard their advantages or can appeal to these protection measures also has an impact on the level of specialization.

The **environmental regulations** also stimulate specialization in an indirect way. These regulations have increased the need for knowledge development and research. In addition, the increasing trend of **eco-innovation** and improved technologies automatically lead to higher specialization levels.

Further, specialisation is very much influenced by the **availability of inputs** in the region. In the recycling industry, for example, the OECD countries have much more facilities available for aluminium recycling than other regions in the world. And labour intensive segments (such as the sorting of cloths segment in the recycling industry) are typically found in low labour cost countries/regions.

INPUTS

Labour

The **technical evolutions**, **eco-innovation**, **globalisation** and **demographic change** (including ageing and migration) have altered the required labour skills: there is an increased need for new skills and a higher skill-level. Furthermore, some of the existing skills will become obsolete. A subsector where the altered skill-level is of particular importance is the eco-construction industry. At the moment, most builders cannot apply the sustainable building techniques in a proper way, which is nevertheless crucial to get an eco-efficient result. In addition, a shift from sequential tasking to an interactive 'building team' that closely collaborates and works in parallel forces the organisational structure to change.

This expected shortage of skilled employees is fortified by the relatively **inflexible EU labour market**. In the environmental technologies industry, for example, the absence of an open global market for the attraction of non-EU people is putting serious pressure on the competitive position of the European companies.

Educating and training of the current labour force, and a revision of the relatively inflexible labour market regulations are required to remain competitive.

Capital

The relative importance of capital in the production process differs per subsector. Some of the eco-industries, such as water treatment and supply and parts of the recycling and solid waste sub-sectors, are very **capital intensive**, with high sunk costs and large plant sizes. The increased importance of **innovation** and the necessity to adapt the production process and organization to evolutions in the field of **technology** in order to stay competitive in a further internationalizing industry have a positive influence on the need for capital.

Access to finance is a crucial factor for a sector or industry to obtain capital. The extent to which access to finance is an issue differs per subsector. In the recycling industry, for example, access to finance for innovation is not a real barrier to the sector's development. The main problem in this subsector is the fact that collaboration to get the necessary funds is absent.

On the contrary, in the environmental technologies industry investments are often considered to be riskier than other technology investments. These perceived risks have an obstructing influence on capital injections. Besides subsector, also the size of the enterprise matters as regards access to finance. Venture capitalists that are active in the market mainly focus on larger companies and projects. SMEs, however, have to rely on traditional local banks for their funding, which are mostly rather risk-averse and not specialised enough in the technological specifications of eco-industry projects to fully evaluate the risks involved. Furthermore, also the low rate of return, the long pay back periods, the high level of uncertainty, and the recent **financial crisis** have a decreasing impact on the level of funding-availability.

Thus, in the future, it will be of extreme importance to create an attractive climate for investment in order to persuade new investors, such as the introduction of more sector specific standards and codes of conduct which has already increased the **confidence** for **bankers and businesses** to invest in innovative products and services.

Intermediate goods & services

Evolutions with regard to **innovation and technology** affect the need and use of intermediate goods and services. The supply of intermediate goods, however, will also be hampered by the current **economic crisis**.

Knowledge & technology

Innovation plays a key role in the context of connecting sustainability and economic growth, since it is the very mechanism that potentially enables the prevention or reduction of environmental risk, pollution and other negative impacts of resources use, without slowing down economic activity. **Climate change**, **limits to resources** and **global competition** are key drivers of eco-innovation. These are also identified in the study by Reid and Miedzinski (2008).

High costs of innovation activity, the lack of appropriate **sources of finance** and **economic risk** perception are identified as important barriers to eco-innovation, which is also confirmed by the Community Innovation Surveys (CIS). Another issue of topical interest that is hampering innovation is the current financial crisis. In the waste management industry, for example, FEAD members find it harder to obtain the necessary funding for new innovative projects.

The impact of European environmenta**l regulations and technological standards on** innovation and knowledge development is less clear-cut. It is mainly considered to be positive and stimulating. However, they might also have a hampering effect on innovation and take away the required flexibility to deploy new technologies. Non EU countries, where the EU environmental regulations are not in force, might make up arrears vis-à-vis their European competitors in the longer term in the field of innovation, because they can experiment more freely.

8.3.3 Conclusion

In this section, we summarize the most important lessons learnt from the competitiveness grid, with specific attention to some important topics.

Environmental change

Climate change and related regulations are an important driver for the demand eco-industries. Also the increased ecological awareness of consumers and the increased cost-efficiency awareness of producers provide a positive momentum for the further development of the EU eco-industries.

Addressing environmental pollution and climate change problems has been a major concern for both policy makers in the EU. In order to tackle the major environmental challenges, a range of policies and legislative measure have been introduced to address these concerns.

Consumers consider environmental issues to be of high priority, meaning they are more likely to adopt eco-technologies (e.g. hybrid cars, eco-construction) and pay higher prices for e.g. ‘green energy’. However, it has to be indicated that the current crisis might dampen the potential effects, putting relatively more emphasis on budgetary and financial aspects than environmental.

Finally, the increased interest in the sustainable use of resources, in combination with the diminishing supply of raw materials, some important up- and downstream industries are more and more interested in applying sustainable management and exploring potential green opportunities.

Eco-innovation and access to finance

The importance of innovation for the EU eco-industries is mentioned several times throughout this report and it is one of the most important comparative advantages vis-à-vis competitors from the rest of the world. However, it is important to stay vigilant and forward-looking, because some countries are catching up, and in certain sub-sectors such as bio-fuels and photovoltaic cells the BRIC countries are in the lead.

Eco-innovation and access to finance are closely linked to each other. Considering the high perceived risks of investments in several of the eco-industry sub-sectors, and the unfamiliarity of traditional banks with these sectors, access to finance is one of the major barriers to innovation for some sub-sectors, e.g. environmental technologies, renewable energy development.

SMEs

As SMEs play an important role in industry, especially in the new "regulation driven" market, their potential should be used to the full. Therefore, policy intervention is important to stimulate and support SMEs to maximally use their entrepreneurship capabilities in developing their organisation and thus the industry a whole. The competitiveness grid helped identifying these conditions that have a particularly strong impact on SMEs. In what follows, we describe these conditions that have to be taken into consideration.

First of all, SMEs are more sensitive to limited access to finance. Although there are venture capitalists active in the market, they mainly focus on the larger SMEs and the larger projects, leaving most SMEs reliant on traditional local banks for their funding. However, the latter are not specialised enough in the technological specifications of innovation projects in eco-industries to be able to fully evaluate the risks involved. Moreover, traditional banks mostly have a rather risk averse profile. Especially for larger projects involving large investments (often already in the demonstration phase), it is difficult to find enough financial means. Since SMEs have only limited resources, large investments in new developments are often not feasible and access to finance is more difficult because of limited guarantees.

This leads us to a second issue regarding their small scale of operations. Their limited size often puts an extra burden on their internal organization. SMEs often lack the scale needed to introduce new technologies and do the necessary organizational changes. They also frequently do not have the market expertise and resources to offer innovative products and solutions outside of their home markets. Consequently, internationalization prospects are more limited and their competitive position is threatened more by increased global competition. Also the differences in language and culture are an important barrier for SMEs to collaborate internationally. In international collaborations (e.g. for innovation projects) it demands a lot of extra effort and time to discuss differences across countries and find solutions that are of mutual interest. Also the many 'informal' barriers that still exist in the market are particularly important for SMEs. Finally, SMEs do not have the organisational capacity to deal with complex labour market regulations, differing across countries. As a consequence, they refrain more often from attracting the required (especially highly-skilled) workforce.

Therefore, the creation of an environment in which collaboration and consolidation are promoted, and in which SMEs have the potential to grow, attaining the required minimal scale to survive, will determine the dynamism and competitiveness of the sector in the years to come.

Single market functioning

One of the major disadvantages the EU eco-industry has to deal with (especially some of its sub sectors such as air pollution control and recycling), is the absence of a functioning single European market. Policy initiatives should therefore focus on the harmonization of some of the framework conditions in order to tackle this problem.

First of all, the regulation and harmonization of existing standards and certifications and the introduction of new standards will play an important role in order to establish a more even playing field on which companies can develop business opportunities and co-operate.

In addition, the lack of a uniform implementation and enforcement of regulations and directives at the level of the Member States create an uncertain and non-transparent business environment, obstructing investments, further internationalisation and growth of the industry.

There is also still no single labour market in Europe. Although the barriers to the mobility of people within Europe have been largely overcome, labour market regulation remains very complex across countries. Providing specialised educating and training of the current labour force and a revision and further progress towards a higher level of harmonization of the labour market regulations are required to maintain a competitive position.

9 EU eco-industry outlook and suggestions for an industrial policy

9.1 Introduction

The goal of this chapter is to provide an outlook for the EU eco-industries over the medium to long term and to identify the critical competitiveness factors. Based on these, potential policy actions are suggested along with actions which can be done by the industry.

From a policy perspective, one of the first logical questions to be asked is: Why should one intervene? The next section provides a base for answering this question. It presents the dynamic SWOT analysis of the EU eco-industry as a whole, focussing on insights from the particular sub-sectors that have been identified as core sectors at the onset of the study: air pollution control, recycling, environmental technology – equipment providers, and renewable energy. The interaction with the connected industries will be discussed as well, in particular sustainable construction.

Subsequently, we turn to what should be done and how. Therefore the last section provides a number of suggestions for policy actions and potential sector initiatives. These will be discussed first in terms of the EU eco-industry as a whole, and then for the sub-sectors.

9.2 Dynamic SWOT of the EU eco-industry and the relation with the connected industries

On the base of the various sub-sectors of the EU eco-industry, which have been described in detail in the Final Report – Part 2, a dynamic SWOT for the core EU industry has been made. Where relevant also the EU eco-construction industry has been incorporated as an important connected industry; finally we also consider the various connected sectors identified in the study.

Table 9.1 Dynamic SWOT analysis of the EU eco-industry

Strengths	Weaknesses
• **Policy environment**: eco-industries are at the "front line" in reducing GHG and combating climate change. Overall the policy environment for sectors such as RES, eco-construction and clean air technologies amongst others is positive; • **Consumer awareness**: citizens are becoming increasingly aware about the impact of their actions and behaviour on the environment, which has positive repercussions for the eco-industry, increasing demand for goods and services from the industry; • **Technological advancements**: EU manufacturers are able to provide increasingly advanced technological goods and services; European eco-solutions are often tailor-made and client-focussed; • Strong environmental values, **European leadership** on climate change and corporate social responsibility reinforces the impetus for cleaner production methods and is another driver of the growth of the eco-industry; • The eco-industry evolves as the situation dictates, i.e. it is a dynamic industry that **adapts** according to the changing political and economic environment.	• **Policy environment**: In some sectors, there is a lack of knowledge regarding foreign market developments. In addition, there is a lack of integration of various policy directives, e.g. air pollution control policies and measures are not utilizing all the potential synergies that exist with climate policies and instruments; • Different degrees of **implementation** of EU directives within the various EU countries; within certain sectors there is also different regulation across EU countries; • **Capital**: capital is especially hard for SMEs to come by, also due to the effects of the financial crisis; • **Labour market** : the lack of a skilled work force is an important issue in a lot of eco-industry sectors; training and education also takes time to carry out and implement before discernible results are achieved; • **Demand** in some eco sub-sectors is driven by a "minimum-required to-achieve-norm": investment in eco-technology for example is limited to the bare minimum required to conform with legislation; • Most sectors still do not enjoy **economies of scale** in the eco-industry. This is also due to the various levels of implementation of EU directives, and the lack of harmonisation across Member States that hampers scale benefits and a fully functioning internal market

Opportunities	Threats
• **Policy-making:** harmonization of national implementation, and removing regulatory barriers between the various EU Member States, harmonized standards; • **Increased global demand**: this may come about as climate policies integrated with clean-air policy becomes more concrete; increased demand from BRIC and developing countries • **Catching up of the New Member States provides** additional investment and business opportunities to the EU eco-industry • **Technology and innovation:** European eco-industrial companies generally spend a high	• **Labour skills**: adequate knowledge transfer and a focus on skills development are crucial to stay ahead of non-EU countries; both technically as well as in terms of bringing environmental solutions to the market; • **Strong international competition** is likely to intensify as BRIC economies in particular grow at relatively fast rates; • **Lack of political will** to tackle cross cutting policy issues may have adverse effects on the sector; e.g. internal market and PPP • **Absence of a global level playing field** in terms of eco-labels, verification schemes,

share of turnover on research and development, which has the potential to deliver innovative product designs and services making the sector more competitive; further cooperation between research institutes (e.g. universities) and the business community and R&D departments of market players • **Further EU leadership** on issues such as climate change and environmental protection will enhance the credibility of the sector, and provide investor's perspective • **New business models leading to an improvement of cost efficiency** in industry and services (buildings) through integration of eco-solutions such as renewable energy and pollution control, leading to better international competitiveness • **Widening of the scope of eco-applications** in production processes, allowing both eco industries and other industries to tap into the green market, e.g. ICT software, hybrid cars, sustainable building, energy recovery, use of recyclates etc.	standards, trade regimes (barriers) • Long-term **technological change** in other markets may render some eco-industrial processes obsolete if such changes are not foreseen. For example, the introduction of electric cars may have adverse impacts on particulate filter technology companies, process integrated pollution prevention techniques reduce the need for specific clean-air technology; • **Lack of internal market** and dominance of local and MS regulations that differ substantially • **Application of environmental technical solutions that are not cost effective,** especially when driven by regulation • **Commodity and oil price bust, renewables and recycling** become less attractive to invest in; • **Prolonged economic crisis,** more stringent access to finance, reduced willingness to pay and reduction in private R&D funding • **Global over supply in specific sub-sectors (photovoltaic cells)** as a consequence of subsidy programmes and emergence of new players

A number of key aspects can be identified that are important as a base for further development of an overall industrial policy for eco-industries. Starting from the general to the more specific, the following parts highlight a number of issues.

Flexibility and leadership: One of the critical factors that determine competitiveness of the industry is the ability of European companies to alter their processes and products according to a changing technological and economical environment. Innovation is usually highest where there is a limiting factor in the production process, and in the case of the EU eco-industry, the kind of factors that may lead to innovation and increased competitiveness which have been reported by a number of sources is the setting of clear standards for environmental quality in general. Maintaining a clear leadership role by the EU and Member States encourages innovative production processes as the market looks at how best to fill in these quality standards. The ability of EU companies in the sector to strengthen their market power is also an important aspect to maintaining competitiveness, while wider aspects such as the sectoral system of innovation (the value chain), and macro-economic factors such as price stability also play an important role.

Value creation along the value chain: Chapter 7 documented the highly interrelated nature of the eco-industries and the possibilities for value creation. Eco-construction serves as an excellent example. A characteristic of the eco-construction sector is the high level of integration with other eco-industry sectors. The sector addresses issues related to modern housing requirements and resource efficiency, especially material resources, energy and water. Development is usually *designed* to be as affordable as possible by reducing building and running costs through the use of relatively easily buildable technology, and providing a highly-insulated building. However, the average consumer tends not to want to pay extra for materials and construction methods that may well be sustainable or environmentally friendly, but under budgetary restrictions are considered as too expensive. The strategic focus of the eco-construction sector is geared towards helping construct buildings with low emissions and energy efficient processes that in the long-term are key elements to making the sector competitive, especially as clients will be obliged to integrate eco-construction methods into their building processes when stricter legislation on energy efficient buildings continues into the future.

The single market and globalisation: The outlook for the eco-industry as a whole in Europe is most likely to be determined firstly by the external conditions in competing regions in the world, and secondly, but therefore not less important, by the development of the European single market. In addition the entrepreneurial talent to spot and valorise eco-opportunities is crucial. The further integration of the eco-industry across Member States will be conducive to exploiting larger market opportunities and achieving economies of scale. The driving mechanism behind the growth of the industry is a strong single European home market, partly reliant on maintaining strong policies to aid the transformation to a low-carbon economy. This is critical as climate change policies will be mainstreamed across various eco-industrial sub-sectors, which provides opportunities to create synergies between hitherto separate initiatives and policy drives. A good example is the clean air technology sector, which has achieved many successes, but can be further integrated into the process of mitigating climate change.. Economies of scale and a strong home market will also further enhance the EU's global competitiveness, as it faces competition from large players such as the US and Japan and emerging powerhouses such as India and China in particular.

Skills: A commonality that has been identified between the various eco-industrial sub-sectors is the need to make sure that there are enough skills amongst the workforce and management. There are many reports from industry leaders and researchers indicating that a lack of skills is a major barrier for the eco-industry. European organisations such as Cedefop are currently mapping the gaps in skills amongst the various sectors. Not only technology skills are crucial, also the know-how of bringing new eco-innovations to the market is a need that is ever more pertinent.

Access to finance: Some of the eco-industry sectors are highly capital-intensive, in which sunk costs are high and plant sizes usually quite large, e.g. sectors such as water treatment and supply, parts of the recycling and solid waste sub-sectors and suppliers of renewable energy. For these sectors it is important that capital maintenance and capital improvements can be financed easily. Consolidation is one way to achieve a larger size and access to capital, and should give these larger companies a competitive edge over external competitors. However, the ongoing financial crisis and postponement of investments to finance capital purchases will have a negative effect on competitiveness in the medium term. This is also due to the lower dynamism of the (sub-)sectors as entry into the market is made more difficult, and hence competition is reduced. For example, often new investments in air pollution control, mostly in the New Member States, are hindered by the inability to finance these projects. Incentives such as subsidies or cheap loans could help implement such projects which are not always a priority in infrastructure development or environmental protection policies and programmes. Developing the capacity for SMEs to access capital is also extremely important for the long-term dynamism of the industry, as it is often small firms that bring innovative ideas and new concepts to the market, but that require adequate funding to scale their operations up. Public funding for environmental protection and development of environmentally friendly alternatives has increased substantially in recent years, partially as a result of increased environmental taxes. This is a positive development and has helped alleviate environmental pollution and counter the lack of private funding that that has resulted from the smaller flow of credit from the banking system.

Policy coherence: Competitiveness factors affecting eco-industries are similar to those affecting their connected industries, although what may be positive for one (e.g. stricter regulation) could be perceived as a cost factor to the other. As eco-industries are essentially dependent on their connected industries, both in terms of reliability of supply (e.g. recycling) and expansion of their markets, environmental regulation that pushes conventional industries out, will ultimately also affect eco-industries.

In this respect it is worth noting that the evidence is growing of an increasing application of eco-industry products and services which in the mid to long term improves the competitiveness of the conventional industries both inside the EU market as well as on a global scale. Well known advantages are energy and resource efficiency, yet also providing the technical and business wise opportunity of accessing the 'green segment' in one's own market are important.

Policy coherence requires a common vision and close coordination between the EU and member states levels, as well as between the different Directorates of the EC. Moving towards a green and low carbon emissions economy requires an EU strategy that incorporates environmental, enterprise, trade and employment aspects. The Lisbon Agenda provides a framework and starting point for this; the next step would be serious commitment at all levels to implementing this agenda.

Financial crisis: The current financial crisis is likely to have some longer term effects on several connected industries, both in terms of capacity reduction, strategic focus and consolidation. The former may affect eco-industries negatively, but our expectation is that the latter will prove to be more important in the mid to long term. While most eco-sub-sectors experienced a decrease in sales at the end of 2008 and first half of 2009, some sub-sectors such as recycling, started to show a stabilisation and even a gradual recovery in the second half of 2009. The strategic re-orientation is evident in two ways. First, the crisis encouraged client industries to further integrate eco-concepts into their business models in order to capture new business opportunities that lay ahead. Notable examples of this are the car manufacturers, the paper industry and the sustainable building sector. Second, a number of companies that were hit particularly hard, out of sheer necessity put short-term survival above long-term strategy and reduced not just their workforce but also in e.g. expenditures on R&D, ICT projects, and innovation activities. SMEs are particularly prone to be in this category since they tend to depend relatively more on bank financing. As a consequence a number of R&D and innovation projects have not reached the demonstration phase or market initialisation. It might be expected that in certain sub-sectors such as renewable energy, the large cash rich incumbents will buy up cash strapped SMEs in a move towards further integration and control over technology and consolidation of the market.

Energy and resource efficiency: Energy efficiency will remain an issue for most connected industries and globally the demand for renewables has therefore increased, to a point where some have become commercially viable alternatives to fossil fuels. Although the pace at which renewable energy production techniques are integrated in other sectors' business operations is co-determined by the price evolution of commodities, gas and oil, it is expected that in the longer term the demand has a positive trend. Although it has to be added that we recognise that significant technological progress still would need to be made in terms of the reliability of supply of renewables for some customer sectors, such as smart grids.

Connected industries: Key strengths of connected industries in our view lie in their relative technologically advanced levels as well as the fact that earlier than in other countries and regions 'green business' has become more prominent and is increasingly seen as a core thrust of company strategies. For some industries, such as the automotives sector, 'going green' has almost become an essential strategy for survival. This bodes well for further synergy between eco- and conventional industries and integration of the supply chains in which they operate. Similarly, fostering research partnerships and participatory approaches and combined governmental and industrial initiatives to improve sustainability and innovation and to connect the eco-industry research science with principal industrial applications are recommended. The need to stimulate research and development, especially eco-industries active in the field of air pollution control require support for their Research and Development (R&D) programmes. In this respect the potential of eco-industry clusters should also be highlighted. Identification of emerging clusters and best practice examples of existing clusters could provide valuable insights into initiatives (private, public or PPP) to enhance and facilitate such cluster development.

New Member States: Our analysis showed evidence of a catching-up of the New Member States in eco activities. Not only the innovation expenditure as a percentage of GDP in the water supply and recycling sector, but also a strong revealed comparative advantage in the goods trade certain sub-sectors such as air pollution control, hydro power and photovoltaic cells are important indicators in this respect. Undoubtedly the adoption of and compliance with the EU policy and directives played an important role. Within the EU the New Member States are considered as an important potential growth market, which could further enhance economies of scale within the EU if integrated properly.

9.3 Suggestions for an industrial policy and potential sector initiatives

Given the results and findings of the previous section that provide an indication of the aspects that are relevant for policy making, a number of policies and sector initiatives can be suggested. The main questions to be addressed in this section are: what can be done, by whom and how. In the following parts the main policy suggestions are introduced, first in general terms and subsequently in more detail for the sub-sectors.

9.3.1 Measuring the EU eco-industry

It has been reported regularly in this study that quantitative information about the eco-industry and its sub-sectors is limited. Trade data focus primarily on goods. Services are not covered, while exactly services are an important part of the eco-industry's activity. Eurostat's SBS follow the NACE code, which implies that only recycling (NACE 37) and waste collection and management (NACE 90.01; 90.02 and 90.03) are covered in the statistics. The 'new' eco-industries renewable energy, air pollution control and the connected eco-industry eco-construction are not identifiable as separate sectors in the NACE classifications.

The recent publication of the Eurostat handbook on data collection for environmental goods and services is very much welcomed. Yet a better identification of the relevant sub-sectors in a future version of the NACE classification will be very helpful for analysing and monitoring the EU eco-industry in the future.

9.3.2 Deepening of the Sustainable Consumption and Production and Sustainable Industrial Policy

The Sustainable Consumption and Production (SCP) and Sustainable Industrial Policy (SIP) Action Plan[60] provide a policy framework to improve the energy and environmental performance of products and to promote the uptake of these by the consumers. The framework rest on three pillars:

- smarter consumption and better products
- leaner production, and
- global markets for sustainable products.

The first pillar comprises policy initiatives such as the Eco-design Directive[61], labelling schemes[62] and public procurement. The second pillar focuses on eco-efficient production in the sense of resource efficiency, and eco-innovation. This part also includes the formulation of an industrial policy for the eco-industries and for SMEs. The third pillar addresses the promotion of sectoral approaches in international climate negotiations as part of the international climate change agreement after 2012, SIP promotion as part of a

[60] See European Commission, 2008,

[61] Directive 2005/32/EC of the European Parliament and of the Council establishing a framework for the setting of eco-design requirements for energy using products.

[62] The labelling schemes include e.g. the Energy Labelling Directive (Council Directive 92/75/EEC of 22-09-1992); the Energy Star Regulation (EC No 106/2008 of the European Parliament and of the Council of 15-01-2008 on a Community energy efficiency programme for office equipment); the Ecolabel Regulation (EC No 1980/2000 of the European Parliament and of the Council of 17-07-2000 on a revised Community eco-label reward scheme.

wider UN framework of programmes and the promotion of international trade in environmentally friendly goods and services.

It is evident that a further deepening and development of the SCP and SIP Action Plan will be beneficial for the EU eco-industry since it provides a substantial part of the solutions, goods and services that help other industries, consumers as well as authorities comply with the environmental policies and with the SCP and SIP.

Yet from industrial policy perspective it is recommended to envisage both the core and connected industries in order to avoid potential distortions between various sectors and to create a level playing field among the sectors. Practical examples are e.g. the implementation of the WEEE directive for producers of domestic equipment and the recycling industry (see box 5), or the issue of recycling versus waste incineration and bio-energy production.

Also the consistency and interaction with other policy initiatives is an important point of attention. For instance grants and support for investments in first-class water purification plants and latest technology waste management sites for regional development purposes, is of little avail if the up- and downstream activities are not included or if the delivery or collection networks are limited by local borders. It has been reported that especially for the New Member States this is a point of attention. Therefore it is advisable to promote the mutual consistency of the environmental, regional, labour, and industrial policies.

Recycling and waste management

The introduction and promotion of product life-cycle thinking in product design in manufacturing and other industries is a valuable policy action. Especially relevant for the recycling and waste management industry is the concept of 'design for recycling' and C2C. This has already been introduced in e.g. the car industry. Yet applications in other industries would bring additional sustainable economic development effects. The policy framework has already been laid down, namely the sustainable consumption and production policy. Particular actions that can be taken in this context are bringing manufacturers of products together with the recycling and waste management industries in forums and platforms, focussing on knowledge transfer and skill development.

Environmental technology providers

Generally speaking, the environmental technology providers are in favour of control and performance verification systems. Through such systems customers can evaluate new technologies on the basis of independent information and test data. While verification systems are quite common in the US and Japan, they tend to be less prevalent in the EU. Nevertheless examples in the EU do exist where both business organisations and policy makers cooperated at the EU level, e.g in air emission technology.

9.3.3 Internal market

The harmonized EU-wide implementation of regulations and standards at the Member States level is essential for creating a well functioning internal EU market for the EU eco-industry's products and services. Given the expected increase in global competition a

European home market is very important for its companies. This holds both for the eco-industry and connected industry alike. While it is felt that the necessary regulations are in place at the EU level, still marked differences exist at the level of the MS' implementation and enforcement of the environmental and other directives, particularly in terms of standards and procedures. This creates not only a cumbersome administrative burden for doing business across the Member States, but prevents many companies, especially SMEs, from benefitting from scale economies in a cost-efficient manner, reducing the home-market potential.

From this perspective EU wide standards and regulations are to be preferred compared to Member States' implementation of a directive. Yet initiatives could also be taken to bridge the information gaps between the Member States. Especially for SMEs information costs are relatively more important compared to large companies that can afford specialized personnel or departments. EU-level sector initiatives combined with government support in terms of finance and providing the appropriate conditions might be helpful in this respect. Equally important is the contribution of the national Member States and the national industry associations in providing information with respect to the particular implementation of e.g. a directive or national standard.

Due to the increased size of operations, e.g. infrastructure investments and R&D, and the increased interconnectivity and cross border nature of operations, public private partnerships (PPPs) become ever more important in the field of eco-industries. PPPs are by their very nature relatively complex in setting, involving many actors. Yet, the regulatory differences across Member States increase the costs of cross-border PPPs for large environmental projects, especially in the New Member States. This limits the opportunities for large scale eco-industry projects in the EU internal market, as well as small scale projects in border areas. EU wide regulations, standards and certification procedures promote the applicability of cross-border PPPs and therefore also to a better functioning internal market for the EU eco-industry.

Recycling

Particularly in the recycling market there is a need to establish a single market for recycled products. Not only has the varying progress in the implementation of the directives and regulations actually fragmented the EU market, also the practical implementation itself. Examples are varying VAT schemes on remanufacturing, and national bans on particular recyclates. Therefore the harmonization of the VAT schemes for remanufacturing and an EU-wide uniform regulation on the use of recyclates would be valuable policy actions.

Particularly important is the implementation of the European Waste Shipment Regulation, where it has been reported that the current implementation gives too much scope for protecting the national benefits rather than providing an adequate framework for free trade.

The adoption of clear EU wide end-of-waste criteria is another important point of action for the recycling industry, as well as for connected industries (see box 5). Currently, Member States give their own interpretation to what is to be considered waste, leading to a segmented EU waste market.

Air pollution control

It has been reported that the current implementation of the IPPC Directive differs across Member States, due to variations in regulatory systems, historical context, political priorities and attitudes and vision about environmental protection. Although in some countries the permit systems are restructured, it is a point of attention to come in the short term at similar systems all over the EU.

In this context it has also to be indicated that the field practice also varies substantially. Standardisation and accreditation such as ISO-14001, the Community eco-management and audit scheme (EMAS) are helpful instruments since a myriad of standalone norms causes excessive administrative burden. Especially the revised EMAS regulation of 02 April 2009 is a step in the good direction from this point of view.

Environmental technology providers

The EU market for environmental technology supplies is still quite fragmented due to differences across Member States in certifications, cost and ways of testing, and recognition procedures. Initiatives to streamline these across Member States are therefore helpful in promoting a single market in environmental technology goods and services and in improving the functioning of the internal market for this sub-sector.

Renewable energy

Currently the mechanisms to support the production of renewable energy vary greatly among Member States. Harmonization towards simplified, common support mechanisms and towards a common approach (rules) in subsiding R&D is desirable. This would lead to a further increase in the production and the use of renewable energy, also taking into account the sensitivities of the EU regarding its energy supply.

Eco-construction

Firms acting in this sub-sector at a European scale often have to adapt their procedure and product/service to be in line with the national legislations. Also in this sub-sector it is important to establish EU-wide standards, norms and testing procedures for eco-construction goods and services. The recently changed European Performance Building Directive for example, is a move in the good direction. Yet it still leaves ample room for national differences in energy performance assessment procedures across Member States given the variations in building stock. From single market point of view, the incorporation of an EU wide regulation on these aspects would be advisable.

9.3.4 EU-wide functional performance criteria and technical standards: the right balance

For the highly dynamic industries such as renewable energy, environmental technologies, and air pollution control, functional performance standards for the EU as a whole are to be preferred rather than technology-based standardisation. It is expected that this would reduce the variety of technological standards across Member States. Additionally it leaves also sufficient room for innovation. It has been reported by a number of stakeholders that technology based standardisation tends to limit the scope for innovation in comparison with countries where these standards do not exist. This reduces, ceteris paribus, the competitive position on the global market.

Nevertheless it is important to have a ‘common language’ in terms of technical standards across Europe, especially in the various new technological applications of the EU eco-industry. Yet the art will be to reach a sufficient level for creating a common EU-wide technology base and to avoid over-standardization that limits the scope for innovative applications.

Environmental technology providers

The environmental technology suppliers are not in favour of more standards. Standards are perceived as a necessary component for reducing uncertainties, improving confidence from customers, co-operators, up- and downstream industries and financers. Yet at the same time the industry warns that they can be too tight and can become a barrier to innovation. Functional performance criteria might be better suited than too strict technology standards. In combination with performance verification systems they have the potential to provide the necessary information to the customer, as well as risk reduction.

Eco-construction

Particularly in eco-construction the practical interpretation at Member States’ level of concepts such as ‘passive house’, ‘zero emission building’ or ‘low-energy house’ differs. The introduction of EU-wide technical standards would be helpful to create a common technological platform as a basis for business development at EU level.

Yet this standardisation should not be overdone. For instance in the area of building chemicals, it is felt that too much standardisation reduces the innovation potential and reduces the global competitiveness position. In this case functional performance criteria can be a golden midway providing the advantages of having a standard and leaving room for innovation.

9.3.5 Environmental skills and the EU labour market

The current relatively good global competitive position can only be retained if sufficient skilled labour can be attracted to the eco- and connected industries. With respect to environmental engineering and technology, skill shortages have been reported. The introduction of specific environmental technology programmes in regular education and curricula might be an important step as well as integration in lifelong learning programmes. Evidently the industries can contribute to this as well with on the job training programmes, and cooperating with schools, universities and research centres. Furthermore, with the provision of eco-technology solutions, training services can be added which provide additional business opportunities.

While in the past the focus was on eco-technical skills, e.g. bio-engineering, the need for skills in the future will be related more to the ability and knowledge to bring new environmental technologies to the market. This involves a larger degree of entrepreneurial talent. Entrepreneurship promotion policies can be very fruitful in contributing towards eco-entrepreneurship development.

Environmental technology providers
It has been reported that the lack of the necessary skills to adopt environmental technologies in other industries is a potential barrier for collaboration across the supply chain. Since there is a trend towards more integrated systems, the demand for multidisciplinary skills will increase, not only in the environmental technology industry itself, but also in the client industries. These multidisciplinary skills range from engineering to the ability to implement organisational changes in existing companies due to the implementation of new eco-technologies.

It has been reported that no particular environmental technology degrees or curricula exist in regular education systems. Furthermore, current EU labour market regulations make it relatively costly to attract high skilled people from outside the EU. Therefore it is advisable that, both in regular education and in job training and lifelong learning schemes, environmental technology gets a more systematic place and that the EU labour market will be made more open to non-EU eco-talent.

Renewable energy
Renewable energy is relatively labour intensive in the manufacturing and deployment phase, as well as in the R&D phase. Yet the operational phases typically require less labour. Therefore, from employment policy point of view, the R&D and manufacturing stages are very important. It is however, crucial that the labour force is adequately trained. The lack of specialised education and training should be remedied.

Eco-construction
Eco-construction generally requires a better trained workforce than most mainstream construction activities. Since sustainable building is a more integrated concept compared to conventional building activities, each player in the production chain needs to have a minimum understanding of the whole chain. Especially in small companies, there is frequently a lack of expertise and skilled workforce both with regard to eco-efficient construction and retrofitting. Managerial positions in eco-construction are dominated by engineers and scientists and some companies find it hard to find personnel combining entrepreneurial talent with a sufficiently deep understanding of the science and technology dimension involved in their business. Particularly the know-how for implementing the various new eco-construction technologies, e.g. the integration of renewable energy technologies, in a practical manner remains a challenge. Specialised training schemes and education programmes are advisable. Also forums for the exchange of information between research centres, businesses and technical schools contribute to the development of critical eco-construction skills.

9.3.6 Asymmetric information and platforms

It has been illustrated in previous chapters that inter-sectoral cooperation is crucial for developing new innovation opportunities as well as for making the production process more cost-efficient. Yet in many cases, given the complexity of the environmental solutions and the relative novelty of the methods and techniques, potential clients are not always aware of the potential eco-applications which might improve competitiveness. The opposite can be true as well, in the sense that opportunities for environmental goods and services in the other industries are not fully known to the actors in the eco-industry. In this respect forums across industries are important. Examples are technology platforms that connect industry, researchers and authorities, and government funded programmes such as FP7.

Environmental technology providers
One of the most important barriers that have been identified for business in the sector of environmental technology is the lack of information about the latest developments and potential of environmental technologies with business clients of other industries and consumers. It has been the experience that the cost of purchase ranks higher with customers than the overall lifetime cost and the net benefits over time. Although improvements can be observed, the lack of awareness of the overall costs of obtaining, using and disposing materials and energy is still an important barrier to the wider implementation of eco-innovations.

Additionally the absorptive capacity in the downstream industries is crucial for the successful uptake of environmental technologies. This is largely related to education and skills. Lack of absorptive capacity is a potential barrier to collaboration in the supply chain.

9.3.7 Eco-innovation and R&D policy

Technological progress and innovation in the field of environmental applications are a crucial part of the EU eco-industry's value added creation. A strong base in eco-technologies is crucial in maintaining the relatively strong competitiveness position in the global market. Examples of policy actions are the Framework Programme (FP), environmental technology platforms, as well as specific R&D grants at Member State level.

Recycling
It has been reported that R&D collaboration between companies in the recycling sector is rare. This prevents from engaging in large scale research projects, which in the longer term might lead to a reduced competitiveness. Sector initiatives combined with appropriate policy instruments that provide a vehicle to bring companies together might be helpful. Examples of the latter are the FP and technology platforms. Also research programmes that are focussed on involving SMEs are helpful, both at national and EU level. In terms of research agenda, recycling new materials and the challenges for remanufacturing is an important topic where public initiatives can be fruitful.

Air pollution control
The government support and initiatives at EU and national levels for R&D in the air pollution control sector have been well received by the sector. R&D in this sector is typically done in universities and state funded research labs, while the implementation and commercialisation is done by the companies. Beside the government support, initiatives such as long-term agreements and public private partnerships are important vehicles for knowledge transfer, and innovation.

Environmental technology providers
Environment and climate change was one of the major themes of FP7. Also in FP6 eco-innovation received ample attention. Also other sources such as Environment LIFE, Structural Funds, the Cohesion Fund, and the Competitiveness and Innovation Programme (CIP) are important policy instruments for stimulating eco-innovation. These have been appreciated well by the industry and future initiatives along these lines are welcomed.

Beside specific dedicated initiatives such as the Framework Programme, dedicated environmental oriented policies have proven to be an important driver for innovation and R&D. In this respect the further deepening of e.g. the SCP and SIP are important.

9.3.8 Access to finance and the economic crisis

The economic crisis has affected the eco-industry subsectors in different degrees. Beside the immediate effect on the cash flow and the challenge to keep the workforce, virtually all sub-sectors witnessed a pressure on the financing of innovation and R&D activities, particularly for SMEs. Getting innovations to the demonstration phase became more difficult. Providing (Member State level) credit guarantee schemes that are in line with EC competition policy has been an important instrument to help SMEs. Also the R&D support initiatives at EU and Member States' level are important instruments to keep the focus on R&D and innovation in times of crisis.

Recycling
The recycling sector has been particularly hit hard due to the collapse of the primary resources, followed by a price decrease of the recyclates, which led in turn to a deterioration of the profitability. This has limited investment ambitions in the sector substantially, especially for the SMEs, which are situated upstream of the recycling process and form a crucial part of it.

Air pollution control
Beyond the compliance with legal obligations, the air pollution control aspect of infrastructure development is quite often not considered as a priority. This is particularly felt in times of crisis, and in the New Member States. Therefore related investments might be encouraged by grants or loans at low interest rates.

Environmental technology providers
Research on financing difficulties in environmental technology applications found that these can be related to two major aspects:

1. An expectation gap between the technology developers, private investors and policy makers, and
2. A high degree of uncertainty and lack of financing between the early stage innovation phase and the commercialisation phase, potentially leading to the so-called 'valley of death'.

The latter occurs when funding for R&D projects is more readily available for basic or early-stage research (a peak) than for the intermediate stages (the valley). Finding sufficient funding for financing the demonstration phase and market introduction is, however, crucial. Since this mostly happens through corporate funding, it becomes clear that the effects of the current financial crisis will be felt particularly in the last phases of the innovation cycle. R&D funding for environmental technologies that incorporates as well the intermediate stages might therefore innovative performance of the environmental technology providers. Additionally forums and platforms help bridging the expectation gap between the various stakeholders in the field.

9.3.9 Green procurement

Green procurement has often been suggested as a means of stimulating the demand for eco-industry goods and services, as well as for providing a demonstration function. Although it is a measure that primarily impacts the eco-industry's market size, it can indeed provide a catalytic effect in further market development and in gaining business momentum, which in turn improves competitiveness. It certainly contributes to creating a home market for the EU eco-industry, provided that the procurement rules are not widely different across Member States. There have been initiatives to address these differences at EU level, e.g. within the Renewable Energy Sources Directive and through the EU Energy policy, which recognise the fact that such differences in procurement policies may reduce opportunities for increasing productivity, developing new technologies with high market potential, etc.

Recycling

The recycling industry perceives green public procurement especially as an exemplar role that over time may change attitudes towards recycling and waste management of the wider public. However the industry argues that equal procurement rules and procedures for both private and public players is an important issue for the further development of this market segment.

Environmental technology providers

The public sector largely invests in infrastructure and monitoring systems, where environmental technologies can play a major role. However, it is perceived by the environmental technology providers that the public sector is a rather 'conservative' buyer and could do more to adopt new environmental technologies. With the introduction of green procurement by public authorities a step in the right direction has been taken. However, a major information gap exists between the environmental technologies industry on the one hand and the public authorities on the other hand. Consequently the role of the public sector in the adoption of new environmental technologies has not been optimised. Technology forums, organised in co-operation of the industry and the authorities, can reduce this information gap. With respect to the internal market promotion, it is advisable to initiate these forums primarily at EU level.

Eco-construction

Even though advanced technologies and solutions are available, tested and reliable in eco-construction, still barriers remain for their broad uptake and demand is highly fragmented. 40% of demand for construction works comes from the public sector, but decision-makers are unaware of the scope within the existing legal framework for adopting innovation-oriented solutions. The introduction of life-cycle-costing (LCC) could facilitate the public procurement of eco-construction works.

9.3.10 International trade and globalisation

The EU's current position as one of the most competitive regions in eco-industries can be valorised further by promoting open markets (trade policy) and creating a level playing field worldwide. This will enable EU producers and services providers to expand their trade and investments in other markets. Among others, this requires a global comparable certification and labelling development (voluntary) within both eco- and conventional industries. Also the removal of existing trade barriers with the rest of the world allow the EU eco-industry to benefit from its relative comparative advantage.

Recycling
Beside the existing barriers in the internal market of the EU (see 9.3.3) substantial trade barriers still exist for trade of recycled materials on the global market. Since the value chain of the EU recycling industry becomes more global, due to de-industrialisation and a move outside Europe of manufacturing plants, trade barriers become an ever more hindrance of competitiveness at the global scale.

Air pollution control
In terms of global competitiveness our analysis showed a leading position of the EU in air pollution control, although it became under pressure from Japan and Brazil. It is however crucial to provide the appropriate international trade conditions for the EU air pollution industry to turn its relative comparative advantage into market share. Given the international climate change challenges, a move towards a more level global playing field clearly improves the opportunities for the EU air pollution control business.

Renewable energy
Removing trade and investment barriers between countries with significant renewable resources would provide a substantial drive to various segments of the renewable energy sector in which the EU has a strong competitive position, e.g. wind energy and solar thermal energy production.

Box 4 Leakage problem and the WEEE-Directive

According to the definition in the Official Journal of the European Union, the purpose of the WEEE Directive (Dir 2002/96/EC) is, "as a first priority, the prevention of waste electrical and electronic equipment (WEEE), and in addition, the reuse, recycling and other forms of recovery of such wastes so as to reduce the disposal of waste. It also seeks to improve the environmental performance of all operators involved in the life cycle of electrical and electronic equipment, e.g. producers, distributors and consumers and in particular those operators directly involved in the treatment of waste electrical and electronic equipment".

Concerning this directive, CECED (Conseil Européen de la Construction d'appareils Domestiques – European Committee of Manufacturers of Domestic equipment) highlighted and documented the so called leakage problem.

While the WEEE directive puts the responsibility and cost of treating WEEE with the producers, the collection and treatment are not entirely within their control. For, they do not have the enforcement power to make consumers hand in end-of-life products. Given the potential value of used WEEE, scrap dealers, municipal waste collectors, recyclers and other operators on the waste treatment market, are equally involved. Yet these operators are not subject to the directive, and consequently do not bear its compliance costs.

Furthermore, the producers of domestic equipment tend to end up with the low value WEEE, since higher value WEEE goes primarily through other operators. This implies that in times that the WEEE has a high price, this waste is treated through the other channels, and the producers end up only with small amounts and vice-versa. Consequently in times of high WEEE prices, the domestic equipment manufacturers do not have the volumes to benefit from the price increases. While in times of low WEEE value, producers are faced with large stocks of WEEE with little or no market value. The same reasoning can be made on the product level: the producers receive mostly the products with low or negative value, while the higher value products end up elsewhere in the waste treatment cycle.

A related issue is that there is no clear cut definition of end of product life. Old appliances can be reused or exported to third countries, thereby introducing products with lower energy standards, and therefore from global environmental point of view sub-optimal. In this respect the definition of waste is important and its implications for free waste trade.
A synchronization of the end of waste directive and the WEEE directive is therefore advisable. It would help creating a level playing for the various players in the internal EU waste and recycling market. CECED advices to make all players on the WEEE market subject to the directive.

10 Bibliography

AEA (2008), http://www.aea.be/areas/priorities/environment/index.html

Berger, Roland (2007) Elements of a European Ecological Industry Policy. Working Paper to the Informal Meeting of Environment Ministers in Essen.

Businessweek.com (2008), Is Carbon Capture and Storage the Fix? 11 November 2008 http://www.businessweek.com/globalbiz/content/nov2008/gb20081111_820595.htm

Biofuels Research Advisory Council (2006), Biofuels in the European Union, A vision for 2030 and beyond

BMU (2007) GreenTech made in Germany. Umwelttechnologie-Atlas für Deutschland, Berlin.

CALM-network (2004), Research for a quieter Europe in 2020 (http://www.calm-network.com/bluebook/content/pdfs/sp2004.pdf)

Capros P., Mantzos L., Papandreou V., Tasios N., Mantzaras A., (2005) Energy systems analysis of CCS technology, Primes Model Scenarios

CleanEdge (2009), Clean energy trends 2009

DTI and DEFRA (2006) Bridging the gap between environmental necessity and economic opportunity, Environmental Innovation, First Report of the Environmental Innovations Advisory Group, London

ECORYS (2008a), Environment and labour force skills, Overview of the links between the skills profile of the labour force and environmental factors, final report on behalf of European Commission DG Environment, Rotterdam, 9 December 2008, 77pp. http://ec.europa.eu/social/BlobServlet?docId=2637&langId=en

ECORYS (2008b), Study on Industrial Policy and Services Within the Framework Contract of Sectoral Competitiveness Studies – ENTR/06/054

Ecotec (2002), Analysis of the EU eco-industries, their employment and export potential, report for the European Commission DG Environment, 103 pp.

ECTP, European construction Technology Platform (2005), Challenging and changing Europe's built environment

EGEC, European Geothermal Energy Council (2008); Research agenda for geothermal energy, Strategy 2008 to 2030.

EREC (2008) Renewable Energy Technology Roadmap: 20% by 2020, Brussels. http://www.erec.org/fileadmin/erec_docs/Documents/Publications/Renewable_Energy_Technology_Roadmap.pdf

Ernst & Young (2006) Eco-industry, its size, employment, perspectives and barriers to growth in an enlarged EU, Brussels.

ESTIF, European Solar Thermal Industry Federation (2007) Action Plan for Europe Heating & Cooling from the Sun

EU-OEA, European Ocean Energy Association (2009) http://www.eu-oea.com/index.asp?sid=74

Eurobserv'ER (2008) The state of renewable energies in Europe (8th Eurobserv'ER report) http://www.eurobserv-er.org/pdf/barobilan8.pdf

European Commission – Eurostat (2009) Data Collection Handbook on Environmental Goods and Services Sector, Final Draft, Eurostat Unit E3 – Environment Statistics, March 2009, ENV/EXP/WG/07 (2009), 201 pp.

European Commission, 2008, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan, Brussels, 16.07.2008, COM(2008) 397 final, 12 pp. http://ec.europa.eu/environment/eussd/pdf/com_2008_397.pdf

European commission DG Research (2006) The state and prospects of European Energy Research, Comparison of Commission, Member and Non-Member States R&D portfolios

Frondel, M., Horbach, J., Rennings, K. (2007) End-of-pipe or cleaner production – An empirical comparison of environmental innovation decisions across OECD countries, in: Johnstone, N. (Ed.): Environmental Policy and Corporate behaviour. Cheltenham, Northampton, pp. 174-212.

Fuji-Keizai USA, Inc. (2008) Clean-Tech: Current status and worldwide outlook

GHK, Cambridge Econometrics, IEEP (2007) Links between the environment, economy and jobs, London.

Huisjes E., Colombel K. and Lesjean B. (2009) The European MBR Market: specificities and future trends, conference proceedings MBR-Network workshop Berlin 2009

International Energy Agency (2008) Harnessing the Power of the Oceans - An IEA OPEN Energy Technology Bulletin 1 Article by Gouri S.Bhuyan, Issue No. 52, July 2008

Köppl, A. (2006) The Austrian Environmental Industry: Summary of Results, Vienna.

MBR-network (2009), http://www.mbr-network.eu/mbr-projects/index.php

McDonough , W. and Braungart, M. .(2002) *Cradle to Cradle: Remaking the Way we Make Things.* New York: North Point Press.

PV-TRAC (2005) A Vision for Photovoltaic Technology: Report by the Photovoltaic Technology Research Advisory Council

OECD (2004) Environment and Employment: An Assessment

OECD (2000) OECD Seminar Social and Environment Interface, PROCEEDINGS, Paris, 178 pp, http://www.oecd.org/dataoecd/51/15/33848718.pdf

UN (2006) World Water Development Report

VITO (2009), expert consultation

WIFO (2006) Eco-industries: Scoping paper

WSSTP, Water supply and sanitation technology platform (2005), Water: safe, strong and sustainable. European vision for water supply and sanitation in 2030

WSSTP, Water supply and sanitation technology platform (2006), Strategic research agenda. Water Research – A necessary investment in our common future.

WWEA World Wind Energy Association (2009), World Wind Energy Report 2008

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13 Annex I: Methodological clarifications to chapter 5

13.1 The size of the EU eco-industry in terms of turnover

With respect to the estimation of the size of the EU eco-industry, it has been the goal to be consistent with the existing studies in the field, most notably the Ernst & Young (2006) report, which builds further on the methodology that was developed earlier by Ecotec (2002). Therefore we have applied the same methodology as documented ini Ernst &Young (2006) An attempt has been made to come to the same result as E&Y (2006) for comparable years. Subsequently on the base of the same methodology estimations for 2008 were made. In this section it is shortly explained what has been done.

In order to measure the EU eco-industry several issues need to be resolved. First of all, it's important to define the Eco-industry. Furthermore, it should be clear what should be measured and for which countries it should be measured. We used the same definition as E&Y (2006), Ecotec (2002) and Eurostat, which was used as a basic database for E&Y. In this definition several environmental domains are captured, shown in table 1.1. However, the names used for the several environmental domains differ between these studies. Moreover, the environmental domains "General Administration" and "Environmental management (private)" both belong to the category "Others", which is virtually impossible to distinguish, given the available data and are therefore grouped to "Others". Also for clarification purposes, shorter names are given as well.

Table 1.1 Environmental terminology across studies: correspondence				
#	**Eurostat / Ecotec (2002)**	**E&Y (2006)**	**This study**	**Remarks**
1	Air	Air Pollution Control	Air	
2	Waste water	Wastewater Treatment	Wastewater	
3	Waste	Solid Waste Management	Waste	
4	Soil and groundwater	Remediation & Clean Up	Soil	
5	Noise	Noise & Vibration	Noise	
6a	Others*	General Administration	Others	
6b		Environmental Management (private)	Others	
7	Water Supply	Water Supply	Water Supply	NACE codes 41 (1999, ECOTEC p41)
8	Recycled materials	Recycled materials	Recycling	NACE codes 37 (1999, ECOTEC p41)
9	Renewable Energy	Renewable Energy	Energy	ECOTEC study p 49 year 1999
10	Biodiversity and Landscape	Nature Protection	Biodiversity	

*General Administration and Environmental Management (private) both belongs to Others

Normally an industry can be measured by turnover, employment and trade figures. In this chapter the turnover is considered to be equal to the expenditures in the Eco-industry also called "Environmental Protection Expenditures (EPE)". The data for EPE is scattered over several industries. The Eurostat Chronos database made a division between several NACE codes, which are shown in Table 1.2. For the environmental domains "Renewable energy", "Recycled materials" and "Water supply" no data were found on EPE in the Eurostat database. For these domains data have been taken from Ecotec (2002) for the year 1999. To estimate the data for these domains in the period 2000-2008 growth rates were taken from other sources. The assumption of the growth rate of Renewable energy is taken from E&Y (2006) and is 20% per year. For Recycled materials and Water supply the growth rates of EPE are assumed to be the same as the growth rates of the production value of the industries DN_37 and E_41 as described in Table 1.2.

Table 1.2 Industries (NACE codes)**		
NACE codes	Industry	Remarks (used for)
A_B	Agriculture, hunting, forestry and fishing	EPE
C	Mining and quarrying	EPE
D	Manufacturing	EPE
E	Electricity, gas and water supply	EPE
EP_OTH	Other business sectors (excluding producers of environmental services)	EPE
EP_PRIV_PUB	Private and public specialised producers of EP services	EPE
EP_PUB_SEC	Public sector	EPE
EP_HOUS	Households	EPE
DN_37	Recycling	production value growth rates
E_41	Collection, purification and distribution of water	production value growth rates

**The EPE of all industries has been added up for the total EPE per environmental domain and country

As aforementioned, some data are missing. To calculate/estimate these data points a linear growth is assumed. Table 1.3 shortly summaries the calculation/estimation method used for the EPE data found on Eurostat. Where reliable data was available, which showed an upward trend, a linear growth rate was calculated using the first and last available data points, which was in turn used to fill the gaps. However, for some countries and some environmental domains there was no or a decreasing trend. In this case the average was taken to fill the gaps. In the case of unreliable data with an upward trend (large differences between years) the growth rate was calculated using several data points that seem to reflect the situation most accurately (often higher data points, which indicate that data was found on more industries). In the case of unreliable data, with no or decreasing trend, the average of several data points, seem to reflect the situation most accurately.

Table 1.3 Calculation/estimation method for missing data points***

Trend\data	Reliable data	Unreliable data	
Upward trend	A linear annual growth rate was calculated using the first and last available data point. With this growth rate the data was intra- and/or extrapolated	A linear annual growth rate was calculated using 2 reliable (often highest or last) data points. With this growth rate the data was extra- and/or intrapolated	
No or decreasing trend	Average of all years were taken to fill the gaps	Average from only reliable (often highest or last) data points were taken to fill the gaps	

*** excluding recycled materials, water supply and renewable energy

For the EPE data for environmental domains which could not be found on Eurostat, data was taken from ECOTEC (2002) for 1999. Also, as mentioned earlier, the growth rate of EPE was assumed to be the same as the growth rate of the production value of the relevant industries as shown in Table 1.4.

Table 1.4 Data info for recylced materials, water supply and renewable energy (2000-2008)

Environmental domain	Source 1999 data	Source growth rate
Recycled materials	Ecotec (2002) and Eurostat for countries between EU 15 and EU 27	Growth rate of production value was taken (NACE: DN_37 and E_41 from Eurostat). The calculation/estimation method is explained in Table 1.5
Water supply		
Renewable Energy		E&Y (2006) used a growth rate of 20%

With the data found in the sources mentioned above, the growth rates of the production values of Recycled materials and Water supply are calculated in a similar way as in Table 1.3. However, the New Member States were not described in the Ecotec (2002) study. For these countries, the EPE value of 1999 is calculated using the EU27 EPE values and their share of total production value.

Table 1.5 Calculation/estimation method of recycled materials and water supply	
Countries with data	The value of 1999 multiplied with the growth rate of the production value which was calculated in a similar way as in table 1.3
Countries with no data	The difference between EU-27 and the sum of all countries with data is divided, on basis of their share in total EU27 GDP, to the countries with no data available.

13.2 The size of the EU eco-industry in terms of employment

The employment figures are calculated using the following data:

- Environmental Protection Expenditures (EPE) per environmental domain and country
- The ratio between wage + salaries costs and total costs per environmental domain and country
- The ratio between compensation of employee and total costs per environmental domain and country
- The percentage of total expenditures used on current activities and not investment (OPEX)
- The annual wage per environmental domain and country

In an attempt to calculate the employment figures in a similar way as E&Y and ECOTEC did, two trials are made both giving other results than E&Y had. In the first attempt the EPE is multiplied with the wage + salaries to total cost ratio (average around 70) divided by 100 times 100 and then divided by the annual wage. The results are higher (25%). In our second attempt the compensation of employee to total cost ratio (average around 44%) has been taken instead of wage + salaries to total cost ratio and the OPEX percentage is taken to only calculate the employment of the current expenditures and not of the investment. This attempt was lower compared to the E&Y figures (53%).

Table 1.6 Employment

Employment trial 1	[EPE * wage + salaries to total cost ratio / 100 * 1000] / wage
Employment trial 2	[EPE * compensation of employee to total cost ratio * 1000 * OPEX] / wage

13.3 The selection of companies for the micro analysis

To the degree possible, the study made use of harmonized company balance sheets and profit and loss accounts which are contained in the Amadeus and Orbis databases. The advantage of these data is that they can provide insights in company performance at a micro level, across various sectors.

The identification of the companies was initially based on three search criteria: geographical scope, type of accounts and industry code.

- Geographical scope: the EU-27 and its different Member States.
- Type of accounts: In order to make a reliable distribution of the companies over the EU27-countries, unconsolidated accounts were taken, even if there were also consolidated accounts available, in order to avoid bias towards headquarter locations.
- Industry code: to identify companies that are active in the different eco-industries activity groups, a top down approach was followed using the NACE-classification as well as a bottom-up approach using keywords. Ideally the companies can be identified on the base of the NACE classification as main activity code. Unfortunately only a limited number of environmental sub-sectors have a clearly defined NACE category. This is illustrated in the following table.

The advantage of this keyword search is that it is still possible to identify companies that are not covered by a particular NACE-code. The disadvantage is that not all companies active in a sub-sector will be found as it will depend on whether the keyword is in the trade description provided by the company. Especially for very large companies with several subdivisions an eco-industry activity can be marginal for the company as a whole (and thus not recorded in the company description), although the company may turn up as a major player in this activity area. When using company accounts, it was not possible within the scope of this study to determine to which degree a subdivision of a company contributes to the value that corresponds with e.g. turnover, added value, profit in the eco-industry activity.

Another possibility is that important players are not in the list simply because eco-industry not indicated as a main activity or the particular keyword is not in the trade description.

Table 13.1 Sub-sectors in the eco-industry, micro-economic search criteria and number of companies

Activity group	**Search criteria**	**Number of companies in 2006**
Waste water treatment	NACE 90.01 *Collection and treatment of sewage* as main activity code	5.493
Solid waste management	NACE 90.02 *Collection and treatment of other waste* as main activity code	5.315

Activity group	Search criteria	Number of companies in 2006
Soil and groundwater remediation	NACE 90.03 *Sanitation, remediation and similar activities* as main activity code	1.103
Recycled materials	NACE 37 *Recycling* as main activity code	9.716
Air pollution control	keywords 'air pollution' or 'clean air'	32
Renewable energy production	keywords 'bio fuel' or 'biomass power' or 'biomass energy' or 'biomass' or 'biogas' or 'wind power' or 'wind energy' or 'wind turbine' or 'wind farm' or 'hydro-electricity' or 'hydro-power' or 'solar power' or 'solar energy' or 'photovoltaic' or 'solar PV' or 'tidal power' or 'wave power' or 'geo-thermal power' or 'geo-thermal energy' or 'renewable energy' or 'renewable power' or 'sustainable power' or 'sustainable energy'	669
Eco-construction	keywords 'eco-construction' or 'eco-building', 'passive building', 'sustainable construction'	45
Environmental technologies	keywords 'environmental technologies'	74

A first analysis indicated that for the non-NACE sectors the sample of companies was not satisfactory and not representative. Therefore four additional sources have been used to improve the datasets significantly:

- Individual checks on company's website to control whether the company (found by keyword search) had significant activities in one of the three activity groups.
- Stakeholders' information and validation.
- Information from specialised networks.
- Membership lists from various representative organisations

Air pollution control :

- Association for Emissions Control by Catalysis's (AECC)
- Verband Deutscher Maschinen- und Anlagenbau (VDMA)

Renewable energy:

- European Wind Energy Association (EWEA)
- European Biomass Industry Association (EUBIA)
- European Biomass Association (AEBIOM)
- European Bioethanol Fuel Association (eBIO)
- European Geothermal Energy Council (EGEC)
- European Photovoltaic Industry Association (EPIA)

- European Small Hydropower Association (ESHA)
- European Ocean Energy Association (EU-OEA)
- European Renewable Energies Federation (EREF)
- European Solar Thermal Electricity Association (ESTELA)
- European Renewable Energies Centres Agency (EUREC)

Eco-contruction:
- Vlaams Instituut voor Bio-Ecologisch Bouwen en Wonen (VIBE)
- Baubook

This improved the sample of companies substantially, both in terms of number of (relevant) enterprises as in terms of representativeness of the sample.

Activity group	**Number of companies identified after refining keyword search**
Air pollution control	73
Renewable energy production	235
Eco-construction	282

For the comparison with the rest of the world it was only possible to build a reliable sample for the renewable energy sector. The member lists of the following associations were used to build the sample of 163 key companies:
- World Wind Energy Association (WWEA)
- International Hydropower Association (IHA)
- International Solar Energy Society (ISES)

14 Annex II: Methodological clarifications to chapter 6

14.1 Trade data and analysis

This analysis draws on official trade statistics ("trade code" data) provided by EUROSTAT for the period 2000 to 2007. Gaps and limitations of the available data, including e.g. lack of compatibility, and sometimes reliability of that which is available, means that it is difficult to produce an accurate analysis of the trade in environmental goods and services. To provide a more in-depth picture, we have analysed standard export and import data for a limited number of relevant trade codes similar to the earlier studies done by ECOTEC and Ernst & Young. The advantages of such an approach are that the resulting analysis is based on a comprehensive and consistent set of data for all EU Member States, both export and import data is available and it offers a complete and up-datable time series.

14.2 COMEXT Trade codes included in each sub-sector

The table below lists and describes all trade codes that are included in our analysis of trade data under the different sub-sector categories.

Table 14.1 COMEXT trade codes used for the analysis of intra-EU trade patterns

Category	Comext code	Description
Air Pollution Control	84213930	Machinery and apparatus for filtering or purifying air (excl. Such articles for civil aircraft of subheading 8421.39.10, isotope separators and intake air filters for internal combustion engines)
	84213951	Machinery and apparatus for filtering or purifying gases (other than air), by a liquid process (excl. Such articles for civil aircraft of subheading 8421.39.10 and isotope separators)
	84213955	Machinery and apparatus for filtering or purifying gases other than air, by an electrostatic process (excl. Such articles for civil aircraft of subheading no 8421.39-10 and isotope separators)
	84213971	Machinery and apparatus for filtering or purifying gases (other than air), by a catalytic process (excl. Such articles for civil aircraft of subheading 8421.39.10 and isotope separators)
	84213999	Machinery and apparatus for filtering and purifying gases other than air (excl. Those which operate using a liquid, electrostatic, catalytic or thermic process, machinery and apparatus for civil aircraft of subheading no 8421.39-10 and isotope separators)

Category	Comext code	Description
Hydropower	84101100	Hydraulic turbines and water wheels, of a power <= 1.000 kw (excl. Hydraulic power engines and motors of heading 8412)
	84101200	Hydraulic turbines and water wheels, of a power > 1.000 kw but <= 10.000 kw (excl. Hydraulic power engines and motors of heading 8412)
	84101300	Hydraulic turbines and water wheels, of a power > 10.000 kw (excl. Hydraulic power engines and motors of heading 8412)
	84109090	Parts of hydraulic turbines, water wheels incl. Regulators (excl. Of cast iron or cast steel)
Monitoring equipment	90268091	Electronic instruments or apparatus for measuring or checking variables of liquids or gases, n.e.s.
	90268099	Non-electronic instruments or apparatus for measuring or checking variables of liquids or gases, n.e.s.
	90271010	Electronic gas or smoke analysis apparatus
	90271090	Non-electronic gas or smoke analysis apparatus
	84178090	Industrial or laboratory furNACEs, including incinerators, (non-electric), (excl. 8417.10-00 to 8417.80-10)
Other Environmental Equipment	84219900	Parts of machinery and apparatus for filtering or purifying liquids or gases, n.e.s.
Photovoltaic	85414000	Light-emitting diodes, incl. Laser diodes
	85414090	Photosensitive semiconductor devices, incl. Photovoltaic cells
	85414091	Solar cells whether or not assembled in modules or made up into panels (excl. Photovoltaic generators)
Solar thermal	84191100	Instantaneous gas water heaters (excl. Boilers or water heaters for central heating)
	84191900	Instantaneous or storage water heaters, non-electric (excl. Instantaneous gas water heaters and boilers or water heaters for central heating)
Waste Disposal	84178010	FurNACEs and ovens for the incineration of rubbish, non-electric
	84179000	Parts of industrial or laboratory furNACEs, non-electric, incl. Incinerators, n.e.s.
Water Pollution Control	84137021	Submersible pumps, single-stage
	84212990	Machinery and apparatus for filtering or purifying liquids (excl. Such machinery and apparatus for civil aircraft of subheading 8421.29.10 and for water and other beverages, oil or petrol-filters for internal combustion engines and artificial kidneys)

14.3 Method of estimation for capital expenditures (CAPEX)

As some data for capital expenditures per sub-sector are missing, we have calculated/estimated these data points by assuming a linear growth or no growth depending on the data. Table 14.2 shows how the growth rates are calculated to fill the gaps for EPE data which could be found on Eurostat (all except recycled materials, water supply and renewable energy) [63]. For these missing sectors the EPE is multiplied by the ratio of CAPEX/EPE of the total eco-industry. Data for the sub-sector are found to be reliable if the data appear to be consistent. Note that for some larger counties, e.g. Germany, there are no CAPEX data at all.

Table 14.2 Method of calculation for missing data points for sectors which are defined in Eurostat

Trend/data	Data	Unreliable data
Upward trend	A linear annual growth rate was calculated using the first and last available data point.	A linear annual growth rate was calculated using 2 reliable[64] data points.
No or downward trend	Average of all years/sectors were taken	Averages from only reliable**Error! Bookmark not defined.** data points were taken.

[63] The results outlined here may differ from the results of the sub-sector approach due to differences between the data on macro and micro level. Furthermore there was no data found for Malta.

[64] Higher data points, which indicate that data was found in more industries

15 Annex III: Intra-EU trade data by country (chapter 6)

Intra-EU trade patterns are illustrated in Figure 15.1. and Figure 15.2. The top 10 importers are all EU-15 countries, with the exception of the Czech Republic; the same goes for exports with the top 10 of exporters consisting mainly of EU-15 countries, with only Estonia and the Czech Republic appearing in the list.

Figure 15.1 Intra EU Import per country 2007 (€ million)

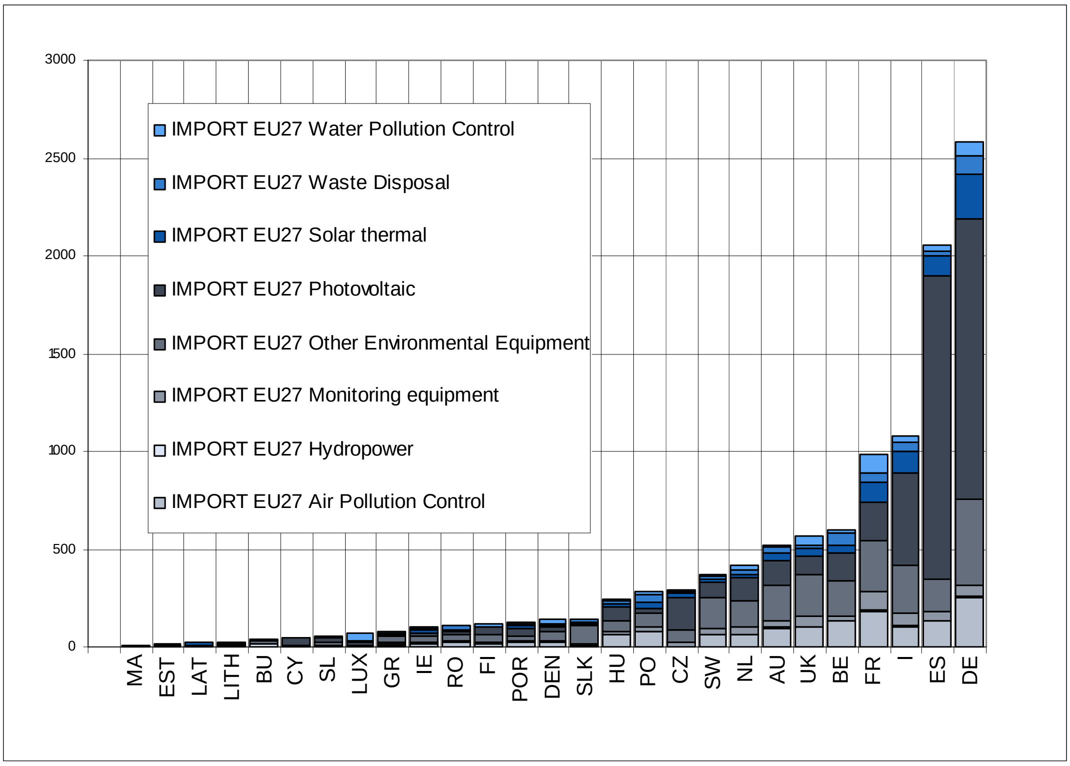


Figure 15.2 Intra EU-27Export per country 2007 (EU* million)

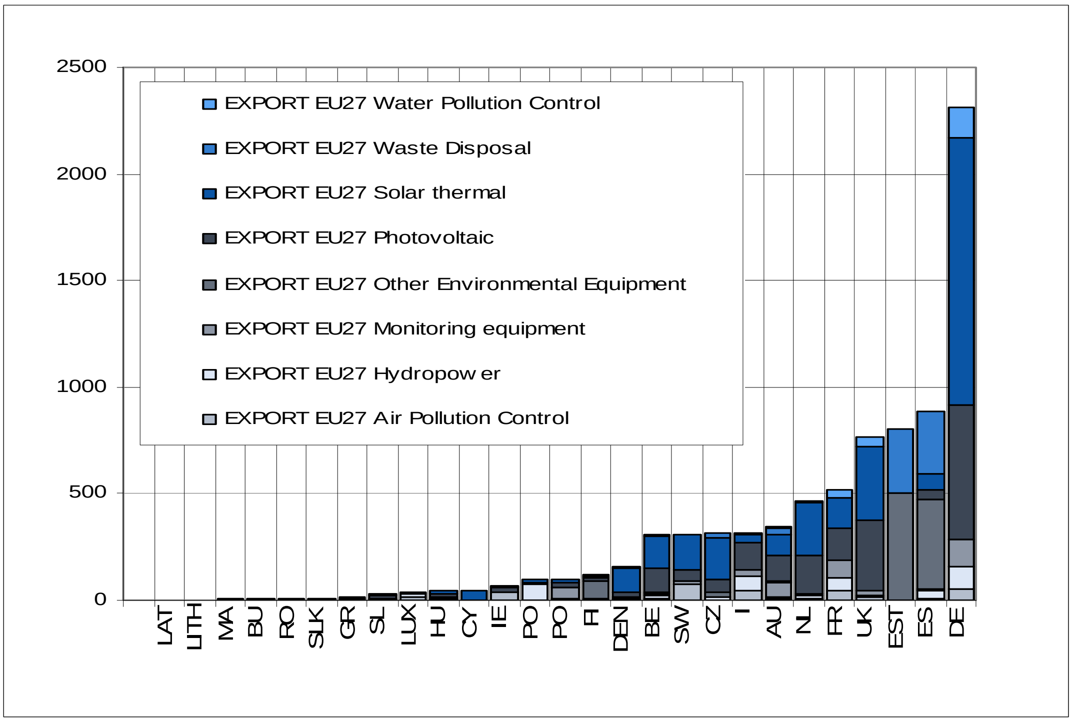
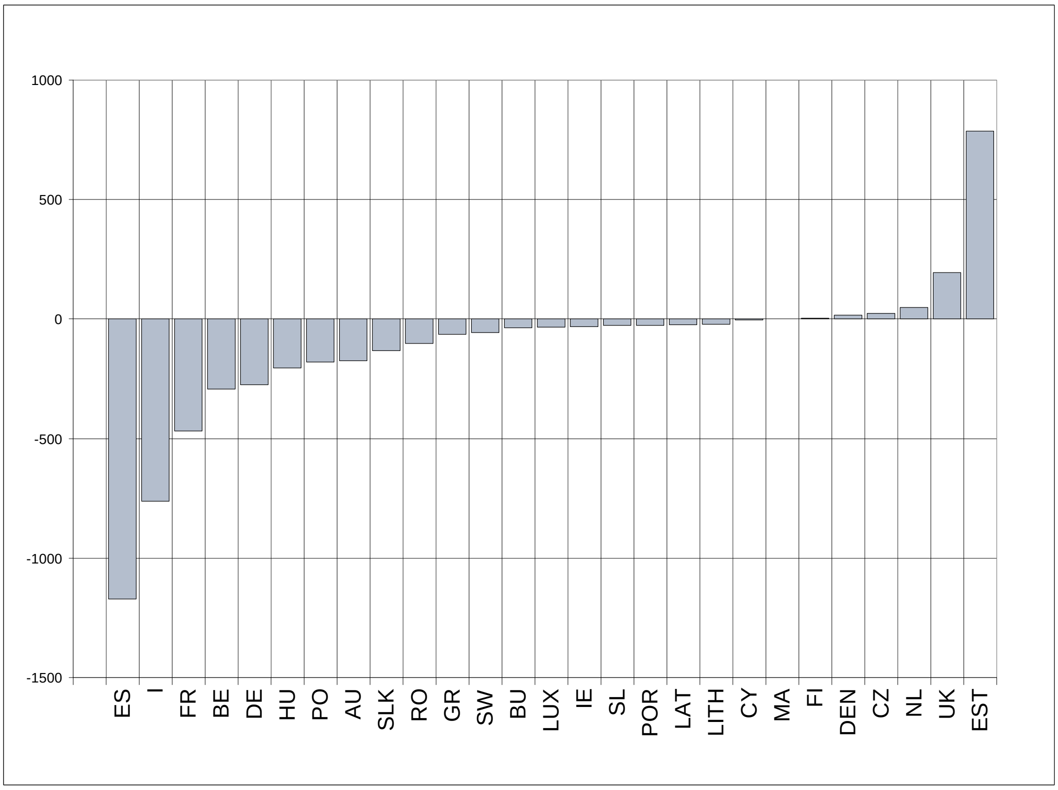


Figure 15.3 provides the trade balance for all EU 27 countries, indicating a significant trade deficit for Spain, France and Italy. Die to discrepancies in the trade data, the total size of imports in the data, is larger than exports. This explains why, apart from Denmark, Czech Republic, Netherlands, the UK and Estonia, all countries are operating at a trade deficit. A large share of the trade deficits is explained by photovoltaic and monitoring equipment imports.

Figure 15.3 Intra-EU trade balance for Eco-industries, 2007 (€ million)



16 Annex IV: RCA and the Balassa Index (chapter 6)

The chosen index for an overview of the competitiveness of EU eco-industries in the different sub-sectors is the Revealed Comparative Advantage (Balassa 1965). Considering a sector *S* and a set of countries *C*, this index is built as follows:

$$RCA = \frac{X_c^s / X_c^S}{X_C^s / X_C^S}$$

where *s* indicates a subsector of *S*, *c* a country of the set of countries *C* and X stands for exports. X_C^s would then be the exports of the set of countries *C* of products belonging to subsector *s*.

If $0 < RCA < 1$, then country *c* has a revealed comparative disadvantage in subsector *s* with respect to sector *S* and the set of countries *C*. Vice versa if $RCA > 1$.

Simply put, the RCA measures if the weight of exports of products of subsector *s* with respect to the export of products of sector *S* is larger or smaller in country *c* than in the set of countries *C*. In the former case, the RCA will result to be larger than 1, in the latter, the RCA's value will be between 0 and 1.

17 Annex V: The framework grid results (chapter 8)

The overall aim of the framework grid is to provide a general synthesis of regulations, conditions and effects from the analysis presented in this report, as a primary source of information, and from literature and other studies, as a secondary source of information. The goal is to generate a clear and accurate view on the framework within which the EU eco-industries operate. This synthesis should subsequently allow us to identify the most relevant indicators for the completion of the competitiveness grid. Furthermore, it will lead to the formulation of a number of general and sub-sector-specific conclusions.

The framework grid is divided into three parts:
1. Regulatory conditions;
2. Framework conditions, and
3. Exogenous conditions.

For each type of condition, a list of items and sub-items has been provided, according to the regulations, framework conditions and other exogenous conditions that are applicable to the EU eco-industries. It is at this level of sub-items that the grid is filled in. Importance, trend, geographical concentration and specific sub-sectors affected are identified. A final column maps the potential effects of each of the conditions on the competitiveness of the EU eco-industries.

To comprehend the conditions and their effects described in the framework grid, it is important to point out the specific interpretation of each of the columns and how they were filled in.

Importance

The column "Importance" indicates the importance of the condition for the eco-industries and its sub-sectors. In a first sub-column, the importance at the sector level is expressed by means of a score between 1 and 10, 10 being most important. In a second sub-column, the importance of the eco-industry interaction with other sectors is expressed by means of a score of 1 to 3 stars, 3 stars being very important. To grade the importance of the condition, a number of characteristics and issues were taken into account:

- Does the condition specifically/only apply to (a part of) the eco-industries?
- Does the condition apply to the eco-industries more than to other sectors due to its characteristics (cost structure, labour skills, energy intensity of the production process, use of raw materials, sector structure,…)?
- Does the condition apply to the EU eco-industries in a way that influences its competitive position relative to non-EU countries?
- Does the condition apply to the EU eco-industries in a way that influences its competitive position relative to alternative goods?

Trend

The column “Trend” refers to the expectations stated in literature and various interviews regarding the evolution of the condition’s impact. Will the impact of this regulation or issue increase/decrease/stay the same in the future? The underlying reasons for this trend can be, e.g. an increasing importance of the characteristic to which the condition refers, or a strengthening of the regulation or condition.

Geographical concentration

The column “Geographical level” shows the EU Member States that are likely to be most affected by the regulation or issue. A criterion for this is that the sub-sectors affected are concentrated in these Member States. The list is not exhaustive, in the sense that it does not include all Member States with plants of a particular sub-sector, but only the Member States in which a substantial share of activities is concentrated.

Specific sub-sectors

The column “Specific sub-sectors” lists the eco-industries that might be affected by, or that are the aim of, the regulation or condition in question. As mentioned before, we will start from this list of sub-sectors to identify which Member States are most affected.

Potential effects

In the column “Potential effects”, the potential effects of the condition on the specified sub-sectors are listed. These include the effects that are found in empirical literature and interviews [1], the effects that are described as potential in literature and interviews [2] and the effects that we find to be a potential consequence of the condition, based on own insights and economic theory [3].

TABLE V.1: FRAMEWORK GRID FOR ECO-INDUSTRIES AND ITS SUB-SECTORS

Eco-industries	Relevance 1 - 10		Trend < / = / >	Geographical level	Specific sub-sectors affected	Potential effects [1]=Empirical evidence; [2]= Literature; [3]=Own appreciation based on insights
	sector level	interaction				
I Regulatory conditions						
• **EU Environmental Regulation and issues**	9	***	>	• EU27 • France, Sweden, Germany, UK, Italy, Belgium, Spain, Poland, Greece, Austria, Denmark	• Air pollution control, recycling industry, environmental technologies, renewable energy, eco-construction	• Enhancing competitiveness, because of the following conditions: The use of economically efficient types of regulation, in particular tradable permits; [2] A favourable market structure, in particular demand for environmentally differentiated goods by a sufficiently high number of consumers; [2] => production increases to comply with increased demand for environmentally differentiated good (specialisation + segmentation) [1-3] • The availability of unused technology with higher efficiency; [2] • Downsizing and capital modernisation makes trade-offs less grim. [2] • Where EU standards and regulations are more stringent, they may prove to be barriers

TABLE V.1: FRAMEWORK GRID FOR ECO-INDUSTRIES AND ITS SUB-SECTORS						
Eco-industries	Relevance 1 - 10		Trend < / = / >	Geographical level	Specific sub-sectors affected	Potential effects [1]=Empirical evidence; [2]= Literature; [3]=Own appreciation based on insights
	sector level	interaction				
						to competitiveness vis-à-vis other countries. These effects will differ strongly per sub-sector and play a more substantial role in the connected industries than in the core industries. [1]
• Directives in order to limit and control concentrations of pollutants in the air[65]	9	***		• EU27 • France, Sweden, Germany	• Air pollution control technology	• Differing conditions and requirements from site to site and country to country wrt the implementation of the IPPC-Directive may eventually give rise to competitive distortions [2]
• EU Waste Regulation[66]	9	***		• France, UK, Germany, Italy, Belgium	• Recycling industry	•
• Directives regulating waste streams[67]	9	***		• France, UK, Germany, Italy,	• Recycling industry	•

[65] Directive 96/61/EC concerning IPPC, Air Quality Framework Directive 96/62/EC, Directive 99/13/CE wrt VOC emissions, Directive 99/30/CE fixing limits for emissions of nitrogen and sulphur oxides, Directive 2000/69/CE fixing limits for emissions of carbon monoxide and benzene, Directive 2000/76/CE on waste incineration, Directive 2001/80/CE on emissions of combustion plants, Directive 2001/81/EC on national emission ceilings, Direct 2003/87/CE establishing EU ETS, Directive 2004/107/CE imposing emission limits for metals

[66] Waste Framework Directive 2008/98/EC, Waste Shipment Regulation (EC) No 1013/98/EC

TABLE V.1: FRAMEWORK GRID FOR ECO-INDUSTRIES AND ITS SUB-SECTORS						
Eco-industries	Relevance 1 - 10		Trend < / = / >	Geographical level	Specific sub-sectors affected	Potential effects [1]=Empirical evidence; [2]= Literature; [3]=Own appreciation based on insights
	sector level	interaction				
				Belgium		
• **EU Labour market and migration regulations**	7-8	*	=	• EU27	• Especially sub-sectors that are highly dependent on high skilled personnel (Environmental technologies, renewable energy)	• The absence of a single labour market in Europe, and lack of the necessary flexibility to attract knowledge workers from all over the world => barrier to the industry's competiveness [1-3]; diminishing of labour productivity [3] • Especially SMEs do not have the organisational capacity to deal with such complexity and therefore refrain from hiring. => further weakening of position SMEs on world market [1-3]
• **Enforcement and improvement of IPR legislation**[68]	7-8	**	>	• EU27	• All, but most important for radical research-intensive eco-innovations	• Ecological services are difficult to protect under the conventional patenting regime: IPR issues are very complicated => further development and amelioration of a strong IPR

[67]End-of-life Vehicles Directive 2000/53/EC, Waste of electric and electronic equipment Directive 2002/95/EC, Directive 94/62/EC on packaging and packing waste
[68] Directive 2004/48/EC of the European Parliament and of the Council of 29 April 2004: enforcement of intellectual property rights.

TABLE V.1: FRAMEWORK GRID FOR ECO-INDUSTRIES AND ITS SUB-SECTORS						
Eco-industries	Relevance 1 - 10 sector level	Relevance 1 - 10 interaction	Trend < / = / >	Geographical level	Specific sub-sectors affected	Potential effects [1]=Empirical evidence; [2]= Literature; [3]=Own appreciation based on insights
						System, protecting the European eco-industry interests could drastically improve the competitiveness of the EU eco-industries [2-3] • However, increased regulation may decelerate developments and cooperation between companies. Some companies may become active in patenting in response to pressure from venture capitalists, so that an increase in patenting may threaten the diffusion of certain technologies. [2] • In addition, the enforcement of IPR will lead to an increase in administrative burden, which is especially problematic for SMEs [3]
• **Sector specific standards and codes of conduct**	7	**	=	• EU27 • France, Sweden, Germany, UK, Italy, Belgium Spain, Poland, Greece, Austria, Denmark	• Eco-construction • Air pollution control technology, recycling industry • renewable energy • Waste water	Positive impact: • Increase in the confidence from customers, bankers,… [2-3] • compared to stand-alone norms: diminishing bureaucracy and cost inefficiencies [1] Negative impact:

TABLE V.1: FRAMEWORK GRID FOR ECO-INDUSTRIES AND ITS SUB-SECTORS						
Eco-industries	Relevance 1 - 10		Trend < / = / >	Geographical level	Specific sub-sectors affected	Potential effects [1]=Empirical evidence; [2]= Literature; [3]=Own appreciation based on insights
	sector level	interaction				
					treatment	• Barrier to innovation, because less flexibility to deploy new technologies [3] • Extra delay at the moment of market introduction [3] Uncertainties: • International level playing field => impact on export and trade [3]
• Environmental verification systems	5	**		• Germany, EU	• Environmental technologies • Air emission technologies	• Allows customers to test and evaluate specific air emission technologies on an objective, independent basis. [1] • European counterpart of similar instruments developed in the US, Canada and Japan. [1]
• **National regulatory measures**	9	***	=	• France, Sweden, Germany, UK, Italy, Belgium, Spain, Poland, Greece, Austria, Denmark	• Air pollution control technology, recycling industry, environmental technologies, renewable energy, eco-construction	• The transposition of European legislation into national law will be an important challenge because of the heterogeneity amongst different Member States [2]. => Differing conditions and requirements from site to site and from country to country may eventually give rise to competitive distortions (inequality view).

TABLE V.1: FRAMEWORK GRID FOR ECO-INDUSTRIES AND ITS SUB-SECTORS						
Eco-industries	**Relevance 1 - 10**		**Trend < / = / >**	**Geographical level**	**Specific sub-sectors affected**	**Potential effects [1]=Empirical evidence; [2]= Literature; [3]=Own appreciation based on insights**
	sector level	**interaction**				
						• Own interpretation of the Member States to what is considered waste is hampering the single market functioning [1]
• **Completion of internal market legislation**	8	**	=	• France, Sweden, Germany, UK, Italy, Belgium, Spain, Poland, Greece, Austria, Denmark	• Recycling industry, environmental technologies, • Renewable energy, eco-construction • Air pollution control technology	• Difficulties due to national cultural and technical barriers [2] (see also 'national regulatory measures)
• **Competition policy issues**	6	*	>	• France, Germany, Spain, Poland, Italy, UK	• Renewable energy, eco-construction	• Influence on the merger and acquisition dynamics in the eco-industries [3]
• concentration					• waste management sector, soil remediation, wind power and renewable energy in general.	• The driving factors behind increasing concentration: is the desire for firms to extend geographic coverage, increase business activities, and reach critical mass for bearing the upfront cost of R&D => mergers to generate scale economies and efficiency gains

TABLE V.1: FRAMEWORK GRID FOR ECO-INDUSTRIES AND ITS SUB-SECTORS						
Eco-industries	Relevance 1 - 10		Trend < / = / >	Geographical level	Specific sub-sectors affected	Potential effects [1]=Empirical evidence; [2]= Literature; [3]=Own appreciation based on insights
	sector level	interaction				
						=> However, possible reduction of industry competition and induction of losses in consumer surplus.
II Other framework conditions						
• **Access to finance**	9	0	>	• EU27 • France, Sweden, Germany, Spain, Poland, Greece, Austria, Denmark	• All • Water supply and waste water treatment facilities • Air pollution control technology • Waste treatment facilities • Renewable energy sectors	• Low level of availability of funds (due to long pay back periods, low rate of return, uncertainty, which is increased by the financial crisis of 2008-2009) => less 'innovative' projects will be funded => increased competition from other more innovative countries (e.g. BRIC) [1-3] • Venture capitalists mainly focus on the larger SMEs and the larger projects. Most (smaller) SMEs rely on traditional local banks for their funding. Problem: traditional banks are not specialised enough and mostly have a rather risk averse profile = > difficult for environmental technology suppliers to get the funds needed (especially for larger

TABLE V.1: FRAMEWORK GRID FOR ECO-INDUSTRIES AND ITS SUB-SECTORS

Eco-industries	Relevance 1 - 10		Trend < / = / >	Geographical level	Specific sub-sectors affected	Potential effects [1]=Empirical evidence; [2]= Literature; [3]=Own appreciation based on insights
	sector level	intera ction				
						projects involving higher investments). Because of financial crisis, access to finance especially problematic for research in later stages (demonstration stage), that receive less public funding than pre-market research. [1]/[3]
• **Knowledge and innovation**	8-9	**	>	• France, Sweden, Germany, UK, Italy, Belgium, Spain, Poland, Greece, Austria, Denmark	• Air pollution control technology, environmental technologies, renewable energy • Recycling industry, eco-construction	• Key role for the connection between sustainability and economic growth [2] • However, hampering factors are the high cost of innovation activity, lack of appropriate sources of finance, economic risk perception, unawareness of long-term financial benefits of investments in eco-innovation [2] • Quality improvements, increased energy efficiency (=> cost reductions), improvement of 'image' => entrance in new markets, enlargement of existing markets [2] [3] • More efficient use of resources [2]
• Partnership building	9	***		• France, Sweden, Germany	• Air pollution control technology	• Dissemination of knowledge about technologies [2]

TABLE V.1: FRAMEWORK GRID FOR ECO-INDUSTRIES AND ITS SUB-SECTORS						
Eco-industries	Relevance 1 - 10		Trend < / = / >	Geographical level	Specific sub-sectors affected	Potential effects [1]=Empirical evidence; [2]= Literature; [3]=Own appreciation based on insights
	sector level	interaction				
						• Improvement of communication: reduction of the information gap [2] • R&D improvements, better application and product development [2]
• Development of new methods pushed by legislation	7	**		• France, UK, Germany, Italy, Belgium	• Recycling industry	• Improvement of the quality of the recycled materials, enabling them to increase the price of the recycled material. [2] • More efficient techniques for the recycling of recycled materials that were destined for landfill before [2] • Product design that optimally allows for dismantling and separation of all components, allowing recycling industry to maximally recycle and thus to keep useful resources in circulation. [2] • However future effects are depending on legislation, because of lack of economic incentives to use these designs spontaneously [2]
• **Openness of international markets (trade and**	8	**	<?	• France, Sweden,	• Renewable energy	• Trade barriers hinder free trade and distort

TABLE V.1: FRAMEWORK GRID FOR ECO-INDUSTRIES AND ITS SUB-SECTORS						
Eco-industries	Relevance 1 - 10		Trend < / = / >	Geographical level	Specific sub-sectors affected	Potential effects [1]=Empirical evidence; [2]= Literature; [3]=Own appreciation based on insights
	sector level	interaction				
investment)				Germany, UK, Italy, Spain, Belgium	• Air pollution control technology, eco-construction, recycling	competition. [2] • Negative effect on export and trade [3]
• Shipment of waste	9	***		• France, UK, Germany, Italy, Belgium	• Recycling industry	• Existing trade barriers hinder access to customers and thus hinder free supply and demand. [2] • Negative effect on export and trade [3]
• Lack of openness in labour market	7	*			• Environmental technologies	• see EU labour market regulations above
• **Structural change**	7		>	• France, UK, Germany, Italy, Belgium, Spain, Poland, Greece, Austria, Denmark •	• Recycling industry • Environmental technologies • Renewable energy, eco-construction	
• Process of deindustrialisation	9	***		• France, UK, Germany, Italy, Belgium	• Recycling industry	• Manufacturing industries as important customers for the recycling industry increasingly moving away from Europe [1] • It is expected that over time recycling

TABLE V.1: FRAMEWORK GRID FOR ECO-INDUSTRIES AND ITS SUB-SECTORS						
Eco-industries	Relevance 1 - 10		Trend < / = / >	Geographical level	Specific sub-sectors affected	Potential effects [1]=Empirical evidence; [2]= Literature; [3]=Own appreciation based on insights
	sector level	interaction				
						companies will reorganize their value chain and relocate parts to outside of Europe [2]
• Climate change (sustainability in production process)	7	***		• France, UK, Germany, Italy, Belgium	• Recycling industry • Environmental technologies	• Sustainable use of resources and the development of life-cycle thinking in waste management as a reaction on climate change and diminishing supply of raw materials => increasing demand for recycling industry [1-3]
• **Market organisation**	7	***	>	• EU27 • NMS	• All	• Emergence of public-private partnerships (PPP) as well as privatization thrusts has to some extent been able to render the market competitive and well calibrated to adapt both to new regulation and market pressures. [1]
• PPP (public private partnerships) and privatization thrusts	8	***		• EU27 • NMS	• All	• Further development of capacity for private sector to bid for projects in areas such as utility management for both private and public sector will determine dynamism and competitiveness of the sector in the years to come, especially for SMEs [2]
• **Labour force, knowledge and skills**	7	*	>	• France, Sweden, Germany, Spain,	• Environmental technologies,	• Shortage of required skills and lack of sufficient knowledge in EU [2]

TABLE V.1: FRAMEWORK GRID FOR ECO-INDUSTRIES AND ITS SUB-SECTORS						
Eco-industries	**Relevance 1 - 10**		**Trend < / = / >**	**Geographical level**	**Specific sub-sectors affected**	**Potential effects [1]=Empirical evidence; [2]= Literature; [3]=Own appreciation based on insights**
	sector level	**interaction**				
				Poland, Greece, Austria, Denmark, UK, Italy •	renewable energy • Eco-construction • Air pollution control technology	• negative effect on business efficiency [3] • increased importance of education/training [3] • decrease of competitiveness [3]
III Exogenous conditions						
• **Technological change**	7	*	=	• France, Sweden, Germany, UK, Italy, Belgium, Spain, Poland, Greece, Austria, Denmark • •	• Renewable energy • Air pollution control technology, environmental technologies, Eco-construction • Solid waste management, water supply, recycling industry	
• Auto-sorting technology					• Solid waste management	• Reduce production costs [2] • Avoidance of outsourcing outside EU [2]
• Peak technology	7	**		• France, Sweden, Germany	• Air pollution control technology	• Only important if technology renders eco-goods redundant

TABLE V.1: FRAMEWORK GRID FOR ECO-INDUSTRIES AND ITS SUB-SECTORS						
Eco-industries	**Relevance 1 - 10**		**Trend < / = / >**	**Geographical level**	**Specific sub-sectors affected**	**Potential effects [1]=Empirical evidence; [2]= Literature; [3]=Own appreciation based on insights**
	sector level	**interaction**				
• Alternative technology					• Water supply	• Competitiveness depending on further development of alternative technologies to meet high quality requirements [2]
• Carbon capture and storage (CCS)				• Germany, Spain, Denmark, Italy, France, UK	• Renewable energy	• Depending on the right technology input, there is still room for further improvements [2]
• 2nd generation biofuels, biomass	8		>	• Germany, Spain, Denmark, Italy, France, UK	• Renewable energy	• Large-scale deployment of biofuels can be expected by 2020-2030. • Liquid biofuels are compatible with current technology. Consequently they offer the highest potential for fast introduction of biofuel on a large scale. • Biogas is likely to replace an increasing share of the CNG in automotive fuel market [2]
• Thermal heating	7		>	• Especially Germany, Greece and Austria, and the high-potential countries Italy, France and Spain	• Renewable energy	• Matured solar thermal technologies already available, but further developments needed. • Given the price level, European manufacturers cannot easily compete in markets like China, India and Turkey. And if the EU does not catch up soon with a

TABLE V.1: FRAMEWORK GRID FOR ECO-INDUSTRIES AND ITS SUB-SECTORS

Eco-industries	Relevance 1 - 10		Trend < / = / >	Geographical level	Specific sub-sectors affected	Potential effects [1]=Empirical evidence; [2]= Literature; [3]=Own appreciation based on insights
	sector level	interaction				
						significant growth in the domestic market, it will be difficult to maintain its technological leadership [2]
• Solar/photovoltaic technologies	6-7		>	• Especially Germany, Spain, Italy, Portugal and France	• Renewable energy	• Increasing competition from China and Japan • Further investments in PV innovations and more focus on long-term strategies will become indispensable for the European PV industry in order to ensure the position of the European companies in the market [2-3]
• Wind turbine technology	7-8		>	• Especially Germany, Spain and Denmark	• Renewable energy	• The biggest market, Germany, is expected to show bigger market growth in the short term, as a consequence of the amendment of the renewable energy law EEG. • Without additional incentives for wind power in more EU member states, the EU may not be able to achieve its 2020 targets for renewable energy [2]
• Hydropower	5		<	• Germany, Spain, Denmark, Italy, France, UK	• Renewable energy	• Most potential sites in Europe have been fully developed. Only at the level of small hydroelectric power stations, further

TABLE V.1: FRAMEWORK GRID FOR ECO-INDUSTRIES AND ITS SUB-SECTORS						
Eco-industries	**Relevance 1 - 10**		**Trend < / = / >**	**Geographical level**	**Specific sub-sectors affected**	**Potential effects** [1]=Empirical evidence; [2]= Literature; [3]=Own appreciation based on insights
	sector level	**interaction**				
						technology development is expected [2]
• Geothermal energy	5		=>	• Especially Sweden, Germany and Austria	• Renewable energy	•
• Ocean energy technologies	4		=>	• Especially UK, but still limited	• Renewable energy	• More research in the future, but technologies not yet at the commercial level of energy production from solar, wind and bio-mass [2]
• Passive housing technology				• Italy, Spain, Germany, Denmark, France, UK, Poland, Czech Republic	• Eco-construction	• Problem of innovation in eco-construction not so much in the development of new techniques and technologies, but more in the implementation of this knowledge within the building companies and the adoption of the new techniques ⇨ Future development depending on skills and specialisation: if techniques are wrongly applied, a passive house is worthless [2] ⇨ education and training becoming more important [3]
• Development of new materials	5	*		• France, UK,	• Recycling industry	

TABLE V.1: FRAMEWORK GRID FOR ECO-INDUSTRIES AND ITS SUB-SECTORS						
Eco-industries	**Relevance 1 - 10**		**Trend < / = / >**	**Geographical level**	**Specific sub-sectors affected**	**Potential effects [1]=Empirical evidence; [2]= Literature; [3]=Own appreciation based on insights**
	sector level	**interaction**				
				Germany, Italy, Belgium		
• **Socio-economic developments**	7	**	>	• France, Sweden, Germany, UK, Italy, Belgium, Spain, Poland, Greece, Austria, Denmark • •	• Air pollution control technology, renewable energy • Eco-construction • Recycling industry, environmental technologies	• Increase of the ecological awareness in Europe encouraged the introduction of more sustainable alternatives (e.g. recycling): Europe has moved up in the waste hierarchy. => positive impact on the demand for eco-industry services [1]
• Policy consistency and pressure	9	***		• France, Sweden, Germany	• Air pollution control technology	• Maintenance of green culture as seen as extremely important to continued development of the industry [1]
• More ecological awareness	7	*		• France, UK, Germany, Italy, Belgium	• Recycling industry, Environmental technologies	• Increased demand and willingness to pay [1] • Higher quality requirements of production and solutions [3]
• **Global competition**	8	**	>	• France, Sweden, Germany, UK, Italy, Belgium, Spain, Poland, Greece, Austria, Denmark	• Recycling industry, renewable energy • Air pollution control technology • Environmental	• Mergers and acquisitions => impact on size of enterprises and concentration ratio [2-3] • Competition from alternative goods + competition from non-EU producers, e.g. from US, Taiwan,..., is a threat for the competitive

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	sector level	**interaction**				
					technologies, eco-construction	position of the EU-eco industry on the world market [2-3] • Increased competition stimulates innovation [2-3]
• Growth of China	7	**		• France, Sweden, Germany	• Air pollution control	• Both seen as opportunity (market potential) as well as threat (producers) [2-3]
• **Economic/financial crisis**	8			• EU27 • France, UK, Germany, Italy, Belgium	• Recycling industry	• Increased risk and uncertainty due to price collapsing of raw materials => decrease of economic benefits for using recycled materials => decrease of demand [2-3] • In addition, access to finance more problematic => negative impact on investments in innovation and new technology [2-3]