The number of Jobs dependent on the Environment and Resource Efficiency improvements

Final report

Client: DG Environment

Rotterdam, 3 April 2012

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Preface

The background of this study is the emerging discussion on how environmental protection and resource efficiency goes hand-in-hand with job creation. Improved use of resources will increase the competitiveness by reducing costs and improving processes. Moreover, improved technology provides a technological advantage which can be used and exported. A few key studies on the green job debate and eco-industries have been made over the last decade. In this report we have refined and updated the numbers and methodologies from these studies. The results show the heavy influence of scope, methodology and data availability. However, whatever the choices about how to measure 'green jobs', the number seems to be increasing and the debate is only over how fast and how many.

This report is the result of a project carried out for the European Commission – DG Environment under framework contract ENV.G.1/FRA/2006/0073. The project work started in early 2011 and has been running throughout the year. The study has been carried out by consultants from Ecorys and Cambridge Econometrics. The consultants have been well-placed to carry out the assignment since both were engaged in previous key studies. Nevertheless, the study has benefited tremendously from feed-back by several DGs in the European Commission and Industry Associations. Moreover, a large number of interviews have been carried out. We would like to thank all people involved for their engagement and insightful comments.

Rotterdam, 3rd April 2012

Executive Summary

Why this study

A number of studies have shown the positive link between environmental performance and job creation. The research shows how ‘greening the economy’ can boost job creation in areas directly connected to the environment such as conservation, waste, water and air quality. These are often referred to as *eco-industries* and are covered in studies such as:

- Analysis of the EU eco-industries, their employment, and export potential (Ecotec, 2002);
- Eco-industry, its size, employment, perspectives and barriers to growth in an enlarged EU (Ernst & Young, 2006), and;
- Study on the competitiveness of the EU eco-industry (Ecorys and IDEA, 2009).

These studies use a statistically delineated definition which relies heavily on Environmental Protection Expenditures (EPE). However, this definition focuses on money spent to protect the environment, and is much weaker on jobs that depend on a good environment, or depend on natural resources. A study by GHK, IEEP and Cambridge Econometrics (2007) on ‘Links between the environment, economy and jobs’, looked not just at the direct jobs captured in the eco-industry concept, but also used multiplier effects to calculate the ‘indirect’ jobs created and jobs dependent on a good environment within for example eco-tourism and organic farming.

The different approaches show how **methodologies and conceptual design of the studies are central to the outcomes**. Moreover, in later years the concept of resource efficiency has enjoyed increased attention. It is based on the idea that economic activity generally depletes finite, and also renewable, resources. Some resources are also concentrated in a few countries and/or in inaccessible areas. The result has been increased natural resource prices, volatility on commodity markets and uncertainty which is harmful to the competitiveness of European companies. By boosting resource efficiency – to do more with less – could therefore improve the competitiveness and create jobs.

The above context lead us to the objectives of the study which were:

1. Update existing studies on how many jobs are related to the environment;
2. To determine the competitiveness of EU eco-industries; and,
3. To provide examples of how jobs can be created by improving environmental performance and resource efficiency.

Results

How many people work in the eco-industry?

The eco-industry "produces” 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”. The sectors fall into two general categories, pollution management and resource management.

Estimating the number of jobs starts with estimating the turnover of the sector, and then requires the number of jobs associated with that employment to be estimated. Both of these steps are subject to uncertainty, although the data and methodologies are improving. Therefore, the update of the Ecorys and IDEA (2009) study has been conducted in two ways. Firstly, only the EPEs were updated, secondly, the methodology was updated and applied.

Based on updated EPEs, new methodology and updated labour compensation levels, the following key figures can be derived:

- Around **2,2 million people** worked in the EU-27 eco-industry in 2000.
- About **2,7 million people** worked in the EU-27 eco-industry in 2008 which represented **0,81%** of the total workforce (people age 15 - 64).
- For 2012, with extrapolation from reported figures, the total number of people working in eco-industries is around **3,4 million**.
- The average annual growth (2000 - 2008) in eco-industry jobs is approximately **2,72 %** corrected for inflation.
- The EPE levels in 2000 amounted to **EUR 223 - 243 million**, depending on methods for calculation and representing **2,95%** of EU-27 average GDP.
- In 2012, the estimated EPE of EU-27 is **EUR 557 million**.
- The average growth rate for EPE (2000 – 2008) was **2,8%**.
- The annual growth rate over 2004 – 2008 for employment in eco-industries was **0,7%**.

In general, updates of data-sets, vague and blurred definitions, and differences in methodologies oblige us to read the study results cautiously. We would rather the study is used to show directions of trends and further the discussions on what constitutes a 'green' job, and not see it as a precise statistical estimate. **The general trend is of a growing number of 'green jobs', with the majority dependent on the environment as an input**.

In some cases the increase in jobs are due to changes in methodology for collecting national accounts in Member States. This is for example true in the case of Germany where EPE figures for waste management in 2000 moved from 4 to 16 billion. However some sectors show a clear increasing trend. The most significant change is observed in 'renewables' and 'recycling' with 78% and 38% growth respectively.

The labour compensation factors, which show occasionally large shifts, have been updated. There seems to be a trend in some sub-sectors moving from labour intensity towards more capital intensity, probably due to maturing of the markets.

Finally, the update of the GHK study shows how a broader definition of jobs related to the environment increases the numbers. If one use the broader definition, some **19 million jobs** in Europe are related to the environment which represents some **5%** of the total working population (2010 figures).

Competitiveness and trade

The **global market for eco-industries is estimated at roughly EUR 1.15 trillion a year** (2010 figures for turnover) with some big differences in estimates due to different definitions and lack of robust statistics. More consistently, the EU-27 is seen as capturing around one third of the global market. There is also broad consensus that the global market could almost double, with the average estimate for 2020 being around **EUR 2 trillion a year.**

Estimates on the growth potential vary among European companies working in environmental and resource efficiency related sectors. Generally speaking, the European companies are performing well on the global market. In three out of seven sectors – photo-voltaics, air pollution control, and waste disposal - the EU has a revealed comparative advantage. Hydropower and other environmental equipment are more middle performing sector with growing competition coming from Brazil and Russia in the former sector and the US in the latter.

Many environmental sectors included in the study are highly bound to local, regional or national markets and are not traded extensively. Others, such as photovoltaic allow for more cross-border trade. The figures retrieved for the study are not complete and therefore we advise that they should be read as depictions of flows and streams.

China has in terms of total value the highest export figures for its eco-industry in 2010. This is especially due to their exports of photovoltaic equipment[1] which represents over 95% of their exports. These figures should be interpreted with care as large parts of these exports may not exclusively be for the use in electricity generation, but it is not possible to get more accurate data. The **EU-27 has a strong export position vis-à-vis nearly all of the world's largest economies** and is, by these measures, the third largest exporter of environmental goods, just behind Japan. The EU-27 has a particularly strong position in the emerging BRIC (Brazil, Russia, India and China) countries compared to other established western economies. Furthermore, the EU is the world's biggest importer of environmental technologies, with imports of photovoltaic goods accounting for a large share of this.

Job creation by boosting resource efficiency

The third and final objective was to explore how improved resource efficiency and environmental protection could boost job creation. The final chapter is made up by six case studies on: insulation, electric (hybrid) vehicles, copper, cement, drip irrigation and heat-pumps. These areas are either contributing to resource efficiency directly, or represent highly energy or resource intensive industries.

The general conclusion is, not surprisingly, that **improving resource efficiency leads to job creation**. In particular the implementation of energy efficiency policies has considerable potential. For heat pumps and insulation the implementation of European policies in energy efficiency and savings are crucial. The EPBD will require all buildings to be 'near zero energy buildings' by 2020. To reach this goal demands a large push not only in zero emission new homes but also in the requirements for refurbishments. Among the most energy efficient investments possible in buildings are insulation and heat pumps, therefore, the growth of employment in these sectors will be directly dependent on, and benefit from, policy implementation.

For the large energy intensive industries, cement and copper, energy prices and tradable emission certificates have already put large pressure on these industries to improve their efficiency. Other environmental policies and regulations relating to air, water and waste are also highly relevant. These industries are not foreseen to see any significant increase in employment in the near future.

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[1] More specifically HS code 85414: Photosensitive semiconductor devices, incl. photovoltaic cells whether or not assembled in modules/made up into panels; light emitting diodes

Finally, electric (hybrid) vehicles and drip irrigation are more specific cases where a possible development is trade-offs in job creation. For drip irrigation an increase in efficiency is likely to reduce the number of jobs downstream. On the other hand, to increase efficiency it will be necessary to employ more people in R&D. This analysis, however, should be considered a rough estimation. For hybrids the market is equally unsure. Japan is world-leading in the hybrids market and currently only assemblage and some manufacturing of parts takes place in Europe. Moreover, there are no 'hard' policy incentives for European manufacturers to reduce their emissions to levels the equivalent of hybrid cars. On the other hand, if a European manufacturer takes up a bigger part of the global market, then jobs may be created in the industry. However, it is also likely that these jobs will mean re-skilling of existent workers rather than additional job creation.

List of Abbreviations

Abbreviation	Long version
ASHP	Air-Source Heat Pumps
BAT	Best Available Techniques
BAU	Business as Usual
BEV	Battery Electric Vehicle
BRIC	Brazil, Russia, India and China
CAP	Common Agricultural Policy
CAPEX	Capital Expenditure
CE	Cambridge Econometrics
COP	Coefficient of Performance
CSI	Cement Sustainability Initiative
DEFRA	Department for Environment, Food and Rural Affairs (UK)
DG	Directorates-General (of the European Commission)
DTI	Danish Technological Institute
EME	Energy and Material Efficiency
EP	European Parliament
EPBD	Energy Performance of Buildings Directive
EPBD	Energy Performance of Buildings Directive
EPE	Environmental Protection Expenditure
EPE	Environmental Protection Expenditures
EREC	European Renewable Energy Council
E-REV	Extended-Range Electric Vehicle
ETS	Emissions Trading Scheme
EU	European Union
EUR	Euro
European LFS	European Labour Force Study
EV	Electric Vehicle
EWEA	European Wind Energy Association
FDI	Foreign Direct Investment
FTE	Full Time Equivalent
GBP	Pound Sterling
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GSHP	Ground-Source Heat Pumps
HEV	Hybrid Electric Vehicle
HMG	High Market Growth
HVAC	Heating, Cooling and Ventilation
IAE	International Agency for Energy
ICSG	International Copper Study Group
ICT	Information and Communication Technology
IEE	Intelligent Energy Europe
ICE	Internal Combustion Engine
IO table	Input-Output table
JEMU	Joint Environmental Markets Units

Abbreviation	Long version
LCF	Labour Compensation Factor
LME	London Metal Exchange
LMG	Low Market Growth
MATSA	Minas de Aguas Tenidas
MEPS	Minimum standards of for energy performance
MMG	Medium Market Growth
MS	Member States
MW	Megawatt
NACE	Nomenclature statistique des activités économiques dans la Communauté européenne
OECD	Organization for Economic Co-operation and Development
OPEX	Operational Expenditure
PHEV	Plug-in Hybrid Electric Vehicles
PIR	Polyisocyanurate
PU	Polyurethane
PUR	Polyurethane
R&D	Research and Development
RCA	Revealed Comparative Advantage
REACH	Registration, Evaluation, restrictions, and Authorization of CHemicals
RES	Renewable energy source
RF	Russian Federation
RMI	Raw Materials Initiative
ROHS Directive	Restriction of Hazardous Substances Directive
SME	Small and Medium sized Enterprise
SO_2	Sulphur Dioxide
SPF	Seasonal Performance Factor
TCO	Total Cost of Ownership
UK CEED	UK Centre for Economic and Environmental Development
USD	United States Dollar
WBCSD	World Business Council for Sustainable Development
WEEE Directive	Waste Electrical and Electronic Directive
WFD	Water Framework Directive

1 Introduction

This report is a contribution to the growing literature on how many jobs the environment creates and sustains. Environmental protection and resource efficiency are increasingly understood as propellers of job creation and sustainable economic growth.

From a global perspective resource efficiency has gained strategic importance. Globalization and rapid economic growth in emerging economies has led to increased global competition for natural resources and recyclable materials. It has led to resource shortages on the global market, which results in higher prices, which is significant when, as is the case for the EU, there is a dependence on imports. This has further implications for the EU economy as non-EU companies with easy and cheap access to resources may gain a competitive advantage relative to their European counterparts.

As such, there is a positive correlation between the resource efficiency of countries and their competitiveness. There is also some evidence that higher levels of resource productivity go hand in hand with the competitiveness of a sector or even individual companies (Ecorys and IDEA, 2009). Resource scarcity and dependency on resource imports into the EU-27 present a clear threat to the international competitiveness of the EU, making resource efficiency a strategic factor in the European economy, and as such implicitly in the European employment market.

The EU eco-industry is an important source of economic growth and employment and this is largely attributable to proactive adoption of environmental regulation (Ecorys and IDEA, 2009) and the interest of businesses to improve their resource efficiency. However this competitive position is under pressure from emerging countries like China, which have successfully developed high-tech (green) subsectors often through FDI (e.g. photovoltaic).

1.1 Resource efficiency and jobs

Resource efficiency and improved environmental performance lead to innovation and job creation. The jobs created due to policy interventions in resource efficiency and environment are sometimes referred to as 'Green Jobs'. Over the last decade several studies have investigated the link between the environment, resource efficiency and jobs. For example:

- 'Analysis of the EU Eco-industries, their employment and export potential' by Ecotec, 2002
- 'Eco-industry, its size, employment, perspectives and barriers to growth in an enlarged EU' by Ernst and Young, 2006
- 'Links between the environment, economy and jobs' by GHK et al, 2007
- 'Study on competitiveness of the EU eco-industry' by Ecorys and IDEA, 2009.

A main reason for European companies to further invest in environmental technologies and resource efficiency is the creation of a comparative advantage. Efficient use of resources keeps costs down, and allows Europe to preserve its competitiveness.

To remain competitive, the European (eco-) industries have three transformation strategies:
1. Moving to 'up-market' segments;
2. Process innovation and reducing resource-intensity;

3. Increase presence in growth markets and relocate to low-cost countries.

The two former strategies aim to boost innovation and implementation and are as such relevant for 'green' employment. Therefore, a key assumption is that improved competitiveness of resource efficiency technologies, and improved resource efficiency in industries which depend on substantial resource inputs, can be linked to certain (economic) benefits. This fits in with an overall strategic approach to decouple economic growth from increased resource use. Decoupling could have several co-benefits such as:

- Improved resilience in industries to declining resource supply and increased competition for resources;
- Improved competitive position on the international market;
- Strategic benefits such as a reduced dependence on (strategic) resource inputs and imports.

EU Resource Efficiency policy

The EU has become increasingly active in making policy for resource efficiency. Already in 2006 the Renewed EU Sustainable Development Strategy put forward goals such as:

- *"Improving resource efficiency to reduce the overall use of non-renewable natural resources and the related environmental impacts of raw materials use…;*
- *Gaining and maintaining a competitive advantage by improving resource efficiency, inter alia through the promotion of eco-efficient innovations;*
- *Avoiding the generation of waste and enhancing efficient use of natural resources by applying the concept of life-cycle thinking and promoting reuse and recycling;*
- *Strengthening the focus on the social dimension of sustainable development in terms of – among others – the employment potential related to climate change, environmental related industries (e.g. eco-industries) and environmental policies (e.g. resource efficiency)."*

In later years the Europe 2020 agenda aims to generate smart, sustainable and inclusive growth in the EU, with high levels of employment and provides a policy vision for the years to come. It pays ample attention to the targets concerning the increase of (green) employment, investments in R&D, and greening the European economy. The strategy specifies seven flagship initiatives to catalyse implementation. Two of the seven flagship initiatives are of special interest in light of resource efficiency and employment.

Flagship initiative 4: "Resource efficient Europe" - This initiative aims to decouple economic growth from the use of resources, support the shift towards a low carbon economy, increase the use of renewable energy sources, modernise the EU's transport sector and promote energy efficiency. And;

Flagship initiative 5: "An industrial policy for the globalisation era" - The goal of this initiative is to improve the business environment, notably for SMEs, and to support the development of a strong and sustainable industrial base able to compete globally.

Finally, the Commission recently released its Roadmap for a resource-efficient Europe. This creates a framework for action to ensure that resource efficiency policies reinforce, and are supported by, other initiatives - for example on low-carbon technologies and development.

We also see a positive dynamics between an increase in (sectoral) resource productivity and (green) employment. In Germany for example, the resource productivity in the sectors that reduced their requirements for a resource-intensive supply increased significantly, where decoupling effects were observed in the less-resource intensive sectors (Bringezu, S et al, 2009). Furthermore, econometric analysis indicates that, at least within Germany, the risk of becoming unemployed grows with the life-cycle wide resource requirements of the sector, which means that higher resource productivity and lower resource use, besides contributing to resource conservation and mitigating climate change, supports the labour market (Bringezu, S et al, 2009). These observations stress the importance of more and better knowledge and understanding about the links between resource efficiency improvements and employment, and the importance of this study.

The above mentioned studies have investigated several macro-economic effects of greening the economy such as job creation, competitiveness, strategic resource dependence and influence on the environment. Several of the numbers used in the reports have since been updated and the methodologies for calculations have been fine-tuned.

In this context, the updating of numbers and methodologies, will help European policy makers to improve their understanding of the size of the green jobs industries, their competitive position vis-à-vis non-EU markets and finally, a few examples on how improved resource efficiency and environmental performance could boost job creation and European competitiveness.

1.2 Structure of the report

The remaining chapters of this report are organized as follows:

- **Chapter 2** presents the update on the two studies of GHK (2007) and Ecorys and IDEA (2009) on jobs dependent on the environment – direct and indirect;
- **Chapter 3** presents the approach, methodology and results for accessing the EU's position on the global market for eco-industries and industries heavily dependent on the environment;
- **Chapter 4** includes fact sheets on the case studies carried out for the study, which outline the possibilities of creating jobs by increased resources efficiency;
- **Chapter 5** sums up the analysis made in the three previous chapters and comments on the results.
- **Annex A** clarifies some of the methodological issues regarding trade data and trade-related indicators for market size and competitive position of the EU;
- **Annex B** comprises the complete sectoral case studies underlying the fact sheets in Chapter 4.

2 The number of jobs dependent on the environment

In the following chapter we present an update of the key studies which assess the number of jobs dependent on the environment. Two studies in particular are updated namely "*Links between the environment, economy and jobs*" (GHK et al, 2007) and "*Study on competitiveness of the EU eco-industry*" (Ecorys and IDEA, 2009). These studies are different in both approach and scope. Whereas GHK et al uses an input – output model and a broader scope for green jobs, the Ecorys and IDEA study uses statistical reporting based on Environmental Protection Expenditure (EPE) and a more narrow scope. Chapter two is not meant to dig deeper into the various definitions and methodologies, but rather to use updated figures, mainly from Eurostat, to update the results from these methods.

2.1 Objective and approach

Objective

The main objective of Chapter two is to (re-)estimate the number of jobs that are directly or indirectly dependent on the environment by different environment related categories and for all EU-27 Member States. It has focussed on updating employment figures in two key reports:

- "*Links between the environment, economy and jobs*" (2007) by GHK in association with Cambridge Econometrics and IEEP[2]
- "*Study on competitiveness of the EU eco-industry*" (2009) by Ecorys with IDEA[3]

To allow for correct estimations, the study follows the methodologies in the previous studies. Since this is only one part in this 'new' study, the methods used in the 'old' studies are only briefly explained. For further explanations and discussions, we refer to the full 'old' studies.

Approach and definitions

Both the Ecorys and IDEA study and the GHK study base their definitions on an OECD – Eurostat definition from 1999 which argues that eco-industries are:

> *"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"*

The Ecorys – IDEA study narrows the definition down to limit the scope and exclude adjacent industries:

> *"Eco-industries are those sectors within which the main – or a substantial part of – activities are undertaken with the primary purpose of the development of technologies and 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 ecosystems"*

[2] From hereon referred to as "the GHK study"
[3] From hereon referred to as "the Ecorys and IDEA (study)"

The definition excludes jobs such as eco-tourism which are termed ‘connected’ industries. Furthermore, jobs created as a result of "unnatural" innovation, and jobs that have been "relabelled green" (green washing) have been eliminated from the calculation of environmental and resource efficiency jobs.

The GHK study, on the other hand, has generated a typology of jobs related to economic and environmental linkages and thus casts the net much wider that than Ecorys and IDEA. In both studies the use of direct and indirect jobs and industries are used.

There are a number of activities falling under the scope of employment dependent on the environment and resource efficiency improvements, and can be broken down into three types of categories:

1. Activities where the environment is a ***primary natural resource*** or input into the economic process – Agriculture, forestry, mining, electricity generation and water supply;
2. Activities concerned with ***protection and management*** of the environment - Waste recycling, pollution & sewage control and environmental management;
3. Activities dependent on ***environmental quality*** – Environment related tourism

The Ecorys and IDEA study has focused mainly on category 2 activities, that mainly fall within the definition of Eco-industries, whereas the GHK study looks at the broader picture and to a higher extent includes categories 1 and 3: the environment as the *primary natural resource* as well as activities dependent on *environmental quality*.

The following section 2.2 and 2.3 presents the updated figures of the both studies. 2.4 provides a synthesis and discussion on the results.

2.2 Update of the Ecorys and IDEA study

As outlined before, the focus of the Ecorys and IDEA study is mainly on protection and management activities, or eco-industries. For example, eco-tourism, where the primary purpose is tourism, is not included in the main analysis. We call these industries ‘connected’ eco-industries. Other examples of ‘connected’ eco-industries are automotive, ICT, paper industry, chemicals.

Furthermore, a few activities have the environment as a primary natural resource or input into the economic process, e.g. agriculture, forestry and mining, are not considered in this update as they do not fit under the previously mentioned definition of eco-industries.

2.2.1 Approach and methodology

The approach and methodology of this update follow the Competitiveness study on Eco-industries by Ecorys and IDEA (2009). Meanwhile, some of the indicators in the methodology have been updated, or more information has been made available, a refined approach and methodology has been added to the analysis. Therefore, we have an ‘old’ methodology and a ‘new’ methodology. For the data ranges that have been updated in Eurostat, the most recent figures have been used for the analysis. This is important (and interesting) as data in Eurostat is sometimes retrofitted when updated, meaning that some historical data has been changed/updated since the Ecorys and IDEA study. Besides updating the historical data, the new data on the relevant variables to calculate employment in the eco-industries have been added to the analysis, which will be elaborated upon further in the next section.

The updated methodology and numbers are a better representation of jobs related to the environment for several reasons. First, previous studies have relied on numbers which are now outdated. New information has been made available and lead to changes in labour compensation factors and EPE levels. In some cases the updated numbers have lead to rather large differences in the results compared to old studies. Moreover, the updated figures accommodates new methods of estimating EPEs in member states which also should increase the reliability of our model. Second, the updated methodology reflects the improvements in data in Eurostat. The introduction of new NACE codes enable us to better understand the metadata underlying EPE figures. Moreover, issues of double counting in particular in the waste and recycling sectors have been addressed in close cooperation with Eurostat staff. Finally, Eurostat also released improved data on labour compensation which has made it possible to refine the model with regard to OPEX and CAPEX. In sum, since the previous studies made on green jobs, Eurostat has released both new figures, introduced new NACE codes, and improved labour compensation data. This makes it possible to refine the methodology as well as updating the data sets with reliable data instead of extrapolations and estimations.

2.2.2 *'Old' methodology*

To estimate the size of the employed workforce, a top-down estimation has been conducted using Environmental Protection Expenditures (EPEs). In Eurostat, the following definition of EPE is provided on the scope and coverage of these expenditures[4]:

"EPEs are defined as the money spent on all purposeful activities directly aimed at the prevention, reduction and elimination of pollution or nuisances resulting from the production processes or consumption of goods and services. Excluded are activities that, while beneficial to the environment, primarily satisfy technical needs or health and safety requirements.
Taking into account the limitations that occur due to data availability, the indicator environmental protection expenditure (EPE) that can be found in the data base includes total investments and total current expenditure"

In the 2009 Ecorys and IDEA study, a set of ten sectors were defined that classify under the definition of eco-industries. For sake of methodological congruency, the same classification is used for conducting the update of the 2009 Ecorys and IDEA study – for both the 'old' methodology and the 'new' methodology. The defined sectors taken into account in the analysis are:

Pollution management

1. Air pollution control
2. Waste water management
3. Solid waste management
4. Soil and groundwater remediation
5. Noise and Vibration control

Resource management

6. Biodiversity & Landscape
7. Water supply
8. Recycled materials
9. Renewable energy production
10. Others (includes for example, General public administration and Private environmental management)

[4] Eurostat (2012), '*Environmental protection expenditure in Europe - detailed data*', Metadata information in Eurostat Statistical Handbook on the Eurostat online website

For these sectors, an update is given to the (direct) environmental employment. The following data series have been used for (re-)calculating the employment figures:

- EPE per environmental domain[5] and country (Eurostat);
- The Labour Compensation Factor (Ecorys and IDEA, based on ECOTEC 2002) per environmental domain and country;
- The percentage of operational expenditures (OPEX) used for current activities in the total expenditures. As such, the analysis focusses on employment in operational activities related to the environment and does not estimate investment-related jobs;
- The annual wage in the different environmental sectors/domains and EU-27 countries (Eurostat)[6]

Based on these data series, the employment in eco-industries – in line with the definition used in the Ecorys and IDEA study – has been defined as:

Employment *= [(EPE * Labour Compensation Factor) / (wage per year * OPEX[7])]*

The main scope for the employment analysis is linked to the different environmental domains, as defined by Eurostat (see list above). For each of these environmental domains the EPEs have been retrieved, however, the quality of data differs significantly per domain. For some of the environmental domains (in particular for 'soil and groundwater' and 'noise and vibration') the data availability for some EU-27 countries was rather limited or even missing. In order to get a representative figure for the overall EU-27 figures of EPEs, the data gaps have been filled. This means that country series have been completed (or filled in) via an average calculated EPE ratio in the EU-27 countries were data is available for the environmental domain[8].

For each of the environmental domains, EPE data has been retrieved from Eurostat for the NACE classified sectors in Table 1. Eurostat does not contain EPE data for all the environmental domains – for which proxies had to be calculated – but does contain EPE data for:

- Air pollution
- Waste water management
- Waste management
- Soil and groundwater
- Noise and Vibration
- Biodiversity
- Other environmental domains (protection against radiation, research and development and CEPA 9 - general administration of the environment, education, training and information, etc)

5 As adopted by the UN Statistical Commission, the international standard for Environmental Protection is CEPA 2000 (Classification of Environmental Protection Activities and Expenditure). CEPA classifies environmental protection activities and expenditure in nine main areas known as "environmental domains". Each domain is then further divided into categories and subcategories, however for this study we will remain on the first level.

6 The average annual wage was used for the closest matching NACE code sector for which data was available through Eurostat. Member State specific wages were used. Use of average wages is subject to certain statistical limitations, for example it gives no reflection of wage distribution, though for the purposes of this update of total jobs this was judged to be acceptable.

7 Within this formulae, EPE represents the total environmental protection expenditures. More important to note is that OPEX refers here to the share of operational expenditures (OPEX) in the total EPE (and not to the OPEX numbers).

8 The EPE ratio has been calculated on a per capita basis. The methodology for this has been as follows: The EPEs of individual EU-27 countries in a certain environmental domain have been aggregated to an EU-figure (e.g. EU-25 when 2 EU countries were missing). The aggregated EPE number has been divided by the total population in the EU countries that are represented in the EU-figure, resulting in an average EPE/population share. For the EU countries were data was missing, the average EPE/population share has been multiplied by the total population in the EU country missing. The calculated EPE data series have been checked for robustness via data comparison (with other EU countries and consultation of national statistical agencies).

Table 1 NACE classification for Environmental Protection Expenditures (EPEs)

NACE code	Industry
A_B	Agriculture, hunting, forestry and fishing
C	Mining and quarrying
D	Manufacturing
E	Electricity, gas and water supply
EP_SPE	Private and public specialised producers of EP services
EP_GOV	General government
EP_OTH	Other business sectors (except producers of environmental services)

Source: NACE classification nomenclature and Eurostat

In Eurostat, EPE data for the environmental domains ‘Water Supply’, ‘Recycling’ and ‘Renewable energy production’ is missing/not available such that some good proxies for EPE had to be identified.

For ‘Water Supply’ and ‘Recycling’, the production values from the national accounts of the countries have been collected as proxy for EPE in the environmental domain – in line with the defined proxy in the 2009 study. Important to note is that the values in the national accounts are production values and not expenditures. In other words, the production values give an indication of output values instead of expenditures. However, the retrieved growth rates from the production values give a good indication of trends in EPE in those environmental domains.

The calculation of EPEs on ‘Renewable energy production’ is more challenging. Data is available on supplied renewable energy source (RES) however investments, particularly environmental protection related investments, are difficult to find and/or if available are greatly aggregated. The European Renewable Energy Council (EREC) estimates the annual turnover of the industry at EUR 70 billion, however it cannot provide an account for the separate countries or sectors. Therefore, to come to a good estimation, we used total installed renewable energy capacity per year and per country and multiplied this by the average investment costs per megawatt (MW) installed (Ecofys, 2011). This means that the assumption is made that average investments in renewable energy are taken as a proxy for EPE in renewable energy. The total installed capacity for the renewable energy sources in MW per year[9] have been retrieved from Eurostat. Based on the total installed capacity per year, annualized capacities (relative change per year) have been calculated, or the *annual installed* capacity in MW per technology group. Using the average investment cost per MW, multiplied by the annual installed capacity, the annual average investment per technology group and EU-27 Member State per year could be calculated. Given this methodology, the average investment in renewable energy source technologies would be EUR 54 billion in 2009, which comes close to the figures provided by EREC. By further scanning of existing literature on this topic, the investment figures for wind energy (EUR 11 billion in 2009) are the same as those published by the European Wind Energy Association (EWEA) (EWEA, 2011). For photovoltaic our estimation, EUR 25 billion in 2009, is very close to other estimates such as Greenpeace’s EUR 21 billion for 2009 (Greenpeace, 2009).

Finally, it was necessary to make inter- and extrapolations to fill the ‘missing gaps’ in the available data. Usually averages from the year before and after – for which data was available – were taken and annualized growth rates were used to make estimates for future years. For ’Water Supply’ and ‘Recycling’, if data was missing for countries, OECD data was used. Results for EPE data between

[9] Data for: Hydro (small, medium and large scale), Solar Photovoltaic, Solar Thermal Electric, Wind, Municipal Waste, Biomass Waste, Tidal, Landfill Gas, Swage Sludge Gas and Other Biogas (note: Biofuels and Fuels cells have been excluded).

this study and the 2009 study can vary considerable between countries, but generally EPE is recorded at higher levels for this study.

2.2.3 *'New' methodology*

After a closer examination of the approach and methodology of the Ecorys and IDEA study, as well as the metadata for EPE and the calculation method, a more robust and complete result through modifications on some parts of the methodology could be generated. In particular, since some assumptions of the 2009 study are 'out-dated' as more recent data has been made available. Below the modifications are listed which are also worked out in the results and comparison section.

Increasing completeness of data

Since the 2009 study, Eurostat has implemented additional data sets to the online database in the form of the European environmental accounts. The environmental accounts focus specifically on the environmental protection expenditures (EPEs) tailored towards industry, size classes, environmental domains and NACE classifications. In the detailed data set, the EPE data is split into four main sectors:

1. Business Sector Total
2. Private and public specialised producers of EP services
3. General government
4. Other business sectors (except producers of environmental services).

We would assume that the 'Business sector total' should be the aggregate of EPE data for the NACE code sections 'Agriculture, hunting, forestry and fishing', 'Mining and quarrying', 'Manufacturing and Electricity', 'Gas and water supply' (NACE codes A_B, C, D, E) as it has been used in the 2009 study. However, the 'Business Sector Total' yields higher EPE figures than the aggregate of the separate subsectors. These higher number is due to double-counting of 'other business sectors' since these are included in 'Business sector total'. 'Other business sectors' takes up a fairly small share namely 1% in 2000 and 7% in 2008.[10] However, the EPE data for the 'Business sector total' (aggregate of the NACE activities A_B, C, D and E, together with the 'Other business sectors (EP_OTH)) result in the same EPE figures as the separate NACE codes. Therefore, for simplicity, the EPE data of the 'Business sector total' (EP_BUS) has been used instead of the separate sub-classifications.

For the 'new' methodology the NACE codes described in Table 2 have been used.

Table 2 NACE codes used for updated calculations

NACE code	Industry
EP_BUS	Business sector total (All NACE activities (A_B, C, D and E), except for activities of specialized producers (EP_SPE), recycling (DN37) and government (EP_GOV)
EP_SPE	Private and public specialised producers of EP services
EP_GOV	General government

Source: NACE classification nomenclature and Eurostat

Redefining waste management

In the 2009 study, the environmental domains 'Waste Management' and 'Recycling' were both used. For 'Waste Management' the EPE data were retrieved from Eurostat, where 'Recycling' data were based on production values from the national accounts. Potentially, this could lead to double-counting as the EPEs of specialized producers (EP_SPE) were already taken into account,

10 Explanation derived from personal communication with Eurostat staff.

additionally to the EPE data of the 'Business sector total'. Further counselling the metadata in Eurostat, the 'Private and public specialised producers of EP services' are defined as those that could also include environmental management activities provided by environmental consultants, the activities of e.g. volunteer environmental organizations or secondary environmental activities in e.g. NACE Rev. 1.1 division 37 Recycling (NACE Rev. 2 class 38.3 Materials recovery). The potential double-counting would result from aggregating the total EPEs of all sectors, with the assumption that all these EPEs have a labour content. A practical example: if the expenditure of one company for buying waste management services are added to the operating expenditure of the company that provides these services, there would be a double-counting 'problem', as only the latter expenditure has a labour content.

In the 2009 study, the total EPEs of the 'Business sector total' (EP_BUS) were added to the EPEs of the specialized producers (EP-SPE) and as such they would lead to a double-counting 'problem' given the new definitions in the European environmental accounts database (established after 2009). Therefore, the EPEs of the specialized producers should not have been added to the overall EPE figures. However, in the first update of the EPE data in this study, it has been assumed that 'Recycling' is covered by 'Waste Management' by all sectors, and therefore the total 'Recycling' figures were subtracted from the 'Waste Management' figures in Eurostat. Besides subtracting the figures of 'Recycling' from the 'Waste Management' data, at the same time, the EPEs of the specialized producers were added to the overall aggregate of EPEs of the 'Business sector total' (EP_BUS) and 'Government' (EP_GOV) in the first update.

Based on the Environmental Goods and Services Sector (EGSS) data in Eurostat, 80-90% of the 'Recycling' belongs to 'Waste management'. Moreover, a same percentage of EPEs of the specialized producers (EP_SPE) are assigned in Eurostat to 'Waste management'. Theoretically, the best method to 'correct' for the double-counting issue would be to have the full EPEs for 'Waste management' and to exclude the EPEs of specialized producers (EP_SPE) for the analysis. However, given that the impact might be insignificant (for doing the one or the other), some small experiments have been conducted to see what the impact would be of the 2 different approaches. After doing some experiments and making some robustness checks, it turned about that the error margin, in terms of underestimation of EPE, was below 1,5%. Therefore, the proposed redefinition of waste management (so include EP_SPE and subtract 'Recycling' from 'Waste management') has been kept and notice has been taken of the other (methodologically 'better') method to take into account for further updates of this study.

Calculation Adjustments

The below formula has been used to calculate the employment in eco-industries in the Ecorys and IDEA study, and has been used under the 'old' methodology:

***Employment** = [(EPE * Labour Compensation Factor) / (wage per year * (OPEX/EPE))]*

There are two important points and notes to be mentioned regarding this formula.

1. First, the Labour Compensation Factor used in the Ecorys and IDEA study was based on a factor from an ECOTEC (2002) report. Therefore, an update of this factor would increase the robustness of the model, in particular since significantly more data and information has been made available;
2. Secondly, when applying the 'updated' Labour Compensation Factor (methodology is explained below), there is no need to further multiply the equation by OPEX, as the 'old' Labour Compensation Factor of the ECOTEC study relied on operational expenditures only instead of EPEs (so operational expenditures and capital expenditures). In other words, the 'new' Labour Compensation Factor already 'adjusts' for OPEX in calculating the sectoral LCF-factors.

Hence, the following (adjusted) formula to calculate employment in eco-industries should be applied, given the 'new' (calculated) Labour Compensation Factor:

Employment 2 *= [(EPE * Labour Compensation Factor) / wage per year]*

The 'new' Labour Compensation Factor has been calculated by dividing the 'Total Labour Compensation' by 'Total (gross) Output' of the relevant NACE subsectors in Eurostat. The ECOTEC Labour Compensation Factors were relying on the operational expenditures within the different environmental domains. Practically, this means that these old LCFs included only the labour compensation for operational activities (i.e. these are mainly labour-intensive), instead of overall activities – the ECOTEC study had different factors for operating expenditure and for investment – and therefore seems to be overestimating the share of labour compensation. For this reason the old LCF 'needs' to be corrected for OPEX in order to have a more accurate estimation of the labour share within the EPEs.

The 'new' proposed methodology is based on the available labour compensation data in Eurostat, which was, most likely, not available at the time of the ECOTEC study. The labour compensation data of Eurostat cover the entire environmental domain/sector, and as such provides a more accurate estimate of LCF than the compilation of LCF in the ECOTEC study. Furthermore, Eurostat allows the use of a LCF over time (per year, instead of one LCF over a certain time scale) and per EU-27 Member State. This means that a differentiation on a Member State level can be made now, as the ECOTEC study applied the same LCF to every Member State over all years.

To give a better indication what this means, the reader is advised to refer to the table below for a comparison between the 'new' and 'old' Labour Compensation Factor. In general, the move to a new way of calculating the labour compensation factor has resulted in a decrease in the factor, as seen in the average changing from 42% to 25%. For individual sectors there have also been significant changes, the two lowest factors by the previous method (air pollution control and remediation) being shifted up, while all other sectors saw reductions. Variation between the sectors is relatively low in both the old and new methods, with most factors clustered around the average. The table shows the range of MS factors produced using the new calculation method.

Without having access to the original ECOTEC calculations and methods it is impossible to see directly how the old factors were reached, it appears that the original calculations were based on costs, with the new method based on output, an important difference in calculation method, justified by the reasons outlined above. Without knowing the 'old' method exactly it is not possible to explain why the, sometimes drastic, changes in factors occur beyond the view that outputs are higher than costs, leading to a natural downward bias as labour compensation is divided by a higher figure. An argument could also be made that the sectors were more labour intensive in the past and that they have, over time, become more capital intensive. This would be particularly evident in the important sector of waste management where a greater trend towards automation has clearly been happening. While these explanations are not wholly satisfactory we are confident that the new factor is more robust and transparent than that used previously, and checking at the micro (firm) level confirms this (see below).

Table 3 Comparison between different Labour Compensation Factors (LCFs)

Environmental Domains	ECOTEC 'old' LCF	New calculated LCF	Maximum value for LCF factor (MS range)	Minimum value for LCF factor (MS range)
Air Pollution Control	15%	24%	45,8%	15,0%
Waste Water Treatment	40%	25%	35,8%	12,0%
Waste Management	60%	27%	57,2%	15,0%
Remediation	20%	27%	57,2%	15,0%
Noise & Vibration	65%	24%	45,8%	15,0%
Biodiversity	44%	27%	60,5%	6,3%
Other	44%	31%	43,4%	15,0%
Water Supply	40%	25%	35,8%	12,0%
Recycling	44%	13%	29,6%	5,3%
Renewable Energy	44%	24%	45,8%	15,0%
Average	**42%**	**25%**		

Source: Ecorys and IDEA (2009), AMADEUS database and own calculations

Table 3

To give a better indication what this means, the reader is advised to refer to the table below for a comparison between the 'new' and 'old' Labour Compensation Factor. In general, the move to a new way of calculating the labour compensation factor has resulted in a decrease in the factor, as seen in the average changing from 42% to 25%. For individual sectors there have also been significant changes, the two lowest factors by the previous method (air pollution control and remediation) being shifted up, while all other sectors saw reductions. Variation between the sectors is relatively low in both the old and new methods, with most factors clustered around the average. The table shows the range of MS factors produced using the new calculation method.

Without having access to the original ECOTEC calculations and methods it is impossible to see directly how the old factors were reached, it appears that the original calculations were based on costs, with the new method based on output, an important difference in calculation method, justified by the reasons outlined above. Without knowing the 'old' method exactly it is not possible to explain why the, sometimes drastic, changes in factors occur beyond the view that outputs are higher than costs, leading to a natural downward bias as labour compensation is divided by a higher figure. An argument could also be made that the sectors were more labour intensive in the past and that they have, over time, become more capital intensive. This would be particularly evident in the important sector of waste management where a greater trend towards automation has clearly been happening. While these explanations are not wholly satisfactory we are confident that the new factor is more robust and transparent than that used previously, and checking at the micro (firm) level confirms this (see below).

Table 3 illustrates that through the new calculation method different compensation factors per environmental domain can be used. This is illustrated by the minimum and maximum boundaries for the compensation factor per environmental domain, which refer to a specific LCF for a specific Member State. In other words, the last two columns indicate the spread in labour compensation factors, with the fourth column (maximum value) indicating the highest LCF for a particular domain. The last column is indicating the same principle, but then for the minimum values per environmental domain.

Because this information is gathered on a macro-economic level, questions regarding the validity at micro level are valid, and some robustness checks should be considered. For checking on robustness two different methods have been used:

1. Annual financial reports of Europe's largest companies in waste management, renewable energy and waste water were scanned. The results found on labour compensation ratios were all within the ranges suggested in the table, and close to the new suggested LCFs.
2. Furthermore, IDEA Consult has been consulted for a check on robustness following micro level data via the AMADEUS database. Within AMADEUS, the labour compensation factors for 'Water collection, treatment and supply (NACE code 36)', 'Waste collection, treatment and disposal activities; materials recovery (NACE code 38)' as well as 'Wholesale of waste and scrap (NACE code 46.77)' on a micro level have been aggregated to macro level data. The results obtained for the LCFs showed small differences (that were not significant) compared to the LCFs calculated via the 'new' methodology.

Therefore, for environmental domains where the LCF of AMADEUS had insignificant differences with the 'new' methodology, the LCFs of this 'new' methodology has been used for the relevant environmental domain. For the environmental domains where the LCF of AMADEUS was significantly different from the 'newly' calculated LCFs, the LCF from AMADEUS is used as the AMADEUS LCF are more robust and seem to be more reliable.

2.2.4 *Results and comparison*

The results and comparisons are from using the 'old' and 'new' methodologies are presented separately below.

Results and comparison – 'Old' methodology

Using the 'old' methodology the employment directly related to the environment and resource efficiency improvements (hereafter referred to as employment) of the total EU eco-industry in the EU-27 following the update is estimated at about 3,1 million jobs in 2008. This is in line with, but slightly lower than the number of jobs calculated in the Ecorys and IDEA study of 3,4 million (see Table 4 and Table 6)

The growth rate of employment is also lower than in the Ecorys and IDEA study. Between 2000 and 2008 the total growth rate is adjusted from 72% previously to 25%. On an annualized basis (2000-2008) this equates to 7% and 2,8% growth respectively, where the annualized growth rate between 2004 and 2008 decreased from 3,9% to 0,7% (see Table 5 and Table 7).

Table 4 Total employment in millions – 2009 study

Total (in million)	'00	'01	'02	'03	'04	'05	'06	'07	'08
Total employment	2,0	2,4	2,4	2,5	2,8	2,9	3,1	3,2	3,4
Annual growth (%)		19%	2%	3%	10%	6%	5%	6%	6%

Source: Ecorys and IDEA (2009) (shaded cells are estimations)

Table 5 Percentage change (%) in employment – 2009 study

% change '04 - '08	% change '00 - '08	Annualized '00 – '08	Annualized ''04 – '08
25,0%	71,6%	7,0%	3,9%

Source: Ecorys and IDEA (2009)

Table 6 Total employment in millions – new figures

Total	'00	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12
Total employment	2,5	2,9	2,9	2,9	3,1	2,9	3,0	3,1	3,1	3,2	3,4	3,6	4,0
Annual growth (%)		14%	2%	-1%	6%	-7%	7%	1%	2%	3%	7%	3%	12%

Source: Ecorys calculations (shaded cells are estimations)

Table 7 Percentage change (%) in employment – new figures

% change '04 - '08	% change '00 - '08	Annualized '00 – '08	Annualized '04 – '08
2,8%	24,6%	2,8%	0,7%

Source: Ecorys calculations

The updated methodology shows a relatively lower increase in employment in the current study, compared to the 2009 study.

Part of the explanation for this lower increase in the total number of employees (i.e. employment directly related to the environment and resource efficiency improvements), are overestimations of 'future' EPEs for certain EU-27 Member States in the 2009 study. By updating the actual EPEs, some overestimations were recognized. This resulted in subsequently higher reported EPEs. For example, when the actual Eurostat data on EPE for 'Waste Management' in Spain would be inserted into the employment calculations of the 2009 study, total employment would drop by 150.000 jobs.

Another part of the explanation is that the average wage levels have increased in many of the EU-27 Member States compared to earlier projections, either in real terms or due to methodological changes in Eurostat, which means that the 'EPE* Labour Compensation Factor' component of the employment 2 equation is divided by a higher wage level.

Finally, more robust and accurate data can be accessed on Eurostat regarding OPEX. This means that the share of OPEX/EPE has, on average, fallen slightly and can therefore explain a further drop of the estimated employment.

Important to note is that, for the years with actual data (from 2001 to 2008), the environmental domains show – broadly speaking – a stable trend in terms of employment. From 2008 onwards, an annualized growth rate – calculated over the last 5 years of available data – has been applied. Only the last 5 years have been taken into account to as we wanted to give particular weight on the most recent trends in EPE, and to 'prevent' optimistic overestimations from historic data (i.e. the high growth rate in the 'first' years of the environmental domains might bias the trends in EPEs of recent years). Therefore, the estimations for some domains might seem to deviate from the stable trend over the years with actual data.

Table 8 shows the distribution of employment amongst the different environmental domains. The 'Waste' domain has the highest share of labour with about 1,3-1,4 million people employed. The two sectors with the largest observed growth between 2000 and 2008 are 'Recycling' and 'Renewable energy' with 75% and 78% respectively. The table indicates that renewable energy has a relatively low absolute share of employment although it has the second highest growth rate

(75%), however, investments in renewable energy increased rapidly from 2008 onwards and in 2010 the estimations for the domain are over 568.000 people employed.

Table 8 Updated total employment figures

	Employment 2000	Employment 2008	Employment 2010	Growth rate 2000 -2008 (per year)	Total growth 2000 - 2008
Air	33.668	30.816	29.598	-1,10%	-8,47%
Wastewater	390.138	418.324	417.002	0,88%	7,22%
Waste	1.111.613	1.361.160	1.339.923	2,56%	22,45%
Soil & groundwater	14.460	21.111	21.029	4,84%	46,00%
Noise	11.688	9.005	8.018	-3,21%	-22,96%
Biodiversity and Landscape	40.123	47.746	53.025	2,20%	19,00%
Other	144.861	180.399	177.309	2,78%	24,53%
Water supply	375.981	367.943	348.481	-0,27%	-2,14%
Recycling	238.774	425.373	480.056	7,48%	78,15%
Renewable energy	160.136	280.394	568.002	7,25%	75,10%
Total	**2.521.442**	**3.142.272**	**3.442.443**	**2,79%**	**24,62%**

Source: Ecorys calculations (shaded cells are estimations)

Table 9 presents a comparison of the total employment directly linked to the environment in the Ecorys and IDEA (2009) study and the employment figures from Table 8, including the distribution over the different environmental domains and time. Generally speaking, employment in the environmental domains follows a similar distribution. However, the employment in the domains: ‘Waste’, ‘Water supply’ and ‘Recycling’ are not as large as the updated figures in the Ecorys and IDEA study. On the other hand, employment in ‘Renewable energy’ is roughly 110.000 jobs higher than the estimates from the 2009 study.

Table 9 Comparison between Old and New employment figures

	Ecorys and IDEA 2009 study			New study; only updated EPE		
	Employment 2000	*Employment 2008*	*Annualized growth 2000-2008*	*Employment 2000*	*Employment 2008*	*Annualized growth 2000-2008*
Air	22.600	19.067	-2,1%	33.668	30.816	-1,10%
Waste water	253.554	302.958	2,3%	390.138	418.324	0,88%
Waste	844.766	1.466.673	7,1%	1.111.613	1.361.160	2,56%
Soil and groundwater	14.882	18.412	2,7%	14.460	21.111	4,84%
Noise	4.176	7.565	7,7%	11.688	9.005	-3,21%
Biodiversity & Landscape	39.667	49.196	2,7%	40.123	47.746	2,20%
Others	129.313	193.854	5,2%	144.861	180.399	2,78%
Water supply	417.763	703.758	6,7%	375.981	367.943	-0,27%
Recycle	229.286	512.337	10,6%	238.774	425.373	7,48%
Renewable energy	49.756	167.283	16,4%	160.136	280.394	7,25%

	Ecorys and IDEA 2009 study			New study; only updated EPE		
	Employment 2000	*Employment 2008*	*Annualized growth 2000-2008*	*Employment 2000*	*Employment 2008*	*Annualized growth 2000-2008*
Total	**2.005.764**	**3.441.102**	**7,0%**	**2.521.442**	**3.142.272**	**2,79%**

Source: Ecorys - IDEA (2009) and own calculations

With regard to EPE, we observe two developments in comparison to the 2009 study:
First, EPE figures for the year 2000 and later were revised in Eurostat. For some countries and domains this resulted in a downward correction (in other words, reduction in EPE figures), but overall the majority of the figures were revised upward. In for example Germany, the figure for 'Waste Management' increased from EUR 4 billion to EUR 16 billion. These corrections can explain almost 70% of the upward revision. The large increase can be explained by a change in reporting methods from Germany in 2010. In 2008 the German EPE for public sector and specialised producers were not calculated since Germany only reported investments figures but not total current expenditure for these sectors (for calculation of EPE both variables are necessary). Total current expenditure was not reported because those figures would have contained only data on internal current expenditure but not fees and purchases (fees and purchases are not available in Germany for these two sectors). In 2010 Germany, in line with the practice of other countries, revised their time series as compared to 2008 data collection and reported values for total current expenditure even if they included only data for internal current expenditure. This revision of Germany data resulted in an increase of EUR 26 billion as a whole for 2000, more than 11 billion EUR in waste management and EUR 13 billion EUR in wastewater management for Germany.[11] The revision clearly influences the high figures from 2000;

Secondly, actual EPE figures for the year 2008 turned out to be higher than the estimated based on growth rates until 2005 in the previous study. Especially expenditure in 'Wastewater Management' and 'Renewable Energy' are higher by 60% and 40% respectively.

Overall, as both 2000 and 2008 EPE values increased in absolute terms, whereas the relative annual growth rate 'declined' in the same period for the updated values. Corrected for inflation, the annualized growth rate (2000-2008) in the Ecorys and IDEA study was 6,7% per annum, where the annualized growth rate in the update is 3,3%.

Table 10 Comparison between Old and New EPE figures

	Ecorys 2009 study			New study; only updated EPE		
	EPE in 2000 (EUR million, nominal)	*EPE in 2008 (EUR million, nominal)*	*Annualized growth 2000-2008 (corrected for inflation)*	*EPE in 2000 (EUR million, nominal)*	*EPE in 2008 (EUR million, nominal)*	*Annualized growth 2000-2008 (corrected for inflation)*
Air	4.838	7.237	3,1%	11.284	14.410	0,5%
Wastewater	22.035	34.323	3,6%	43.482	55.884	0,6%
Waste	49.793	92.207	5,9%	70.034	95.672	1,3%
Soil and groundwater	4.275	6.353	3,0%	3.340	6.976	6,9%

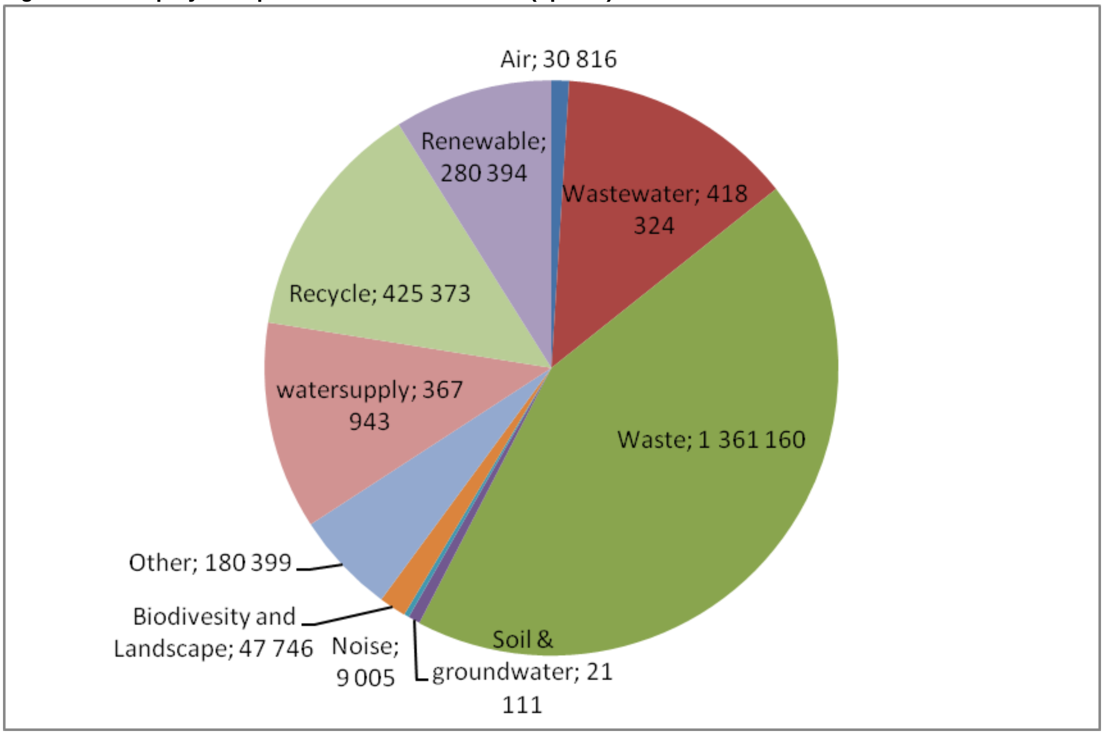
[11] The explanation provided for the German case has been given by Eurostat through personal communication.

	Ecorys 2009 study			New study; only updated EPE		
	EPE in 2000 (EUR million, nominal)	*EPE in 2008 (EUR million, nominal)*	*Annualized growth 2000-2008 (corrected for inflation)*	*EPE in 2000 (EUR million, nominal)*	*EPE in 2008 (EUR million, nominal)*	*Annualized growth 2000-2008 (corrected for inflation)*
Noise	522	1.112	7,8%	1.156	1.200	-2,1%
Biodiversity & Landscape	3.830	6.775	5,3%	6.030	10.006	3,8%
Others	14.035	26.663	6,2%	17.741	28.590	3,5%
Water supply	39.329	63.248	4,0%	39.282	55.289	1,7%
Recycle	17.444	54.816	13,1%	19.538	49.163	9,4%
Renewable	6.122	26.325	17,6%	11.811	37.647	12,7%
Total	162.223	319.060	6,7%	223.698	354.836	3,3%

Source: Ecorys and IDEA (2009) and Ecorys calculations

Figure 1 and Figure 2 visualize the distribution of employment for both the previous study and the updated figures.

Figure 1 Employment per environmental domain (update)



Source: Ecorys calculations

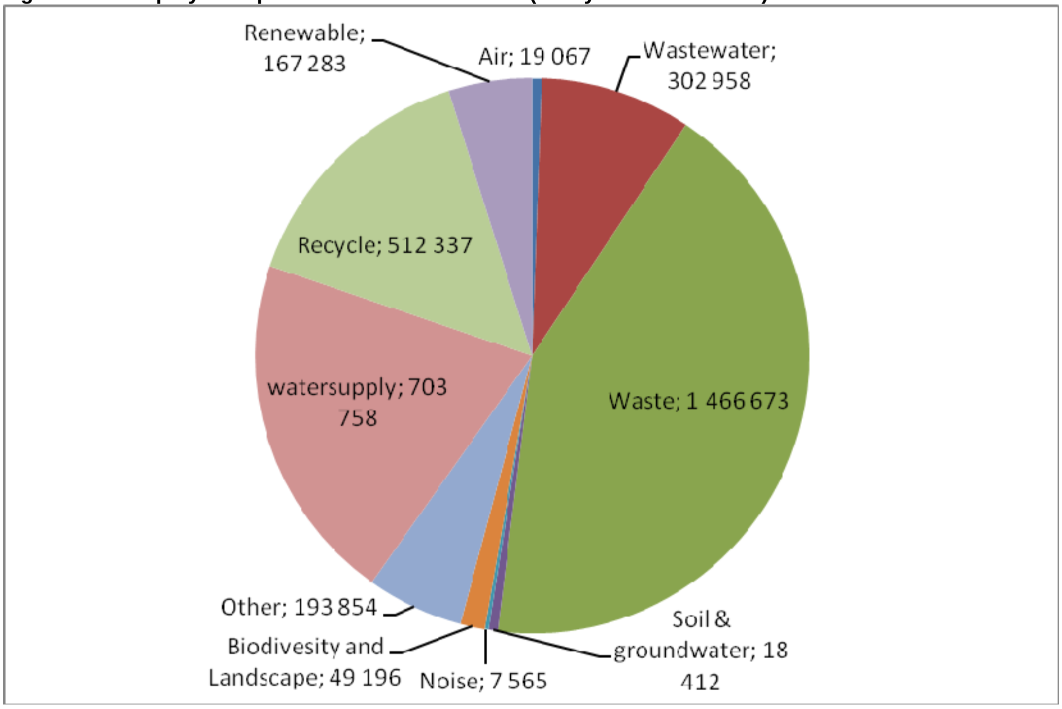
Table 11 Employment per environmental domain (update)-2

EU (27)	2008
Air	30.816
Wastewater	418.324
Waste	1.361.160
Soil & groundwater	21.111
Noise	9.005

EU (27)	2008
Biodiversity and Landscape	47.746
Other	180.399
Water supply	367.943
Recycle	425.373
Renewable energy	280.394
Total	3.142.272

Source: Ecorys calculations

Figure 2 Employment per environmental domain (Ecorys and IDEA 2009)



Source: Ecorys and IDEA (2009)

Table 12 Employment per environmental domain (Ecorys and IDEA 2009)

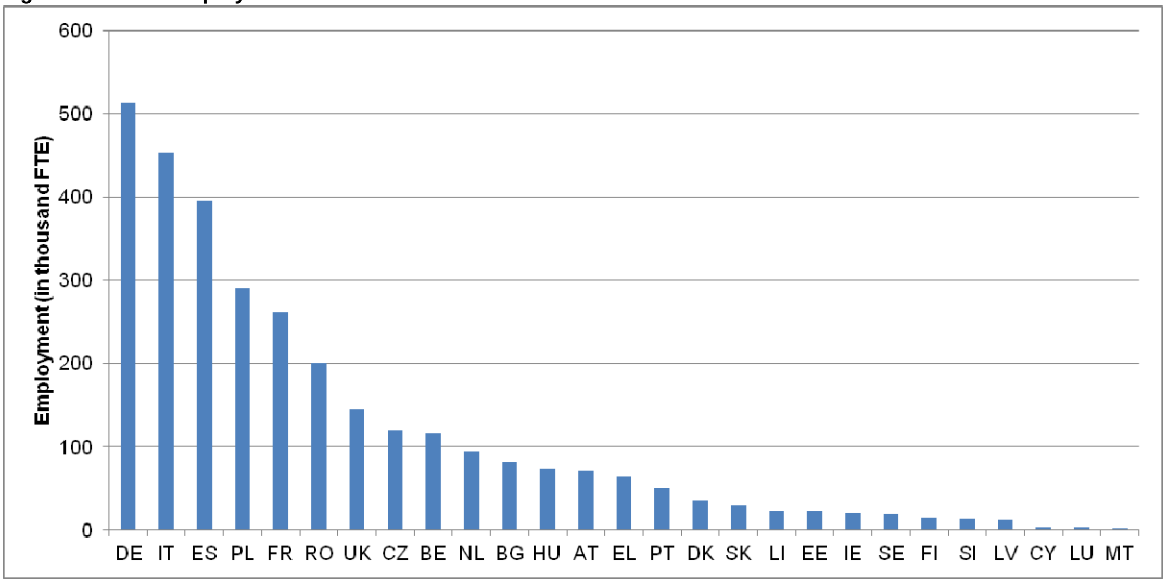
EU (27)	2008
Air	19.067
Wastewater	302.958
Waste	1.466.673
Soil & groundwater	18.412
Noise	7.565
Biodivesity and Landscape	49.196
Other	193.854
watersupply	703.758
Recycle	512.337
Renewable	167.283
Total	3.441.102

Source: Ecorys and IDEA (2009)

Insight view into EPE data and employment

In the previous paragraphs the employment figures per environmental domain have been presented for both the 2009 study and the updated figures. However, it would be interesting to see how changes in employment relate to changes in EPE data on a Member State level in the updated figures. The distribution of total employment in the eco-industries amongst Member States can be seen in Figure 3. It is not surprising that the larger EU countries also boast a larger workforce in eco-industries, although some of the potential limitations of the method are visible, for example in the low employment estimated in the UK, a result of low recorded EPE. Comparing employment in eco-industries as a percentage of total working age population as presented in Figure 4, Estonia achieves the highest ratio with 2.41%.Overall, the EU-27 average is 0,94% for *direct employment* in eco-industries. Please note that the denominator of all *potential* workforce might skew the result as the average may rise if one use the *actual* workforce. It means that the average is probably a conservative estimation.

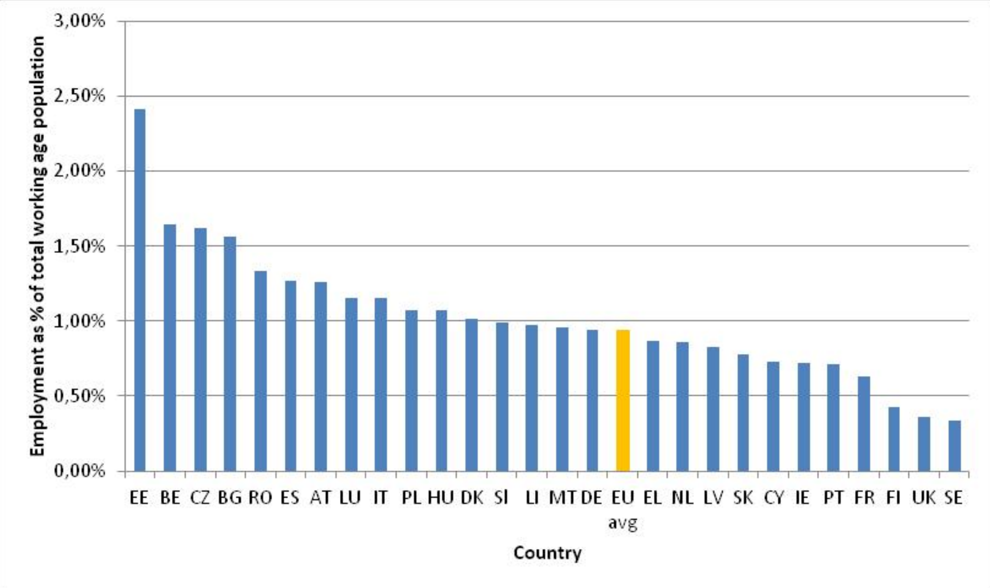
Figure 3 Total employment in eco-industries in 2008



Source: Eurostat and Ecorys

Furthermore, it should be noted that figures are based on calculations explained previously and do not account for intra-EU (or extra-EU) trade. A country which has a low level of employment relative to their total workforce in eco-industries (based on their total EPE), could show that the machines, filters or other equipment, were purchased in from another Member State. Intra-EU27 trade data of environmental technologies for 2007 can be reviewed in Table 13. Therefore, actual employment in the eco-industries per member state may be slightly different, but on aggregate level, they should sum up to the same level (although here different labour compensation factors and wage levels per country are used).

Figure 4 Employment in Eco-Industries as a % of total working age population in 2008



Source: Eurostat and Ecorys (Note: then average is 0.81 %)

Table 13 Net export position of Intra-EU trade of Environmental Goods and Services – 2007

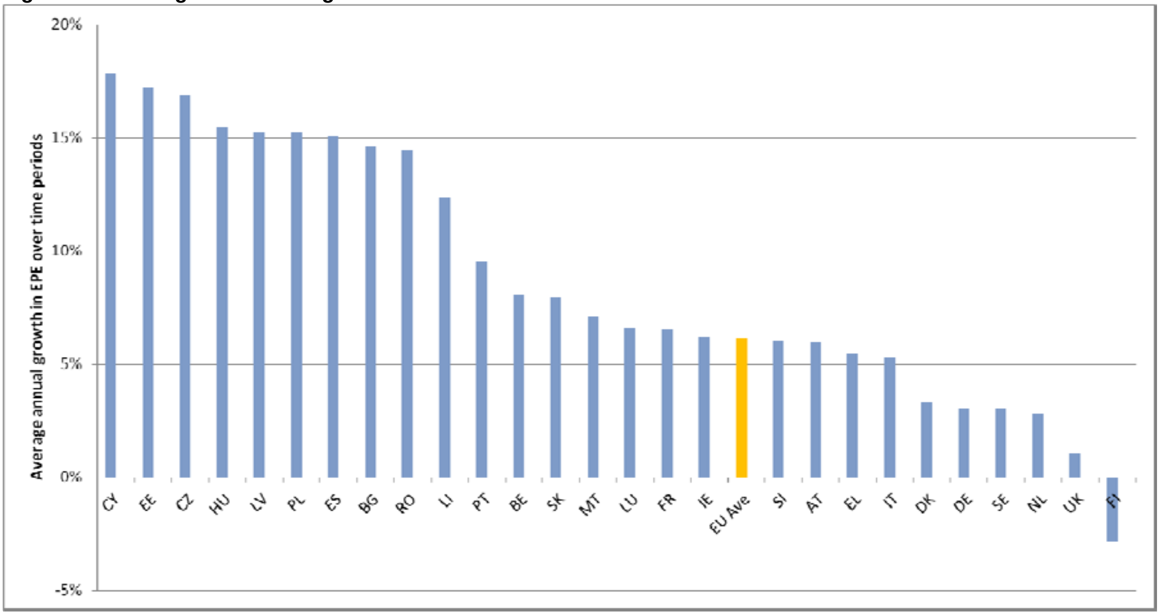
Country	Net Export Position (EUR million)	Country	Net Export Position (EUR million)
Austria	558	Sweden	-609
Belgium	533	Bulgaria	-81
Denmark	6.892	Cyprus	-8
Germany	-69	Czech Rep.	279
Spain	-4.268	Estonia	2.067
Finland	607	Hungary	2.133
France	27.497	Lithuania	1.376
UK	-1.156	Latvia	242
Greece	1.970	Malta	233
Ireland	67	Poland	-557
Italy	-2.067	Romania	345
Luxembourg	-179	Slovakia	-46
Netherlands	-927	Slovenia	-81
Portugal	1.524		

Source: COMTRADE database

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

Figure 5 illustrates that the growth in EPE over the years, on an annualized basis, has been 6,1% between 2000 and 2008 for the updated EPE figures. In absolute terms, except for Finland, all EU-27 Member States demonstrate a growth in EPE over the years. Finland saw a decline in EPE between 2000 and 2008. Overall, the annualized growth on average was higher in the period 2004 to 2008 (6,3%) compared to the 2000 to 2004 period (5,9%). Over the whole of the EU, the average growth rate of EPE is 6.1 %.

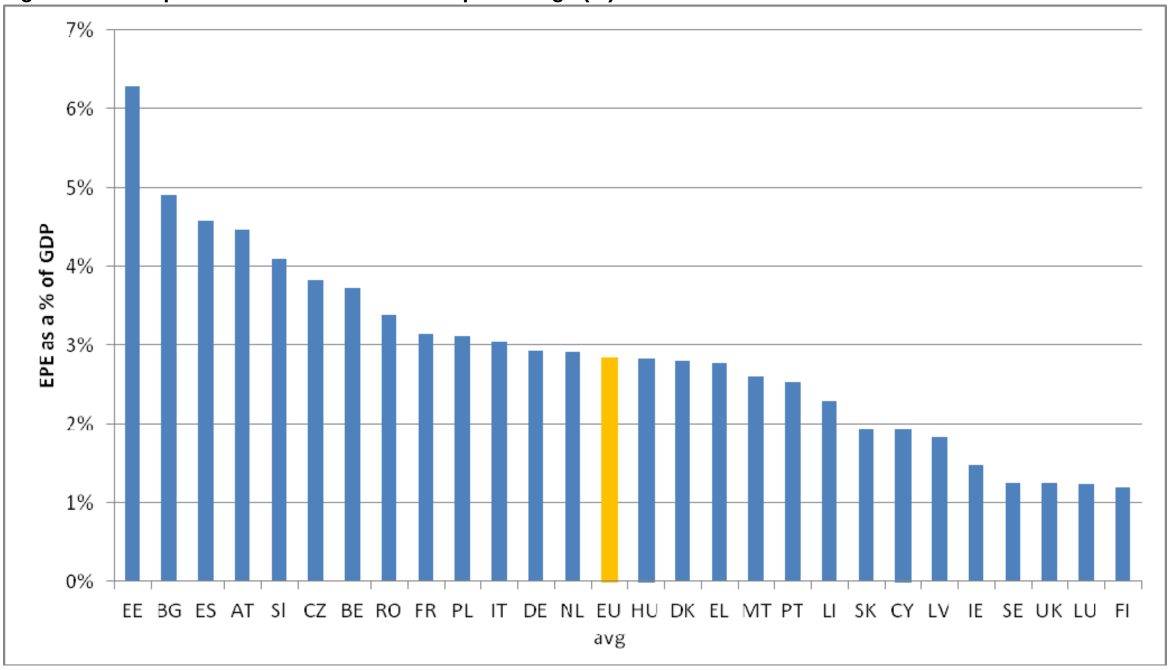
Figure 5 **Average annualized growth rate of EPE 2000 - 2008**



Source: Eurostat and own calculations

The absolute figures above show a certain picture, compared to absolute GDP, Figure 6 shows the division amongst countries, including the EU average. Ireland and Greece stand out as low spenders, as mentioned previously but this is mainly due to missing EPE data in Eurostat. Overall, the EU-15 countries have an average share of EPE to GDP of 2,4% compared to 3,2% by the EU-12 countries. Bulgaria and Spain demonstrate the highest share of EPE as a percentage of GDP (between 4,5% and 5%), with Estonia and Austria close behind with around 4,5%. Over the whole of the EU, the average share of EPE to GDP is 3,81 % (2008 figure).

Figure 6 EPE per EU-27 Member State as a percentage (%) of national GDP



Source: Eurostat and own calculations

Results – 'New' methodology

Before going into the results, it is important to note that the results are achieved by using two different 'new' methodologies. Hence, there are two types of calculations conducted to achieve employment results. These types of calculations are defined by:

- **Trial 1:** Calculation including Eurostat data updating and completeness, including a redefinition of 'Waste Management', using the 'old' ECOTEC labour compensation factor and multiplication with OPEX.

- **Trial 2:** Calculation including Eurostat data updating and completeness, including a redefinition of 'Waste Management', using the 'new' calculated labour compensation factor and not multiplying by OPEX.

Using the 'new' methodologies the employment directly related to the environment and resource efficiency improvements (hereafter referred to as employment) of the total EU eco-industry in the EU-27 is, following the update, estimated at about 3,1 million jobs in 2008 for Trial 1 and about 2,6 million jobs in 2008 for Trial 2.

Trial 1 results

Table 14 shows the distribution of employment amongst the different environmental domains, based on the redefined definition of 'Waste Management'. It indicates that employment in 2008 is about 3,3 million, which is higher than the updated figures following the 'old' methodology. Comparing to Table 8, it can be observed that the distribution is quite similar in pattern. Absolute values are larger for the (relatively) smaller environmental domains, such as 'Air', 'Noise', 'Biodiversity' and 'Other'. As expected, the employment figures for 'Waste Management' fell as the Eurostat data has been adjusted. The two sectors with the largest observed growth between 2000 and 2008 are Recycling and Renewable energy which grew by 79% and 75% respectively.

Table 14 Updated total employment figures: Trial 1

	Employment 2000	Employment 2008	Employment 2010	Annualized growth rate 2000-2008	Total growth rate 2000-2008
Air	47.996	38.545	38.671	-2,7%	-19,69%
Wastewater	458.630	539.598	573.896	2,1%	17,65%
Waste	1.062.603	1.205.116	1.167.342	1,6%	13,41%
Soil & groundwater	24.756	27.323	27.382	1,2%	10,37%
Noise	16.137	12.721	11.566	-2,9%	-21,17%
Biodiversity and Landscape	40.890	58.496	69.376	4,6%	43,06%
Other	193.489	250.861	254.836	3,3%	29,65%
Water supply	381.709	417.711	425.599	1,1%	9,43%
Recycling	237.635	424.515	479.051	7,5%	78,64%
Renewable energy	160.136	280.976	568.002	7,3%	75,46%
Total	2.623.981	3.255.862	3.615.722	3,0%	24,08%%

Source: Ecorys and IDEA (2009) and Ecorys (shaded cells are estimations)

Trial 2 results

Table **15** shows the distribution of employment amongst the different environmental domains, based on the redefined definition of 'Waste Management' and the newly calculated labour compensation factors. Employment is calculated to be about 2,7 million jobs in 2008, which is significantly lower than the updated figures following the 'old' methodology, which can be explained by the lower labour compensation factors and higher wages. The two sectors with the largest observed growth between 2000 and 2008 are 'Recycling' (still) and 'Renewable energy' with 78% and 38% growth respectively. The significant differences between the Trial 2 methodology and the 'old' methodology can be explained by the decreased labour compensation factors (checked for robustness with AMADEUS calculations) and the higher wage ratios for each of the environmental domains.

Table 15 Updated total employment figures – Trial 2

	Employment 2000	Employment 2008	Employment 2010	Annualized employment growth rate 2000-2008	Total employment growth rate 2000- 2008
Air	163.495	129.646	137.385	-2,9%	-20,70%
Wastewater	411.762	496.132	529.261	2,4%	20,49%
Waste	528.805	623.291	605.675	2,1%	17,87%
Soil & groundwater	49.877	63.753	72.260	3,1%	27,82%
Noise	15.621	12.481	12.019	-2,8%	-20,10%
Biodiversity and Landscape	59.069	80.226	97.104	3,9%	35,82%
Other	223.876	319.974	320.148	4,6%	42,93%
Water supply	406.197	463.153	479.507	1,7%	14,02%
Recycling	166.487	296.464	331.089	7,5%	78,07%
Renewable energy	169.264	233.967	381.380	4,1%	38,23%
Total	2.194.452	2.719.089	2.965.828	2,72%	23,91%

Source: own calculations; Note: shaded cells are estimations

Table 17 show the differences in the three methods and the outcomes for EPE and employment respectively. Even with the corrections for waste management, the figures for 2008 are higher compared to the previous study. However, in combination with higher figures for 2000, the growth rate per annum - corrected for inflation - is slightly lower.

Regarding employment, the changes in methodology achieve slightly higher figures overall. Adjusting the new figures with the new Labour Compensation Factor (LCF) results in an overall 'drop' in employment in both 2000 and 2008. As Table 3 indicated, the labour intensity especially for waste management halved and accordingly brought about the largest share for the reduction in employment figures. As the employment figures for 2000 and 2008 dropped almost proportionally, the growth rate per annum decreased only slightly from 3% to 2,7%.

The explanation for the higher updated employment estimate for 2000 is due to a higher EPE in that year. In the Ecorys and IDEA study EPE for 2000 was EUR 162 billion, where in the study's update EPE for 2000 (depending on what methodology used) is between EUR 210 – 230 billion. This difference results from a change in Eurostat data and a retroactive update of figures. An indicative example is Germany where the figure for 'Waste Management' increased from EUR 4 billion to EUR 16 billion – this is one of the main reasons why the 2000 employment figures are higher. The new LCF increases/decreases overall employment at a proportional rate, meaning that the annualized growth rate does not change much due to the new LCF (-0,3% compared to the same methodology but old LCF).

Table 16 **Comparison & results for EPE (times thousand EUR)**

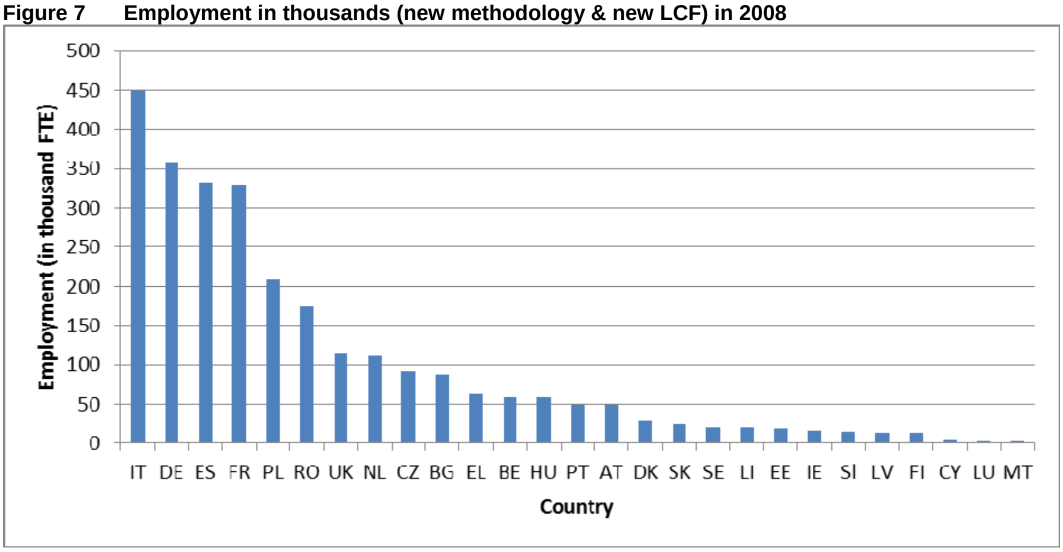
	New study; only updated EPE				New study; changed methodology, same LCF			
	2000	*2008*	*2010*	*Annualized growth '00-'08 (corrected for inflation)*	*2000*	*2008*	*2010*	*Annualized growth '00-'08 (corrected for inflation)*
Air	11.284	14.410	16.094	0,5%	15.197	19.393	22.396	0,5%
Wastewater	43.482	55.884	60.327	0,6%	49.932	63.727	68.442	0,5%
Waste	70.034	95.672	106.378	1,3%	69.038	83.797	89.637	-0,1%
Soil	3.340	6.976	8.217	6,9%	5.602	9.383	11.104	4,0%
Noise	1.156	1.200	1.252	-2,1%	1.634	1.819	1.935	-1,2%
Biodiversity	6.030	10.006	12.416	3,8%	6.532	11.385	14.869	4,5%
Others	17.741	28.590	30.393	3,5%	24.874	41.862	45.404	4,0%
Water supply	39.282	55.289	59.289	1,7%	39.282	55.289	59.289	1,7%
Recycle	19.538	49.163	60.771	9,4%	19.538	49.163	60.771	9,4%
Renewable	11.811	37.647	74.746	12,7%	11.811	37.647	74.746	12,7%
Total	223.698	354.836	429.882	3,3%	243.439	373.466	448.595	2,8%

Table 17 **Comparison & results for Employment (in thousands)**

	New study; only updated EPE				New study; changed methodology, same LCF				New study; changed methodology, changed LCF			
	2000	*2008*	*2010*	*Annualized growth rate (2000-2008)*	*2000*	*2008*	*2010*	*Annualized growth rate (2000-2008)*	*2000*	*2008*	*2010*	*Annualized growth rate (2000-2008)*
Air	33.668	30.816	29.598	-1,10%	47.996	38.545	38.671	-2,7%	163.495	129.646	137.385	-2,9%
Wastewater	390.138	418.324	417.002	0,88%	458.630	539.598	573.896	2,1%	411.762	496.132	529.261	2,4%
Waste	1.111.613	1.361.160	1.339.923	2,56%	1.062.603	1.205.116	1.167.342	1,6%	528.805	623.291	605.675	2,1%
Soil	14.460	21.111	21.029	4,84%	24.756	27.323	27.382	1,2%	49.877	63.753	72.260	3,1%
Noise	11.688	9.005	8.018	-3,21%	16.137	12.721	11.566	-2,9%	15.621	12.481	12.019	-2,8%
Biodiversity	40.123	47.746	53.025	2,20%	40.890	58.496	69.376	4,6%	59.069	80.226	97.104	3,9%
Others	144.861	180.399	177.309	2,78%	193.489	250.861	254.836	3,3%	223.876	319.974	320.148	4,6%
Water supply	375.981	367.943	348.481	-0,27%	381.709	417.711	425.599	1,1%	406.197	463.153	479.507	1,7%
Recycle	238.774	425.373	480.056	7,48%	237.635	424.515	479.051	7,5%	166.487	296.464	331.089	7,5%
Renewable	160.136	280.394	568.002	7,25%	160.136	280.976	568.002	7,3%	169.264	233.967	381.380	4,1%
Total	2.521.442	3.142.272	3.442.443	2,79%	2.623.981	3.255.862	3.615.722	2,83%	2.194.452	2.719.089	2.965.828	2,72%

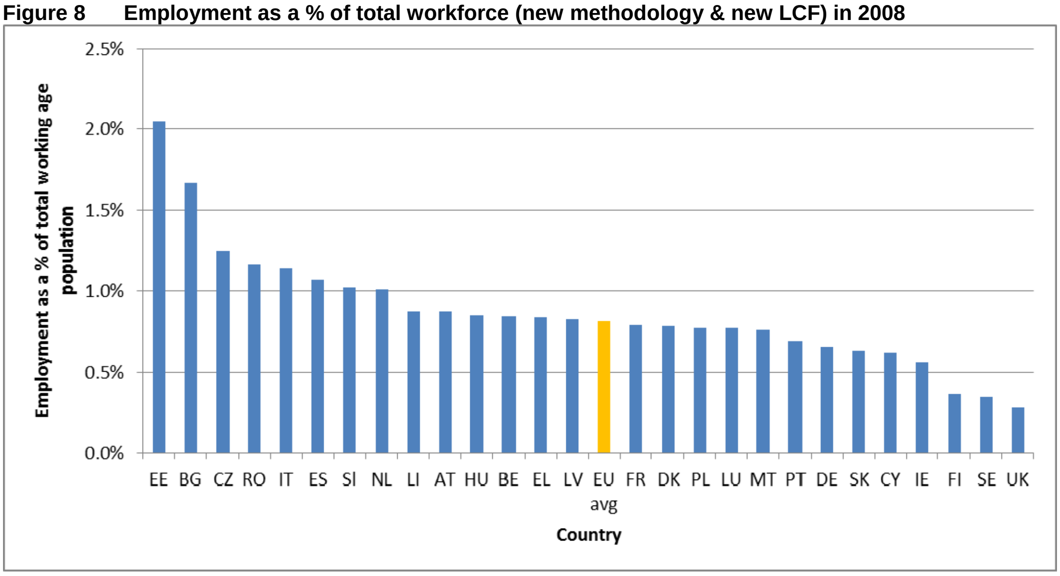
Figures 7-9 represent the results of Trial 2 and the calculations with the new methodology and adjusted LCF. Compared with the previous results of the 2009 study and methodology, there are some differences in the relative performance of Member States. This is due to a decrease in the absolute and relative figures. The outcomes are represented in Figure 8 and Figure 9 which illustrate the employment in eco-industries and the percentage of employment in eco-industries in the total workforce given the 'new' methodology and new LCFs. Countries with a high share of employment in 'Waste Management' are affected more strongly than others, this is particularly the case for Germany, Belgium and Estonia. To ease comparison, the Member States are listed in the same order in the figures. For example, Estonia has the highest employment share of Eco-industries in its total workforce, but in absolute FTEs a rather low number of employees in Eco-industries compared to e.g. Italy, Spain and France. Figure 9 presents the share of EPE in total GDP for each of the Member States and the EU average in 2008 with the 'new' methodology and the new LCFs.

Figure 7 Employment in thousands (new methodology & new LCF) in 2008



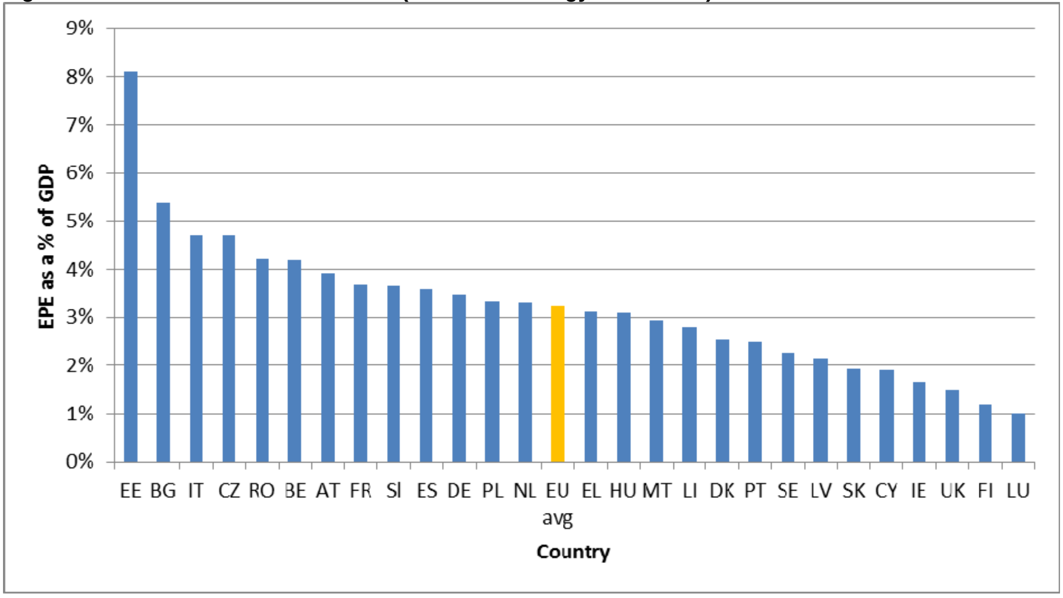
Source: Eurostat and own calculations

Figure 8 Employment as a % of total workforce (new methodology & new LCF) in 2008



Source: Eurostat and own calculations

Figure 9 EPE as a % of GDP in 2008 (new methodology & new LCF)



Source: Eurostat and own calculations

2.3 Update of the GHK study – Direct employment

As outlined before, the focus of the GHK study covers more broadly the whole range of sectors and activities related to the environment and resource efficiency improvements in the three categories: (1) Activities where the environment is a primary natural resource or input into the economic process – Agriculture, forestry, mining, electricity generation and water supply; (2) Activities concerned with protection and management of the environment - Waste recycling, pollution & sewage control and environmental management; and (3) Activities dependent on environmental quality – Environment related tourism .Section 2.2 on the other hand was mainly focused on protection and management activities or 'eco-industries'. In general the GHK study therefore extend the analysis to people working in sectors which are dependent on the environment as an input for resources as well as managing and exploiting natural resources.

This section will describe the update in direct employment figures based on the approach and methodology set out in the GHK study (2007) which was made in association with Cambridge Econometrics and IEEP, where a same structure will be followed as the Ecorys and IDEA (2009) update.

2.3.1 Approach and methodology

The approach and methodology for this subtask follows the GHK study on the '*Links between the environment, economy and jobs'*. Below the approach and methodology will be discussed where later on the results and comparison of the updated figures compared to the original report will be presented.

Approach

The results presented in this section provide an update to the study carried out by GHK, Cambridge Econometrics and IEEP *Links between the Environment, the Economy and Jobs*. The approach remains similar to the one used in that study, but with the data updated.

In this approach we make an estimate of the number of jobs directly dependent on the environment by carrying out a broad data collection exercise, drawing together figures from several sources to cover the various sectors. Indirect estimates of employment are derived using input-output tables and a multiplier-based approach; this takes into account supply chain effects (Type 1 multiplier) but also the effects of induced spending (Type 2 multiplier), which will be discussed and elaborated in Section 2.4. An example of each is given below:

- The fishing industry creates direct employment but also indirectly employs people who build boats, and people who supply wood and metals.
- Fishermen also create local jobs in retail and food production from the income they spend.

The total employment dependent on the environment is estimated as the sum of the direct and indirect jobs. The key data that we use are the estimates of jobs in the environmental sectors and the input-output tables that are used to estimate indirect impacts.

In the revised data set, all the new data in levels are for 2007 unless stated otherwise. The reason for choosing 2007 is that it has the best coverage in the Eurostat Environmental Accounts and therefore gives us the best basis for a consistent coverage across all the groups. It is noted that 2007 is before the economic crisis. However, more recent estimates for 'Activities based on Natural Resources' can be obtained from the Eurostat National Accounts.

The input-output tables used have a base year of 2005, which is the most comprehensive recent year that is available from Eurostat. In the previous report all data (both time series and input-output tables) were for the year 2000.

It was necessary to make some quite strong assumptions to compensate for the gaps in the available data; these are outlined in the sections below. As with the previous study, the final outcomes should be viewed as approximate rather than absolute estimates, but we believe give a good indication of the scale of environmental employment in Europe.

Methodology

As set out in the introduction of this chapter, there are a number of activities falling under the scope of employment dependent on the environment and resource efficiency improvements. However, the definition and allocation of activities is different between Eurostat and the method used in the GHK study. Therefore, activities have been allocated differently. The activities identified in the GHK study which has a direct link between employment and the environment can be classified as:

1. Activities based on natural resources
2. Environmental management
3. Resource management
4. Eco-tourism

The methodology for each of the different categories will be discussed below.

1. Activity based on natural resources

The primary data source for all the data that we have used is Eurostat. Data for agriculture, forestry, fishing, mining, electricity production and water supply are taken from the Eurostat National Accounts breakdowns. A measure of FTE equivalents is used where possible, but headcounts are used instead if the data are not available. These sectors account for by far the largest share of total employment in our results. The results for this group of sectors should be broadly comparable to the results for the previous study carried out by GHK, although this time around we are in some cases able to use more detailed published figures.

The splits for organic and other agriculture are based on the percentage of total agricultural area attributed to organic agriculture at a national level. Similarly, the split for sustainable forestry is based on the share of total forest area that is defined as being certified (for 2006), which was also used in the previous GHK study. We thus follow the shares used at the European level from the previous report. It should be noted that this approach implicitly assumes that the number of people employed per unit of land use is the same for organic and conventional agriculture.

The split for jobs in renewable and conventional power generation was determined by the share of renewable energy in total generation at a national level (not including nuclear). Similarly to the approach used for the agricultural and forestry sectors, this makes an assumption that the labour intensity of both types of generation is the same.

2. Environmental management

Of the nine categories under the environmental management category, six are available in the current Eurostat environmental accounts. This data set includes only eight EU countries but by our estimation covers almost 70% of total European employment in these sectors (these estimates are based on the results from the previous GHK study) and therefore provides a good basis for European estimates of employment. In the countries where data are not available for 2007, estimates were made using growth rates from a parent (NACE 2-digit) sector.

To produce estimates for the other countries we use a fixed ratio (based on the previous report) to the countries for which there are data available. For example, if the UK had employment levels equalling 10% of employment levels in these eight countries previously, it is assumed to do so in 2007 as well.

For two other categories in this group, growth rates were assumed to be the same as the parent NACE 2-digit sector (e.g. growth rates in Environmental R&D and R&D are taken as the same) which were obtained from the Eurostat National Accounts breakdowns. For one category, Environmental Monitoring and Instrumentation, there are no data now or in the previous report, so this sector remains missing in the results.

It is noted that there are quite large differences in the current Eurostat data to the results that were presented in the GHK study. The GHK calculated direct employment using the same method as in 2.1 through a combination of total EPE, the ECOTEC labour compensation factor and average wages for parents NACE codes. As we applied a different data collection method to estimate direct employment for the environmental management sectors, this can explain large parts of the differences.

3. Resource management

For recycled materials we are now able to use the Eurostat category for recycling in the breakdowns section of the National Accounts. This provides a complete data set for the sector.

For nature protection we have been unable to obtain updated data so the 2000 level is used. This is not ideal, as the sector is likely to have grown over 2000-07 and therefore we may be underestimating employment. However, it is quite a small sector so this is unlikely to have much impact on the overall results.

4. Eco-tourism

As recognised in the previous GHK study it would be a major undertaking to provide a comprehensive new estimate of jobs in environment-related tourism and we were unable to find updated figures. We have therefore taken the previous figure for 2000 and used a combination of the growth rate for aggregate tourism from Eurostat Industry data.

Methodology – Member State analysis

For the economy based on natural resources, data were taken from the Eurostat National Accounts breakdowns at the Member State level, measured in number of persons. Where this was not available (due to the different ways that Member States measure employment in their accounts) number of jobs was used instead. If neither of these were available, alternative sources (either the breakdowns data at a lower level of disaggregation, or the European LFS) were used.
In some cases, alternative sources were used to provide a best gap. This includes using years close to 2007 or using EU shares to split aggregate data to more detailed sectors.

The splits between organic and conventional agriculture, sustainable and conventional forestry, and renewable/non-renewable electricity were carried out using the ratios that were derived previously (these were originally done at Member State level anyway).

The procedures for collecting and estimating the figures for environmental management and environmental quality were also the same as used previously. It is noted that for this section a much larger share of the figures are estimated. When checking the country-level data we found that the Eurostat figures now provide a complete EU data set for tourism, so it is no longer necessary to use Hotels and Catering as a proxy in some countries.

2.3.2 Results and comparison

The results from the data collection are shown in Table 18. Overall we estimate that in 2007 there were nearly 19 million jobs (right column) in Europe that are directly dependent on the environment, with the largest share (15,5 million) based in activities dependent on natural resources. This middle column represents the employment figures from the initial GHK (2007) study.

Table 18 Direct employment (in thousand full-time equivalents) in Environment Related Activities, EU27, 2007

Sector	*Direct Employment (2000)*	Direct Employment (2007)
ACTIVITIES BASED ON NATURAL RESOURCES		
TOTAL	***17.472***	**15.464**
Agriculture (non-organic)	*13.970*	11.884
Organic farming	*300*	311
Forestry (other)	*405*	342
Sustainable forestry	*133*	112
Fishing (incl recreation*)	*247*	220
Mining, extraction and quarrying	*901*	838
Non-renewable electricity generation	*985*	977
Renewable electricity generation	*131*	315
Water extraction and supply	*399*	465
ENVIRONMENTAL MANAGEMENT		
TOTAL	***1.834***	**1.480**
Pollution management		
Solid Waste Manage & Recycling (SWM)	*846*	334
Waste Water Treatment (WWT)	*428*	249
Air Pollution Control (APC)	*39*	164
General Public Administration (GPA)	*104*	111
Private Env. Management (PEM)	*82*	118
Remed. of Soil & Groundwater (RCSG)	*22*	163
Noise & Vibration Control (NVC)	*21*	47
Environmental R & D (ERD)	*N/A*	26

Sector	*Direct Employment (2000)*	Direct Employment (2007)
Environmental Monitoring & Inst. (EMI)	*N/A*	N/A
Resource management		
Recycled materials	*223*	200
Nature protection (2000 value)	*68*	68
ENVIRONMENT QUALITY		
TOTAL	*1.589*	2.115
Environment related tourism	*1.589*	2.115
TOTAL	***20.894***	**18.924**

Source: GHK (2007) study and CE calculations
Note: the figures for 2000 are retrieved from the initial GHK (2007) study
* was included in tourism previously

Perhaps surprisingly, the total number of jobs directly dependent on the environment fell slightly between 2000 and 2007. However, this can largely be explained by the definitions used; the largest sectors that are included are ones that have declining employment levels. In particular, agricultural employment (which is by far the largest share of total direct employment) continues to decline across Europe, but the extraction and utility sectors that are included in the calculations also have declining employment levels.

Despite the decline in agricultural employment, our results suggest that employment in organic agriculture has not changed. For sustainable forestry there is an increase although this could reflect the change in data sources that we have used, as the new estimates are based on a complete set of Eurostat data that is specific to the sector.

The methodology used to estimate employment in renewable energy has also changed slightly from the previous study; results are higher than previously, but this is likely to also reflect the growing share of renewable energy in electricity generation over the period 2000-2007.

Our results also show a lower employment figure for pollution management (1,2 million) than the previous report. It should be noted that the 1.2 million is smaller than the over 3 million jobs which was the result in section 2.2. Pollution management excludes sectors such as renewables and biodiversity. Moreover, we do not believe that the results between the two reports are directly comparable because the definitions used are likely to have changed. Most obviously, the new figure for employment in Solid Waste Management (Eurostat Environmental Accounts plus our estimate for other countries) is considerably lower than that derived previously (by around 500.000 people). Some caution is thus urged when making this type of comparison over time.

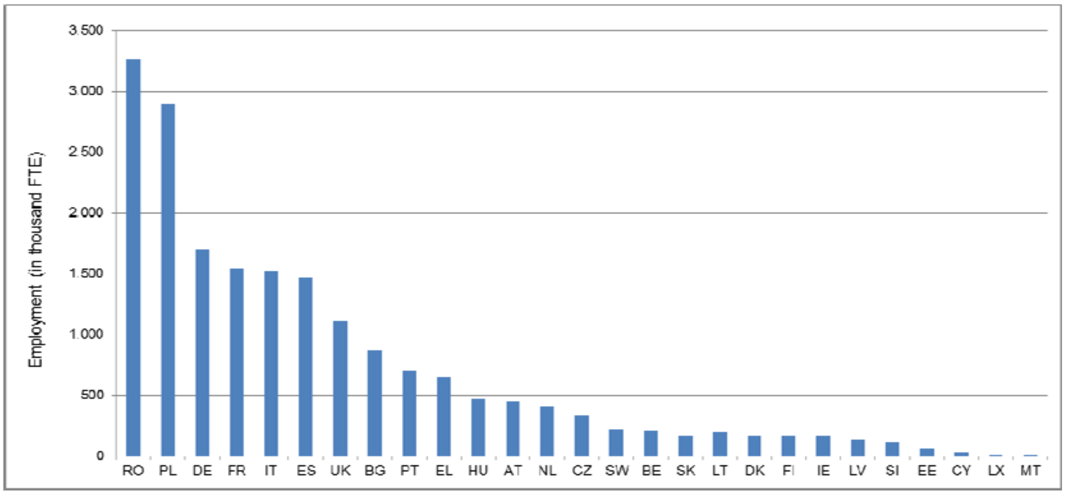
The updated results also include a lower value for recycling than previously. Again, this is likely to do with statistical definitions and data sources (the new figure is based on published National Accounts data so should be more accurate) rather than an actual fall in the number of jobs in the sector.

The figure for environment-related tourism was derived from the previous report with an assumed growth rate based on growth in the sector as a whole; it is thus larger but comparable in size. It should be noted that a large share of the estimated increase in environmental tourism employment comes from Spain as there was a large increase in tourism employment in Spain over this period. It is less clear that there was rapid growth in eco-tourism in Spain over 2000 - 2007 so these figures may overestimate the true picture but, as with all of the detailed estimates, should be viewed as approximate.

Further insight in (direct) employment on Member State level

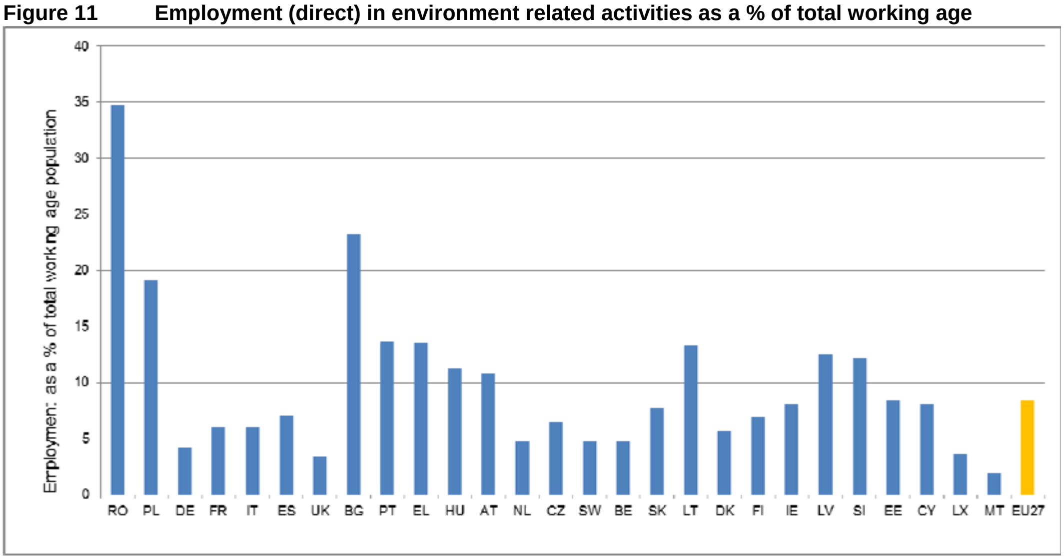
The additional tables include a disaggregation by Member State. They also give figures as a share of total direct employment in each European country. It should be noted that some of the figures are estimated. Although this is also true at the European level, there is a much greater range of uncertainty when considering figures on an individual country basis. Our aim is to provide a broad overview rather than specific figures.

Figure 10 Total (direct) employment in environment related activities in 2007



Source: CE calculations

Figure 11 Employment (direct) in environment related activities as a % of total working age



Source: CE calculations

The share of employment that is directly dependent on the environment range from 2-13% across the Member States. Romania and Bulgaria are an exception, with a total of over 30% (Romania also has the highest absolute number of people employed in environmentally-dependent sectors, 3,2 million) and 23% respectively. These shares are highly dependent on the share of agriculture in the economy, as this is by far the largest component of environmental employment.

Austria has the largest share of employment in environmental management (2,2%). Several other countries, including Belgium, Denmark, Hungary, Poland and Slovakia, have shares over 1%. In many other Member states though, the share is 0,2% or less. In most EU countries, environmental tourism accounts for around 1% of total employment (direct measure). This sector is smaller in Romania and larger in Cyprus.

2.4 Update GHK study – Indirect employment

As outlined before, the focus of the GHK study covers more broadly the whole range of sectors and activities related to the environment and resource efficiency improvements (categories 1-3), where section 2.2 was mainly focused on *protection and management* activities or 'eco-industries'. This section will describe the update in indirect and induced employment figures based on the approach and methodology set out in the GHK study (2007) in association with Cambridge Econometrics and IEEP, where a same structure will be followed as the Ecorys and IDEA (2009) update.

2.4.1 Approach and methodology

The approach and methodology for this subtask follows the GHK 2007 study on the '*Links between the environment, economy and jobs'*. Below the approach and methodology will be discussed and then the results and comparison of the updated figures compared to the original report will be presented.

Approach

The approach to estimate the number of jobs indirectly dependent (indirect and induced employment) on the environment and resource efficiency improvements is based on multiplier analysis. It is described in this section.

Methodology

The multipliers needed for the analysis were estimated using an identical method to the GHK study, but using input-output (IO) tables for the year 2005. Where necessary, IO tables for 2005 were estimated from the closest year available, although there are typically not large changes from one year to the next (accumulated differences between 2000 and 2005 are larger).

For setting up the IO tables and derived multipliers, the following steps were required:

1. Construction of consistent sets of IO tables
2. Calculation of economic multipliers
3. Calculation of employment multipliers
4. Estimation of indirect and induced employment via employment multipliers

1. Construction of consistent sets of IO tables

   In order to estimate the multiplier effects, it was necessary to produce a consistent European input-output table. This meant the following steps: a) Estimating IO tables for a single base year (rather than the range of years for which they are published); b) Using a single defined set of sectors. An aggregate EU IO table was constructed by summing the tables (in flows) for each EU-27 Member State and then dividing by total European production to convert to coefficients. It was not possible to obtain recent data for Malta and Cyprus so they are excluded although, given their small size and margins for error elsewhere, we do not expect this to significantly impact on overall European results.

2. Calculation of economic multipliers

   Output multipliers are the total (direct and indirect) impact divided by direct impact, defined as the level of the shock entered. Output multipliers were calculated directly from the IO tables. This has been done by using the formula for the sum of a geometric series, which requires the IO table to be transformed using the formula (I – IO)-1, where I is a unit matrix and IO is the IO table. After this calculation shocks have been entered by sector using a simple matrix multiplication. The employment effects have been calculated using the assumption that labour costs remain constant as a share of gross output and, as wage rates are also assumed to be constant, this means employment increases in line with output for each sector.

3. Calculation of employment multipliers
The employment multipliers were defined slightly differently. The shock to the economic system was still measured in monetary terms, in millions of EURs. This shock has been translated into employment (using the sectoral ratios between output and employment), giving a direct, indirect and induced employment effect. The total effect on employment is calculated in a similar manner, except using the overall change in output to determine employment levels and the multiplier is calculated by dividing the total change in employment by the direct change.

The last step – estimation of the indirect and induced employment effects – will be elaborated in the next section.

2.4.2 *Results and comparison*

The results from the data collection are shown in Table 19. Overall we estimate that in 2007 there were nearly 10,9 million indirect jobs and about 6,1 million induced jobs in Europe that are indirectly and dependent on the environment, with the largest share (8,3 million and 4,3 million respectively) based in activities dependent on natural resources.

Table 19 Indirect and induced employment (in thousand full-time equivalents) in Environment Related Activities, EU27, 2000 and 2007

Sector	*Indirect Employment (2000)*	Indirect Employment (2007)	*Induced Employment (2000)*	Induced Employment (2007)
ACTIVITIES BASED ON NATURAL RESOURCES				
TOTAL	***8.847***	**8.701**	***3.356***	**4.262**
Agriculture (non-organic)	*4.630*	4.385	*1.189*	1.450
Organic farming	*151*	109	*48*	42
Forestry (other)	*124*	150	*67*	85
Sustainable forestry	*61*	30	*30*	21
Fishing (inclusive recreation*)	*85*	64	*47*	53
Mining, extraction and quarrying	*1.082*	413	*607*	407
Non-renewable electricity generation	*2.289*	2.032	*1.086*	1.271
Renewable electricity generation	*121*	659	*101*	402
Water extraction and supply	*304*	858	*182*	530
ENVIRONMENTAL MANAGEMENT				
TOTAL	***894***	**1.590**	***656***	**1.157**
Pollution management				
Solid Waste Manage & Recycling (SWM)	*342*	420	*260*	260
Waste Water Treatment (WWT)	*173*	292	*132*	234
Air Pollution Control (APC)	*45*	218	*31*	161
General Public Administration (GPA)	*31*	32	*48*	64

Sector	*Indirect Employment (2000)*	Indirect Employment (2007)	*Induced Employment (2000)*	Induced Employment (2007)
Private Env. Management (PEM)	*30*	71	*29*	67
Remed. of Soil & Groundwater (RCSG)	*9*	191	*7*	153
Noise & Vibration Control (NVC)	*25*	63	*17*	46
Environmental R & D (ERD)	*N/A*	22	*N/A*	26
Environmental Monitoring & Inst. (EMI)	*N/A*	N/A	*N/A*	N/A
Resource management				
Recycled materials	*211*	264	*112*	132
Nature protection (2000 value)	*28*	16	*21*	13
ENVIRONMENT QUALITY				
TOTAL	*1.084*	1.115	*646*	783
Environment related tourism	*1.084*	1.115	*646*	783
TOTAL	***10.861***	**10.861**	***4.658***	**6.162**

Source: GHK (2007) study and CE calculations
Note: the figures for 2000 are retrieved from the initial GHK (2007) study
* was included in tourism previously

The totals for indirect and induced employment are lower than those presented in the previous GHK study, but this is because of the results for direct employment that are used as an input to these calculations. In particular, the number of jobs in agriculture fell between 2000 and 2007, which also led to falls in supporting jobs dependent on agriculture, and those that cater for agricultural workers.

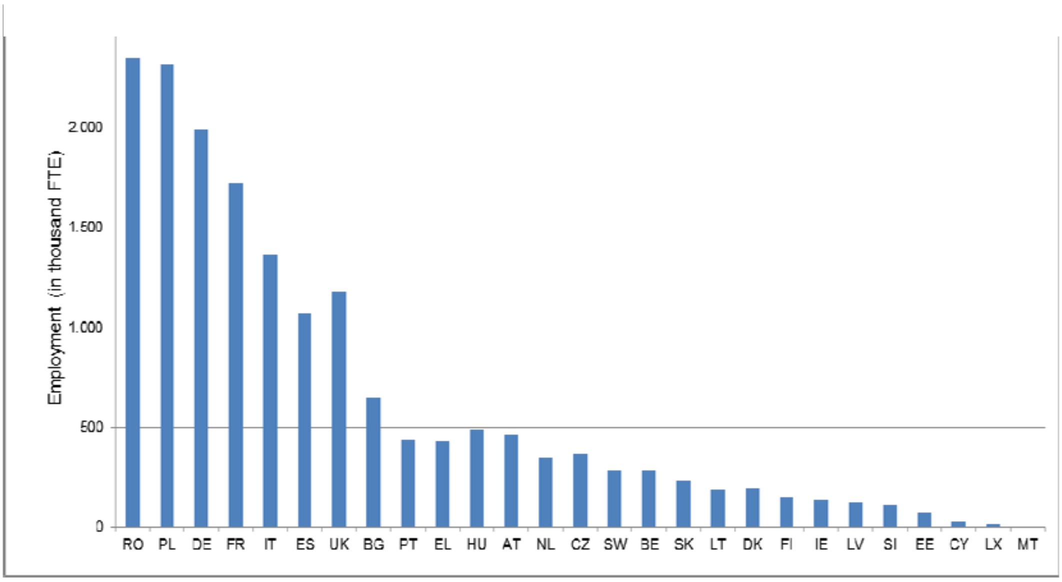
Overall, there is in fact a small increase in the multipliers used (implying that if direct employment had not changed, indirect and induced employment would have increased slightly). This does, to a certain extent, reflect relative wage rates across the different sectors. For example low-paid agricultural jobs would be expected to have a lower multiplier effect, as they result in smaller changes in income that can be spent elsewhere.

Even taking these factors into account the differences in indirect employment between the results presented here and those from the previous study are in fact quite small. The conclusion is that, at the 2-digit level, which is the maximum level of detail allowed by input-output tables, there has not been a major change in purchasing patterns between industries across Europe as a whole.

Further insight in (indirect and induced) employment on Member State level

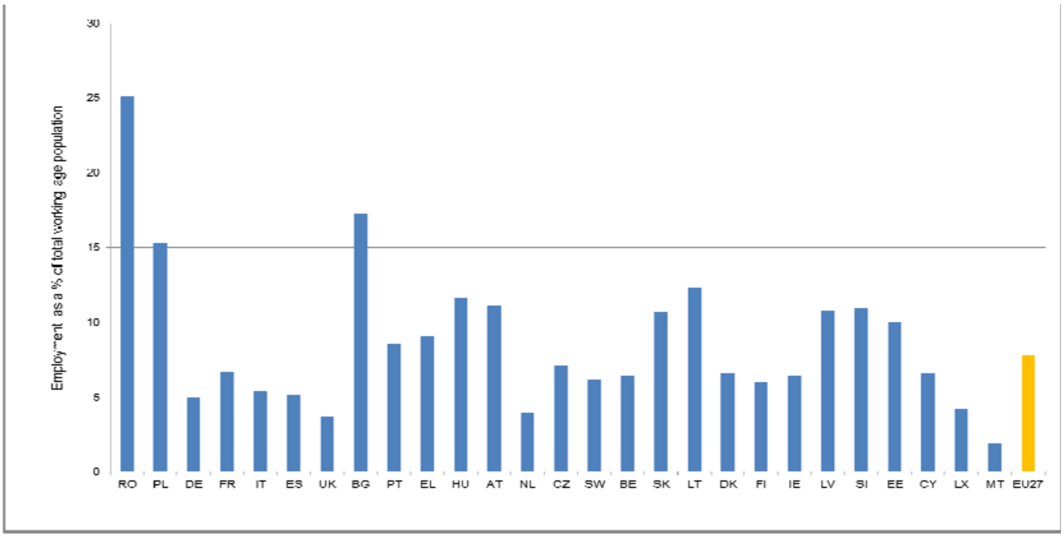
The additional tables include a disaggregation by Member State. They also give figures as a share of total indirect (Type 1 effect) and induced (Type 2 effect) employment in each EU-27 country. It should be noted that some of the figures are estimated. Although this is also true at the European level, there is a much greater range of uncertainty when considering figures on an individual country basis. Indirect and induced employment is estimated using multipliers that have been calculated at the European level. The reason for this is that the input-output tables we used were calculated at the European level and so include trade between Member States. The results should thus be interpreted as jobs that are indirectly created within this country or within other EU countries.

Figure 12 Total (indirect and induced) employment in environmentally related activities in 2007



Source: CE calculations

Figure 13 Employment (indirect and induced) in environmentally related activities as a % of total



Source: CE calculations

The share of employment that is indirect (and induced) environmental related activities ranges from 2-17% across the EU-27 Member States. Romania is an exception with a total of over 25%.These shares are highly dependent on the share of agriculture in the economy, as this is by far the largest component of environmental employment. For most western European countries the share of indirect employment is typically around 10%, and higher (20%-30%) in countries with larger agricultural sectors.

2.5 Total number of jobs dependent on the environment

Given the reworking of the data to update both studies we are now able to present an overall update of employment numbers dependent, both directly and indirectly, on the environment and resource efficiency improvements. As both the Ecorys and IDEA study and the GHK study shed light on employment directly related to the environment (in particular Eco-industries), and also for consistency of approach (environmental domains versus sectors) and classifications are not the same, the following table will only present the direct employment following the results of the update on the GHK study in Table 20.

Furthermore, Figure 14 and Figure 15 include a disaggregation by Member State and are aggregated from Figures 11-14. These figures give the share of total employment and the share of employment in Eco-industries as a percentage of the total workforce in each of the Member States, including the EU-27 average in 2007.

Table 20 Total employment (in thousand full-time equivalents) in environment related activities, EU-27, 2007

Sector	Direct Employment	Indirect Employment	Induced Employment	Total Employment
ACTIVITIES BASED ON NATURAL RESOURCES				
TOTAL	**15.464**	**8.701**	**4.262**	**28.428**
Agriculture (non-organic)	11.884	4.385	1.450	17.719
Organic farming	311	109	42	462
Forestry (other)	342	150	85	577
Sustainable forestry	112	30	21	164
Fishing (inclusive recreation*)	220	64	53	338
Mining, extraction and quarrying	838	413	407	1.658
Non-renewable electricity generation	977	2.032	1.271	4.280
Renewable electricity generation	315	659	402	1.376
Water extraction and supply	465	858	530	1.853
ENVIRONMENTAL MANAGEMENT				
TOTAL	**1.480**	**1.590**	**1.157**	**4.227**
Pollution management				
Solid Waste Manage & Recycling (SWM)	334	420	260	1.014
Waste Water Treatment (WWT)	249	292	234	775
Air Pollution Control (APC)	164	218	161	544
General Public Administration (GPA)	111	32	64	207
Private Env. Management (PEM)	118	71	67	255
Remed. of Soil & Groundwater (RCSG)	163	191	153	507
Noise & Vibration Control (NVC)	47	63	46	156
Environmental R & D (ERD)	26	22	26	75

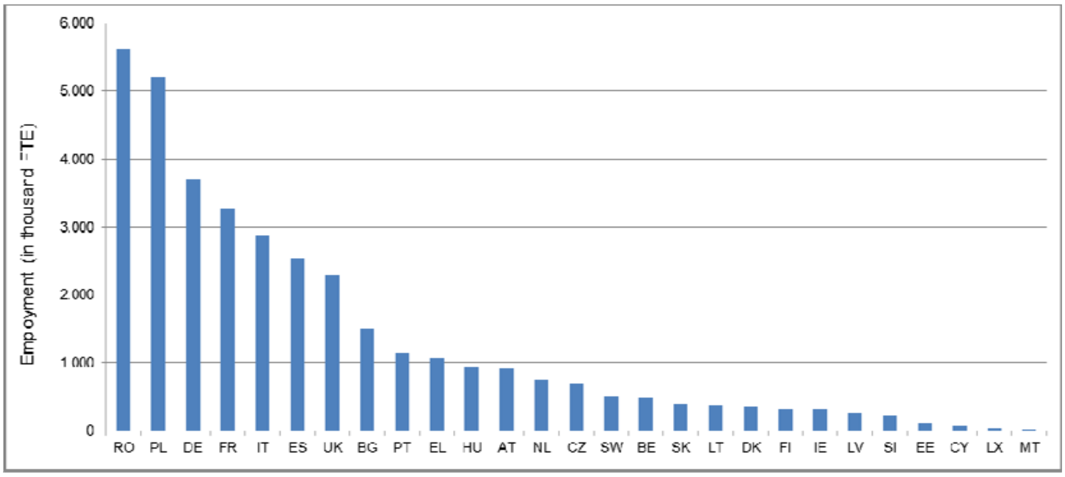
Sector	Direct Employment	Indirect Employment	Induced Employment	Total Employment
Environmental Monitoring & Inst. (EMI)	N/A	N/A	N/A	N/A
Resource management				
Recycled materials	200	264	132	596
Nature protection (2000 value)	68	16	13	98
ENVIRONMENT QUALITY				
TOTAL	2.115	1.115	783	4.012
Environment related tourism	2.115	1.115	783	4.012
TOTAL	**19.059**	**11.406**	**6.202**	**36.666**
As % of EU jobs **	**8.7 %**	**5.5 %**	**2.8 %Z**	**16.7 %x**

Source: CE calculations

* was included in tourism previously

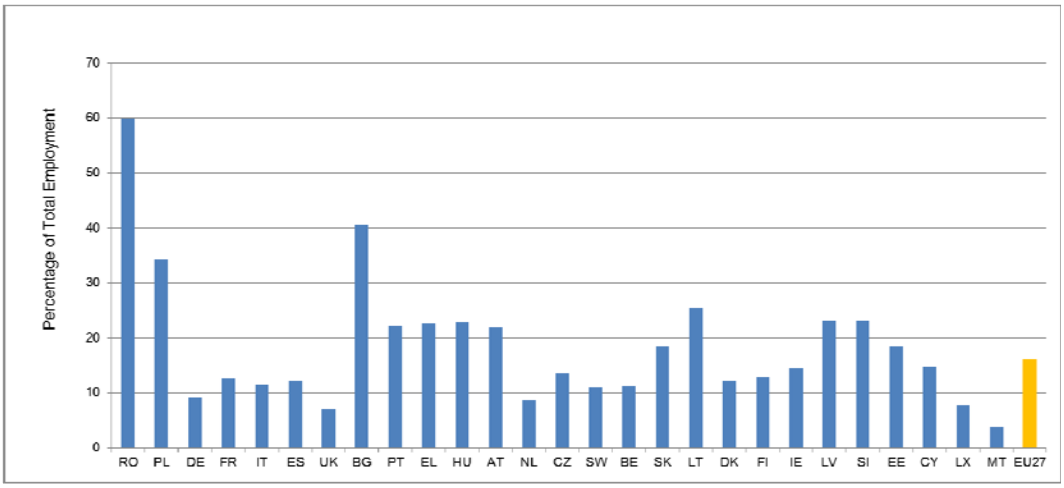
** Based on Eurostat for annual average in EU-27 for 2007 which equals almost 219 million jobs

Figure 14 Total employment in environment related activities in 2007



Source: CE calculations

Figure 15 Employment in environmentally related activities as a % of total working age population



Source: CE calculations

3 The EU's position on global market

In this chapter 3, the results from previous chapters are presented in their global perspective. It focuses on the position of environmental technologies and the related sectors that are heavily dependent on the environment. The EU's market share in eco-industries was already determined in the Ecorys and IDEA 2009 study. In this sense, chapter 3 is also an update and re-estimation by using new and more complete numbers from, among others, Eurostat and COMTRADE.

The chapter starts with a literature review of the three recent publications on the subject. In chapter 2 a separation has been made with regards to sectors that are dependent on the environment and resource efficiency improvements, like 'Protection and management' and 'Environmental quality' – following the categorization of sectors and environmental domains within eco-industries. Therefore, the selected environmental domains (or sectors) are equivalent to Ecorys and IDEA (2009) study, namely:

1. Waste management
2. Water supply
3. Waste water management
4. Recycled materials
5. Others
6. Renewable energy
7. Air pollution
8. Biodiversity
9. Soil and groundwater
10. Noise and Vibration

The markets dependent on the environment are, to a large extent, national in scope. Information on the size of these environmental domains (sectors) would provide insights into the structure of the economy (i.e. high/low revenues from agriculture as % of GDP) but less on their relative importance. Furthermore, often it is not possible to directly translate the scope and methodology into our study. Nonetheless, core environmental domains i.e. 'Waste Management', 'Recycling', 'Wastewater Management', 'Renewable energy production' and 'General pollution control' are recurring environmental domains in most of the existing literature.

Based on the Ecorys and IDEA (2009) study, the following indicators are of interest in assessing and analysing the EU's market share in the global market for eco-industries:

1. Total market share
2. Net export position
3. Technological innovator (ranking)

The total market share is calculated by turnover which is optimally - in accordance with Ecorys – IDEA (2009) equal to EPEs which include: 1) total investments and total current expenditures; 2) the sum of total investments, total current expenditure and subsidies/transfers given (for public sector). However, since reliable data on EPE is only retrievable for the EU-27 and separate Member States, we had to rely on indicators used by other (existing) reports and publications to estimate the size of the global market for eco-industries.

3.1 Literature review of three studies

3.1.1 US Department of Commerce / Environmental Business International (EBI)

Environmental Business International (EBI) is a market research company that is most likely the only company that assesses the Environmental Goods and Services (EGS) market worldwide through surveys and stock market analysis. As EBI is often the only source to refer to, many government and non-government researchers quote the figures. A comprehensive report by the U.S. Department of Commerce quotes the most recent figures for environmental technologies. The methodology used is very similar to that in the previous sections (EBI, 2011).

EBI estimates the global market for environmental technologies to $ 780 billion in 2008. Then historical growth rates are applied and transferred into a global market which results in a turnover to $848 billion in 2010 (EBI, 2011). According to the report, the market share of the US is on average 38%, EU-27 29%, Japan 13% and 8% for the rest of Asia.

Table 21 Market Volume and Market Share for 2007 and 2010

From US department of commerce / EBI	2007 Market (in $)	2007 Market (in EUR)	2010 Market (in EUR)	% of total
USA	289,6	211	*246*	38%
Western Europe	209,5	153	*178*	28%
Japan	99,6	73	*85*	13%
Rest of Asia	59	43	*50*	8%
Rest of Latin America	6,2	17	*19*	3%
Canada	22,7	14	*17*	3%
Central & Eastern Europe	19,8	13	*15*	2%
Australia/NZ	13,6	10	*12*	2%
Middle East	18,2	9	*11*	2%
Africa	13	5	*6*	1%
Mexico	6,8	5	*5*	1%
Total	758	553	*644*	100%

Source: US Department of Commerce; Note: shaded cells are estimations

According to this calculation, the total market value of the European eco-industry is EUR166 billion – assuming that the EU-27 total is more or less Western Europe and Central & Eastern Europe combined. This is considerably lower compared to the EPEs calculated in chapter 2 of EUR 336 billion in 2007. It is difficult to explain this rather larger difference as, with reference to the methodology used[12], the analysis covers the same markets. It appears that the EBI report underestimates certain markets and therefore we consider the figures in this report to represent a bottom line.

A comprehensive study in 2006 by UKCEED for the UK Department of Environment, Food and Agriculture (DEFRA) and DTI refers to these figures as does the Joint Environmental Markets Unit (JEMU) of the UK.[13],[14]. However, both studies also refer to branch associations of the

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12 Industry definition:all goods and services that generate revenue associated with environmental protection, assessment, compliance with environmental regulations, pollution control and prevention, waste management, renewable energy, remediation of contaminated property, design and operation of environmental infrastructure, and the provision and delivery of environmental resources.

13 DEFRA & DTI (2006) http://www.ukceed.org/files/downloads/emergingmarkets_full.pdf

14 http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/whatwedo/sectors/environmental/archive/environmentreport/page34696.html

environmental sub-industries to get an indication of elements included. Yet, due to methodological differences it is not possible to make a worldwide comparison on a sub-sector basis.

3.1.2 *Innovas Solutions - 'Low Carbon and Environmental Goods and Services'*

The 2009 report 'Low Carbon and Environmental Goods and Services: an industry analysis commissioned by Innovas Solutions for the UK Department for Business Enterprise and Regulatory Reform sets the global market value for Low Carbon and Environmental Goods and Services for 2008 at £ 3 trillion (EUR 3.4 trillion Asia accounts for 38% of this total, the EU-27 for 27%, and the US and Central and Southern America for 30%[15]. The scope of the report includes the sectors listed in Section 3.1 of this report and further comprises additionally 'Emerging Low Carbon' sectors such as 'Alternative fuels', 'Carbon finance', 'Carbon capture and storage (CCS)' and 'Building technologies'. The report has expanded the scope of analysis to include activities within the broader environmental supply chain as well as activities across the full environmental value chain including R&D, design and development, installation, manufacturing, supply, distribution, retail, maintenance, operations, consultancy and support services.

The measure of market value in this report relates to the economic activity by the identified company (or installation). As EPEs measure only the specific activities and not the entire turnover of the company/installation the values produced in this report are considerably higher. Therefore, it is difficult to compare the numbers and figures with the obtained EPE figures of chapter 2. However, there are indications that the report's calculations are at the high end. The global market value for wind energy, for example, is set at EUR 401 billion, while the Global Wind Energy Council (GWEC) sets global market value for 2010 at EUR 47 billion[16] such that the numbers should be taken with caution.

3.1.3 *Roland Berger - 'Greentech made in Germany 2.0'*

In Roland Berger's *'Greentech made in Germany 2.0'* the global market in 2007 for environmental technologies is EUR 1400 billion with the potential to double by 2020[17]. As can be seen in Table 22, Roland Berger uses a different methodology regarding environmental sectors.

Table 22 Global Market for environmental technologies and EU's market share

Sector	Market volume in billion EUR (2005)	Market volume in billion EUR (2007)	EU market share
Power generation (renewable)	100	155	± 40%
Energy efficiency	450	538	± 35%
Material efficiency and natural resources	40	94	± 10%
Sustainable water management	190	361	± 30%
Sustainable mobility	180	200	± 35%
Recycling	30	35	± 50%
Other	130	-	N/A
Total	**1.000**	**1.400**	

Source: Roland Berger (2007 & 2009)

As the report was written for a German ministry, the report focuses on sectors where Germany has a comparative advantage, clean tech as well as production and innovation in mobility. To a lesser

15 http://www.bis.gov.uk/files/file50253.pdf
16 http://www.gwec.net/index.php?id=8
17 BMU - http://www.bmu.de/wirtschaft_und_umwelt/downloads/doc/43943.php

extent it includes basic or core environmental protection tasks such as traditional waste management or soil remediation.

3.1.4 *Synthesis of the literature review*

Table 23 summarises the results about the global market for eco-industries from the literature review. The difference in estimations provided by the reports are useful to estimate a range. We consider the estimations of EBI and Innovas to be on the low and high end respectively. There are also clear differences in the studies. The study of Roland Berger, for example, includes sectors not present in other studies i.e. mobility (railroad infrastructure, hybrid cars etc.) but does not take account of traditional 'Waste Management' activities, i.e. waste incineration. Only recycling and reuse of materials. As such, the different methodologies could balance each other out. Therefore, we would use the average of EBI, Roland Berger and the controlled Innovas figures to arrive to a (conservative) estimate of the global size of the eco-industries market, which translates into EUR 1.000 billion in 2007 and EUR 1.164 billion in 2010 with the potential to double by 2020.

Table 23 Overview of studies on Global Market share (in billion EURs)

	2005	2007	2010	*2020*
US Dep. Commerce / EBI	530	553	654	*1.086*
Roland Berger	1.000	1.400	1.650	*3.100*
Innovas		*3.383*	*3.967*	*6.746*
Innovas*		1.014	1.189	*2.022*
Average	**765**	**989**	**1.164**	***2.070***

Source: Various sources and Ecorys calculations
Note-1: Innovas data was controlled for renewable energy & emerging low carbon to 10% of total each
Note-2: Shaded cells are estimations

Table 24 and Table 25 present the division of market volume amongst the subsectors of the global market for eco-industries in 2007, the last year where original data is available. As indicated above, the calculations of Innovas for renewable energies are high, as are projections for energy efficiency (incl. alternative fuels, carbon capture and storage). In order to make comparisons possible, both subsectors were assumed to represent 10% of total market volume, equalling roughly the share of total that was calculated in Section 3.1.

Table 24 Market volume of eco-industries sub-sectors in 2007 (in billion EUR)

	US Dep. Commerce / EBI	Roland Berger	Innovas	Innovas*
Waste management	131	N/A	263	263
Water supply	70	90	0	N/A
Waste water management	123	271	183	183
Recycled materials	51	35	207	207
Others	62	N/A	90	90
Renewable energy	38	155	1.044	101
Air pollution	32	8	5	5
Biodiversity	N/A	N/A	30	30
Soil and groundwater	22	N/A	4	4
Noise and Vibration	3	4	31	31
Energy & material efficiency		632	1.560	101
Mobility		188		
Total	**EUR 532**	**EUR 1.383**	**EUR 3.417**	**EUR 1.014**

Source: Various sources and Ecorys calculations

Note: Innovas data was controlled for renewable energy & emerging low carbon to 10% of total each.

Table 25 Market volume of eco-industries (in % of total)

	US Dep. Commerce / EBI	Roland Berger	Innovas	Innovas*	This study
Waste management	25%	N/A	8%	26%	23%
Water supply	13%	7%	N/A	N/A	16%
Waste water management	23%	20%	5%	18%	17%
Recycled materials	10%	3%	6%	20%	14%
Others	12%	N/A	3%	9%	10%
Renewable energy	7%	11%	31%	10%	11%
Air pollution	6%	0,58%	0,14%	0,48%	5%
Biodiversity	N/A	N/A	1%	3%	2%
Soil and groundwater	4%	N/A	0,11%	0,39%	2%
Noise and Vibration	1%	0,29%	1%	3%	0,41%
Energy & material efficiency		46%	46%	10%	
Mobility		14%			
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Source: Various sources and Ecorys calculations
Note: Innovas data was controlled for renewable energy & emerging low carbon to 10% of total each.

Based on the table above, the averages can be seen below in Table 21. Depending on whether one includes Energy and Material Efficiency (EME) by Roland Berger and Innovas, the averages over the sectors are different. In the below table, the averages from the Roland Berger study are presented

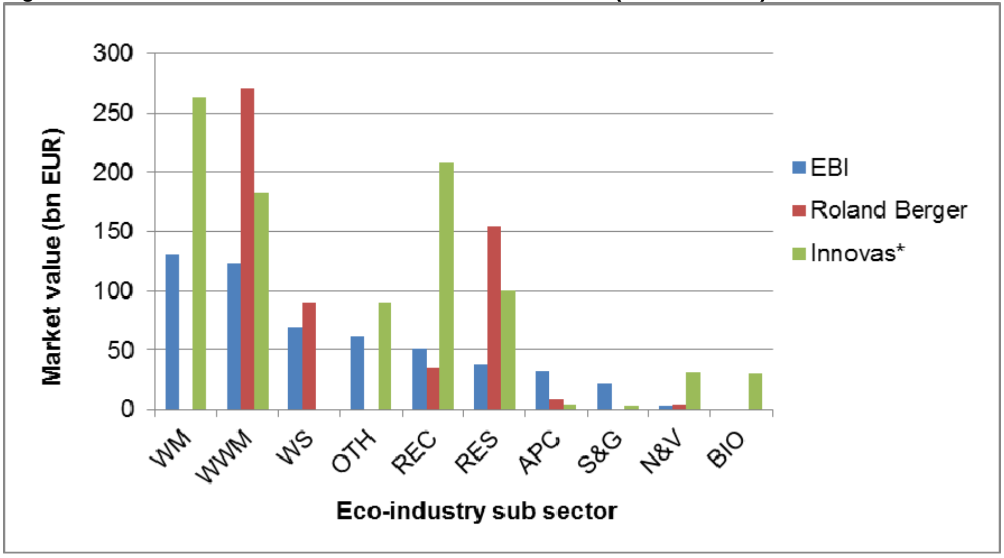
Table 26 Average % of investment over subsectors

	average	average without EME	average with EME
Waste management	25%	26%	20%
Water supply	12%	12%	9%
Waste water management	20%	20%	16%
Recycled materials	12%	12%	9%
Others	10%	10%	8%
Renewable energy	10%	10%	8%
Air pollution	3%	3%	3%
Biodiversity	3%	3%	2%
Soil and groundwater	2%	2%	2%
Noise and Vibration	1%	1%	1%
Energy & material efficiency	28%		22%
Mobility			
Total		**100%**	**100%**

Source: Roland Berger (2007 & 2009)

From Figure 17 a better indication of the relative market sizes of each sector can be obtained. ‘Waste Management’ and ‘Wastewater Management’ represent the largest shares of the total global market of eco-industries. Depending on the source, renewable energies have the third largest share.

Figure 16 Market volume of eco-industries sub-sectors (in billion EUR)



Source: Various sources and Ecorys calculations

Note: Innovas data was controlled for renewable energy & emerging low carbon to 10% of total each.

3.2 External Trade

Certain sectors of the eco-industries are, at least with respect to their production and distribution, location bound and do not provide the possibility to export or trade on the global market. Nevertheless, sectors that do rely on machines and equipment for purification (water filters etc.), filtering (air pollution control) or electricity generation (wind and solar) are open to the international market and trade patterns can be analysed. Official trade data may be able to capture certain aspects of trade dimensions and directions. Given the uncertainties, the data should be considered an indication of the flows and their directions rather than absolute numbers.

Table 27 External trade for environmental technologies and goods in 2010 at 2010 prices

		Importer									
	(in million EUR)	**Brazil**	**China**	**EU27**	**India**	**Japan**	**Russia**	**USA**	**Canada**	**TOTAL**	**%**
Exporter	**Brazil**	1	10	32	7	0	0	21	23	93	0%
	China	118	1.172	20.128	414	1.323	176	2.256	312	25.782	54%
	EU27	293	1.850	0	1.114	413	1.086	2.042	226	6.731	14%
	India	13	69	682	0	5	3	71	5	835	2%
	Japan	101	2.683	2.488	93	0	62	1.359	105	6.790	14%
	Russia	0,08	2	12	15	2	0	3	0,39	33	0%
	USA	213	763	2.651	190	391	234	0	1.477	5.707	12%
	Canada	9	40	116	13	2	8	683	12	874	2%
	TOTAL	749	6.589	26.110	1.846	2.135	1.569	6.436	2.160	47.595	100%
		2%	14%	55%	4%	4%	3%	14%	5%	100%	

Source: COMTRADE database

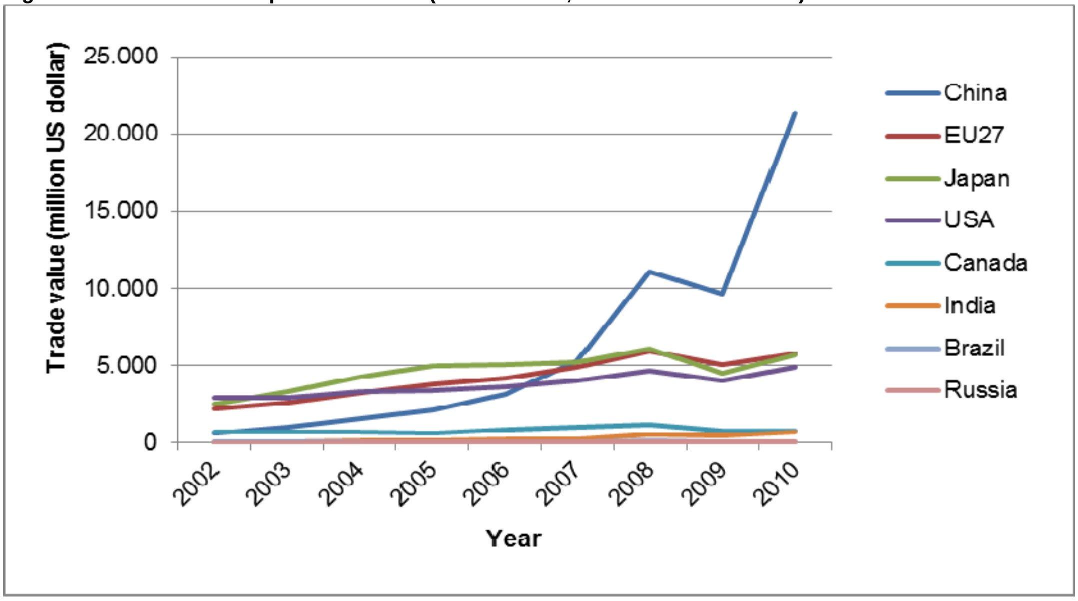
Note: Trade flows include the following product categories: air pollution control, hydropower, monitoring equipment, other environmental equipment, photovoltaic, waste disposal and water pollution control

Clearly, China has, in terms of total value, the highest export figures of all industries in 2010. This is especially due to their exports or photovoltaic equipment[18] that represents over 95% of their exports, 1/3 of these exports going to Germany alone. These figures should be interpreted with care as large parts of these exports may not exclusively be for the use in electricity generation, but it is not possible to get more accurate data.

The EU-27 has a strong export position on nearly all of the world's largest economies and is by these measures the third largest exporter of environmental goods, just behind Japan. Especially in the emerging BRIC (Brazil, Russia, India and China) countries there is a clear lead compared to other established western economies. Furthermore, the EU is the main importer of environmental technologies, although the magnitude is skewed by the large imports of photovoltaic goods.

Table 25 only shows a snapshot of the trade patterns in 2010, below the trade over time can be seen. Undoubtedly China has demonstrated the largest growth in exports, in absolute and relative numbers (59% annualized growth), nonetheless, the EU is performing also well with an annualized growth rate of 15%. Furthermore, although the global export market for environmental technologies was not spared during the global economic crisis in 2008, it swiftly rebounded in 2009-10.

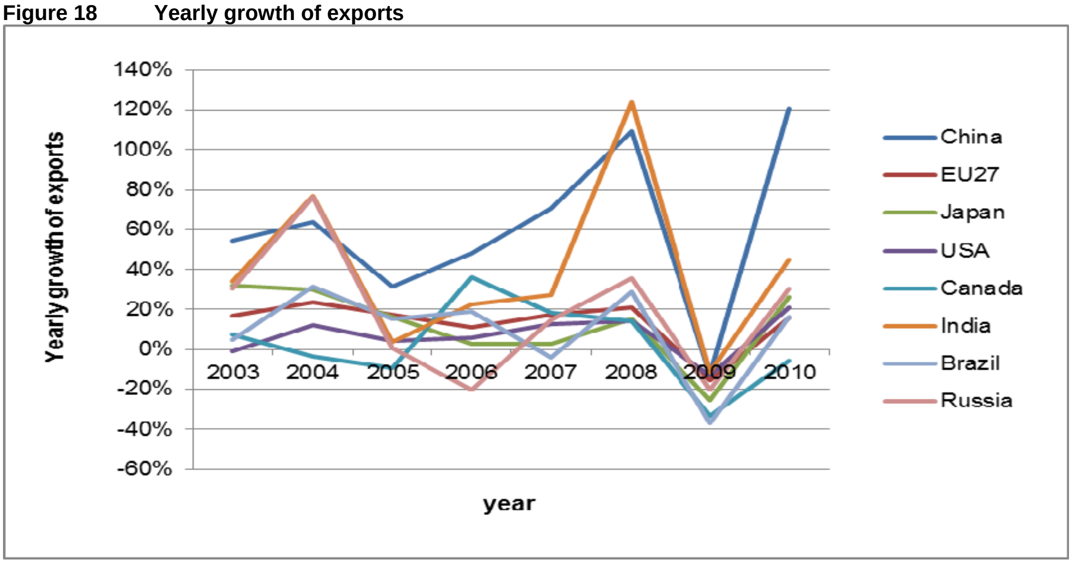
Figure 17 Value of Exports over time (in US dollars, corrected for inflation)



Source: COMTRADE database

18 More specifically HS code 85414: Photosensitive semiconductor devices, incl. photovoltaic cells whether or not assembled in modules/made up into panels; light emitting diodes

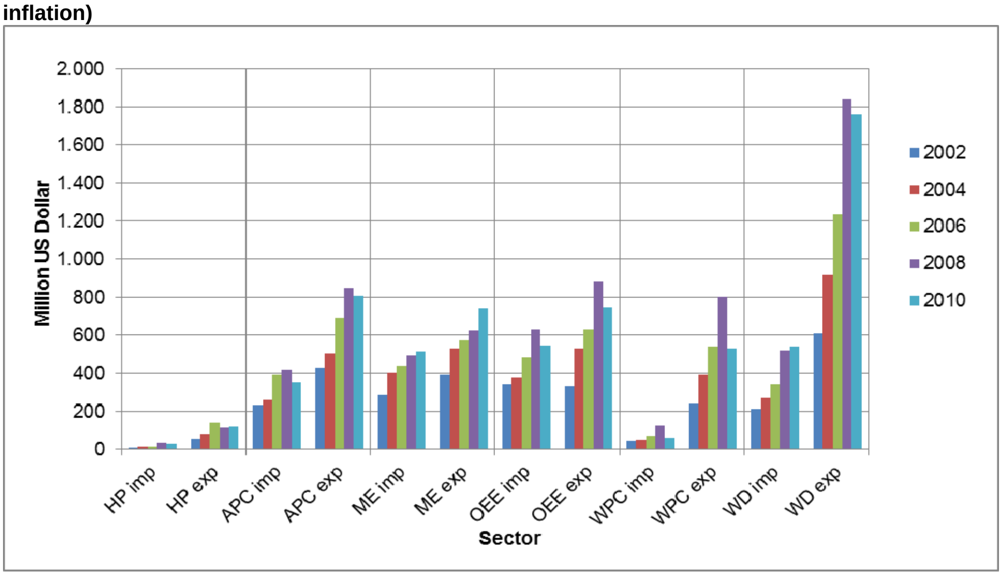
Figure 18 Yearly growth of exports



Source: COMTRADE database

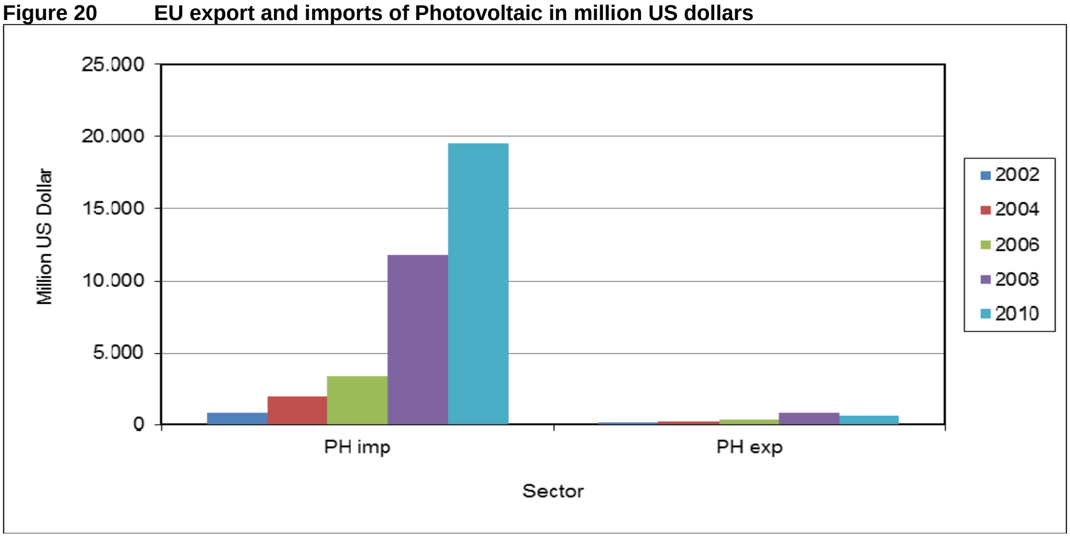
In Figure 19 and Figure 20 the exports and imports per environmental technology are shown. Except for photo-voltaics, the EU has a net export position compared to the rest of the world for the selected environmental technologies. Again, the flows merely represent a magnitude indication of selected technologies. Both imports and exports have grown at a steady pace until 2008, when in 2010 exports and imports levels dropped, except for Measurement Equipment and photo-voltaics, where both imports and exports increased. Imports of Photo-voltaics are by far the largest category and require a graph on their own. The largest bulk of the imports are sourced from China, the rest from Japan.

Figure 19 EU exports and imports of environmental technology in million US dollars (corrected for inflation)



Source: COMTRADE database

Figure 20 EU export and imports of Photovoltaic in million US dollars



Source: COMTRADE database

The net export position of the EU environmental technology industry is good, in every sector, except again for photo-voltaics, the balance remains positive over the years, underscoring once more the strong position of the EU in the production of environmental technologies. This will further be highlighted below.

Table 28 Net export position of EU environmental technology trade (in million of US dollars)

	2002	2004	2006	2008	2010
HP	44	65	124	81	89
APC	197	246	298	432	456
MEE	104	129	135	128	229
OEE	-9	153	140	256	202
PH	-673	-1.742	-2.965	-10.948	-18.874
WD	192	344	470	680	468
WPC	393	645	896	1.317	1.220
Total	249	-161	-901	-8.054	-16.209

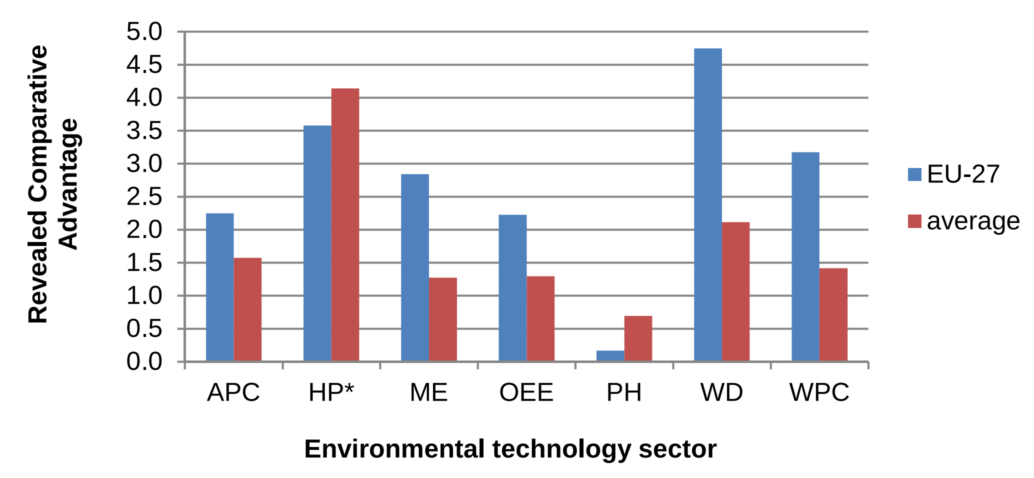
3.3 Revealed Comparative advantage

Based on the same methodology as applied for the Ecorys and IDEA (2009) study the Revealed Comparative Advantages (RCA) for the EU-27 *vis-à-vis* other global market players in 2010 has been calculated[19]. Bilateral trade flows between EU-27 Member States have been omitted. Instead only the comprehensive trade flow of the EU - 27 towards six major world players: Brazil, China, India, Japan, the Russian Federation (RF) and the United States (US).

The tables and figures below give an impression of the relative position of the EU-27 in terms of trade specialization for each sub-sector, compared to the average of the other countries. If *RCA < 1*, then a country has a revealed comparative disadvantage in the sub-sector. Vice versa if *RCA > 1*, and the larger the RCA, the higher the comparative advantage.

19 For more information see Annex A

Figure 21 Revealed Comparative Advantage of the EU-27 vs. selected countries average in 2010



Source: COMTRADE database and Ecorys calculations

Note-1: RCA for Air Pollution Control, Hydropower, Monitoring equipment, Other environmental equipment, photovoltaic, waste disposal and water protection control

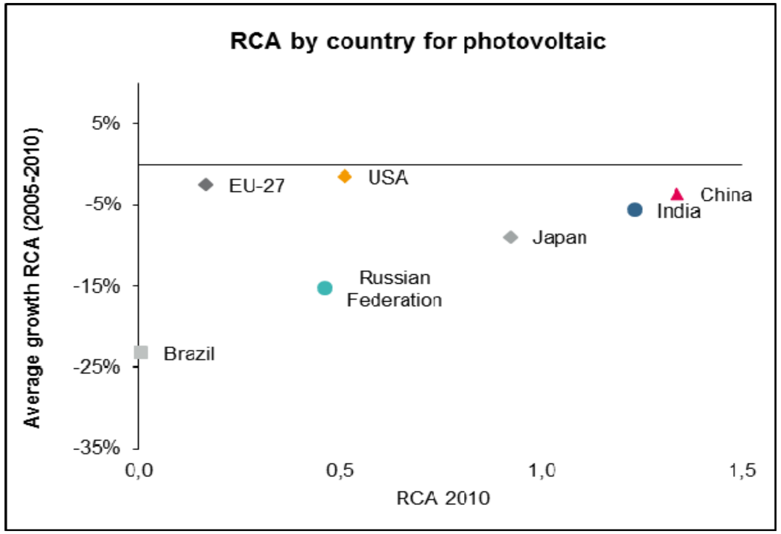
* Brazil has a RCA of 83 in Hydro, including this outlier would skew the graph to much

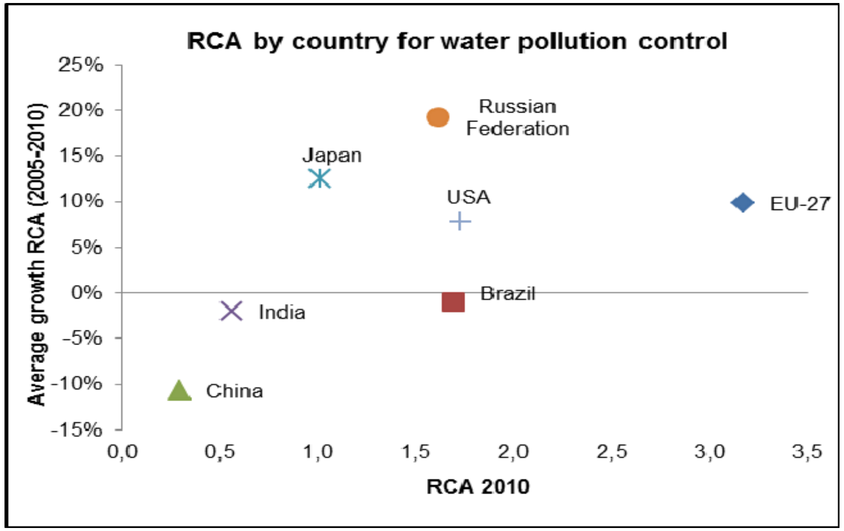
From the figures some general trends can be discerned:

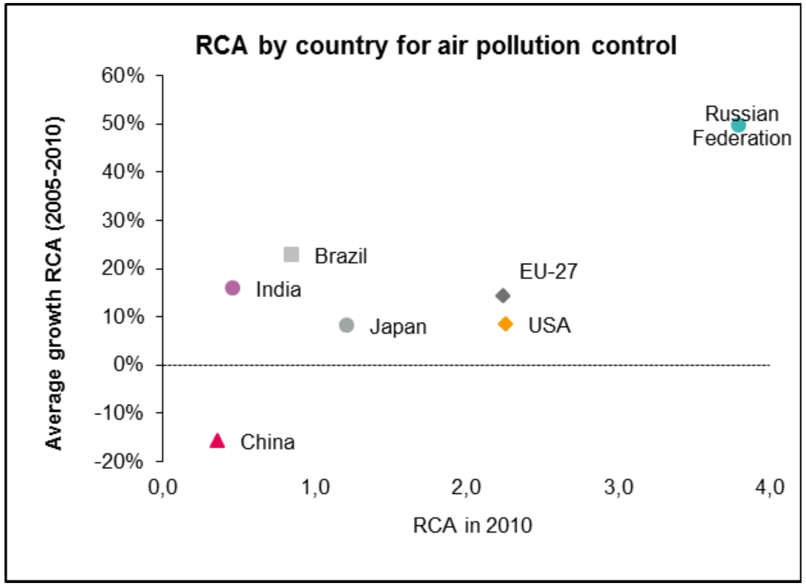
- **Europe seems to perform well overall**, having a trade specialization (revealed comparative advantage) in five out of seven sectors
- In **hydropower** the EU holds a middle position, with Brazil and Russia ahead of the EU both in terms of the value of their RCA and the growth rate. Brazil is clearly by far the most specialized country in this sub-sector
- In **photo-voltaics**, the EU is one of the least specialized however 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 a very strong position measured by RCA. Although Russia has a higher RCA in 2010, this is due to trade in 2010 that is 4-times larger than its average, raising questions about the consistency of this data point over time. 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 has surpassed the US, compared to the Ecorys and IDEA study. The growth rate the EU is also similar to that of the US and Japan, surpassed only by Russia, but quite clearly stronger compared to the other emerging economies.
- For **other environmental equipment** the US is clearly the most specialised, 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, although Japan has showed a stronger growth in the last years.
- Finally, in terms of **waste disposal** the EU has the strongest level of trade specialization, although not as clearly is in 2007. Growth rates in Russia, Brazil and Japan are also high. In 2007, India and China also demonstrated double-digit growth rates, suggesting these countries are catching up as population growth, urbanization and economic growth are placing increasing demands on waste management services. However, their RCA fell back to 2000 levels.

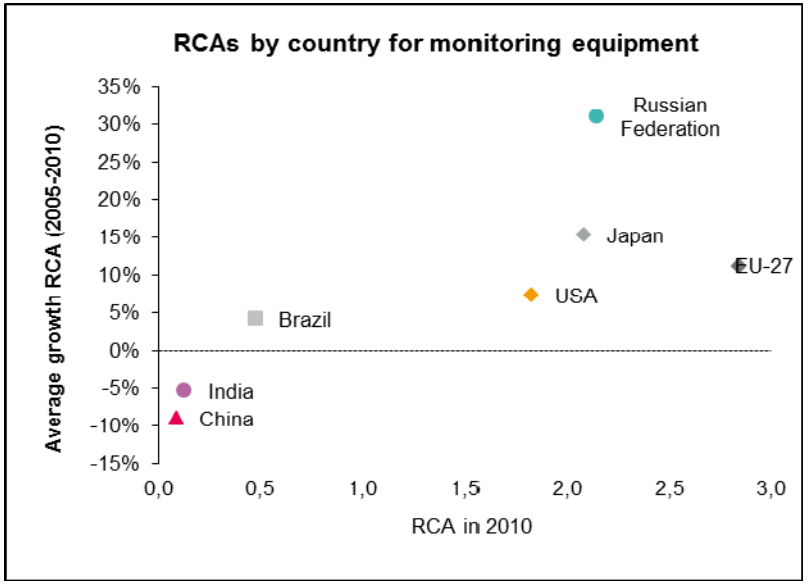
Below some of the key graphs are high-lighted:

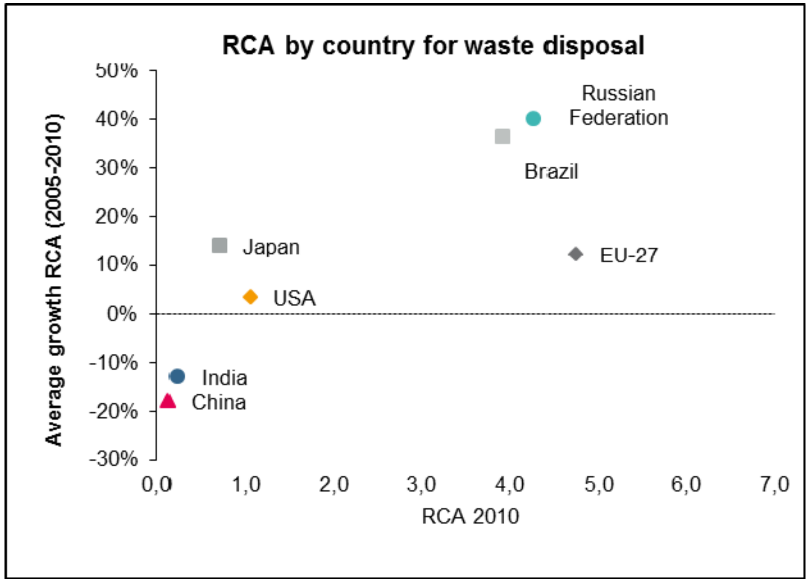
Figures 22 RCA for EU-27 and main trading partners for various environmental goods, technologies and services (Source: COMTRADE database and Ecorys calculations)

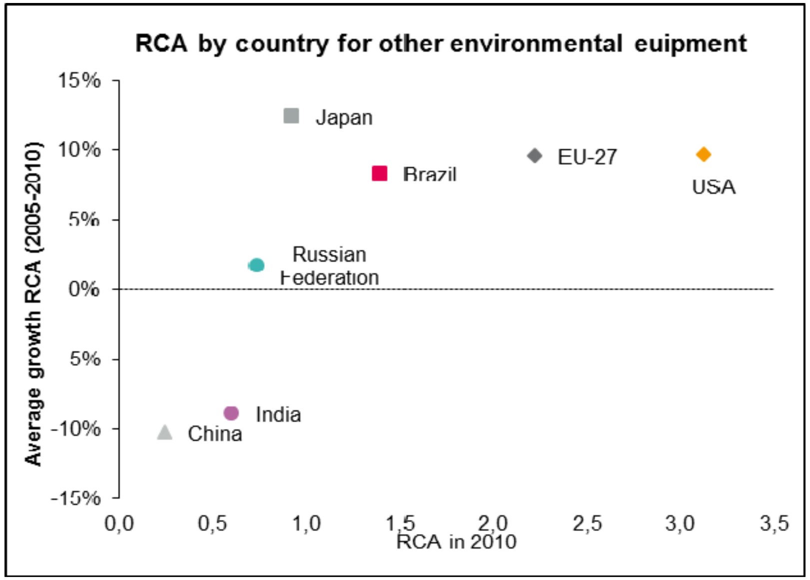





RCA by country for air pollution control
Average growth RCA (2005-2010)
60%
50%
40%
30%
20%
10%
0%
-10%
-20%
0,0
1,0
2,0
3,0
4,0
RCA in 2010
Russian Federation
Brazil
India
Japan
EU-27
USA
China

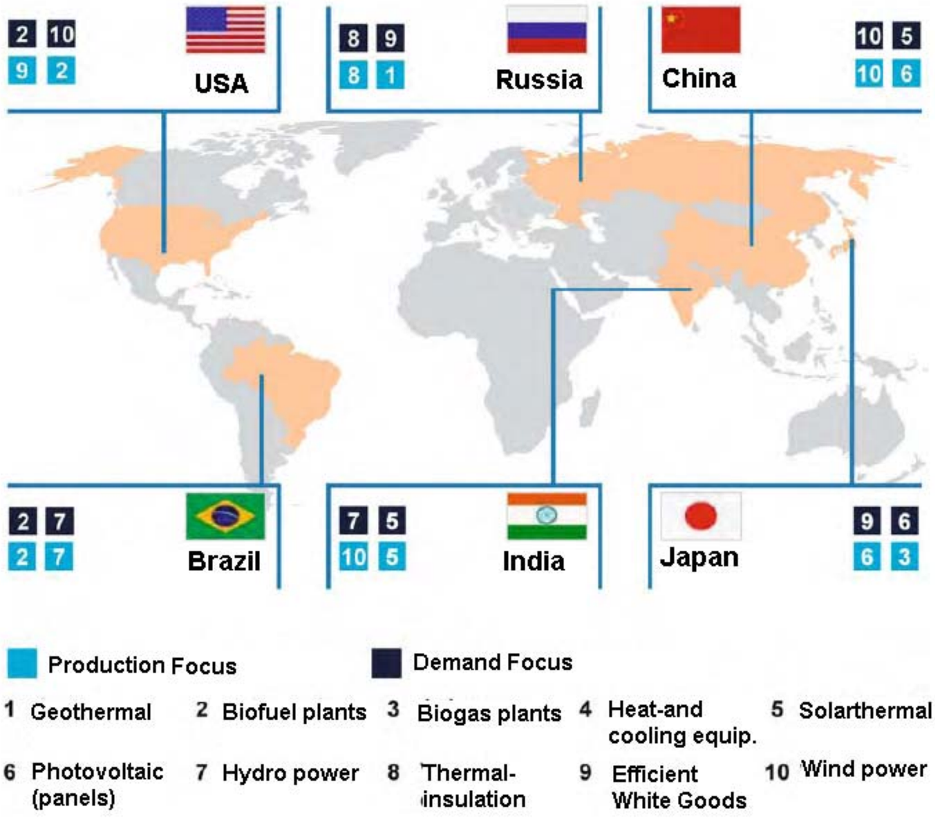

RCAs by country for monitoring equipment
Average growth RCA (2005-2010)
35%
30%
25%
20%
15%
10%
5%
0%
-5%
-10%
-15%
0,0
0,5
1,0
1,5
2,0
2,5
3,0
RCA in 2010
Russian Federation
Japan
EU-27
USA
Brazil
India
China


RCA by country for waste disposal
Average growth RCA (2005-2010)
50%
40%
30%
20%
10%
0%
-10%
-20%
-30%
0,0
1,0
2,0
3,0
4,0
5,0
6,0
7,0
RCA 2010
Russian Federation
Brazil
Japan
EU-27
USA
India
China


RCA by country for other environmental euipment
Average growth RCA (2005-2010)
15%
10%
5%
0%
5%
-10%
-15%
0,0
0,5
1,0
1,5
2,0
2,5
3,0
3,5
RCA in 2010
Japan
EU-27
Brazil
USA
Russian Federation
India
China

In Figure 23 the production and demand focus regarding environmental technologies of selected countries is presented. Different countries, dependent on their natural resources and environmental capabilities, have an appropriate focus on production and demand that can further be broken down into sub-categories, however the overview creates a good understanding at first sight. Although the EU-27 is not explicitly mentioned in figure 25, it would have a production focus on wind energy and hydropower and a demand focus in photovoltaics and wind energy.

Figure 23 Production and demand focus of selected countries



Source: Roland Berger (2007 & 2009)

3.4 Innovation

Hard data on innovation expenditure is difficult to retrieve for environmental sub sectors. Aggregated R&D expenditure for economic activities are available, however they would not represent reliable interpretations for environmental domains.

'Measuring Eco-Innovation' is an initiative by DG research that offers a conceptual clarification of eco-innovation, however it does not produce data to give an indication of comparative innovative advantages. They conclude that it is possible to use patent applications as an indication of eco-innovativeness, although certain cautions apply (Kemp et. Al, 2008).

The last comprehensive report on environmental innovation stems from a 2006 report by DTI and DEFRA (2006). It 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.

3.4.1 Summary

The general observation is that the global market – as expressed in annual turnover – for eco-industries is estimated at roughly EUR 1,15 billion a year in 2010, with over one third coming from the EU-27. The United States (US) and Japan account for the largest part of the remaining global turnover for eco-industries after the EU-27. The EU's comparative advantage and niche markets are seen to lie in 'Renewable power generation technologies' (over 40% of global market shares) and 'Waste Management' and 'Recycling technologies' (50% of global market shares). Although it is an established market player in certain segments, the European eco-industry is under increasing pressure from Japanese, Taiwanese and Chinese competition in a range of market segments.

It is difficult to get a clear indication of the exact size, as the statistical boundaries are often unclear, traditional and eco-industries are overlapping, and commodities may be produced or used for either industry.

4 Potential job creation from improved environmental performance: Case studies

The fourth chapter intends to showcase potential employment benefits from investments in environmental technologies and resource efficiency. Six case studies have been made for different sectors or industries with the goal to show how different actors, mechanisms and investments can yield employment benefits. The case studies should be considered as thought experiments and rough assessments rather than comprehensive, full-fledged scenario building for different sectors.

The case studies and their categories are the following:

- Green/sustainable construction
  - **Insulation**
  - **Heat pump technologies**
- Recycling
  - **Copper**
- Resource dependent sectors
  - **Cement**
- Technologies for resource efficiency
  - **Electrically propulsed vehicles (Hybrids)**
- Infrastructure
  - **Water-efficient agricultural irrigation technologies**

The main research approach has been a mix between internet based research and fact-finding, and a large number of targeted interviews.

The following pages present a summary version of each case study, the full versions of which can be found in the annexes to this report.

4.1 Insulation

The insulation sector is potentially a substantial source of future job creation due to its central role in energy efficiency in the built environment. Buildings account for 40% of European energy use, although this which is meant to drastically decrease with the implementation of the European Building Performance Directive (EPBD). Due to the size and weight of insulation materials it is generally not cost-efficient to import over long distances, i.e. transport from China, because of this and other factors the majority of the European market is supplied by European companies. Furthermore, a number of the key players globally are based on the European continent and employ a great number of people. In table 27 the key overall figures for the European insulation industry can be seen.

Table 29 Key figures in the European insulation industry

Key figures - insulation industry (2009)	
Turnover	
• Manufacturing	EUR 6,7 billion
• Installation	EUR 14,339 billion
Employment	
• Manufacturing	61.250 (FTEs)
• Installation	170.800 (Employed)[20]
Total	
• Turnover	EUR 21,339 billion
• Employment	232.050

Table 30 Top four insulation manufacturers globally (by turnover).

	Company	Headquarters	Sales (millions)	Employees
1	St. Gobain / Isover	France	EUR 2.700[21]	11.000[22]
2	Rockwool Group	Denmark	EUR 1.575 [23]	8.808
3	Knauf Insulation	Germany	> EUR 1.000	5.000 [24] (76% in Europe)
4	Owens Corning	US	EUR 950[25]	15.000[26]

The insulation industry is driven by two factors: (1) rate of new buildings being constructed, and (2) refurbishments. The current combined rate of new buildings and refurbishments is only around 1% of the European building stock annually. It is hoped that the recast of the EPBD will spur investment in public and private buildings. However, the latest financial crisis has slowed the speed of policy implementation.

To accommodate this high level of uncertainty the case study on insulation assumes three scenarios with different rates of growth. It is also assumed that trade will remain intra-EU and most jobs will be created within the European region. Based on market studies and the impact assessment for the EPBD, the growth scenarios assumed were for annually: 1,2% in a low growth scenario, 2,2% in a medium growth scenario and 5% for a high growth scenario.

20 Ecorys (2011) http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Glossary:Employee_-_SBS
21 2008 sales Isover, worldwide http://www.isover.com/About-Isover/Organisation-and-key-figures
22 Worldwide; http://www.isover.com/About-Isover/Organisation-and-key-figures
23 2010 net sales
24 2010 sustainability report
25 Annual report 2010, net sales insulation division (1 309 mln usd)
26 In Total business, no separate figures on insulation; annual report 2010

In terms of turnover, the following calculations have been made:

Turnover (Low growth, billion EUR)	2010	2015	2020
Manufacturing	6,7	7,1	7,5
Installation	14,3	15,4	16,1
Total	21,0	22,6	23,7

Turnover (Medium growth, billion EUR)	2010	2015	2020
Manufacturing	6,7	7,5	8,3
Installation	14,3	16,0	17,8
Total	21,0	23,4	26,1

Turnover (High growth, billion EUR)	2010	2015	2020
Manufacturing	6,7	8,5	10,9
Installation	14,3	18,3	23,3
Total	21,0	26,8	34,3

In terms of job creation, the following calculations have been made:

Employment (Low growth, x 1.000)	2010	2015	2020
Manufacturing	61,3	65,0	69,0
Installation	170,8	181,3	192,4
Total	232,1	246,3	261,4

Employment (Medium growth, x 1.000)	2010	2015	2020
Manufacturing	61,3	68,3	76,1
Installation	170,8	190,4	212,3
Total	232,1	258,7	288,5

Employment (High growth, x 1.000)	2010	2015	2020
Manufacturing	61,3	78,2	99,8
Installation	170,8	218,0	278,2
Total	232,1	296,2	378,0

In conclusion, the growth of the European insulation industry is dependent on the rate of implementation of the EPBD (or on efforts to improve energy efficiency in general). Non-EU manufacturers are not presumed to be a direct threat to employment due to the characteristics of the market.

The turnover of the industry in 2020 is expected to range from EUR 23,7 billion in a low growth scenario to EUR 34,3 billion in a high growth scenario. In terms of employment, the range is from 261 400 in the low growth scenario to 378 000 in the high-growth scenario.

Some investigations were made into innovation and development of more resource efficient manufacturing processes. Industry associations argued that significant innovation is taking place and that there is some potential for reuse of insulation material during refurbishment. However, no major technological or other breakthroughs are foreseen or are included in the case study.

The full case study is included in annex B

4.2 Heat pump technologies

The energy consumption of industry and households takes up an increasingly large share of EU's final energy demand. Households, for example, are estimated to use 24,6% of energy produced in Europe of which the largest part is used to power the heating and cooling of dwellings. About 2/3 of household energy consumption is devoted to run boilers, space heaters and coolers. Besides better insulation, more energy efficient behaviour and improved appliances, the spread of heat pumps also enhances the energy performance of buildings. Heat pumps are devised to use existent energy in mediums such as water, air and ground, to drive heating or cooling processes. In a cooling mode, a refrigerant is run through a closed system, shifting between liquid and gaseous stage to absorb energy from water, air or ground. The main outcome in terms of resource efficiency of an increase in the use of heat pumps is a reduction in the use of regular heating oil and gas for heating and cooling buildings.

In some countries, such as Sweden, Finland and Germany, market uptake of heat pumps has already reached a mature stage on the refurbishment market. In Sweden, for example, 80% of all new buildings are estimated to have heat pumps. In other countries, such as the Netherlands, the market is in an emerging stage with take-off seemingly not far away.

Aggregate data on employment and turnover for the heat pump market is scarce. Manufacturers are often SMEs or part of larger conglomerates such as Mitsubishi. The estimations are therefore mainly based on interviews from industry representatives and reports from a limited number of manufacturers.

Key figures - heat pump industry (2010)[27]	
Turnover	
• Manufacturing & Installation	EUR 3 billion
Employment	
• Manufacturing	20.000 (FTE)
• Installation	21.000 (FTE)
Total	
• Turnover	EUR 3 billion
• Employment	41.000

The market for heat pumps is expected to grow over the next 10 years. The take-up of the technology in most European countries leaves much room for improvement and with large scale energy efficiency legislation, such as the EPBD, expected to impact the minimum energy performance requirements for buildings, heat pumps could gain market shares on conventional boilers. For example, heat pumps are recognised by many National Renewable Energy Action Plans to reduce final energy demand and therefore CO_2 emissions. When analysing the plans, it is expected that the deployment of heat pumps could grow by 30% annually and that by the end of 2020 over 40 million heat pumps units will have been sold in Europe with annual sales having risen to 10 million.

The main employment effects will be manifested from the shift from producing fossil fuel based boilers to heat pumps. The net effect is unclear, but due to a more inter-connected heat pump value chain including design, drilling and installation, more jobs should be created. This would have a

[27] Please see full case study for full explanation of how the estimations were made

positive effect on aggregate employment compared to the status quo (i.e. mostly traditional fossil fuel based boilers).

Based on our scenarios we estimate that by 2020 an optimistic scenario with 35% annual growth in the market, 400.000 extra jobs could be created through drilling and installation of heat pumps. On a global scale European companies are in a good competitive position due to a technological advantage. In particular the Asian markets are growing, however, it is doubtful if it will yield any job-creation in Europe.

The full case-study is included in Annex B.

4.3 Copper

Copper is an essential metal for modern societies. Its characteristics makes it suitable for a large range of applications, from thermal transfers to electrical conductivity. The industry traditionally plays a large role in Europe with a turnover of 46 billion EUR in 2007, within EU metal industries this second to aluminium (52 billion EUR). It employs approximately 46 000 people in the EU, around 10 000 in refined copper production and 36 000 in copper product fabrication. EU involvement in the copper sector increases down the value chain, with relatively low involvement in mining and smelting, but a bigger global role in refining and casting of semi-fabricated products.

Lowering energy intensity and air pollution are central challenges from a resource efficiency perspective. Nevertheless, these are interlinked with the general issues for the future of the European copper industry which include increased competition from emerging economies, and the resulting increases in price, and competition, for copper and scrap metal. Scrap is important as about 40% of the copper used in Europe is recycled, this is the highest rate globally, though recycling rates are increasing in other regions. The tables below presents some of the key indicators for the copper sector, including the key European companies involved in the sector.

Table 31 Key figures for the European copper industry

Key figures - Copper (2007)[28]	
Turnover	
• Manufacturing (mining, refining and fabrication)	EUR 46 billion
Employment	
• Refined copper	10 000 (FTE)
• Copper products	36 000 (FTE)
Total	
• Turnover	EUR 46 billion
• Employment	46 000 (FTE)

Table 32 Main copper producers in Europe

Mining	Smelting	Refining	Other e.g. SX-EW[29]:
Boliden; KGHM; Somincor; Mandesur Andevalo; Minas de Aguas Tenidas (MATSA); Rio Narcea.	Aurubis; Atlantic Copper; Boliden; Metallo Chimique; Montanwerke Brixlegg; KGHM.	Aurubis; Atlantic Copper; Boliden; Metallo Chimique; Montanwerke Brixlegg; KGHM	Cobre Las Cruces; Hellenic Copper Mines.

Source: Ecorys (2011) Competitiveness of the EU Non-Ferrous Metals Industries

Long term employment growth in the EU copper industry is relatively low. Resource efficiency and other investments in the sector have the potential to create a larger number of short-term jobs, which although beneficial are unlikely to add significantly to total sector employment over time.

28 Please see full case study for full explanation of how the estimations were made

29 Solvent extraction/electrowinning (SX/EW) is a two-stage process that first extracts and upgrades copper ions from low-grade leach solutions into a concentrated electrolyte, and then deposits pure copper onto cathodes using an electrolytic procedure

These shorter term jobs are based in the construction and installation of equipment at existing, or potentially new, plants.

The case study of potential jobs related to resource efficiency in the copper industry is based on 3 growth scenarios, which make assumptions regarding relative growth rates of the global and EU copper industries. As a general rule growth rates in the EU are assumed to be slowly declining to 2020, while global growth rates are slowly increasing in the same period.

The following estimates of production and market share have been made for the EU copper industry.

EU refined copper production (million tonnes)	2010	2015	2020
High growth	2.6	2.8	3.0
Medium growth	2.6	2.68	2.75
Low (Historical) growth	2.6	2.65	2.7

EU share of global refined copper production (%)	2010	2015	2020
High growth	13.5	12.9	12.3
Medium growth	13.5	11.6	9.7
Low (Historical) growth	13.5	12.2	10.8

The following estimates of annual average jobs related to resource efficiency have been made for the sector.

Employment scenario	2010	2015	2020
High growth	2 887	2 860	2 832
Medium growth	2 616	2 457	2 298
Low (Historical) growth	2 361	2 403	2 444

In conclusion, while production of the EU copper industry is expected to continue to increase in the future, in all scenarios the EU share of the global market is expected to decline. This highlights a sector struggling to retain its competitiveness.

Employment data suggests a total number of jobs related to resource efficiency in the sector of between 2 300 – 2 900 jobs. The number of jobs varies by scenario, but in all except the low growth scenario the total number of jobs dependent on resource efficiency is estimated to decline. This will still represent approximately 5-7% of all jobs in the sector.

Resource efficiency could be crucial to the future of the industry in the EU. It is crucial to ensure a supply of scrap material to offset rising global copper prices, which the EU is relatively more vulnerable to as a major exporter. Increased efficiency is also crucial to controlling the cost base to remain competitive. This takes into account the additional, compared to most competitors, social and environmental regulation that EU companies need to comply with, which can result in higher costs. Firms in the industry need to maximise the economic gains from resource efficiency, i.e. cost savings in energy use, resource use or need for emissions or pollution permits, to offset these costs.

The full case study is included in Annex B.

4.4 Cement

Cement falls outside the definition of eco-industries used in the study. Yet, cement has been included in the case-studies due to its heavy resource use. Besides high energy use, CO_2, and several other air pollutants are emitted in the processing of cement. On the other hand, the cement industry is a large industry in terms of employment and turnover, as well as, strategic importance.

Cement production in the EU is carried out in 358 cement plants, of which 268 have kilns. The other 90 only have mills. Most plants are in Italy (94), Germany (58) and Spain (50). In 2007, the turnover was 21,5 billion, but dropped to 18 billion in 2009 (CEMBUREAU). In general the European share of the global market has fallen from 14% in 2000 to 6% in 2010. However, global production has increased steadily.

Key figures - Cement (2009)[30]	
Turnover	
• Manufacturing	EUR 18 billion
Employment	
• Production	48.000 (FTE)
Total	
• Turnover	EUR 18 billion
• Employment	48.000

With regards to employment, in 2009, around 48.000 people were directly employed by the cement industry in Europe. As production of cement has become more capital intensive over the last few years there has been a decrease in labour demand in general. From 2005 to 2008 the number of jobs decreased by around 2% annually (from 51.550 to 48.550). Between 2008 and 2009 the number decreased further to 48.000. However, in general terms, there is an observed increase in the demand for higher qualified staff. Especially in research and development, higher qualified staff are being taken on.

Hence, Europe's role in the future of the cement industry is somewhat unclear. The global use of cement is set to increase significantly, especially in China, India and other Asian countries. Cement is by character a regionally produced and consumed product, this is reflected in exports of cement representing only 3% of production in 2007. The industry in Europe is also regarded as mature, with no significant growth or decline expected. Based on WBCSD and IEA figures, the growth scenarios have been fitted with rather conservative rates: High scenario 0,24% growth and low scenario –0,25%.

Employment growth scenarios take a cautious approach and project job creation to range between around 700 (low growth) – 1 250 (high growth) jobs by 2020. Finally, if a historical (medium) growth pattern is assumed, growth is closer to 950 jobs by 2020.

Moreover, the number of jobs estimated are not necessarily "additional jobs" but might mean a "shifts in jobs profiles". This may not necessarily add to the total number of workers in the sector. We argue there could be a mix of two types of jobs:

1. Jobs replacing the "redundant or traditional jobs" with more sophisticated types requiring higher skill levels, which results from the introduction of new machinery or new processes. Re-skilling is assumed however instead of new recruitment.

[30] Please see full case study for full explanation of how the estimations were made

2. Jobs that require more “green knowledge”, such as for example the hiring of expert staff with biodiversity knowledge, R&D and laboratory staff (explained further in the full case study).

As such, the majority of jobs created would belong to the second type, where more green knowledge is needed. And in general terms, the awareness of sustainability is unlikely to prevent an overall decline in jobs in the cement industry, but it may slow the rate of decline by creating some new types of jobs.

4.5 Electrically propulsed vehicles

Emissions from road vehicles contribute around one-fifth of the total CO_2 emissions in the European Union. Therefore, this is an important activity to target carbon emission reductions and electrically propulsed vehicles offer one way to achieve this. This means that there is a role to play for the vehicle manufacturing industry (particularly in some niche manufacturing markets, like technical hybrid/electric components and batteries) to reduce the negative impact of road transport on the environment. To this end, the European Commission (EC) has passed Regulation EC/443/2009 to set standards on the minimum emission performance for vehicles with a target of 130 gCO_2/km by 2015, eventually reaching 95 gCO_2/km by the year 2020. The target for 2015 needs to be reached through a phasing-in of intermediate requirement, with penalties for manufacturers if their fleet average is above the minimum requirements for the respective year.

The market size for electrically propulsed vehicles is scattered and difficult to access. The best available estimates suggest that there were worldwide almost 3,8 million electrically propulsed vehicles sold since the commercialisation of hybrid vehicles until the end of 2010 – with 53% of the sales in the United States, 35% in Japan and 11 % in Europe. On the European market, Toyota (in particular the Toyota Prius) accounts for the largest share of hybrid vehicles sold (about 85-90%). Other car manufacturers that have commercialised hybrid vehicles on the European market lately include, amongst others, Honda and Lexus, but also (some are expected in the near future) the PSA Peugeot/Citroën, Volkswagen, Nissan (e.g. Nissan Leaf) and BMW. Table 33 presents an overview of key figures of the market for the main electrically propulsed vehicle manufacturers (in particular, the market for hybrid vehicles) in Europe.

Table 33 Key figures of the hybrid vehicles industry in Europe

Brand	Model	Since	Cumulative sales until 2010
Toyota	Prius	2000	212.445
	Auris	2010	15.187
	GS450	2006	8.897
Lexus	RX 400h/450h	2005	63.721
	LS 600h / LS600hL	2007	3.536
Honda	Civic	2003	34.000 (2008)
	Insight	2002-2009	392
	Jazz	2011	n.a.
	CR-Z	2010	n.a.
BMW	Active Hybrid X6	only US	n.a.
	X Active Hybrid 7	only US	n.a.
Mercedes	S400 Blue Hybrid	2010	n.a.
VW	Touareg Hybrid	2011	n.a.
Peugeot	3008 Hybrid4	2011	n.a.
Total			**337.786**

Source: Toyota and Honda sales data, Ecorys calculations;

Total annual worldwide car sales were estimated at 61 million in 2010 and are estimated to grow to 75 million in 2020. The market share of hybrid vehicles in these total sales by 2020 has been estimated in a rather broad and widespread range. Factors include the development of the oil price, electricity price, technology developments in the field of internal combustion engine (ICE) propulsion, and significant cost reductions of batteries, but also how important policy makers and customers perceive the need to reduce CO_2 emissions.

Table 34 shows the market estimates from different research institutes of the market share and sales of hybrid vehicles globally and -where available - for Europe for 2020.

Table 34 - Outlook in market penetration of HEVs in 2020

Study	% market share in 2020 of new vehicles sold		Hybrid cars sold in 2020 - in million vehicles	
	World	Europe	World	Europe
Roland Berger (H)	25%	27%	20,4	(4,1)
BCG (H)	26%	18%	19,5	(3,1)
BCG (M)	20%	17%	15,0	(2,9)
McKinsey (H)	18%		13,5	
Shell (H)	17%		13,1	
BCG (L)	11%	10%	8,3	(1,7)
McKinsey (M)	10%		7,5	
Shell (L)	6%		4,1	
McKinsey (L)	1%		0,8	

Note: H = High estimate; M = Medium estimate; L = Low estimate
Source: (BCG, 2009) (McKinsey, 2009) (Shell, 2009) (Roland Berger, 2010)

To accommodate for a large amount of uncertainty the case study on electrically propulsed vehicles assumed five scenarios with different rates of market growth and market share. Based on the market studies, stakeholder consultation, the following scenarios were assumed:

Table 35 - Scenarios on market growth (in %) and market share (in%) for HEVs in 2020

	Market growth (total %)	Market share (production)	Market share (export)
Scenario 1: High market growth & High market share	17	50	30
Scenario 2: Medium market growth & High market share	10	50	30
Scenario 3: Medium market growth & Medium market share	10	25	20
Scenario 4: Low market growth & Medium market share	3	25	10
Scenario 5: Low market growth & Low market share	3	15	10

The production of hybrid vehicles in Europe will take-off and will increase (very) significantly over the next 10 years and as such will inevitably have an impact on employment. However, the main question is whether it will be limited to a replacement effect from conventional vehicles to HEVs or actually create jobs related to resource efficiency improvements. For now, all hybrid components are (still) produced outside Europe. Therefore, the potential impact on the different segments of (hybrid) car manufacturing, in terms of employment effects, will be different with probably a high job potential in some niche markets (e.g. technical and content value hybrid/electric components).

The overall employment impact of an increase in deployment of HEVs in Europe is unclear and can only be estimated by highly speculative means. With a narrow definition of the market segment for HEVs, the main employment effects will be a shift from production of conventional vehicles to HEVs, with negligible effects on net employment. Among the crucial questions to answer is how the European car industry will develop with respect to HEVs, will European car manufacturers locate the necessary R&D infrastructure in Europe and develop their own competitive vehicles. If not, then the employment effects may be limited to increases as production from foreign manufacturers located in Europe increases and slow expansion of the European role in the supply chain.

The full case study is included in Annex B..

4.6 Water-efficient agricultural irrigation technologies

Agriculture is by far the biggest consumer of water worldwide and accounts for about 70% of water use. Approximately 28% of cropland is now under irrigation, with half of this located in Asia. In Europe 24% of total water consumption is used for agriculture and while the size of irrigated areas is increasing the total amount of water being abstracted is decreasing. Efficiencies in irrigation are likely to be a key factor in continuing this trend. Drip irrigation, which is also called micro-irrigation, systems can cut water consumption by between 30% and 70%. Moreover, there are several positive side effects of this technology such as the prevention of soil salination and the decreased use of pesticides.

Data on the total size of the market for irrigation technologies is scattered and not subject to robust estimations. The sector is generally incorporated under “other agricultural equipment” and as such, no official estimates are available. Finally, industry associations provide no details of their members’ turnover or trade figures. The best available estimates suggest that worldwide, turnover is in the range of 1 to 2 billion EUR of which half is produced in the US and 10% in the EU - 27.

Key figures - Drip irrigation (2011)[31]	
Turnover • Manufacturing, installation, operations	 EUR 1 - 2 billion
Employment • Production	 200.000 (employed)
Total • Turnover • Employment	 EUR 1 - 2 billion 200.000

On employment, a market analyst interviewed for this study estimated the total number of people employed in Europe to around 200.000. The figure includes manufacturing, installation and operation. It is, however, a rough estimate. While there are a few large companies based in France, Spain, Germany and Italy, most downstream operators are SMEs, often with no more than 10 employees. At these disaggregated levels there is a gap in sectoral data.

The scenario building and case study’s future outlook for drip irrigation is heavily influenced by the lack of data. In the end, only estimations can be made regarding trends. The first observation is that innovations in irrigation appear to reduce the need for operational expenditures, i.e. downstream employment opportunities are likely to disappear as techniques get more efficient. On the other hand, development in R&D is needed for European companies to stay competitive. With increased water scarcity envisaged in many southern countries, the need for irrigation will continue.

Competition from many Asian producers, for example in China and Japan, is already present and European companies will need to improve their products to continue to compete. Therefore, if current trends in drip irrigation are sustained then there is a possibility that job creation in R&D and job loss downstream could off-set each other.

[31] Please see full case study for full explanation of how the estimations were made

5 Conclusions

This study on “The number of Jobs dependent on the Environment and Resource Efficiency improvements” presents an overview of methodologies and data-sets to calculate the number of jobs related to the environment. These methodologies are tested and discussed throughout the report. It approximates the EU’s global market share, our current competitive position, and it takes a snapshot on what resource efficiency might mean for job creation within a few sectors. In the final chapter we sum up the findings and comment on the notoriously difficult issue of finding robust and complete data-sets.

5.1 The number of jobs related to the environment and resource efficiency

Task one of the study resulted in the revision of the number of jobs related to the environment presented in the Ecorys and IDEA study (2009) and the GHK study (2007). We have aimed to replicate and fine-tune the methodologies in both studies. Overall, the total number of jobs dependent on the environment is smaller than previously estimated. However, the report still shows a **trend of growth in jobs in the eco-industry over time**.

The revision in the jobs estimate stems from changes in Eurostat data-sets (Eurobase). When EU Member States report their figures (for example EPE) they are from time-to-time subject to revisions in methodology and classifications. This results in changes to both historic and future data-points. Some of these changes have been reported and commented upon throughout the text. There have been, for example, changes in NACE codes which has led to double-counting, and the German example on in Chapter 2 clearly shows how national reporting practices can significantly influence results.

From the update of the Ecorys and IDEA study we can conclude the following:

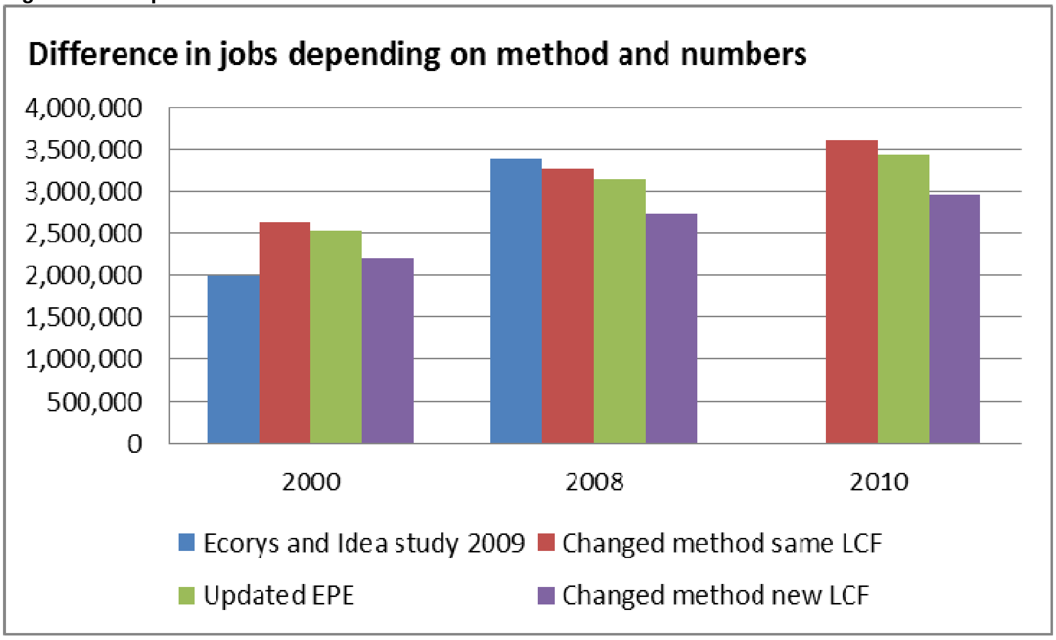
- The EPE figures have, on average, increased across all sectors, mainly due to two reasons: (1) **the NACE codes have changed**: The ‘Business sector total’ should be the aggregate of EPE data for the NACE code sections for a set of subsectors that were used in the Ecorys and IDEA study. Nevertheless, the ‘Business Sector Total’ yields higher EPE figures than the aggregate of the separate subsectors. The higher number is due to double-counting of ‘other business sectors’ since these are included in ‘Business sector total’. ‘Other business sectors’ however takes up a fairly small share namely 1% in 2000 and 7% in 2008. (2) **national reporting methodologies have changed**. In the case of both France and Germany the value of EPE has been revised upwards. Expenditure in ‘Wastewater Management’ and ‘Renewable Energy’ has increased by 60% and 40% respectively.

- Some categories have also been re-classified which has somewhat skewed the results. In the original Ecorys and IDEA study, the environmental domains ‘Waste Management’ and ‘Recycling’ were both used. For ‘Waste Management’ the EPE data was retrieved from Eurostat, where ‘Recycling’ data was based on production values from the national accounts. This presents a clear risk for double-counting. We have assumed that ‘Recycling’ is already covered by ‘Waste Management’ by all sectors and EP_SPE specifically. Therefore, the total ‘Recycling’ figures are subtracted from the ‘Waste Management’ figures in Eurostat and result in a decrease in total EPEs for ‘Waste Management’.

- Finally, the labour compensation factors have changed substantially due to re-calculations based on updated data, now available at the national level.

Overall, the number of jobs dependent on the environment and resource efficiency has been lowered in the 'new' study in comparison to the 'old' study. Figure 24 shows an overview of the results from the 'old' study compared to the results from the three 'new' methodologies.

Figure 24 Comparison of different studies



The 'high' Ecorys and IDEA figures for 2008 could be explained by overly optimistic future EPE estimations, i.e. MS estimations were used when actual data was not yet available, subsequently actual EPE was much lower, a lower wage growth rate (and higher wages) as well as a lower CAPEX – OPEX distribution in the mentioned report.

We also demonstrated that through modifications and updates in the completeness of the data and a redefinition of the 'Waste Management' environmental domain – i.e. using a new calculation method and output data – it is possible to increase the robustness and accuracy of the outcomes. However, due to these modifications employment figures are lower by about 1,2 million in 2008.

The updated figures are in line with the 'direct employment' figures presented in the second part of chapter two, if one used the same environmental sectors. The environmental sectors under 'Environmental Management' as well as 'Renewable electricity generation' and 'Water extraction & supply' have employment of 2,08 million for 2007. This is around 20% lower than the 2007 figures from the Trial 2 method. **Clearly the new methodology proposed in the Ecorys and IDEA study is in line with the CE results from the updated figures.**

From the update of the GHK study we can learn and may conclude that:

- Using a comprehensive definition of jobs dependent on the environment, **almost 19 million jobs directly rely on the environment in the EU-27**. A further **17 million are dependent on the environment indirectly**, either by supplying inputs to the environmental industry or through the spending made by employees in the environmental sectors.

- Using the comprehensive definition of jobs dependent on the environment, the **total figure in Europe has undoubtedly declined.** This is mainly due to European structural change, in particular a long-term decline in agricultural employment, but also a movement away from other primary extraction activities. However, the agricultural sector is still large enough that it dominates the overall results when considering total jobs dependent on the environment (it accounts for around two thirds of the total).

- In the GHK study We estimate that using this method there are around 1,3 million jobs (directly) in the pollution and environmental management sectors, with another 2,5 million indirectly supported The results presented in this report are not directly comparable to those from the previous report. This is partly due to differences in the raw data that are available to work with and partly due to changes in the methodology we have used (which in turn reflect the available data). While this means it is difficult to judge whether total employment in these sectors is growing or not, it highlights the on going efforts that are being made to improve the estimates of their contribution to the European economy.

- **Environment-related tourism is one of the fastest-growing sectors** in the categories that we have defined. By our estimates it accounts for more than 10% of the jobs that are directly dependent on the environment. However, due to issues with the NACE classifications, it remains difficult to measure precisely.

5.2 The competitiveness of European industries

The global market for eco-industries is estimated at roughly EUR 1.15 trillion in turnover a year (2010 figures), with over one third coming from the EU-27. Based on the outcome from the study, one can argue that European companies working in environmental and resource efficiency related sectors are generally performing well on the global market. In three out of seven sectors; photo-voltaics, air pollution control, and waste disposal, the EU has a revealed comparative advantage. Hydropower and other environmental equipment are more middle performing sector with growing competition coming from Brazil and Russia the former sector and the US in the latter.

Many environmental sectors included in the study are highly bound to local, regional or national markets and are not traded extensively. Others, such as photovoltaic allow for more cross-border trade. The figures retrieved for the study are not complete and therefore we advise that they should be read as depictions of flows and streams.

China has in terms of total value the highest export figures of all industries in 2010. This is especially due to their exports of photovoltaic equipment[32] which represents over 95% of their exports. These figures should be interpreted with care as large parts of these exports may not exclusively be for the use in electricity generation, but it is not possible to get more accurate data. The EU-27 has a strong export position vis-à-vis nearly all of the world's largest economies and is, by these measures, the third largest exporter of environmental goods, just behind Japan. The EU-27 has a particularly strong position in the emerging BRIC (Brazil, Russia, India and China) countries compared to other established western economies. Furthermore, the EU is the worlds biggest importer of environmental technologies, with imports of photovoltaic goods accounting for a large share of this.

[32] More specifically HS code 85414: Photosensitive semiconductor devices, incl. photovoltaic cells whether or not assembled in modules/made up into panels; light emitting diodes

5.3 Job creation by boosting resource efficiency

The final chapter is made up of six case studies on: insulation, electric vehicles (hybrids), copper, cement, drip irrigation and heat-pumps. The cases were selected in discussions with the Commission services and are either contributing to resource efficiency directly, or are highly energy intensive industries interesting from a resource efficiency perspective.

For all six studies a point was made that reductions in energy and/or resource use could lead to job creation. The focus was mainly on growth in each sector rather than gains in resource efficiency in manufacturing processes. For example, with heat pumps we have not examined the efficiency gains possible in production processes. Instead we have looked at the construction industry and how to make gains there.

For heat pumps and insulation the implementation of European policies in energy efficiency and savings are crucial. The EPBD will require all buildings to be ‘near zero energy buildings’ by 2020. To reach this goal demands a large push not only in new homes standards but also in the requirements for refurbishments. Among the most energy efficient investments possible in buildings are insulation and heat pumps, therefore, the growth of employment in these sectors will be directly dependent on, and benefit from, policy implementation.

For the large energy intensive industries, cement and copper, energy prices and tradable emission certificates have already put large pressure on these industries to improve their efficiency. Other environmental policies and regulations relating to air, water and waste are also highly relevant. Due to resource scarcity, more efficient processes, a mature business climate, and stringent environmental policies, these industries are not foreseen to see any significant increase employment in the near future.

Finally, electric (hybrid) vehicles and drip irrigation are more specific cases where a possible development is trade-offs in job creation. For drip irrigation an increase in efficiency are likely to reduce the number of jobs downstream. On the other hand, to increase efficiency it will be necessary to employ more people in R&D. This analysis, however, should be considered a rough estimation. For hybrids the market is equally unsure. Japan is world-leading in the hybrids market and currently only assemblage and some manufacturing of parts takes place in Europe. Moreover, there are no ‘hard’ policy incentives for European manufacturers to reduce their emissions to levels the equivalent of hybrid cars. On the other hand, if a European manufacturer takes up a bigger part of the global market, then jobs may be created in the industry. However, it is also likely that these jobs will mean re-skilling of existent workers rather than additional job creation.

5.4 Comments on robustness of results

A clear result from the study process is the central role of methodologies and data availability. We have suggested and presented four different methodologies for calculating employment: the ‘old’ Ecorys and IDEA study; the two new methodologies of the study; and finally, the GHK methodology. Moreover, the study uses two different definitions on which sectors to include in the study. Clearly the GHK study casts a much wider net for defining a ‘resource efficiency’ job. Also, the role of classifications is important. In particular on waste we have seen how what one assumes is included in the definition and what is not, is of great importance for the results. Finally, data availability is key. For some countries EPE are simply unavailable. For others, such as Germany and France, the reporting methodology has changed over time with significant implications for results. In sum, the data availability and quality has had an important influence on the outcomes of the study.

The study team has endeavoured to be clear and transparent in the assumptions made, data source used, and their particularities. Nevertheless, we are fully aware of the shortcomings and occasionally large assumptions implicit in the analysis. This indicates that the results should be used with caution and should not be regarded as definite, static figures.

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Annex A: Methodological clarifications to trade data and indicators

This annex clarifies some of the methodological issues on the calculations of relevant trade-related variables, like the Relative Comparative Advantage (RCA) and Balassa Index. Furthermore, a brief description about trade data and codes is included as these do not match with the NACE/COMEXT sector classification nomenclature.

RCA and the Balassa Index

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.

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.

COMTRADE trade codes included in each subsector

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 36 Eurostat/COMEXT trade codes used for the analysis of intra-EU trade patterns

Category	Code	Description
Hydropower	841011	Hydraulic turbines & water wheels, of a power not >1000kW
	841012	Hydraulic turbines & water wheels, of a power >1000kW but not >10000kW
	841013	Hydraulic turbines & water wheels, of a power >10000kW
	841090	Parts (incl. regulators) of the hydraulic turbines & water wheels of 8410.11-8410.13
Water Pollution Control	841370	Centrifugal pumps (excl. of 8413.11-8413.40)
	842129	Filtering/purifying mach. & app. for liquids (excl. of 8421.21-8421.23)
Waste Disposal	841780	Industrial/laboratory furnaces & ovens (excl. of 8147.10 & 8417.20), incl. incinerators, non-electronic
	841790	Parts of the industrial/laboratory furnaces & ovens of 8417.10-8417.80
Air Pollution Control	842139	Filtering/purifying mach. & app. for gases, other than intake air filters for int. comb. engines
Other Environmental Equipment	842199	Parts of the filtering/purifying mach. & app. of 84.21 (excl. of centrifuges, incl. centrifugal dryers)
Photovoltaic	854140	Photosensitive semiconductor devices, incl. photovoltaic cells whether or not assembled in modules/made up into panels; light emitting diodes
Monitoring equipment	902680	Instruments & app. for meas./checking the flow/level/pressure/other variables of liquids/gases (e.g., flow meters, level gauges, manometers...)
	902710	Gas/smoke analysis app.

Because COMTRADE only allows searching for 6-digit HS codes, below are 8-digit codes that could be used for a better analysis with Eurostat. However, Eurostat only gives figures for direct trade with the EU and not amongst other international players. Therefore in this analysis we only included data retrieved from COMTRADE.

Table 37 COMTRADE trade codes used for the analysis of intra-EU trade patterns

Category	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 thermal process, machinery and apparatus for civil aircraft of subheading no 8421.39-10 and isotope separators)
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.

Category	Code	Description
		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)

Annex B: Full case studies

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