

# Methodological Report

August 2012

## Eco-Innovation Observatory

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

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

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

To find out more, visit [www.eco-innovation.eu](http://www.eco-innovation.eu)

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## Introduction

The establishment of the Eco-Innovation Observatory (EIO) along with the other related activities of gathering strategic knowledge co-financed by the European Commission are an attempt to provide a much-needed integrated information source on eco-innovation for companies and innovation service providers as well as a solid decision basis for policy making. In this context, the EIO will serve as the platform for the structured collection and analysis of a wide range of eco-innovation information.

The EIO approaches eco-innovation as a pervasive phenomenon present in all economic sectors and, therefore, relevant for all types of innovation. Accepting such an approach has important consequences for the scope of the EIO. This methodological report is the milestone in building a solid foundation for the three-year activities of the EIO. The overall logic and activities of the observatory are illustrated by Figure 0-1.

In this context, the key objectives of this report are to:

- put forward a workable definition of eco-innovation distinguishing between various types and features of eco-innovation;
- outline the scope of measurement and analysis performed by EIO, including a tentative set of eco-innovation indicators;
- suggest the methodology of the EIO, including its approach to data analysis and foresight exercises; as well as
- outline the main deliverables and communication strategy of the project.

The report has six main chapters, each addressing a specific aspect of the project implementation and approach. Chapter 1 introduces the working definition of eco-innovation that will be used in the course of the analytical work of the Observatory. It further discusses the resource efficiency, material use and productivity concepts which are a particular focus and the value-added of the observatory.

Chapter 2 presents the scope and approach for measuring eco-innovation as well as the architecture of the EIO database. It discusses the taxonomy of eco-innovations (namely material flow, process, organizational, product, marketing and social) and indicators for measuring various types and dimensions of eco-innovations. It further discusses the EIO approach for analysing barriers and drivers to eco-innovation, the temporal scope covered by the observatory -- including ex post and foresight analysis -- and the thematic and country coverage of the EIO database.

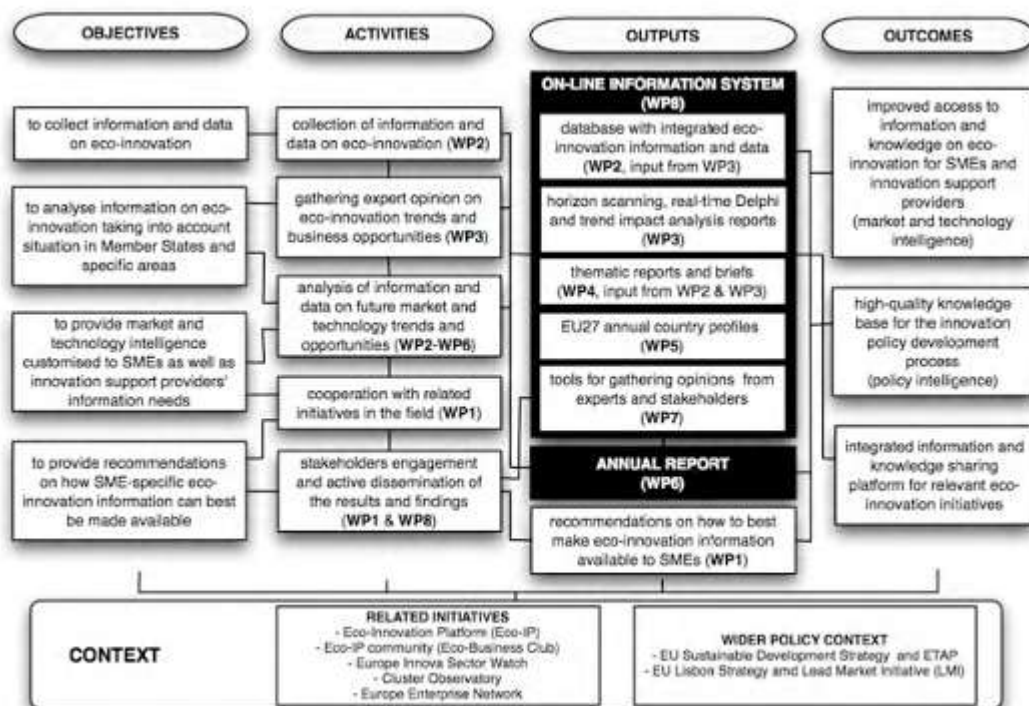
Chapter 3 explains how the observatory delivers upon its purpose and describes the concrete data management and research methods that will be applied. For ex-post related analysis it describes the processes of data-base building, monitoring of eco-innovation trends, sourcing data for specific thematic enquiries, and building composite indicators and the eco-innovation scoreboard. For prospective analysis it explains the techniques of Horizon scanning and on-line Delphi, and how they will be used for technology scenario building, roadmapping and impact assessment.

Chapter 4 overviews the deliverables of the EIO project, which are annual, thematic, and foresight reports, country profiles, eco-innovation briefs, the EIO website, as well as their tentative content.

Chapter 5 describes the principal objectives and instruments of communication and outreach of the EIO, explains how various deliverables are tailored to meet the need of the target groups, such as companies and SMEs, intermediaries, policy makers and researchers.

Chapter 6 outlines the ongoing methodological development of the Observatory including the internal work methods and external advisory system, and presents the next steps in the methodological development process (e.g. database and reporting templates).

**Figure 0-1. Logical framework of the Eco-innovation Observatory**



# 1. Understanding eco-innovation

## 1.1 What is eco-innovation?

This chapter introduces the working definition of eco-innovation to be used in the course of the analytical work of the observatory. The contribution of the EIO is to integrate key environmental aspects and life-cycle systemic thinking to the definition of innovation.

Taking this into account the observatory proposes to define eco-innovation as follows:

***"Eco-innovation is the introduction of any new or significantly improved product (good or service), process, organisational change or marketing solution that reduces the use of natural resources (including materials, energy, water and land) and decreases the release of harmful substances across the whole life-cycle."***

To improve the observatory's outreach to non-experts, a concise definition in layman terms is also proposed:

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

The approach builds on the definitions of innovation used in the statistical work of EUROSTAT and the OECD – as introduced in the Oslo Manual (OECD 2005) - and on literature dealing with environmental economics and resource efficiency. The following sections explain the logic behind this approach and the process of developing the above definitions with reference to the relevant literature.

## 1.2 Defining innovation

### 1.2.1 Basic definitions

This subsection introduces the basic definitions of innovation. The Oslo Manual (OECD 2005) defines **innovation** as “the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations” (OECD 2005, p.46). The minimum requirement for an innovation in this approach is that it must be new (or significantly improved) to the firm (OECD 2005, p.46). The singular characteristic of an innovation, setting it apart from the output of research or business planning, is that it is implemented in the market. Inventions that fail to move beyond the demonstration phase are therefore not considered innovations.

**Innovation activities** are “all scientific, technological, organisational, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations. Some innovation activities are themselves innovative, others are not novel activities but are necessary for the implementation of innovations. Innovation activities also include R&D that is not directly related to the development of a specific innovation” (OECD 2005, p. 47). **An innovative firm** is “one that has implemented an innovation during the period under review” (OECD 2005, p. 47).

The approach of EIO will be largely based on Oslo Manual in a sense that only implemented solutions are considered an innovation. The observatory will extend its the scope also to aspects less elaborated in the manual such as social innovation and system innovation.

### 1.2.2 Types of innovation

The Oslo Manual differentiates between four types of innovation including product (good or services), process, marketing and organisational innovation. These types are defined as follows:

- **A process innovation** is “the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software” (OECD 2005, p. 49).
- **A product innovation** is “the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics” (OECD 2005, p. 48).
- **A marketing innovation** is “the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing” (OECD 2005, p.49). This includes changes in positioning of products or services offered by companies e.g. low-cost airlines.
- **An organisational innovation** is “the implementation of a new organisational *method in the firm’s business practices, workplace organisation or external relations* (OECD 2005, p.51).

From the point of view of the EIO, process innovation is the most significant of the four basic types introduced in the manual as they can offer the most material and energy savings (see section 3.2.1.2).

The eco-innovation observatory will also consider a fifth type of innovation: **material flow eco-innovation**. This type will capture innovation across the material value chains of products and processes that lowers the material intensity of use while increasing service intensity and well-being. It aims to move societies from the extract, consume, and dispose system of today’s resource use towards a more circular system of material use and re-use with less total material requirements overall. See section 1.2.2 for a more detailed discussion.

The observations and analysis undertaken within the observatory will also encompass **social innovations**, which are characterised by different rationale and mechanisms. This is closely linked with the field of social entrepreneurship (see Martin and Osberg 2007). Phills et al (2008, p.36) define social innovation as “a novel solution to a social problem that is more effective, efficient, sustainable than existing solutions and for which the value created accrues primarily to society as a whole rather than private individuals”. Tidd and Bessant (2009, p.569) underline two key elements of social innovation. First, it aims “to create social change and value, rather than commercial innovation and financial value” (ibid.). Second, social innovation processes often involve not only business, but also the public sector and non-governmental organisations.

Therefore, despite sharing many characteristics with other types of innovation, social innovation differs from market-oriented innovations in terms of (ibid. p.572):

- Motives and aims – less concerned with independence and wealth, and more on social means and ends
- Timeframe – less emphasis on short-term growth and longer term harvesting of the venture, and more concern on long-term change and enduring heritage
- Resources – less reliance on the firm and management team to execute the venture, and greater on a network of stakeholders and resources to develop and deliver change.

Another type of innovation is often referred to as a **system innovation**. According to Geels (2005, p.2) “a system innovation is a transition from one socio-technical system to another”. Thus, system innovations lead to systemic changes in both social (values, regulations, attitudes etc.) and technical (infrastructure, technology, tools, production processes etc) dimensions and, most importantly, in the relations between them. System innovation may include elements or combinations of all types of innovations (product, process, marketing, organisational or social) and are, by definition, developed and implemented by many actors. Systemic eco-innovation is also discussed in section 3.1.

The above types of innovation will all be adapted and used in the analysis of eco-innovation. See Chapter 3 for a discussion of what the different types of innovation mean in the context of eco-innovation.

### 1.2.3 Features of innovation

Of fundamental importance for eco-innovation is that innovations take place and have effects in different dimensions. The main dimensions included in the analysis are novelty, impact and level of analysis.

#### 1.2.3.1 Novelty

All innovations must contain a degree of novelty. Depending on the degree of novelty the literature differentiates between three types of innovation: **new to the firm, new to the market, new to the world** (OECD 2005, p. 57). One should note that this includes the adaptation of firms and technologies during diffusion processes and, hence, is in line with recent innovation research that underlines both the importance of those capabilities as well as of sequences of incremental innovation (Fagerberg et al. 2005).

#### 1.2.3.2 Impact

Typically the impact of innovation will range **from incremental to radical or disruptive** (Tidd and Bessant 2009, OECD 2005). Incremental innovations concern improved components of products or services, improved processes or streamlined organisational set-ups that do not lead to a substantial change in a short time. Over time, however, incremental innovations or sequences of incremental innovations may cause systemic, positive or negative changes. Another aspect to be taken into account is the scale of application of innovation: incremental innovation applied on a large scale may lead to significant impacts in e.g. energy efficiency gains as in the example of the insulation of buildings.

Disruptive innovations are often those that imply shifts in a **paradigm** (Tidd and Bessant 2009) **or in the functioning of an entire system**. These innovations may lead to reconfiguring entire markets, consumer behaviour or technological systems. Systemic changes resulting from such innovations can make some existing products or services redundant. It should be noted that **system innovations** include elements or combinations of all types of innovations (product, process, marketing or organisational) and are, by definition, developed and implemented by many actors.

#### 1.2.3.3 Level

The impact of innovation can be analysed not only on the level of an individual company, product or service (**micro level**), but also as a technology field, product system or on a sub-national level (**meso**) as well as on the level of an entire economy or national innovation system (**macro**). This approach will be adapted to the analysis of eco-innovation.

Paradigm shifting innovations are those that are most often analysed taking the meso or macro perspective. It should be kept in mind, however, that incremental innovations could

also be analysed on the macro level (e.g. aggregated material macro savings due to incremental changes at the micro level).

### **1.3 Integrating environmental aspects to the definition of innovation**

The eco-innovation observatory will focus on innovations, which help to reduce resource inputs and enhance resource productivity across the whole life cycle. Material productivity will be the key theme. In addition, the EIO will deliver comprehensive information on other types of resource inputs and resource productivity, primarily energy and – to the extent that data is available – water. Although putting the main emphasis on the input side, the EIO will also include information on some categories of outputs of major importance, most notably emissions of greenhouse gases. The relationship between resource efficiency on the input side and greenhouse gas emissions on the output side will be explored.

Resource use is the central focus of the EIO for the following reasons:

- Reducing resource use and enhancing resource productivity are central targets towards long-term sustainable development in Europe (see Europe 2020 strategy with one of the flagship initiatives coined Resource Efficient Europe);
- The potential to improve environmental performance overall is greater for upstream processes (i.e. reducing inputs) than end-of-pipe technologies (i.e. controlling the impacts of outputs);
- Companies have an economic incentive to eco-innovate by reducing resource use, as this decreases material and energy purchasing costs and costs related to the treatment of emissions and waste, and thus increases their competitiveness (Fischer et al., 2004);
- Companies may benefit from potential market opportunities for resource-efficient goods and services;
- Europe is increasingly dependent on importing resources from abroad, which increases the vulnerability of European industries regarding the disruptions of resource supply. This may be not only be costly, but also associated with the shifting of environmental problems to other world regions;
- Proven methodologies exist to measure resource use on the micro, meso and macro levels, and thus can be implemented to monitor progress over time (Bringezu and Bleischwitz, 2009; Giljum et al., 2009);
- The input-oriented approach allows the interdependencies between inputs (energy, materials, water and land) and outputs (emissions and waste) to be further researched so that correlations and potential synergies or trade-offs can be identified.

#### **1.3.1 Resource productivity, innovation and competitiveness**

Eco-innovations that are geared towards reducing the amount of material or energy used per unit output will result in lower material and energy costs. This is an incentive for companies to eco-innovate or adopt eco-innovative processes. In a world of high prices of raw materials and energy, which are expected to remain on a high level particularly due to continuously high demand by emerging economies such as China (AIECE, 2009), resource productivity will be one key determinant for the competitiveness of European companies on international markets (Bleischwitz et al. 2009a). However, as information deficits prevail, the payback periods are typically longer than many investors wish and other types of barriers exist, so that many companies, especially SMEs, do not make the needed investments.

Eco-innovation may also benefit companies by leading to new products and services, as well as by creating new markets in Europe and abroad. There seems to be considerable market opportunity for enterprises undertaking eco-innovation. Consumer demand for 'greener' products and product chains (for example certified products) is one driver creating new

markets. Increasing scarcity of certain resources may also drive the need for more efficient processes and technologies, thereby opening up markets. Finally, company image may benefit from eco-efficient processes, eco-innovative products and sustainable practices.

The eco-innovation observatory will analyse barriers, drivers and trends and generate recommendations to support and motivate companies towards such investments.

### 1.3.2 Adopting a life cycle approach

While the EIO will include analysis of traditional environmental industries (i.e. those aimed at reducing harmful outputs), its objective is to go further to include, highlight and enhance those eco-innovations which are most urgently needed: those that tackle the environmental problems related to the overall scale of our economic activities. This type of thinking represents a shift from understanding environmental performance as focused on pollution management to it involving a need for increasing resource productivity and dematerialization, i.e. absolute reductions of our resource consumption (Schmidt-Bleek, 2009).

This new perspective stems from a sustainable development perspective, which regards societies and their economic systems as a sub-system of the larger environmental system, in which economies are embedded. This embeddedness is in no contradiction to mutual interdependencies between the ecological, the social and the economic dimension of sustainability. In parallel to living beings, economies are dependent on ecosystem services including a functionally necessary supply of natural resources. Societies thus have a “metabolism” with the surrounding natural systems in a similar way to plants, animals or individual humans (see Figure 2-1).

**Four main types of natural resources** can be defined as necessary inputs to economic systems, i.e. production and consumption processes: **raw materials (including energy carriers), water, air and (land and water) areas**.

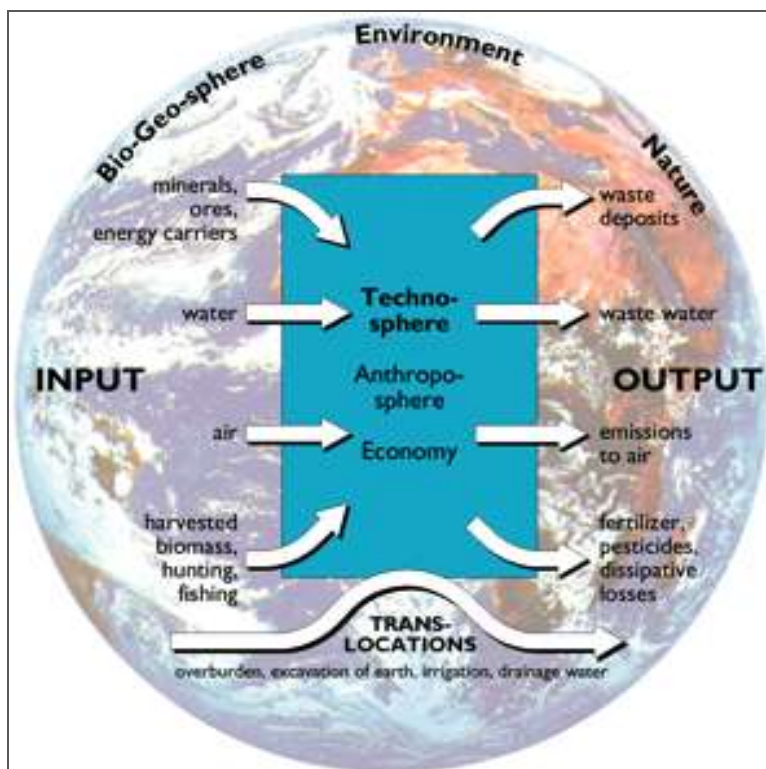
After entering the human economic system, resource inputs are transformed into products (goods and services) and are finally disposed back to the natural system in the form of outputs, mainly **solid wastes, waste water and air emissions**. Depending on the type of good, this throughput of resources can take place very quickly (as, for example, in the case of food products or of fossil fuels used for energy purposes) or involve time-spans of several decades (as in the case of infrastructure, such as buildings or bridges). The stock of materials within the economic system, e.g. infrastructure, has been rapidly growing during the past decades. Regaining materials from this anthropogenic stock may become a significant mining opportunity of the future (also called “urban mining”). Recycling of materials allows breaking the linear throughput flow of materials, and thus can help reducing outflows back to the natural systems. However, all recycling activities again require resource inputs (such as energy) and currently only a small fraction of total resource inputs are recycled. The OECD (2007b) handbook on material flows and resource productivity is the main reference for measuring these activities.

In all economic processes, **land (and water) areas are appropriated by human activities** and land cover is changed (e.g. from forest to agricultural land or built-up land), in order to make areas suitable for different human forms of land use. Land use and the biocapacity of ecosystems, thus, is not only of major importance for all ecosystem services but perhaps the ultimate limiting factor for economies worldwide (WWF et al., 2008).

Since the 1960s, **traditional environmental policy** in industrialised countries has focused on detoxification on the output side of the economy as well as the application of command-and-control mechanisms, such as critical load assessment and pollution abatement

legislation. Following the implementation of these policies, **environmental industries** have been developed which aim to reduce the negative environmental impacts of emissions to air, soil and water or of produced waste (“end-of-pipe technologies”). These regulatory policies have been effective in decreasing many environmental pressures and have led to increased environmental quality, for example of air and water in Europe. Today, these policies still play an important role in ameliorating environmental problems in circumstances where a reduction of specific substances with a high potential for negative environmental impacts is required (e.g., toxic substances; see the REACH chemicals directive). The fragile state of the environment in many developing countries calls for immediate action to reduce the impact of these substances and eco-industries will have to play a role for relief as well as for building up a voice for environmental policy. Eco-industries are relevant players and a driver of European competitiveness on world markets.

**Figure 1-1. The socio-industrial metabolism**



Source: Wuppertal Institute

However, since the mid-1980s, **other types of environmental problems** became increasingly important, associated with global changes in production, trade and consumption patterns. These problems are more difficult to address through policies and industry, as they are complex, international or even global in scope, and involve multi-dimensional cause-effect-impact relationships and time-lags. Issues such as climate change, loss of biodiversity, land cover conversion and high levels of material and energy consumption are part of this new type of environmental problem. These problems are particularly **related to the overall volume (or scale) of economic activities** and less a result of a specific harmful substance. As evidence illustrates, Europe has performed much worse in this regard: many species are threatened by extinction, fish stocks are depleted, water reserves have shrunk, overall waste volumes have been growing, urban sprawl has transformed fertile land into sealed areas, valuable soil has been lost through erosion, energy consumption has grown, and Europe is far from achieving a significant reduction in greenhouse gas (GHG) emissions. Furthermore, the import of resources may contribute to a certain level of problem shifting among countries.

For instance, the use of biofuels provides an excellent example of problem shifting; meaning that while using the biomass in the country of consumption may appear to be a 'green solution' (because it substitutes carbon-emitting fossil fuels), the production of the biomass abroad may be associated with negative environmental impacts, such as cropland expansion, the loss of biodiversity and increased GHG emissions. For this reason, countries must not only consider the impacts of their resource use on their own domestic environment, but also consider the impacts of the resources they use domestically, but which are produced elsewhere.

Based on this assessment, the strategy of "**dematerialisation**" was developed, demanding a significant absolute reduction of Europe's (and other industrialised countries') consumption of natural resources. This dematerialisation should be achieved through a radical reduction of resource inputs (in particular materials) to the economic system. Factor 4 was the level of dematerialization called for by Ernst Ulrich v. Weizsäcker (1997) in the 1990s, recently updated to a Factor 5 (von Weizsäcker et al., 2009), and a factor 10 is demanded by F. Schmidt Bleek (2009)(1998), especially for industrialized countries. Other authors advocate a factor of 8 (Japanese researcher Ryuichi Yamamoto) or a factor 20 (Paul Weaver and others).

### 1.3.3 Material use and material productivity

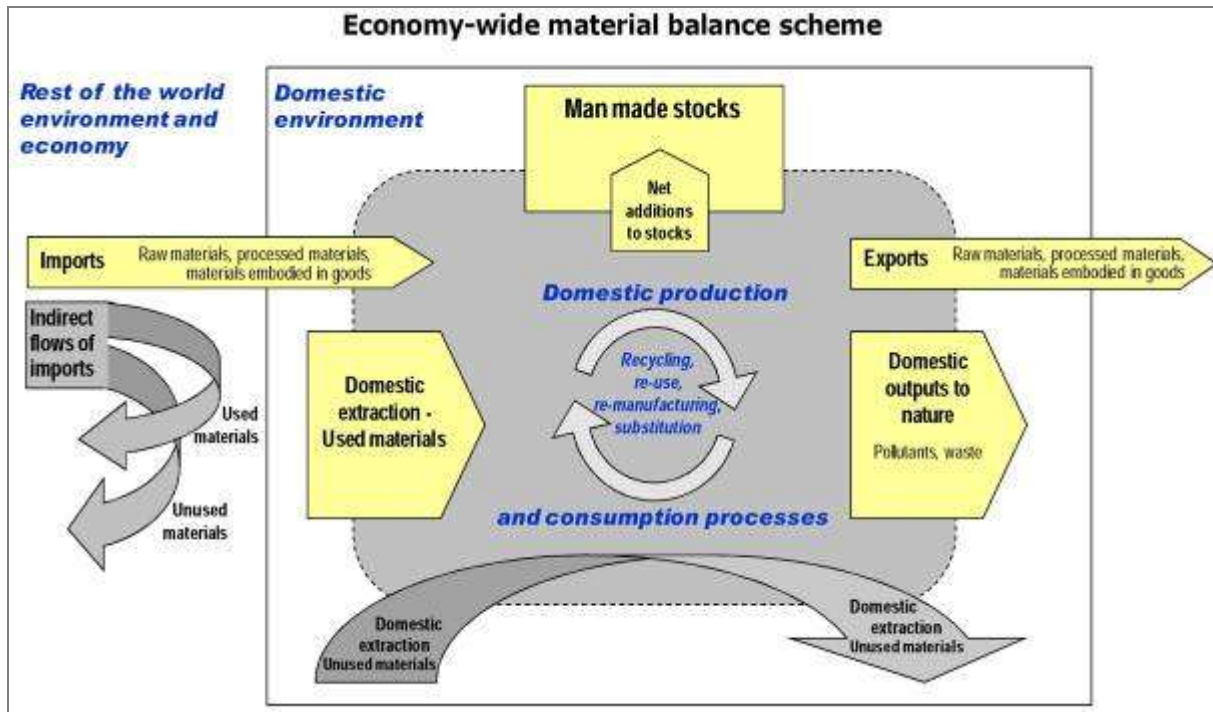
The resource category of "materials" comprises **all non-renewable and renewable materials**, which humans extract from the Earth's crust and ecosystems in order to produce goods and provide services. From a political perspective, knowledge of production, consumption and high import-dependencies have shown current patterns of resource use to be unsustainable in the long term, thus leading to targets directed at dematerialisation. For instance, the 'Thematic strategy for the sustainable use of natural resources' (European Commission, 2005) aims to reduce the environmental impact of resource use while improving resource productivity across the EU economy. For renewable resources this also means staying below the threshold of overexploitation. Recent policy documents, such as the Raw Material Initiative (European Commission, 2008) also address the concern of ensuring access to material resources for European industries in other world regions.

**Material productivity** describes the economic value generated per material used (in mass). In contrast to energy productivity, material productivity has only in the past 10-15 years been recognised as a key innovation area. This development has coincided with methods to measure material consumption, which have provided evidence of the drastic overconsumption and overuse of the earth's resources. Economy-wide material flow analysis (EW-MFA) has been integral to this development, with the 1997 study by Adriannsee et al. being the first to use the resource term. Since then, a variety of indicators have been developed to describe the metabolic performance of an economy (OECD, 2007a), such as the indicators Total Material Consumption (TMC) and Domestic Material Consumption (DMC).

Additionally, easy to understand concepts such as Ecological Footprints and ecological rucksacks have brought the issues and problems associated with resource use into the public eye. While ecological footprints demonstrate overuse of the earth's resources (the average European in 2005 had a footprint of 4.7 global hectares, compared to the available biocapacity of 2.1 global hectares per capita (WWF et al. 2008), ecological rucksacks demonstrate the total quantity of natural resources used to make a good or service, including the unused materials occurring during extraction and downstream processes as well as 'hidden flows' of used materials that do not enter the geographical boundaries of an importing economy (see graph) (Schmidt-Bleek, 2004). Such methods have contributed to

increased knowledge over domestic resource use and international implications, and have helped to make consumers aware not only of the energetic efficiency of the products they purchase, but also of the material dimension of those products.

**Figure 1-2. Economy-wide material balance scheme**



Source: (OECD, 2008)

The major categories usually covered in assessments of material use and material productivity include:

- Non-renewable resources:
  - Fossil energy (for energetic and non-energetic purposes)
  - Metal ores
  - Industrial minerals
  - Construction minerals
- Renewable resources:
  - Agricultural harvest
  - Timber and other wood products
  - Fish

For a more detailed account of the scope of the EIO see Chapter 3 of this report.

### 1.3.4 Other categories of resource inputs

The EIO will also include other categories of natural resource inputs, in particular energy and water, in order to analyse the linkages between material use and productivity on the one hand and energy and water use and productivity on the other hand. Issues related to land appropriation will not be included, as quantitative information (statistics and related indicators) are still too scarce.

#### **1.3.4.1 Energy**

Energy security and the links between energy use, competitiveness and climate change are high on the EU's policy agenda. A number of policy documents have been adopted in the past few years, aiming for example at increasing renewable energy supply (such as the Renewables Directive of 2008) or increasing energy efficiency (such as the Energy Efficiency Action Plan of 2006). Much analytical work has been done and is being done on the use of energy and on energy productivity for countries, sectors and products. Because of the amount of research focused specifically on energy production and use, the EIO will not perform generic calculations and analysis regarding energy performance. Rather, the EIO will make use of existing indicators and databases. Data on energy generation, energy transformation and energy use on the macro level (and to some extent on the sector level) are available from sources such as EUROSTAT or the International Energy Agency.

In the EIO, the focus will be on investigating the inter-linkages (synergies or trade-offs) between energy productivity and material productivity. For example, examining the material consequences of an increased use of renewable energy (both abiotic, such as photovoltaics and wind, and biotic, such as biofuels); for instance looking at whether renewable energy technologies are limited by key materials (such as certain rare metals or the availability of biomass for energetic purposes). Or for instance whether increased energy efficiency (e.g. through the retrofitting of buildings) can be sustainably achieved considering increased material use needs (e.g. of insulation materials).

#### **1.3.4.2 Water**

Water is another key resource of increasing interest to policy makers. So far, European water policy was mainly oriented towards qualitative aspects, i.e. limiting water pollution and ensuring high water quality (see the EU Water Framework Directive). However, also quantitative aspects of water use and water productivity are issues of increasing concern, as water security and water scarcity, especially for agriculture, is becoming an important policy issue in some European regions (particularly in the Mediterranean). Water use is also very closely connected to both material and energy use, for example, in the context of bio-based products and renewable energy production. However, water data is still scarce and so far only available as estimations for the national level and for selected products, for example, in the context of the Water Footprint concept. Water data can therefore only be integrated into the EIO database to a very limited extent, focused on water use on the national level (and to some extent on the sectoral level). It might also be an option to investigate water-related innovation trends in a specific thematic report of the EIO.

#### **1.3.4.3 Land**

Land use is also becoming a topic with increasing political relevance in Europe and around the world. This mainly refers to bioproductive land (and water) areas, which are becoming increasingly scarce resources. Pressures on bioproductive land are likely to increase in the future due to competing demands, such as food production for a growing world population with a greater tendency towards meat consumption, biomass related renewable energy, renewable bio-materials and increasing built-up land.

In Europe, major pressures stem from the loss of agricultural (and to some extent forest) land for infrastructure (e.g. urban sprawl) (EEA, 2006). However, data on land inputs for economic activities are even scarcer than those regarding water inputs. For example, data on the land embodied in products, i.e. the life-cycle wide land requirements, are almost completely absent. Therefore, the dimension of land cover and land use will not be included in the EIO database.

### **1.3.5 Outputs of emissions and waste**

The EIO will put its main focus on innovations oriented towards a reduction of total resource requirements to production and consumption activities. However, traditional environmental industries focusing on “end-of-pipe” solutions will be included in some parts of the analysis, for example, in the assessment of the size and development trends of products and technologies in traditional eco-industry markets versus new resource efficiency markets.

Regarding inclusion of data on emissions and waste, the EIO will focus on data on greenhouse gas emissions, the output category most closely linked to the overall scale of material and energy use in countries, sectors and products. Data on toxic emissions will not be included in the EIO database, as the focus of the analysis undertaken in the EIO will be put on input-oriented eco-innovations, which reduce resource inputs and thus tackle environmental problems at their source. The possibility of including some industrial, household and hazardous waste statistics – most likely on a national level – will be further explored depending on data availability and comparability across the EU.

### **1.3.6 Dependencies between resource inputs and outputs of emissions and waste**

Currently, most media and political attention in environmental policy is given to reducing carbon emissions and combating climate change. However, there are signs that in the near future, resource use and resource productivity will receive equal importance not only as central environmental issues, but also as a key economic issue for Europe.

First, the aim of decreasing carbon emissions can be regarded as part of the broader aim of increasing resource productivity. So far, the potential of a strategy focused on the reduction of resource use as an effective way to reduce greenhouse gas emissions has not been sufficiently analysed. Recent studies have begun to analyse the relationship between resources and CO<sub>2</sub> emissions. On a country level, Bringezu et al. (2009: 141) found that CO<sub>2</sub> emissions and the TMR of most countries are correlated. The authors noted that this indicates a possible alignment of two important fields of environmental policy. On a product level, Moll and Watson (2009) determined that certain high-pressure intensity product groups are associated both with high levels of emissions and high levels of resource use. They identified eight product groups that together account for 60-70% of the key environmental pressures caused by consumption.

For instance, consumption of the 3 products groups construction works (i.e. buildings and infrastructures); food products, beverages and alcohol; and electricity, gas, steam and hot water were found to contribute between 30-40% to both emissions (GHG, acidifying and tropospheric ozone precursors) and domestic material input. Indeed, for certain products and processes a clear relationship between inputs and GHG emission outputs can be observed. For instance increasing the input of fossil fuels used as energy carriers will directly result in higher GHG emissions to the atmosphere, unless technologies can be applied which allow de-coupling fossil fuel use from its negative climate impacts (e.g. CCS technologies). Using less resources ultimately also means producing lower quantities of emissions and waste. Dematerialized products likely decrease the energy demand and the related GHG emissions for production, storage, transport, use and treatment.

Second, strategies solely focused on reducing carbon emissions might overlook potential bottlenecks regarding the availability of resources to implement these strategies. Scarce metals, such as iridium or silicon, might limit the production of new energy and mobility technologies, such as photovoltaic cells or electric cars. The implementation of CCS technologies in power plants significantly increases the material requirements for electricity generation.

Third, from a business perspective, tackling resource use issues makes sense (see section 2.3.1) and from a political perspective, material security is greatly enhanced by focusing on resource productivity because this implies waste avoidance and better recycling. Long-term material security in the EU includes not only the availability and access to the resources on which economies depend, but also involves the ability to cope with volatility and – probably – increasing scarcity and rising prices in a global economy: developing business models and markets that cope with these challenges is of utmost relevance for sustainable growth (e.g. Bleischwitz / Welfens / Zhang 2009).

Continuous eco-innovation including intelligent transition strategies will be necessary to meet these challenges. Improving resource productivity over the entire life cycle not only means reducing material requirements, but also has direct implications for waste and recycling: reducing resource use on the input side results in reduced waste on the output side. Indeed, resource inputs must – according to physical law (conservation of mass) – turn into resource outputs at some stage, which means that the quantities and qualities, i.e. potential for environmental harm, of wastes and emissions are therefore determined by the magnitude of resource inputs as well as by the transformations of these resources within the economy e.g. the production of chemicals. Increasing stress of ecosystems also ought to be taken into account.

Beyond this, resource-oriented eco-innovation may also drive waste avoidance, for instance, by considering how materials can be re-used during the design of the product. This includes the concept of cascading use, which means that a product is designed so that it may be re-used or so that it may be easily recycled into another product, thereby extending the life-cycle wide use of the original resources. Recycling is but one tool for improving resource productivity that will benefit from eco-innovation and help to reduce the quantity of outputs produced by an economy. The recycling of materials, especially of precious metals contained in new technologies, not only encompasses the development of techniques to extract those metals, but also includes logistical and social aspects, for instance encouraging people to recycle their mobile phones.

The recently founded International Panel for Sustainable Resource Management is one key international forum to foster the transition to higher resource efficiency. The panel realised that while existing measures tackle certain aspects of global resource issues, such as climate change and biodiversity, a holistic approach to resource management is needed to better identify inter-linkages and gaps and avoid implementing partial solutions, which only lead to a shift of environmental pressures. In keeping with this logic, the eco-innovation observatory will also assess the interdependencies between resource inputs and outputs of emissions and waste. The aim of the observatory is to learn more about these factors, especially on the level of countries and sectors and make the knowledge gained available to stakeholders to enable action.

Altogether, improving resource productivity focuses on the whole life-cycle, spanning resource inputs and outputs, and encompasses a broad spectrum of types of eco-innovation. While trade-offs between material security and energy security do exist, the full extent of decisions favouring one aspect at the expense of others will not be understood until these trade-offs are assessed in a holistic way. To this end, the eco-innovation observatory, with its focus on resource productivity, will serve as an informational resource for policy makers and businesses alike.

## **2. Scope and approach to analysing eco-innovation**

### **2.1 Systemic approach**

As a pervasive phenomenon, eco-innovation needs to be analysed in a systemic way. In other words, in order to have a better understanding of the full impact of eco-innovation, be it a new technology, product, service or process, it has to be analysed from different perspectives ranging from the level of a single product or service, through a value chain or a sector to an entire economy. The analysis also has to take into account the evolution of eco-innovation effects in time.

In this context, the EIO will conduct its analysis addressing the following questions:

- How to differentiate between different types and features of eco-innovations?
- How to approach the analysis of determinants (barriers and drivers) of eco-innovations?
- How to analyse links and dependencies between different types of eco-innovations?
- How to assess the potential of meso and macro level impacts of eco-innovation when analysing micro level processes (including the issue of scale of application)?
- How to include a time factor in the analysis of eco-innovation impacts?

Through compiling and analysing data on eco-innovation, in particular on material use and material productivity, and through linking these data with other economic and environmental data, the EIO shall investigate:

- Trends of de-coupling on the macro and sectoral levels;
- Determinants of eco-innovation in different EU member states and on different levels;
- Eco-innovation performance of countries and industries over time, in particular the role of prices of material and energy for the innovation performance of different industries;
- Criticality of certain materials and the vulnerability of countries and sectors regarding resource access;
- Correlation between material productivity, eco-innovation activities and key economic variables such as competitiveness;
- Correlation between material productivity and other environmental indicators, such as energy productivity and greenhouse gas emissions.

The following chapters elaborate on the approach adopted by the EIO to tackle these and further questions.

### **2.2 Types and features of eco-innovation**

The eco-innovation observatory will go beyond classifying eco-innovation according only to the categories of innovation proposed by the Oslo Manual (see section 1.2.2). It proposes a new type of eco-innovation: material-flow eco-innovation. The observatory will also focus on process eco-innovation (including organizational eco-innovation) and product eco-innovation. Marketing eco-innovation will be considered, especially on the future side of analysis, and social eco-innovation will be discussed.

Features pertinent to innovation – novelty, impact and level – will also be assessed in relation to eco-innovation. A special focus will be how the impacts of eco-innovation (from incremental to radical) change and evolve over time.

### 2.2.1 Defining different types of eco-innovation

Altogether, there is currently little research on methodological approaches for measuring the different types of eco-innovations. Indeed, only recently have major analysis to this end been undertaken (see for instance EEA 2006; Kemp and Pearson 2007; Huppes et al. 2008; Arundel and Kemp, 2009; Johnstone and Hascic 2009).

Generally, four approaches exist to measure technological change (Kemp & Pearson 2007):

- Input measures (such as research and development)
- Intermediate output measures (such as patents)
- Direct measures (such as new products)
- Indirect measures (such as aggregate data on resource productivity using decomposition analysis).

While the EIO will include analysis using all approaches, the fourth approach will comprise the main focus of assessment. This is because the EIO considers the primary objective of eco-innovation to be reducing material flows. As such, the general approach of the Eco-Innovation Observatory will be to focus on analysing material flows, resource productivity and decoupling as indications of eco-innovative activity. The Community Innovation Survey (CIS) will be an additional pillar for assessing how many and what type of firms eco-innovate and why.

#### 2.2.1.1 Material flow eco-innovation

Because of its focus on resource efficiency, the EIO seeks to explore activities of **material flow innovation**. This type will capture innovation across the material value chains of products and processes that lowers the material intensity of use while increasing service intensity and well-being. It aims to move societies from the extract, consume, and dispose system of today's resource use towards a more circular system of material use and re-use with less total material requirements overall.

While the EIO acknowledges that the categories of process, product and system innovation (and organisational and advertising innovation) have their merits, the claim can also be made that many forms of innovation ought to be related to materials in order to capture innovation activities such as:

- Developing new materials (with better environmental performance)
- Substituting environmentally-intensive materials and products by
  - New materials
  - Functionally new products
  - Functionally new services, which lower the demand for the related product
- Establishing life-cycle wide processes of resource efficiency e.g. by
  - Sustainable mining
  - More efficient production and application of materials
  - Optimising transport logistics
  - Enhancing re-use and recycling
  - Recapturing precious materials from previously open loop systems (e.g. critical metals, phosphorus)
  - Functionally integrating modules and materials in complex goods (e.g. solar cells integrated in roofs)
  - Increasing the lifetime and durability and offer related services
  - Increase the information of consumers on the resource efficiency of products
- Transforming infrastructures towards a steady-state stocks society e.g. via
  - Improved maintenance systems for roads and buildings

- Developing new resource-light buildings and transportation systems and other network goods (such as waste water systems)
- Establishing a solarised technosphere for dwellings and other systems of provision
- Slowing down urban sprawl and include resource efficiency aspects in urban and spatial planning

#### **2.2.1.2 Process eco-innovation**

Process eco-innovations are integral to the reduction of material use and thus one of the most important aspects to consider under the umbrella of eco-innovation. This is because of their low risk and cost saving character. Moreover, relevant gains to resource productivity are to be made when tackling the 'upstream' or production part of the supply chain. Process innovation includes both improvements to production or the delivery method (including equipment and software changes).

Process eco-innovations minimise or reduce effects and emissions of production and consumption, for instance through recycling. Examples of types of process eco-innovations include the substitution of harmful inputs during the production process (for example replacing toxic substances), optimization of the production process (for instance improving energy efficiency) and reducing the negative impacts of production outputs (such as emissions) (Reid and Miedzinski, 2008). In addition, reducing material inputs, i.e. the so-called 'ecological rucksacks', of production and consumption processes can also be captured as process eco-innovation. Common terms heard in connection with process eco-innovations include cleaner production, zero emissions, zero waste and material efficiency (Bleischwitz et al. 2009b).

#### **2.2.1.3 Product eco-innovation**

Product eco-innovation includes both goods and services. Eco-innovative goods are those produced in such a way that the overall impact on the environment is minimized. This includes environmentally improved material products, such as passive houses, and eco-design is a key word in this area. It may come as a surprise that a service society can be just as, or even more, resource demanding than a commodity based society (Reid and Miedzinski, 2008), but this can be the case, especially in relation to the resource intensity of those patterns and the 'rebound effect'.

Eco-innovative services include green financial products (such as eco-leases), environmental services (such as waste management) and services that are less resource intensive (for instance car sharing) (Kemp and Pearson, 2007).

#### **2.2.1.4 Organisational eco-innovation**

Organizational eco-innovation is the introduction of organizational methods and management systems for dealing with environmental issues in production and products (Kemp and Pearson, 2007). The EIO considers such organizational changes to be *the socio-economic dimension of process innovation*, especially as it is closely linked to learning and education (see Bleischwitz, 2003). It includes pollution prevention schemes, environmental management and auditing systems and chain management (cooperation between companies to close material loops and avoid environmental damage across the whole value chain) (Kemp and Pearson, 2007).

#### **2.2.1.5 Marketing eco-innovation**

Marketing eco-innovation involves changes in product design or packaging, product placement, product promotion or pricing. It involves looking at what marketing techniques can be used to drive people to buy, use or implement eco-innovations. In marketing terms,

brand (a collection of symbols, experiences and associations connected with a product or service by potential customers) has become key to understanding the process of commercialisation of products or services. “Buying into a brand” through purchasing a product, service or a technology is to a large extent about choosing to trust in the organisation owning the brand, which implies that the consumers’ choices are not always rational. Better understanding of the specificity (or lack of it) of the market and consumer response to brands related to eco-innovations, i.e. products, services, technologies or companies, becomes strategic knowledge in the market, for actors such as SMEs.

To this end, green branding is very important, but in practice it may not be the only or best way of selling eco-innovations. For instance, a hybrid automobile may have more success on the market when it is marketed as a premium product instead of an eco-product. Labelling is also an aspect of marketing eco-innovation, i.e. eco-labelling, as well as product guarantees, which promise customers a certain level of performance for a given time-period.

The analysis may also encompass address the risk of using “green image” for marketing of non-environmentally friendly products and services.

#### 2.2.1.6 Social eco-innovation

**Social eco-innovation** considers the human element integral to any discussion on resource consumption. It includes market-based dimensions of behavioural and lifestyle change and the ensuing demand for green goods and services. ‘Product service systems’ (Mont and Lindhqvist 2003) are but one example of how features of new products might underline a shift to eco-innovative services. Towards new markets, some firms are experimenting with so-called user-led innovation, meaning that the functionality of new goods is developed with stakeholders thereby minimizing the risk of superfluous product features. However, the social dimension also involves discussions on the creative potential of society, with examples of innovative green living concepts such as guerrilla gardening, and on corporate social responsibility. Sustainable consumption is a key word in the context of social eco-innovation and research to this end is being performed by e.g. the European Topic Centre on Sustainable Consumption and Production at the European Environment Agency.

### 2.2.2 Analysing different features of eco-innovation

#### 2.2.2.1 Novelty

**Novelty** can mean that the eco-innovation is new to the firm, market or world. The most important aspect for the EIO analysis will be how receptive markets in different countries are to the implementation and adaptation of new eco-innovative processes and products. This will be measured by the growth rate of eco-industries. Data from CIS surveys will be used to assess the novelty of eco-innovations at a firm level.

#### 2.2.2.2 Impact: from incremental change to system change

**The Impact** of eco-innovations can range from incremental to disruptive or radical system changes. Examples of incremental additions include end-of-pipe technologies that minimise and reduce negative impacts, such as air emission filters. These types of eco-innovations are often seen as environmental technologies that are ‘solutions’ to problems associated with the way things are currently done. Eco-efficient innovations are the next step. These innovations improve environmental performance by increasing efficiency (the concept of ‘more with less’). However, while they can curb material use and resource depletion, they cannot stop such activities. Both types of change operate within the current system, and are thus seen as practical, action-oriented steps in the short term. In contrast, disruptive technological and radical eco-innovations are associated with a system change. This not only refers to radical and disruptive technologies which alter the market conditions (such as hydrogen and fuel

cells), but also to all types of system changes such as industrial, societal or behavioural changes. It might mean that the system shifts from a linear to a more closed-loop system, where the aim is to use waste as the inputs for new processes (Carrillo-Hermosilla et al., 2009). Such a shift changes the way in which materials flow through societies; it is thus associated with longer-term objectives for sustainable resource use.

The EIO will focus on the resource-use aspect of eco-innovation. As such it will focus on how eco-innovation is reducing resource use in small steps and reducing emissions (incremental impact), increasing resource productivity (sub-system impact) and using resources more effectively (system impact).

While radical change may include the big steps needed to drastically reduce resource use, incremental change includes the small steps that are being taken on a more daily basis. As such, incremental change will also make up a large part of the observation undertaken by the observatory. Moreover, in the context of time and scale, incremental change may take on an important role, especially because sequences of incremental change over time can be radical; incremental change prepares the market for more radical steps; and small steps applied on a big scale can be radical.

#### **2.2.2.3 Level**

The EIO will study eco-innovation on the micro, meso and macro level. The micro level is thought to be *where things happen*, but analysing the micro level comprehensively is fairly difficult for the EU as a whole. Moreover, impacts of micro-level eco-innovations may have different impacts on the meso and macro levels. Sometimes the environmental impact related to the technical eco-improvement of a product may actually be negative on a higher level due to a change in consumer behaviour, i.e. consumers using more of a product, which outweighs the efficiency improvements to that product. This phenomenon is known as the “rebound effect”. For this reason, micro-level indicators need to take wider impacts into account. The link between indicators on different levels will be explored during the development of the database. Special consideration will be given to how micro level data can be aggregated to higher levels. Altogether the EIO will consider eco-innovation across all three levels with illustrations from the micro level, analysis of drivers and barriers, and emphasis on the meso level of industries and the macro level of countries.

### **2.3 Barriers and drivers of eco-innovation**

Analysis of barriers and drivers of innovation is an inherent element of innovation studies. This section will first introduce the general overview of determinants of innovation. The second section will focus specifically on studies focussed on barriers and drivers to eco-innovation. Both sections give indications on sources of data for the analysis across EU member states. The third section presents the EIO approach. Importantly, the EIO will focus on historical data (e.g. how barriers and drivers were perceived by innovating companies) as well as how future barriers and drivers are perceived by companies, policy makers, experts and other relevant actors (e.g. prospective analysis).

#### **2.3.1 Barriers and drivers of innovation**

Barriers and drivers to the innovation process can be approached on different levels, notably on the level of a firm, sector, value chain, an entire innovation system or a geographical region. In innovation studies the barriers and drivers are typically considered on the level of a firm. Determinants of innovation can be internal or external to a firm (or any other organisation implementing innovation). The internal barriers are linked most notably with the absorptive capacity of the company (Cohen 1990). External barriers include, on the one hand, market related factors (“market failure”) and, on the other hand, factors stemming from

the characteristics of a system (e.g. sector, country) an innovator operates in. The latter can be linked to the system of innovation approach, which places the company in a system where knowledge and innovations are created in interaction of many organisations and in a certain regulatory framework (Edquist 2005). Determinants considered from the point of view of a (open) system (be it sector, region, national economy) focus on factors that determine system level behaviour, notably system transition. In this context, the analysis also takes into account the aggregated perceptions of firms and other actors in a studies system.

When addressing issues of barriers and drivers of innovation, the Oslo manual (OECD 2005) integrates various perspectives adopted in innovation studies. It organises barriers to innovation (or “factors hampering innovation activities”) in several groups of factors: cost, knowledge, market and institutional. Table 2-1 introduces the factors considered for each of the group in relation to types of innovation. The perspective on barriers to innovation adopted in the Oslo manual is reflected in the questionnaires developed for the Community Innovation Surveys (CIS), which are the only major comparable source of data on innovation covering EU Member States.

**Table 2-1. Factors hampering innovation activities according to the Oslo manual (2005)**

| Table 7.2. Factors hampering innovation activities                              |                     |                     |                            |                       |
|---------------------------------------------------------------------------------|---------------------|---------------------|----------------------------|-----------------------|
| Relevant for:                                                                   | Product innovations | Process innovations | Organisational innovations | Marketing innovations |
| <b>Cost factors:</b>                                                            |                     |                     |                            |                       |
| Excessive perceived risks                                                       | *                   | *                   | *                          | *                     |
| Cost too high                                                                   | *                   | *                   | *                          | *                     |
| Lack of funds within the enterprise                                             | *                   | *                   | *                          | *                     |
| Lack of finance from sources outside the enterprise:                            |                     |                     |                            |                       |
| Venture capital                                                                 | *                   | *                   | *                          | *                     |
| Public sources of funding                                                       | *                   | *                   | *                          | *                     |
| <b>Knowledge factors:</b>                                                       |                     |                     |                            |                       |
| Innovation potential (R&D, design, etc.) insufficient                           | *                   | *                   |                            | *                     |
| Lack of qualified personnel:                                                    |                     |                     |                            |                       |
| Within the enterprise                                                           | *                   | *                   |                            | *                     |
| In the labour market                                                            | *                   | *                   |                            | *                     |
| Lack of information on technology                                               | *                   | *                   |                            |                       |
| Lack of information on markets                                                  | *                   |                     |                            | *                     |
| Deficiencies in the availability of external services                           | *                   | *                   | *                          | *                     |
| Difficulty in finding co-operation partners for:                                |                     |                     |                            |                       |
| Product or process development                                                  | *                   | *                   |                            |                       |
| Marketing partnerships                                                          |                     |                     |                            | *                     |
| Organisational rigidities within the enterprise:                                |                     |                     |                            |                       |
| Attitude of personnel towards change                                            | *                   | *                   | *                          | *                     |
| Attitude of managers towards change                                             | *                   | *                   | *                          | *                     |
| Managerial structure of enterprise                                              | *                   | *                   | *                          | *                     |
| Inability to devote staff to innovation activity due to production requirements | *                   | *                   |                            |                       |
| <b>Market factors:</b>                                                          |                     |                     |                            |                       |
| Uncertain demand for innovative goods or services                               | *                   |                     |                            | *                     |
| Potential market dominated by established enterprises                           | *                   |                     |                            | *                     |
| <b>Institutional factors:</b>                                                   |                     |                     |                            |                       |
| Lack of infrastructure                                                          | *                   | *                   |                            | *                     |
| Weakness of property rights                                                     | *                   |                     |                            | *                     |
| Legislation, regulations, standards, taxation                                   | *                   | *                   |                            | *                     |
| <b>Other reasons for not innovating:</b>                                        |                     |                     |                            |                       |
| No need to innovate due to earlier innovations                                  | *                   | *                   | *                          | *                     |
| No need because of lack of demand for innovations                               | *                   |                     |                            | *                     |

Source: Oslo Manual (2005)

The Oslo manual is focused on the perspective of a single enterprise and does not elaborate on drivers and barriers to systemic change, which is of high relevance in the case of eco-innovation. Neither does it recognise social and cultural determinants of innovation such as the issues of acceptance of innovation, attitudes towards risk and uncertainty, educational level etc. The social and cultural factors can contribute to better explaining the market factors (e.g. insufficient demand for innovations).

### 2.3.2 Barriers and drivers of eco-innovation

Eco-innovation is determined by general factors typical for any innovation activity and, on the other hand, by specific factors related to environmental aspects. Kemp (2007) lists as the most relevant drivers regulation, cost reduction, profits from commercialisation, pressure from communities, green ethos, and improving the company image. Horbach (2005, 2008) groups eco-innovation determinants in three groups: supply side, demand side, and institutional and political influences. Miedzinski and Reid (2008) adapt Horbach's approach adding fiscal policy that may or may not influence pricing of eco-innovative goods and further shape market demand.

Bleischwitz et al (2009b) studied barriers and drivers of eco-innovation referring to both the supply-demand model (based on Horbach's approach) as well as categorising them into various fields such as political, financial, technical, natural, social etc. Importantly, the authors underline the need to analyse eco-innovation determinants on the level of sectors or a product systems (e.g. deep renovation, smart metering etc). The barriers and drivers are presented on "fish-bone diagrams". The observatory will explore the possibility of further developing the "fish-bone" depiction of barriers and drivers to include a time element.

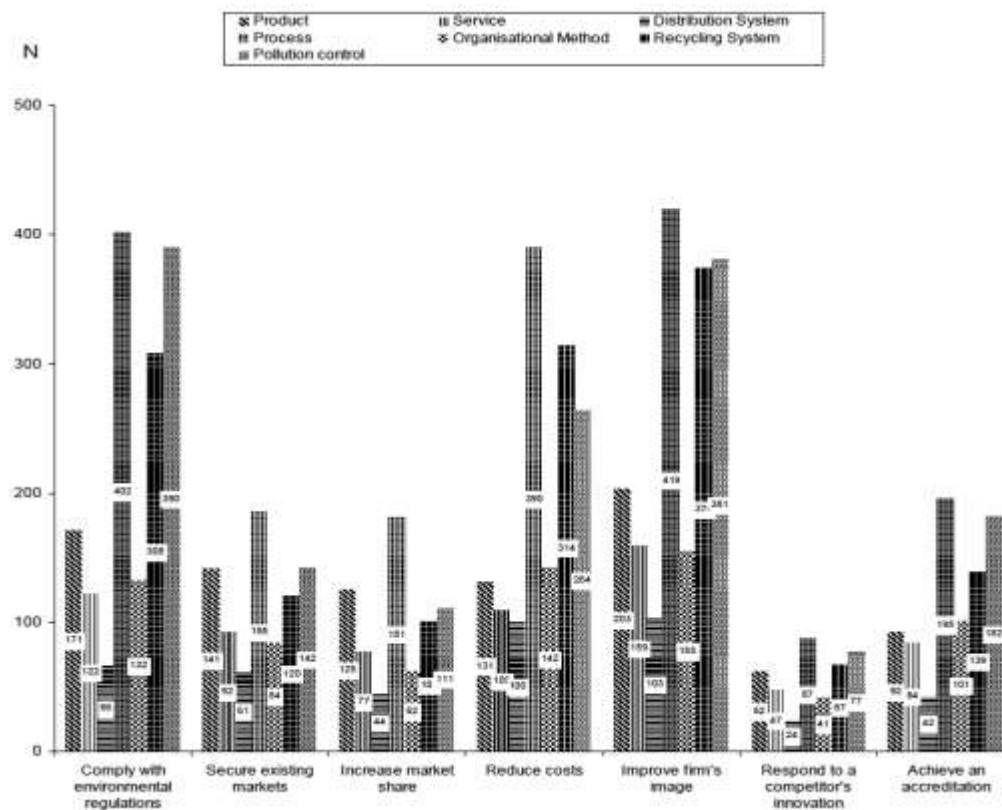
**Table 2-2. Determinants of eco-innovation according to Horbach (2008)**

|                                        |                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Supply side                            | <ul style="list-style-type: none"> <li>• Technological (and management") capabilities</li> <li>• Appropriation problem and market characteristics</li> <li>• Path dependencies (inefficient production systems, knowledge accumulation)</li> </ul>                                                                                                                                                                    |
| Demand side                            | <ul style="list-style-type: none"> <li>• (Expected) market demand (demand pull hypothesis): state, consumers and firms</li> <li>• Social awareness of the need for clean production; environmental consciousness and preference for environmentally friendly products</li> </ul>                                                                                                                                      |
| Institutional and political influences | <ul style="list-style-type: none"> <li>• Environmental policy (incentive based instruments or regulatory approaches)</li> <li>• Fiscal systems (pricing of eco-innovative goods and services)"</li> <li>• Institutional structure: e.g. political opportunities of environmentally oriented groups, organization of information flow, existence of innovation networks</li> <li>• International agreements</li> </ul> |

Source: adapted from Horbach (2005; 2008)

Determinants of different kinds of eco-innovation were studied in the IMPRESS project (ZEW et al 2001). The importance of different determinants differs depending on the type of innovation. In general, however, environmental regulations and the improvement of a firm's image were the most commonly mentioned determinants (see Figure 3-2 below).

**Figure 2-1. Reasons for introducing eco-innovation**



Source: ZEW et al. (2001)

Focusing on environmental technologies Nicholas Ashford (1993 cit in Kemp, 2007) proposed a more detailed categorisation of barriers encompassing aspects of the absorptive capacity of a firm (e.g. technological, organisational, managerial and personnel factors) as well as issues of customer behaviour:

#### 1. Technological barriers:

- Availability of technology for specific applications.
- Performance capability of technology under certain economic requirements and process design standards.
- Lack of (some) alternative substances to substitute for the hazardous components.
- Higher degree of sophistication with operation of some waste reduction technologies.
- Scepticism in performance of certain technologies and therefore a reluctance to invest.
- Process inflexibilities.

#### 2. Financial barriers:

- Research and development costs of technology.
- Costs related to risk of process changes with regard to consumer acceptance and product quality.
- Non-comprehensive cost evaluations and cost-benefit analysis as well as cost calculation method.
- Lack of understanding and difficulty in predicting future liability costs.
- Short-term profitability calculations resulting in low tolerance for longer payback periods of equipment investment.

- Alleged drawback in competitiveness as other companies are not investing in waste reduction technologies.
- Lack of capital investment flexibility due to low profit margin.
- Economies of scale preventing smaller companies from investing in waste reduction options (e.g., in-plant recovery technologies).
- Possibilities that investment in process modification can be inefficient for old companies.
- Company financially (and even technically) tied up due to recent investment in wastewater treatment plant.
- Actual cost of current technologies masked in operating costs.

### 3. Labour force-related barriers:

- Lack of person(s) in charge of management, control, and implementation of waste reduction technology.
- Reluctance to employ trained engineers for the alleged time-consuming design of waste reduction technologies.
- Inability to manage an additional program within the company and, therefore, reluctance to deal with a waste reduction program.
- Increased management requirements with implementation of waste reduction technologies.

### 4. Regulatory barriers:

- Disincentives to invest in reuse and recovery technologies due to RCRA permit application requirements for recycling facilities in addition to compliance requirements, application costs, and so forth (work-intensive).
- Depreciation tax laws.
- RCRA waivers available only for hazardous waste treatment technology or process.
- Uncertainty about future environmental regulation.
- Regulatory focus on compliance by use of conventional end-of-pipe treatment technology (may result in investment in those treatment technologies rather than waste reduction technologies).
- Compliance with discharge standards, thus having "EPA off your back" provides no incentive to invest in waste reduction.

### 5. Consumer-related barriers:

- Tight product specifications (e.g., military purposes).
- Risk of customer loss if output properties change slightly or if product cannot be delivered for a certain period.

### 6. Supplier-related barriers:

- Lack of supplier support in terms of product advertising, good maintenance service, expertise of process adjustments, and so forth.

### 7. Managerial barriers:

- Lack of top management commitment.
- Lack of engineering cooperation to break hierarchical separation of areas of responsibility (e.g., production engineers do not cooperate with environmental engineers in charge of the treatment and disposal of hazardous substances).
- Reluctance on principle to initiate change in the company ("Uncle John did it this way; therefore we are doing it the same way!").
- Lack of education, training, and motivation of employees (e.g., in good housekeeping methods or operation and maintenance of recovery technologies).
- Lack of expertise of supervisors.

Despite its focus on environmental technologies Ashford's approach can be usefully adapted to a wider scope. Its elements will be used in the analyses conducted by the EIO.

### 2.3.3 EIO approach to analysing barriers and drivers of eco-innovation

The EIO will analyse determinants of eco-innovation taking into account all aforementioned analytical dimensions, notably the type of innovation, the level of analysis as well as the temporal scope (past and future determinants).

Further the eco-innovation determinants will be grouped into five types:

- Economic capital (market position, demand, access to capital, relevance of externalities)
- Technical and technological capital (access to and ability to develop and use technical and technological solutions)
- Natural capital (access to and need of material and natural resources)
- Social capital
  - Human and knowledge capital (capacity to learn, manage knowledge, skills)
  - Organisational capital (ability to organise and to manage organisations etc.)
  - Network capital (ability to collaborate and capacity to take collective action)
  - Cultural capital (including consumer behaviour, attitudes towards change, risk)
- Regulatory and policy framework (including legal system, standards and norms, intellectual property rights, fiscal policies, public procurement, subsidies).

Barriers and drivers in different dimensions and on different levels are inter-related. Identifying determinants on different levels will allow for better understanding of such inter-dependencies. Such an approach will inform policies aimed at removing barriers or creating incentives to innovate or diffuse eco-innovations. In addition, the analysis will include consideration of which determinants (barriers and drivers) are most relevant at different stages of innovation activity. This will be especially relevant in the prospective analysis of emerging new eco-innovations. Table 2-3 presents a synthetic overview of analysing barriers and drivers of eco-innovation. The analysis will also consider indigenous (e.g. to a firm) and exogenous determinants of eco-innovation.

|                                  |                                                            |                                 | Determinants of eco-innovation |         |           |         |
|----------------------------------|------------------------------------------------------------|---------------------------------|--------------------------------|---------|-----------|---------|
|                                  |                                                            |                                 | Indigenous                     |         | Exogenous |         |
|                                  |                                                            |                                 | Barriers                       | Drivers | Barriers  | Drivers |
| Level and dimensions of analysis | <b>Micro (firm)</b>                                        | Economic capital                |                                |         |           |         |
|                                  |                                                            | Technical capital               |                                |         |           |         |
|                                  |                                                            | Natural capital                 |                                |         |           |         |
|                                  |                                                            | Social capital                  |                                |         |           |         |
|                                  |                                                            | Regulatory and policy framework |                                |         |           |         |
|                                  | <b>Sub-system</b><br>(sector, value chain, product system) | Economic capital                |                                |         |           |         |
|                                  |                                                            | Technical capital               |                                |         |           |         |
|                                  |                                                            | Natural capital                 |                                |         |           |         |
|                                  |                                                            | Social capital                  |                                |         |           |         |
|                                  |                                                            | Regulatory and policy framework |                                |         |           |         |
|                                  | <b>Socio-economic system</b>                               | Economic capital                |                                |         |           |         |
|                                  |                                                            | Technical capital               |                                |         |           |         |
|                                  |                                                            | Natural capital                 |                                |         |           |         |
|                                  |                                                            | Social capital                  |                                |         |           |         |

|  |  |                                 |  |  |  |  |
|--|--|---------------------------------|--|--|--|--|
|  |  | Regulatory and policy framework |  |  |  |  |
|--|--|---------------------------------|--|--|--|--|

**Table 2-3. EIO classification of eco-innovation determinants**

A special focus will be the role of resource markets as a driver or barrier to eco-innovation. More specifically, it will be analysed how resource prices and resource scarcity affect eco-innovation across the macro, meso and micro level. For instance, the question of how eco-innovation differs in sectors with resource vulnerability compared to the same sectors in different countries with no vulnerability will be addressed. Further it will be enquired how resource prices have developed over time, and whether this has played a role in driving eco-innovation at the enterprise level will also be analysed.

Another focus will be on how policies impact eco-innovation. Again, this analysis will span the country, sectoral, and enterprise levels. For instance, country level analyses will work to identify policies which have supported fast-growing markets for eco-innovative products in different EU countries. Examples of such policies include regulations, taxes, and targets, among others.

The EIO will not only look backwards to learn what impediments have hindered and what drivers have urged eco-innovation, but will also look forward to identify potential future drivers and barriers to eco-innovation. In summary, the EIO will take a comprehensive look at what drives and impedes eco-innovation across all levels of the EU. Its recommendations on how to most effectively induce eco-innovation will not only comprise examples of what has worked well in the past, but will also include forward-looking measures that should continue to drive eco-innovation in the future.

## 2.4 Temporal scope

The overall temporal scope of the analyses undertaken in EIO may extend to 40 years. Depending on data availability the historical analysis aims to cover the past 20 years; the foresight work will be performed up to the year 2030. The data work undertaken in WP 2 and the historical analysis will be closely linked to the foresight activities undertaken in WP 3 and several feedback loops between the work packages will be established, in order to ensure consistency in the overall temporal scope.

### 2.4.1 Time horizon for ex post analysis

The module on general eco-innovation data in the EIO database aims to compile data for the **past 20 years**, i.e. from around 1990 up to around the year 2010. This intended time frame has been selected as many aspects related to innovations in the area of resource use and resource productivity have only climbed up the agenda of policy makers and companies in the past 20 years, after the collapse of the communist regimes in Eastern Europe and the former USSR and the intensification of globalisation processes, including reorganisation of production chains on the international level. Furthermore, for many Eastern European countries, data availability before 1990 is limited and country boundaries have changed (e.g. in the case of Yugoslavia or Czechoslovakia), which impedes consistent comparisons of results on the country level.

Given the large number of indicators included in the EIO database it becomes clear that **availability of time series data will largely differ** from indicator to indicator. For some of the indicators, such as energy use or GHG emissions on the country level, yearly data is available for all current EU-27 member countries. For other indicators (such as material consumption and productivity on the macro level), data is only available for the EU-15 for the whole time period, whereas EU-12 data is only available since the year 2000. Indicators

based on surveys, such as the Community Innovation Survey (CIS), are only available for certain years within the whole time span. In the worst case, indicators could only be available for a single year if data were produced for one specific study and have not been included in any statistical or survey routine; for example, this is the case with the dedicated eco-innovation module of CIS 2008, where detailed information about innovations with environmental benefits are provided; however, in CIS 2010 this module will not be included any more. Whenever possible, however, the EIO database aims to comprise data for the entire 20 year-time period. The database is structured in a flexible way allowing for importing different scopes of time series data for different indicators.

#### **2.4.2 Time horizon for foresight analysis**

Information on eco-innovation trends picked up during the horizon scanning activity of the Observatory will be reported using the temporal scope defined in the original information source. Trend extrapolations based on historical data will be made **up to the year 2030** and the same year will define the temporal scope of all other foresight activities.

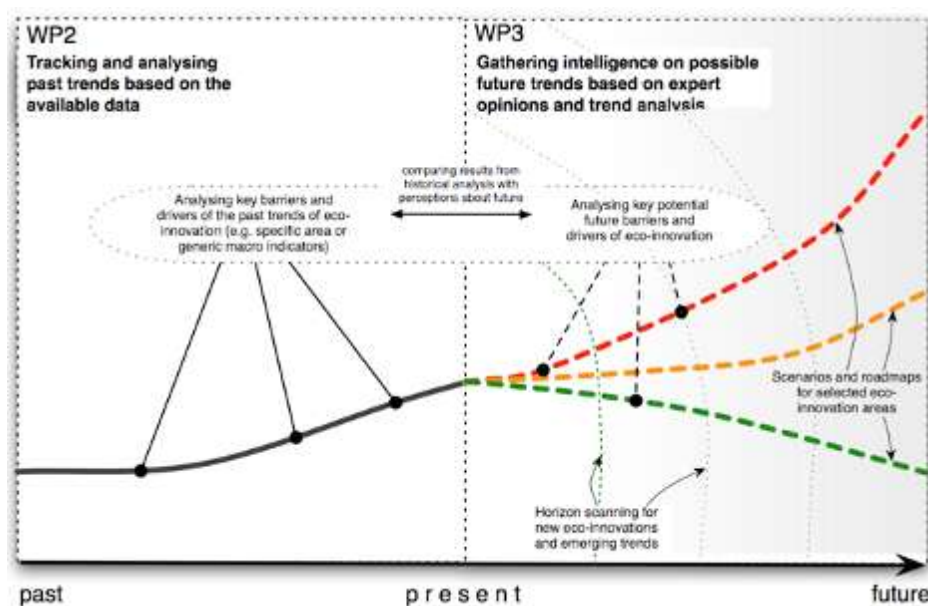
Since the future development of eco-innovations may not be linear due to changes in drivers and/or barriers, foresight activities of the Observatory will construct eco-innovation scenarios, each of them including both a state of the future and a path to it. Foresight activities will be carried out for selected eco-innovation areas, and expert opinions will be collected for a few years between today and 2030 (e.g. for 2015, 2020 and 2025).

#### **2.4.3 Links between ex post and foresight analysis**

The ex-post analysis provides an important starting point for the foresight activities of the project. The findings are used as an input in the foresight activities of the observatory including horizon scanning, Delphi, scenario development and roadmapping. Trend extrapolations are being performed for selected indicators; one example are the extrapolations of EU's resource efficiency path illustrated in the Annual Report 2010. Thus, the EIO team working on data analysis assures information flow to the EIO foresight team.

On the other hand, foresight activity provides feedback to the data analysis. Experts involved in foresight exercises can provide feedback to the ex-post analysis by identifying relevant thematic areas yet not covered by the ex post analysis. They can also be asked to outline a continuation to selected trends up to the year 2030, by presenting figures for the year 2030 and years in between, or by drawing graphs describing their view of probable/preferable future development. Experts thus produce analytical material, which can be used to construct quantitative and qualitative scenarios, which can be also included in the database in the form of "prospective indicators". Figure 2-2 presents possible links and continuation between historical and prospective analyses of the observatory.

**Figure 2-2. Connecting past data and trends with prospective analysis**



## 2.5 Thematic scope

The EIO information repository contains a very rich collection of indicators and data, which are being used in the project for two main purposes:

- Analyses of general eco-innovation data on the country level as well as cross-sectoral analysis serving as the key information base for the country briefs and the annual reports;
- Analyses of specific eco-innovation data for the thematic focus areas, i.e. those areas covered in the thematic reports.

Section 2.5.1 describes the content and structure of the EIO database. Both WP 2 and WP 3 deliver inputs to the database for past trends and future outlooks, respectively. Table 2-4 presents a comprehensive overview of the areas of observation covered by the EIO. Section 2.5.2 contains the description of the specific thematic areas and sectors, which are being analysed in detail in the thematic reports.

### 2.5.1 General eco-innovation data and analysis

#### 2.5.1.1 A glimpse at related projects

Several projects in the past have been devoted to elaborating the conceptual framework for measuring eco-innovation with specific indicator systems. In particular, the FP 6 project “Measuring eco-innovation: ecological & economic performance and derived indicators (**ECODRIVE**)” developed a comprehensive framework for analysing eco-innovation. The ECODRIVE project concluded that eco-innovation should be measured on three levels (micro, meso and macro) and suggested a system of indicator themes relevant to eco-innovation: environmental indicators illustrating the environmental performance, socio-economic indicators to reflect the economic performance and, additionally, policy indicators, institutional indicators and cultural indicators, which have a major influence on the future development of eco-innovation. However, ECODRIVE did not suggest concrete indicators for the suggested areas.

The FP 6 project “**Measuring Eco-Innovation (MEI)**” developed a system of five categories to group eco-innovation indicators: the firm, conditions, linkages, incremental versus radical innovation, and overall performance indicators. Three to nine indicators were suggested in

each of the categories to form a set of 23 eco-innovation indicators. In the approach underlying the EIO database and analysis, some aspects of these previous projects were taken up.

#### 2.5.1.2 EIO approach

In order to establish a possibly comprehensive information repository on eco-innovation in the EU, the EIO system of analysis splits data and indicators into four main areas, or key features, which follow the overall logic of the observatory and the adopted definition of eco-innovation. In this way, the EIO approach both expands on the "traditional" research areas of innovation and environment as well as pushes research on eco-innovation forward by allowing for new data combinations.

The four key areas of observation and analysis include:

- Eco-innovation
- Environment
- Innovation
- Socio-economic framework

The three last areas serve as a pool of data used to, on the one hand, provide an overall context of analysis and, on the other hand, to derive eco-innovation indicators. In this context, the eco-innovation feature is not limited to a simple merging of environment and innovation data, but builds upon both sections as well as integrates eco-innovation specific data. This breakdown also enables correlations between eco-innovation and environmental performance, innovativeness, and the socio-economic conditions, as, for example, performed in the Annual Report 2010..

The four areas are further broken down into areas of observation, i.e. thematic areas with a high relevance for the analysis of past trends and possible future developments. Data and indicators so far included in the EIO database cover the following two levels of economic activity:

- Macro level indicators (countries, country groups)
- Meso level indicators (sectors, supply chains)

In addition to the meso and macro levels, micro level data on single companies and products is also available from the online repository of best practice examples.

Table 3-5 depicts the main areas of observation in each of the 4 featured areas comprising the data analysis of the EIO. While this table is being adapted and expanded as required by the analyses carried out in EIO, it serves to demonstrate the principal approach and structure of the EIO database. The appendix contains tables depicting the first results of data scanning, where certain indicators and potential sources have already been defined and identified. In the course of work, data tables and indicators are being further developed for each level for both past and prospective indicators.

#### 2.5.2 Specific thematic areas and sectors

Specific themes relating to different aspects of eco-innovation will be selected for further analysis. These topics will be chosen based on a number of factors.

For instance future **relevance for markets** will play a big role. Such relevance may stem from expected shortages and constraints related to resource use as well as from expected potential for sustainable growth.

**Novelty** will also be considered in the selection of topics. In other words, the EIO shall be looking at themes for which strategic knowledge is poor. While observing and providing general information on a range of topics is an important aspect of the observatory, the aim of thematic focal areas is to contribute something new that enhances the ability to act for a group of actors. In doing so, the EIO's strategic knowledge shall shed light on a long-term sustainability perspective as well as on steps towards market development.

Analysis of these focal areas will be presented in thematic reports (see section 4.2.2.2) and one theme will be selected for a special feature section of the annual report. Examples of possible themes include:

- sustainable construction (incl. steady-state economy): innovation towards resource-efficient construction and renovation
- re-use (incl. re-manufacturing, post shredder)
- bio-based products (bio-economy)
- phosphorus and sustainable nutrition flows
- critical metals

Additionally some reports will focus on horizontal issues relevant to a wider group of eco-innovations, for example, aspects related to general barriers and drivers of eco-innovations, instruments and policies promoting them.

**Table 2-4. Main areas of observation to be included to the EIO's database**

| Key features                    | Areas of observation (1)                | Areas of observation (2) | Areas of observation (3)                                         |
|---------------------------------|-----------------------------------------|--------------------------|------------------------------------------------------------------|
| <i>Socio-economic framework</i> | Economic performance                    | Economic wealth          | GDP                                                              |
|                                 |                                         | Competitiveness          | Competitiveness indices                                          |
|                                 |                                         |                          | Foreign investment                                               |
|                                 |                                         | Employment               | Active population                                                |
|                                 |                                         |                          | Employment rate                                                  |
|                                 | Social aspects                          |                          | Unemployment rate                                                |
|                                 |                                         | Population               | Size                                                             |
|                                 |                                         |                          | Age                                                              |
|                                 |                                         |                          | Household profile                                                |
|                                 |                                         |                          | Urban/rural                                                      |
|                                 |                                         | Education attainment     | Higher education                                                 |
|                                 |                                         |                          | Secondary education                                              |
|                                 |                                         |                          | Science and engineering                                          |
|                                 |                                         |                          | Humanities                                                       |
|                                 |                                         | Consumer choices         | Attitudes towards waste and recycling                            |
|                                 |                                         |                          | Attitudes towards eco-friendly production and consumption        |
|                                 |                                         | Quality of life          | Objective and subjective aspects of quality of life / well-being |
|                                 | Infrastructure                          | Buildings                | New buildings (net addition to stocks)                           |
|                                 |                                         | Transport                | Length of motorways                                              |
|                                 |                                         | Energy                   | Grid                                                             |
|                                 | General regulatory and policy framework | Demand side              | Income tax                                                       |
|                                 |                                         |                          | Public procurement                                               |
|                                 |                                         | Supply side              | Equity support (general)                                         |
| <i>Environment</i>              | Resource inputs and consumption         | Materials                | Material inputs                                                  |
|                                 |                                         |                          | Material consumption                                             |
|                                 |                                         |                          | Physical trade                                                   |
|                                 |                                         |                          | Productivity                                                     |
|                                 |                                         |                          | Primary raw material prices                                      |

|                   |                                        |                                                                | Secondary raw material prices                                                              |
|-------------------|----------------------------------------|----------------------------------------------------------------|--------------------------------------------------------------------------------------------|
|                   |                                        |                                                                | Material security                                                                          |
|                   |                                        | Energy                                                         | Production                                                                                 |
|                   |                                        |                                                                | Consumption                                                                                |
|                   |                                        |                                                                | Productivity                                                                               |
|                   |                                        |                                                                | Energy prices                                                                              |
|                   |                                        |                                                                | Renewables                                                                                 |
|                   |                                        |                                                                | Energy security                                                                            |
|                   |                                        | Water                                                          | Consumption                                                                                |
|                   |                                        |                                                                | Productivity                                                                               |
|                   |                                        |                                                                | Water prices                                                                               |
|                   | Outputs and emissions                  | Emissions                                                      | GHG emissions                                                                              |
|                   |                                        |                                                                | GHG intensity                                                                              |
|                   |                                        |                                                                | Carbon prices                                                                              |
|                   |                                        | Waste                                                          | Industry waste                                                                             |
|                   |                                        |                                                                | Household waste                                                                            |
|                   |                                        |                                                                | Hazardous waste                                                                            |
|                   |                                        | Recycling                                                      | Municipal waste                                                                            |
|                   |                                        |                                                                | Construction and demolition waste                                                          |
| <i>Innovation</i> | Innovation inputs                      | Finance and investments                                        | government funding                                                                         |
|                   |                                        |                                                                | Overall R&D funding (GERD)                                                                 |
|                   |                                        |                                                                | business expenditures on innovation                                                        |
|                   |                                        |                                                                | Expenditures by universities and research institutes                                       |
|                   |                                        |                                                                | R&D expenditure share from abroad                                                          |
|                   |                                        |                                                                | Expenditures by private non-profit                                                         |
|                   |                                        |                                                                | Venture and risk capital                                                                   |
|                   |                                        | Human resources                                                | Educational attainment                                                                     |
|                   |                                        |                                                                | Knowledge workers                                                                          |
|                   |                                        |                                                                | Innovation training                                                                        |
|                   |                                        |                                                                | Employment in knowledge-intensive service sectors                                          |
|                   |                                        |                                                                | Human resources in science and technology                                                  |
|                   |                                        |                                                                | Tertiary education graduates                                                               |
|                   | Drivers and determinants of innovation | Objectives of firms developing product and process innovations | Increase range of goods or services                                                        |
|                   |                                        |                                                                | Replace outdated products or processes                                                     |
|                   |                                        |                                                                | Enter new markets                                                                          |
|                   |                                        |                                                                | Increase market share                                                                      |
|                   |                                        |                                                                | Improve quality of goods or services                                                       |
| Key features      | Areas of observation (1)               | Areas of observation (2)                                       | Areas of observation (3)                                                                   |
| <i>Innovation</i> | Drivers and determinants of innovation | Objectives of firms developing product and process innovations | Improve flexibility for producing goods or services                                        |
|                   |                                        |                                                                | Increase capacity for producing goods or services                                          |
|                   |                                        |                                                                | Improve health and safety                                                                  |
|                   |                                        |                                                                | Reduce labour costs per unit output                                                        |
|                   |                                        | Objectives of organisational innovation                        | Reduce time to respond to customer or supplier needs                                       |
|                   |                                        |                                                                | Improve ability to develop new products or processes                                       |
|                   |                                        |                                                                | Improve quality of goods or services                                                       |
|                   |                                        |                                                                | Reduce costs per unit output                                                               |
|                   |                                        |                                                                | Improve communication or information sharing within enterprise or with other organisations |
|                   | Innovation process                     | Innovation activity                                            | In-house R&D                                                                               |
|                   |                                        |                                                                | External R&D                                                                               |
|                   |                                        |                                                                | Acquisition of machinery, equipment and software                                           |

|                       |                                |                                                      | Acquisition of external knowledge                                                                                                                          |
|-----------------------|--------------------------------|------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                       |                                |                                                      | Training for innovative activities                                                                                                                         |
|                       |                                |                                                      | Market introduction of innovations                                                                                                                         |
|                       |                                | Collaboration patterns                               | Collaboration partner                                                                                                                                      |
|                       |                                |                                                      | Information source                                                                                                                                         |
|                       | Innovation outputs and impacts | Innovations (types)                                  | Product                                                                                                                                                    |
|                       |                                |                                                      | Process                                                                                                                                                    |
|                       |                                |                                                      | Organisational                                                                                                                                             |
|                       |                                |                                                      | Marketing                                                                                                                                                  |
|                       |                                | Type of process innovation                           | New or significantly improved methods of manufacturing or producing goods or services                                                                      |
|                       |                                |                                                      | New or significantly improved logistics or distribution methods                                                                                            |
|                       |                                |                                                      | New or significantly improved supporting activities                                                                                                        |
|                       |                                | Type of organisational innovation (expected effects) | New business practices for organising procedures (supply chain management, business re-engineering, knowledge management, lean production, etc)            |
|                       |                                |                                                      | New methods of organising work responsibilities and decision making                                                                                        |
|                       |                                |                                                      | New methods of organising external relations with other firms or public institutions (use of alliances, partnerships, outsourcing or sub-contracting, etc) |
|                       |                                | Knowledge creation (IPR)                             | EPO patents                                                                                                                                                |
|                       |                                |                                                      | Community trademarks                                                                                                                                       |
|                       |                                |                                                      | Community trade mark applications per country                                                                                                              |
|                       |                                |                                                      | Community trade marks registered per country                                                                                                               |
|                       |                                |                                                      | Community designs                                                                                                                                          |
|                       |                                |                                                      | Community design applications                                                                                                                              |
|                       |                                |                                                      | Publications                                                                                                                                               |
|                       |                                |                                                      | Scientific publication output per country                                                                                                                  |
|                       |                                | Sales and exports                                    | New-to-market sales                                                                                                                                        |
|                       |                                |                                                      | New-to-firm sales                                                                                                                                          |
|                       |                                |                                                      | Medium and high tech exports                                                                                                                               |
|                       |                                |                                                      | knowledge intensive services exports                                                                                                                       |
|                       | Social aspects of innovation   | Social attitudes                                     | Attitudes towards novelty                                                                                                                                  |
|                       |                                |                                                      |                                                                                                                                                            |
| Key features          | Areas of observation (1)       | Areas of observation (2)                             | Areas of observation (3)                                                                                                                                   |
| <i>Eco-innovation</i> | Inputs into eco-innovation     | Finance and investments in eco-innovation            | government funding on environmental R&D                                                                                                                    |
|                       |                                |                                                      | business funding on environmental R&D                                                                                                                      |
|                       |                                |                                                      | government funding on eco-innovation                                                                                                                       |
|                       |                                |                                                      | private funding on eco-innovation                                                                                                                          |
|                       |                                | Human resources                                      | Educational attainment related to eco-innovation                                                                                                           |
|                       |                                |                                                      | Employment                                                                                                                                                 |
|                       |                                |                                                      | Knowledge workers in eco-industries                                                                                                                        |
|                       |                                |                                                      | Eco-innovation training and "green skills"                                                                                                                 |

|                       |                                            |                                                         |                                                                                                         |
|-----------------------|--------------------------------------------|---------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
|                       | Drivers and determinants of eco-innovation | Determinants of eco-innovation                          | Existing environmental regulations or taxes on pollution                                                |
|                       |                                            |                                                         | Environmental regulations or taxes expected to be introduced in the future                              |
|                       |                                            |                                                         | Availability of government grants, subsidies or other financial incentives for environmental innovation |
|                       |                                            |                                                         | Current or expected market demand from customers for environmental innovations                          |
|                       |                                            |                                                         | Voluntary codes or agreements for environmental good practice within a sector                           |
|                       |                                            | Eco-innovation strategy and procedures                  | Presence of procedures implemented to identify and reduce environmental impacts                         |
|                       | Eco-innovation process                     | Eco-innovation activity                                 |                                                                                                         |
|                       |                                            | Collaboration patterns in eco-innovation process        | Collaboration partner                                                                                   |
|                       |                                            |                                                         | information source                                                                                      |
|                       | Outputs and impacts of eco-innovation      | Eco-innovations (types)                                 | Product                                                                                                 |
|                       |                                            |                                                         | Process                                                                                                 |
|                       |                                            |                                                         | Organisational                                                                                          |
|                       |                                            |                                                         | Marketing                                                                                               |
|                       |                                            |                                                         | Material flow innovation                                                                                |
|                       |                                            | Environmental benefits from process innovation          | Reduced material input                                                                                  |
|                       |                                            |                                                         | Reduced energy input                                                                                    |
|                       |                                            |                                                         | Reduced CO2 emissions                                                                                   |
|                       |                                            |                                                         | Replaced materials with less polluting or hazardous substitutes                                         |
|                       |                                            |                                                         | Reduced soil, water, noise or air pollution                                                             |
|                       |                                            |                                                         | Reduced material use per unit output                                                                    |
|                       |                                            |                                                         | Recycled waste, water or materials                                                                      |
|                       |                                            | Environmental benefits from the use of goods or service | Reduced energy use per unit output                                                                      |
|                       |                                            |                                                         | Reduced energy use                                                                                      |
|                       |                                            |                                                         | Reduced soil, water, noise or air pollution                                                             |
|                       |                                            |                                                         | Improved recycling of product after use                                                                 |
|                       |                                            | Eco-innovation relevant knowledge creation (IPR)        | EPO patents                                                                                             |
|                       |                                            |                                                         | Community trademarks                                                                                    |
|                       |                                            |                                                         | Community designs                                                                                       |
|                       |                                            |                                                         | Publications                                                                                            |
|                       | Eco-innovation market                      | Eco-industries                                          | Size of eco-industry markets                                                                            |
|                       |                                            |                                                         | Turnover                                                                                                |
| <b>Key features</b>   | <b>Areas of observation (1)</b>            | <b>Areas of observation (2)</b>                         | <b>Areas of observation (3)</b>                                                                         |
| <i>Eco-innovation</i> | Eco-innovation market                      | Eco-industries                                          |                                                                                                         |
|                       |                                            |                                                         | Competitive advantage                                                                                   |
|                       |                                            |                                                         | New-to-market sales (eco-iproducs, material flow innovation etc.)                                       |
|                       |                                            |                                                         | New-to-firm sales (eco-products, material flow innovation etc.)                                         |
|                       |                                            |                                                         | Medium and high tech exports (eco-industry)                                                             |
|                       |                                            |                                                         | knowledge intensive services exports                                                                    |
|                       |                                            | Eco-innovative firms                                    | Global share                                                                                            |
|                       |                                            |                                                         | Sectoral shares                                                                                         |

|  |                                                   |                                                 |                                                                         |
|--|---------------------------------------------------|-------------------------------------------------|-------------------------------------------------------------------------|
|  |                                                   |                                                 | Start-ups                                                               |
|  | Social aspects of eco-innovation                  | Social attitudes relevant to eco-innovation     | Attitudes towards environment of citizens                               |
|  |                                                   |                                                 | Public awareness of environmental problems                              |
|  |                                                   |                                                 | Perception of "green brands" by consumers                               |
|  |                                                   | Business attitudes relevant to eco-innovation   | Perceptions of environmental problems by business                       |
|  |                                                   |                                                 | Perceptions of eco-innovation by business                               |
|  |                                                   |                                                 | Corporate Social Responsibility (CSR) and other voluntary codes         |
|  | Regulatory and policy framework of eco-innovation | Supply-side measures relevant to eco-innovation | Equity support for eco-innovation                                       |
|  |                                                   |                                                 | R&D funds for eco-innovation                                            |
|  |                                                   |                                                 | Demonstration and commercialisation support for eco-innovation          |
|  |                                                   |                                                 | Support for eco-innovation PPPs                                         |
|  |                                                   |                                                 | Specific advisory services on eco-innovation for enterprises            |
|  |                                                   | Demand-side measures relevant to eco-innovation | Eco-innovation regulations                                              |
|  |                                                   |                                                 | Eco-innovation fiscal measures                                          |
|  |                                                   |                                                 | Eco-innovation standards                                                |
|  |                                                   |                                                 | Green Public Procurement                                                |
|  |                                                   |                                                 | Eco-innovation TT                                                       |
|  |                                                   | Eco-innovation policy intelligence              | Monitoring eco-innovation related policy impacts                        |
|  |                                                   |                                                 | Existing databases on environmental impacts of enterprises and industry |

### **3. Process and methodology of observation**

#### **3.1 Analysing historical data and trends**

##### **3.1.1 Horizontal monitoring and general trends**

Following the framework of eco-innovation indicators presented above, the EIO set up a comprehensive database covering the macro and meso levels through data and derived indicators and the micro level through a repository of best practices. This information serves as the empirical basis for analysing eco-innovation performance as well as drivers and barriers in the EU. Setting-up this database allows the assessment of eco-innovation performance of all EU member countries and across all economic sectors, in order to provide a horizontal monitoring of eco-innovation trends in the EU. This analysis of general trends forms the background for the more in-depth studies performed in the thematic reports (see next section).

The following step-wise approach is being applied to ensure high-quality outcomes regarding the horizontal monitoring and the analysis of general eco-innovation trends.

##### **3.1.1.1 Step 1: Screening and evaluation of data sources**

First, a screening and evaluation of possible data sources to calculate each of the indicators listed in the Table 3-5 above was undertaken in Work Package 2. Using a template with a standardised set of criteria, the WP 2 team evaluates the suitability of each possible data source for the calculation of an indicator included in the EIO database. This evaluation scheme comprised criteria such as the level of data (macro/meso/micro), access to data, geographical and temporal coverage, frequency of data update and data quality and uncertainty. Data providers include international organisations (such as UN organisations or the OECD), European institutions (such as EUROSTAT) and national institutions (such as national statistical offices or national research institutions).

In several cases, more than one possible source for each of the indicators could be identified. Based on the assessment of each possible source for one indicator, the WP 2 team provide a short summary evaluation for each of the indicators, in which the concrete recommendations for the use of one data source (or a combination of several sources) were derived. The result of step 1 was a clear recommendation of which source/s is/are best to use for the calculation of each indicator, as the basis for the compilation of data in WP 2.2 (and WP 2.3).

##### **3.1.1.2 Step 2: Compilation and quality-testing of primary data sets**

Steps 2 to 5 are being performed as part of work undertaken in WP 2.2. The steps are not performed in a linear way for all of the indicators and therefore overlap or procedures are repeated iteratively, if necessary, in order to achieve a high quality standard.

Step 2 extracts the data from the primary sources recommended in Step 1 and imports them into the EIO data working files, which are MS Excel-based. In almost all cases, this is being done in electronic formats (e.g. download of data in MS Excel format or a format importable to MS Excel); only a few cases occurred, where data needed to be extracted by hand (e.g. from sources which provide data only in pdf printable documents).

In order to test the quality of the data sets, the team performs a number of tests including:

- *Check of plausibility of time trends:* if data are available in time series, the team tests the plausibility of development curves, i.e. whether they are smooth or erratic. If data for

some years seem to be statistical outliers, the team cross-checks the development of time series with other data sources.

- *Filling of data gaps*: if data are missing for single years within larger periods with high data coverage, the team applies estimation methods to fill data gaps (data interpolation).
- *Aggregation checks to test consistency across scales*: several indicators are being collected on more than one level (e.g. macro and meso). If irregularities are being identified, the plausibility of indicators on different levels is being tested through aggregation checks, i.e. resource use indicators on the sectoral level should add up to the total resource use of all economic sectors.

The result of Step 2 are primary data sets, quality tested and consistent, which are further applied in Step 3.

#### **3.1.1.3 Step 3: Calculation of indicators**

Chapter 2 above has already set out the scope for the indicators, which we intend to calculate on the three different levels (in particular, the meso and macro levels), in order to address a number of questions within each of the defined eco-innovation themes. Step 3 takes the primary data sets developed in Step 2 and performs the calculation of the respective indicators.

In many cases, no additional calculation procedures are necessary, as the primary data are already reported as indicators (e.g. material consumption of countries, growth rates of eco-industry/eco-innovation markets, or R&D expenditures). In other cases, simple calculations are performed, in order to calculate the desired indicators (e.g. relating data on national GHG emissions or national water consumption to GDP, in order to calculate the indicators “GDP per output of GHG emissions” or “GDP per water consumption”); this has often been applied in the calculation of the indicators included in the Eco-Innovation Scoreboard.

The calculation of some of the desired indicators requires setting up more comprehensive calculation procedures or even calculation models. For example, the WP 2 team performed so-called “input-output analysis” in order to calculate the material use (and other environmental indicators) of different economic sectors. For doing this for the case of material use, economy-wide data on material input is linked to economic input-output tables, which represent the sectoral structure of countries. Through performing input-output analysis, a widely applied and harmonised calculation procedure, the total material input of countries is re-allocated to the different economic sectors in this country. This procedure delivers sectoral data on material input and can then be related e.g. to value added or total output, in order to calculate the indicators “Value added and/or total output per material input of sectors”.

The final results of Step 3 are the set of indicators ready to import to the EIO data base and ready for use in further analysis.

#### **3.1.1.4 Step 4: Import of final data sets into EIO online database**

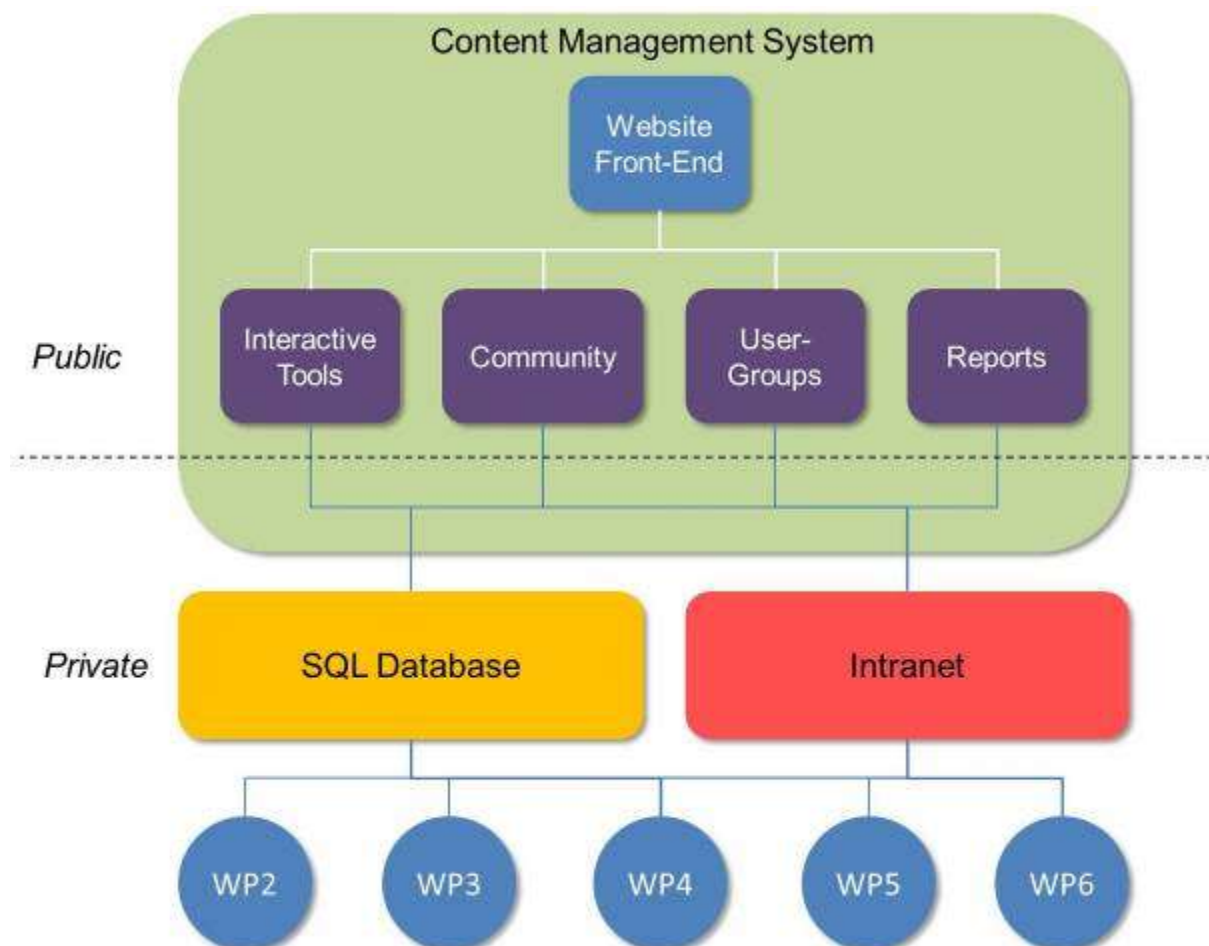
All indicators compiled in the EIO project are made available for further analysis and downloadable by third party users through the EIO website, with a simple registration procedure being asked by users in order having access to the full data system. In conjunction with WP 7, WP 2 set up a structure for the database, determined the software to be used for the on-line data base and imported the data sets into the online data base.

The combination of a website front end, a database back end and a community interface providing options to upload data, download reports and communicate effectively across a large and diverse audience, necessitating a hierarchy of different user permissions to achieve, has the potential to result in a complicated and costly web application framework.

To avoid such a scenario, experience gained from other large-scale knowledge transfer programmes will be used to identify the most suitable software platform for the project. One candidate for the EIO web platform is Joomla ([www.joomla.org](http://www.joomla.org)) a widely used, open source content management system (CMS) platform, PHP and MySQL based, which potentially provides the functionality required for the successful delivery of the EIO web platform. As an open source programme, Joomla benefits from a large and enthusiastic developer community, who continually innovate to meet evolving user needs through the development of applications; applications that could be adopted to enhance the EIO portal over the duration of the project.

Irrespective of the software platform adopted, the desired basic structure and data flow of the on-line information system is represented by the diagram below, also showing the linkage to the project intranet. The SQL database is connected to the content management system, as is each other part of the platform. Everything is connected as one system, reducing software issues, potential downtime and costs. As the common programming language will be SQL, this results in inherent compatibility with Microsoft Access and Excel-format data for uploading and downloading information from the project intranet.

**Figure 3-1. Structure and data flow of the on-line information system**



#### **3.1.1.5 Step 5: Data analysis**

The full potential of the data base and derived indicators for analysing eco-innovation trends, driving forces and barriers can only be exploited, if selected indicators are put into relation.

The WP 2 team addresses a number of questions related to correlation and inter-linkages (synergies and trade-offs) between different indicators. For example, addressing the questions of whether a correlation exists between the level of material consumption of countries or economic sectors and their competitiveness; or whether there is a correlation between resource productivity and eco-innovation activities in different countries, or whether there is a correlation between government expenditures on R&D and the eco-innovation performance of companies in specific countries. Some first results of those correlation analyses have been included in the EIO Annual Report 2010.

For future data analysis, the WP 2 team intends to apply different types of statistical methods, using statistical software systems such as SPSS and STATA, two commonly used software packages for statistical analysis.

Several statistical options are available with these software programmes:

- Descriptive statistics, such as Cross Tabulation and Descriptive Ratio Statistics
- Bivariate statistics, such as Means, Analyses of Variance (ANOVA) and Correlations (bivariate, partial, distances)
- Multivariate statistics and Panel Cointegration Analysis
- Prediction for numerical outcomes, in particular linear regressions
- Prediction for identifying groups, such as cluster analysis

For analytical work in the EIO, the options of bivariate and multivariate statistics are among the most important.

- Analyses of Variances (ANOVA) allow determining the occurrence and magnitude of significant differences in a set of variables. In the EIO context, such a set of variables could for example be one of the EIO indicators (e.g. material productivity), which is then analysed across the EU-27 countries applying ANOVA.
- Different types of correlation analysis is applied in EIO in order to analyse the statistical relationships between two or more variables or observed data values. Such correlation analyses are undertaken to investigate the questions indicated above.

Feedback loops between the analysis undertaken in Step 5 and Steps 2 and 3 are implemented, i.e. analyses performed in Step 5 will likely reveal some weaknesses or even inconsistencies in the basic data, which then need to be revised in Steps 2 and 3.

#### **3.1.2 Specific thematic enquiries**

It has been proposed that there would be two groups of thematic reports: on selected technology areas and on horizontal aspects focusing on analysing barriers and drivers to eco-innovation. The first group would include reports on the eco-innovation areas prioritised by the Lead Market Initiatives, which are sustainable construction, recycling and bio-based products. Other eco-innovation areas not covered by the LMI intended to be based on the analysis of their current and future market potential, as well as based on consultations with the client.

The second group of reports focuses on aspects related to the promotion or hindering of eco-innovation. The project proposal indicates the possible themes and areas. The topics are selected in collaboration with the steering committee taking into account their relevance to

the mission of the observatory (delivering market and policy intelligence) as well as a possibility of creating synergies and sharing knowledge and experience with other related completed and on-going projects and initiatives, in particular those in the framework of Europe INNOVA and ETAP.

As a general pattern, the thematic reports exploit a number of data collected in the general modules of the EIO database, fitting to the theme of the respective reports. These data areas include data from the CIS questionnaires on the micro level, on selected data on the sectoral level (such as material and energy productivity of sectors in different EU countries) and on data from the macro level (such as the implementation of specific policies fostering eco-innovation activities). The choice of topics is partly driven by data availability in certain areas. The exact topics of the thematic reports is agreed as early as possible each year to allow the research team enough time to deliver both data and analysis.

The annotated template has been developed to ensure a standardised format and quality of the thematic reports. The generic structure of the template is presented in Annex II. The preparation of the annotated template for thematic reports is the responsibility of the WP4 leader. The templates are discussed with the key stakeholders and agreed upon with the client. The templates include clear instructions on the main questions to be tackled in each section of the report. Additionally the experts expect to have access to the methodological help desk established in the EIO secretariat. The authors receive a written feedback on the first draft of the report from two reviewers indicated by the WP leader. The WP leader takes a decision whether the final draft can be submitted to the client.

### **3.1.3 Composite indicators: Eco-Innovation Scoreboard**

A large number of composite indices have been developed in the past years, in order to monitor developments in different economic and environmental areas, including innovation, competitiveness, climate change or sustainability (see the 2010 version of the methodological report for a brief review).

Building on those experiences, the EIO developed a new tool to monitor eco-innovation performance across the EU: the Eco-Innovation Scoreboard.

#### **3.1.3.1 The role of the Eco-Innovation Scoreboard**

The Eco-Innovation Scoreboard constructed in WP 2.4 is one flagship medium to communicate selected results from the EIO data collection efforts and the various analyses undertaken in the EIO project. Ideally, it will become a scoreboard on eco-innovation that is widely acknowledged throughout the EU and internationally.

The Scoreboard plays a number of functions and objectives in the different reports of the EIO:

#### **Interlinkages with the EIO Annual Reports**

In the EIO Annual Reports, the Scoreboard fulfils the following objectives:

- To illustrate the overall status/performance of eco-innovation in the EU and to put this in relation to the actual economic (e.g. GDP) and environmental performance (e.g. resource consumption) in the EU;
- To rank and group EU countries regarding the overall eco-innovation performance;
- To identify and compare strong and weak aspects and dimensions of eco-innovation across EU countries and sectors, comparing with average performance in the EU as well as with the top performers in the EU (information taken from country reports);
- To help illustrate how barriers and drivers for eco-innovation differ between EU countries (also based on the analyses of the country profiles) and assist in the identification of policy recommendations to overcome these barriers;

- To facilitate conclusions and to prepare business and policy action.

The Annual Report 2010 introduced the first version of the Eco-Innovation Scoreboard and provided the first analysis of the composite index as well as its sub-components.

For 2012, the WP 2 team also plans to test options for developing a scoreboard for the meso level, illustrating the eco-innovation performance for different economic sectors in a comparable way.

### Interlinkages with Country Profiles

The Eco-Innovation Scoreboard also plays an important role in the country profiles:

- To illustrate the overall status/performance of eco-innovation in single EU countries and changes over time;
- To rank and group EU countries regarding the overall eco-innovation performance; to identify and compare strong and weak areas of eco-innovation in single EU countries, comparing with average performance in the EU as well as with the top performers in the EU;
- To assist in identifying barriers and drivers of eco-innovation in single EU countries.

### Interlinkages with Eco-innovation Briefs

A first brief summarising the results of the 2010 scoreboard has already been produced. It is intended to publish briefs of the scoreboard versions 2011 and 2012.

#### 3.1.3.2 Structure of the Eco-Innovation Scoreboard

The Eco-Innovation Scoreboard structure has the following layers:

- one aggregated layer with the overall scoreboard index (one number per country);
- a second layer with indices from each of the five main components (see below); and
- a third layer with the single indicators included in each of the components.

The following table provides an overview over the principal structure of the EIO scoreboard. We distinguish indicators, which relate more to the environmental or the socio-economic field. The performance profile has 5 main components: Eco-innovation inputs, activities and outputs, environmental outcomes and socio-economic outcomes.

**Table 3-1. Overall structure of the Eco-Innovation Scoreboard**

|                      | Structural profile                                                                                               | Performance profile                                                                                                 |                                                                                                                                 |
|----------------------|------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
|                      | <i>General determinants</i>                                                                                      | <i>Eco-innovation inputs and activities</i>                                                                         | <i>Eco-innovation outputs and outcomes</i>                                                                                      |
| <b>Environment</b>   | <b><i>Environmental trends</i></b><br>(material consumption, energy consumption, GHG emissions, etc.)            |                                                                                                                     | <b><i>Environmental outcomes</i></b><br>(material productivity, energy intensity, GHG emissions intensity, etc.)                |
| <b>Socio-economy</b> | <b><i>Socio-economic trends</i></b><br>(industrial profile, infrastructure, political framework, social context) | <b><i>Inputs</i></b> (funding of eco-innovation, etc.)<br><b><i>Activities</i></b> (eco-innovating companies, etc.) | <b><i>Socio-economic outputs</i></b><br>(patents, etc.)<br><b><i>Socio-economic outcomes</i></b><br>(employment, exports, etc.) |

### 3.1.3.3 Indicators included in the Eco-Innovation Scoreboard (Performance profile)

The second and third version of the Scoreboard presented in the Annual Report and Country Briefs of 2011 and 2012 contain the following 16 indicators in the performance profile of the scoreboard.

**Table 3-2. Indicators in the 2011 and 2012 version of the Eco-Innovation Scoreboard**

| Name of indicator                                                                                                              | Source                       | Year      |
|--------------------------------------------------------------------------------------------------------------------------------|------------------------------|-----------|
| <b>1. Eco-innovation inputs</b>                                                                                                |                              |           |
| 1.1. Governments environmental and energy R&D appropriations and outlays (% of GDP)*                                           | EUROSTAT                     | 2009      |
| 1.2. Total R&D personnel and researchers (% of total employment)*                                                              | EUROSTAT                     | 2007      |
| 1.3. Total value of green early stage investments                                                                              | Cleantech                    | 2007-2009 |
| <b>2. Eco-innovation activities</b>                                                                                            |                              |           |
| 2.1. Firms having implemented innovation activities aiming at a reduction of material input per unit output (% of total firms) | EUROSTAT                     | 2008      |
| 2.2. Firms having implemented innovation activities aiming at a reduction of energy input per unit output (% of total firms)   | EUROSTAT                     | 2008      |
| 2.3. ISO 14001 registered organisations (per mln population)*                                                                  | ISO Survey of Certifications | 2010      |
| <b>3. Eco-innovation outputs</b>                                                                                               |                              |           |
| 3.1. Eco-innovation related patents (per mln population)                                                                       | Patstat                      | 2008      |
| 3.2. Eco-innovation related academic publications (per mln population)*                                                        | Scopus                       | 2011      |
| 3.3. Eco-innovation related media coverage (per numbers of electronic media)*                                                  | Meltwater                    | 2011      |
| <b>4. Environmental outcomes</b>                                                                                               |                              |           |
| 4.1. Material productivity (GDP/Domestic Material Consumption)*                                                                | EUROSTAT                     | 2007      |
| 4.2. Water productivity (GDP/Water Footprint)*                                                                                 | Water Footprint Network      | 1996-2005 |
| 4.3. Energy productivity (GDP/gross inland energy consumption)*                                                                | EUROSTAT                     | 2009      |
| 4.4. GHG emissions intensity (CO <sub>2</sub> e/GDP)*                                                                          | EUROSTAT                     | 2010      |
| <b>5. Socio-economic outcomes</b>                                                                                              |                              |           |
| 5.1. Exports of products from eco-industries (% of total exports)*                                                             | EUROSTAT                     | 2011      |
| 5.2. Employment in eco-industries (% of total workforce)                                                                       | Ecorys                       | 2008      |
| 5.3. Turnover in eco-industries                                                                                                | Ecorys                       | 2008      |

## 3.2 Prospective analysis and future trends

This chapter describes the foresight methodology of the Eco-Innovation Observatory. Applied methods may include, among others, horizon scanning, Delphi, scenarios as well as impact assessment and roadmaps. Possibilities to use and combine different foresight methods depends on the selected theme, so the methods cannot be permanently fixed. A note on methodological flexibility has been accepted by the EC and added to this methodological report (see Annex III).

### 3.2.1 Horizon scanning

Horizon scanning will focus on gathering information on eco-innovations and related trends, such as emerging technologies and services, techno-scientific developments, market trends, socio-economic trends as well as drivers and barriers of eco-innovation developments. Horizon scanning will include a generic part and a specific part emphasizing the selected theme of foresight activities and the thematic scope of the Observatory.

Horizon scanning will not only strive to identify individual technologies, products or services, but will also account for systemic eco-innovations (including issues of industrial ecology and clustering), sustainable households (including recycling and energy usage systems, service delivery etc.) and urban ecology (including transportation, logistics). Emphasis will be placed on innovations with high potential impact to European SMEs and sustainability policies and related investment options. Attention will also be paid to “green branding” in relation to eco-innovations.

#### 3.2.1.1 Step 1: Focusing the scanning

Information to be scanned will be initially restricted to sources available online. Scanning will be started by identifying potential online sources, scanning tools such as search engines and keywords describing the generic part and specific scope of foresight activities and the Observatory. Possible information sources include technology and business periodicals, eco-innovation related journals, magazines, reports and literature, as well as Internet portals, databases and directories, such as digital libraries, innovation platforms, patent registers, eco-innovation web-pages and other on-line materials to be specifically identified and reported during the scanning process. Furthermore, the scanning process will make use of data collected in WP2, notably to identify areas for a more in-depth prospective analysis.

List of materials to be scanned will be updated during the proceeding of the Eco-Innovation Observatory. Examples of materials will be listed in the generic and specific parts of the horizon scanning (see below).

#### 3.2.1.2 Step 2: General horizon scanning

Possible keywords for Google and other search engines including a media monitoring service, internal search function of scanned on-line portals, databases, registers etc. can include the following with different combinations:

- Eco-innovation
- Innovation
- Market
- Trend
- Green brand, branding
- Green market, marketing
- Sustainable development
- Material efficiency

- Resource efficiency
- Energy efficiency
- Sustainability
- Environment
- Environmental impacts
- Eco-product
- Eco-service
- Eco-efficiency
- Eco-competitiveness
- Eco-labeling
- Environmental labeling
- Packaging
- Industrial ecology
- Urban ecology
- Transport

The keyword list for general horizon scanning will be improved by suggestions from the EIO consortium partners, the FFRC team and the interviewed experts. Even more importantly, part of the general horizon scanning is searching for relevant web-based materials for actual scanning. Examples of materials to be scanned in the generic part of horizon scanning include:

- selected scientific journals
- selected business journals and magazines)
- popular science magazines
- reports from major international, EU and national institutions
- reports from research institutes and think tanks

All scanned materials will be listed in the annual horizon scanning reports.

### **3.2.1.3 Step 3: Specific horizon scanning**

Specific horizon scanning will be focused on the selected themes highlighted in the scope of the Eco-Innovation Observatory such as

- Material recycling and re-use
- Bio-based products
- Sustainable construction
- Phosphorous and sustainable nutrient flows
- Critical metals

The keywords lists will be developed during the continuous horizon scanning by the FFRC team and the partners of the EIO consortium. Other foresight activities of WP3 will also contribute to the keyword development for continuous horizon scanning.

Materials to be scanned in the specific part of horizon scanning include specific sources for the selected eco-innovation areas available online, especially related scientific and technological journals and technology magazines, as well as webpages, portals, newsletters, directories, patent registers etc. The materials of general horizon scanning will be scanned also with the keywords of each thematic area of the Observatory. Additional materials will be always used when found.

### **3.2.2 Delphi**

Delphi is a widely used technique involving repeated polling of experts with the idea of achieving a consensus and prioritizing selected topics. The method is used to aid decision-making, especially in the context of selecting investment areas and policy priorities. What distinguishes Delphi from other surveys is that it is repeated using results from the previous rounds.

#### **3.2.2.1 Step 1: Inviting participants**

The aim is to involve at least 100 experts and business stakeholders in the Delphi. The names of the potential participant candidates will be gathered together with the partners. The invitation of the selected experts will be done carefully so that they represent a broad variety of views and different backgrounds. First, the background of the experts will represent a vast geographical distribution among EU-27 countries. Second, the background of the experts will represent different types of organizations: multinational companies, SMEs, research organizations, state administration and NGOs. Thirdly, the background of the experts will represent the scope of the Observatory. Especially, the experts will be invited from the point of experience in relation to resource use efficiency (e.g. energy and materials). The experts will be invited from e.g. European Technology Platforms (ETPs), European or national industrial associations, universities and research institutes as well as from NGOs. Requests on anonymous participation will be appreciated.

#### **3.2.2.2 Step 2: Design of Delphi for different purposes**

Traditional Delphi analysis is an expert method for mapping future alternatives where participants (Delphi panel) react to initial statements by giving arguments and comments for scenario construction. The argumentation will be further commented in the following rounds. Focusing on statements and arguments during two or more rounds makes Delphi different from other expert methods. In the Eco-Innovation Observatory, Delphi is foremost a platform for other foresight activities, such as scenario construction, impact assessment and eco-innovation roadmaps.

The initial Delphi questionnaire will be built on the information needs of selected foresight elements such as scenarios, impact assessment and roadmaps. Typically, participating experts will be requested to assess the eco-innovations and their market potentials with the criteria such as probability (likelihood of occurrence), feasibility (what is needed to make it happen, a “reality check”), timing (time horizon of emerging), desirability (value judgements linked to strategic goals and visions), strategic importance to different stakeholders, alternative options (in relation to roadmaps), drivers and barriers, as well as impacts (for the impact assessment).

#### **3.2.2.3 Step 3: Delphi in practice**

In order to be able to involve a high number of stakeholders, WP3.2 will apply the on-line Delphi approach. On-line Delphi is based on on-line surveys and does not include face-to-face meetings. The respondents are able to see the answers and comments from the previous responders. It is also possible for the responders to return to the questionnaire and statements for modifying their own responses. On-line approach simplifies both the interaction process and data analysis as well as, importantly, significantly reducing the overall cost of the exercise. The task will use a well-established platform eDelfoi (<http://www.edelfoi.fi>) which FFRC has experience with. Additional tools will be used if necessary.

### **3.2.3 Eco-innovation scenarios**

The purpose of the scenario exercises is to understand the nature of market dynamics of selected eco-innovation areas, in particular in regard to assessing their future growth potential beyond the time horizon normally used in purely econometric approaches.

#### **3.2.3.1 Step 1: Identifying available materials and starting points**

Scenarios to be constructed in WP 3.4 will follow the theme selected for Delphi. Scenarios will be based on several materials. Data delivered by WP2 is important for identifying the starting point for future developments, and can be used for constructing a baseline scenario by using e.g. trend extrapolation. Different scenarios can be constructed by using the findings of continuous horizon scanning, and expert opinions and other outputs from the Delphi such as drivers and barriers of eco-innovations. Scenarios can be made, for example, on the basis of probability (probable future), preference (preferred future), and avoidance (future threat).

#### **3.2.3.2 Step 2: Scenario construction**

Two principal approaches of scenario construction include backcasting scenarios (normative, target-based) and forecasting scenarios (explorative, driver-based).

Forecasting scenarios are based on assumed changes in selected drivers and barriers, which may or may not affect the baseline which can be identified by e.g. trend extrapolation if quantitative data is available. Forecasting scenarios will be made on the basis of expert participation in the Delphi.

Backcasting scenarios will be based on principal EU policy targets in relation to the focus of the Observatory. These EU policy targets are notably identified in the ETAP and other eco-innovation related processes. Also policy targets of the Lisbon strategy such as improved innovation performance and competitiveness of SMEs will be taken into account. The backcasting scenarios will recognise the role of SMEs as well as the role of EU and national policies in shaping developments in the areas with high eco-innovation potential.

### **3.2.4 Impact assessment and roadmapping**

The purpose of impact assessment and roadmaps is to process and refine the results from other foresight activities with a focus on selected eco-innovation areas identified as the ones with high market and/or environmental potential within the temporal scope of the Observatory up to the year 2030. In particular, these activities improve understanding of future trends and potential impacts of the selected eco-innovations, both in economic, social and environmental terms. It integrates insights from the previously described EIO foresight activities.

#### **3.2.4.1 Step 1: Definition of starting points**

Specific technologies/services/processes/systems of eco-innovation for impact assessment and roadmaps will be selected within the theme chosen for the Delphi activity. Material for impact assessment and roadmaps will be gathered either from the experts participating in the Delphi or a specific workshop. The roadmaps will be constructed for selected eco-innovation areas in the scope of the Observatory.

#### **3.2.4.2 Step 2: Trend impact analysis**

The Observatory will apply an impact assessment method that will build on the findings of WP2 (historical data analysis) and Delphi, in order to contribute to roadmapping. WP3 envisages the use of Trend Impact Analysis and Cross-Impact Analysis in order to evaluate drivers and factors of eco-innovation trends and markets.

Trend impact analysis includes a baseline scenario based on trend e.g. extrapolation of data collected in WP2, identification of future events and trends that may affect this scenario, and construction of scenarios from the baseline scenario on the basis of combined effect of different future events. Those events can span widely including different aspects, therefore a STEEPV framework (social – technological – economic – environmental – political – value-based) will be used in the analysis as a checklist.

The future events are related to selected areas/topics and, should they occur, they can cause deviations from a trend suggested by trend extrapolation of historical data. For each such event, experts may judge the probability of occurrence as a function of time and its expected impact, should the event occur, on the future trend. An event with high impact is expected to swing the trend relatively far, in a positive or negative direction, from its extrapolated course.

### 3.2.4.3 Step 4: Cross-impact analysis

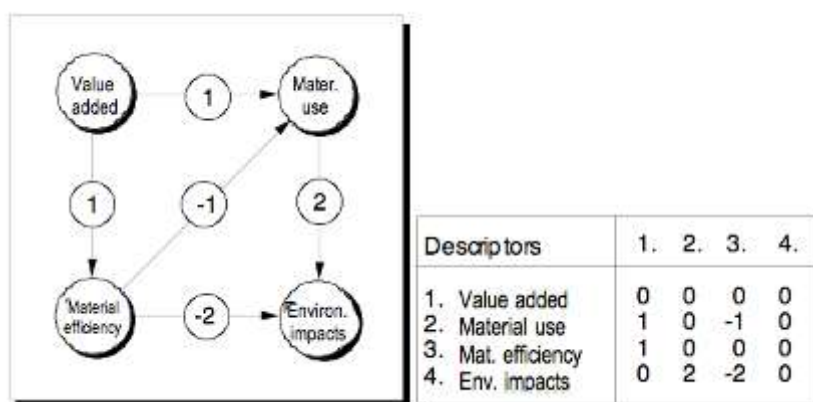
The impact assessment will be further enriched by using the Cross-Impact Analysis which attempts to work systemically through the relations between a set of selected variables or trends, rather than examining each one separately. It will strengthen the findings from Delphi and contribute to the roadmapping process providing a methodological ground for understanding interrelations and mutual influence between the analysed eco-innovation fields and relevant related areas.

During the Delphi, participants will be asked to identify the impacts between given “descriptors” and give them a priori probability and a simple numeric value describing the strength of impact (e.g.  $-3 \leq \text{value} \leq 3$  where negative values refers to decrease or increase), see example in the figure below. Descriptors can be variables which can increase or decrease, and even trends as themselves. Impacts between descriptors constitute a cross-impact matrix, in the simplified matrix many cross-impacts have been assumed to be zero (= no impact).

### 3.2.5 Workshops

At various stages of the WP3 foresight activities, expert workshops will be arranged. Workshops can be useful for e.g. scenario construction, impact analysis (trend impact analysis and cross-impact analysis) and roadmapping.

**Figure 3-2. Simple cross-impact matrix**



The input data for the cross-impact analysis includes the descriptors with their alternative states, their a priori probabilities, and the impact matrix. Basics-algorithm creates probable future scenarios, which are consistent in the sense of the impact matrix and probable in the sense of the a priori probabilities.

The algorithm produces different future scenarios and adjusted probabilities (a posteriori probabilities) for the future states (see table below).

| Occurrences ->        | 3 | 2 | 1 | 1 | 1 | A priori probability | A posteriori probability |
|-----------------------|---|---|---|---|---|----------------------|--------------------------|
| Value added           | 0 | 0 | 1 | 0 | 0 | 0.4                  | 0.125                    |
| Material use          | 1 | 0 | 1 | 0 | 1 | 0.7                  | 0.625                    |
| Material efficiency   | 0 | 0 | 1 | 1 | 0 | 0.8                  | 0.250                    |
| Environmental impacts | 1 | 0 | 1 | 0 | 0 | 0.7                  | 0.500                    |

In this simplified example the a priori probability of value added growth is given 0.4 and its a posteriori probability will be 0.125. The most probable scenario (3 occurrences) is decrease of value added (0), increase of material use (1), slowing down of material intensity development (0), and increase in environmental impacts (1).

In the EIO, the cross-impacts, their strengths and a priori probabilities will be collected from the participants of Delphi or a workshop and data for the actual cross-impact analysis can be provided by using “typical values” (mean value or median) for all responses or groups of “similar” answers identified by a cluster analysis.

#### 3.2.5.1 Step 5: Roadmaps

Eco-innovation roadmaps will explicitly target eco-innovations at different levels (e.g. micro, meso and macro) in order to better understand which one is most appropriate for future policy intervention. Roadmaps can be either technology roadmaps or policy roadmaps. For the purpose of the EIO and due to resource limitations, the policy roadmaps will be preferred. Roadmapping outlines the future of a specific technology, or an otherwise defined area generating a timeline for their development taking into account interrelations (such as dependencies) with others, including competing technologies. This component of the EIO foresight approach is to enhance understanding of the potential impact of the monitored emerging processes.

An eco-innovation roadmap is based on a baseline, collective expert knowledge and imagination of the most significant drivers and barriers of change in the selected type of eco-innovation. Roadmaps will focus on selected eco-innovation areas; following the general focus of the Observatory. Constructing the roadmaps will use the results of all other foresight activities of the Observatory.

### 3.3 Conducting analysis of different types of eco-innovation

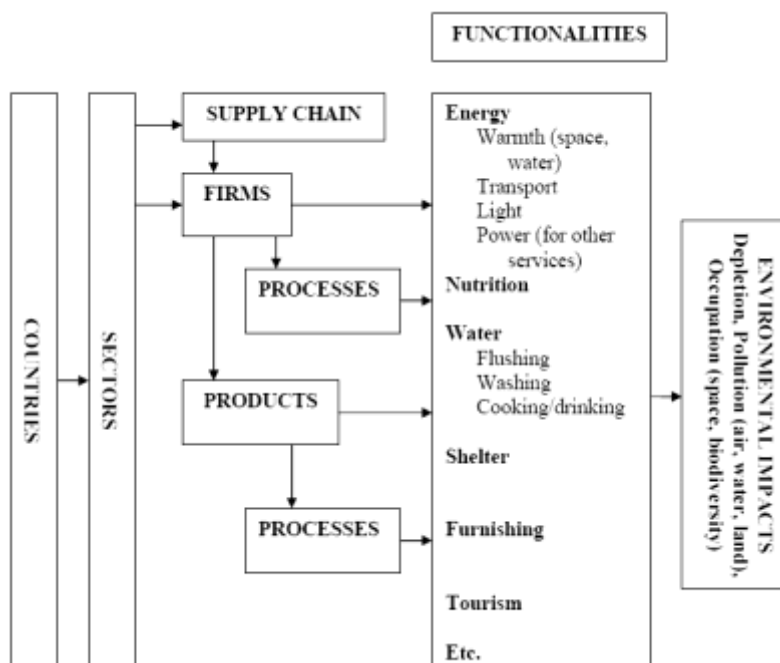
#### 3.3.1 Material flow innovation

Harmonised methodologies exist to account for material use on the economy-wide level (see EUROSTAT/OECD manuals), where extraction of materials within the country borders as well as imports and exports of materials and products are included. Harmonised methodologies also exist on the level of products and processes (see the Material Input per Service Unit (MIPS) concept), where material inputs along production chains are assessed, i.e. a life cycle assessment (LCA) focused on material use. Linking macro data on material use with sectoral economic data (in so-called input-output tables) also allows assessing

material use on the level of economic sectors. Material productivity describes the economic value generated per material used. On the macro level, this indicator is calculated by relating GDP of a country to material use indicators, for example, material input or material consumption of a country. In order to calculate the material productivity of sectors, sectoral material use is combined with sectoral economic data, e.g. generated value added.

Data on product groups can be compiled for the total material requirement in a comprehensive way and comparable to industries and economies. Data on single products can also be done with the same methodology and are useful for benchmarks; however it is more difficult to compare those data with entirely different products. Quite challenging are attempts to measure the 'productivity' of products, e.g. functionality or a service unit. This means that greater functionality is being delivered at the same cost, or that the same functionality is achieved with reduced costs (see figure 4-3). To measure this, bottom-up assessment at the micro level of products, processes or services must be performed (Huppes et al. 2008).

**Figure 3-3. The process of delivery of economic functionality**



Source: Huppes et al. 2008

### 3.3.2 Process eco-innovation

The EIO approach to measuring and observing process innovation will utilise input measures (such as results from research projects and development expenditures) and surveys. Examining the development of resource use at different levels, i.e. the product/firm, sector and country level will also indicate the degree to which eco-innovation activities have been adopted on the micro level and how this has led to improvements of resource-productivity on the macro level. This cross-level analysis will also illustrate whether eco-innovations to reduce resource use on the micro level actually drive dematerialization on the economy-wide level or whether eco-innovations and related cost reductions lead to higher production and consumption, which overcompensates the efficiency gains on the micro level (a phenomenon called "rebound effect").

Regarding the use of survey data, the EIO will particularly exploit the CIS questionnaires. The CIS6 questionnaire published end of 2008, with first results being available during 2010, for the first time contains a section of questions regarding "innovations with environmental benefits". The questionnaire includes questions related to the implementation of innovation activities which resulted in less material and energy input or in less production of waste and emissions, both in the production phase and the end-user phase. The CIS6 questionnaire also reveals the reasons enterprises innovated in environmental areas.

In the EIO, CIS data shall be used to identify the share of firms across industries and countries that have adopted resource efficiency measures as well as to analyse drivers and barriers. The latter will be done by means of regression analyses, i.e. investigating possible correlations between eco-innovation in firms and other variables, such as R&D expenditures.

### **3.3.3 Product eco-innovation**

As regards goods, product eco-innovation will be measured with the help of market analysis and patent analysis. Market analysis for specific technologies will be carried out with indicators such as cumulative growth rate and revealed competitive advantage. Projects such as the German MaRess (Material efficiency and resource conservation) will be taken into account. At the sectoral and country level, analysis of product eco-innovation will be enhanced by studies and databases already developed for eco-industries (including studies such as Ecotec 2002; Ernst & Young 2006; Bilsen et al. 2009) and environmental technologies (such as at the EEA). CIS data will be used to identify the share and profile of companies introducing product eco-innovations.

Patent analysis is a proxy for analysing what, how much and where technological innovation takes place. Therefore it is also a good resource for assessing trends. However, patents show inventions, not innovations, and are limited in their scope; often green products or end-of-pipe technologies are patented, but not services or processes, for instance. Databases such as PATSTAT and the OECD patent database will be explored for their suitability. For selected product groups, the EIO may also be able to carry out benchmarks that help to identify 'best in class' and the range of existing standards.

The observatory will utilise tools such as revealed comparative advantage and cumulative average growth to assess the competitiveness, growth and development of markets for eco-innovation, eco-industry technologies and products over time. This attention to past development and trends will feed into the assessment of future potentials and possibilities (section 3.4).

### **3.3.4 Organisational eco-innovation**

Organisational eco-innovation will be measured by assessing the number and type of enterprises with environmental management and auditing systems in different countries. The CIS data will be used, possibly supported by the EMAS register of organizations and the Global Reporting Initiative.

On the country level, country-specific surveys and databases may enhance evaluation. For instance, information from the BiE Index of Corporate Environmental Engagement may be used for the UK and statistics collected and reported by the German Federal Environmental agency on the percentage of firms with EMAS or ISO141001 may improve data quality for Germany.

### **3.3.5 Marketing eco-innovation**

The marketing eco-innovation analysis performed by the EIO will be focused on the prospective analysis of foresight activities. Horizon scanning includes a generic part dealing

with market trends of eco-innovations (emerging technologies etc.) and a subcontracted part concentrating on eco-innovation related green branding.

### **3.3.6 Social eco-innovation**

Social eco-innovation thus covers a wide spectrum of issues, the most of which fall outside the primary scope of the EIO. A relevant problem, however, is the demand for eco-innovation from society or special user groups as well as the option of user-led innovation processes. This will be approached via market analysis for certain new technologies and consumer goods. Surveys to measure public attitudes towards the environment, such as Eurobarometer, will be used to reflect public perceptions towards the environment. Data on environmental awareness and related sub-indicators shall be used to identify correlations with as well as barriers and drivers to eco-innovation by means of statistical regression analyses.

## **3.4 Conducting country level analysis**

Both quantitative and qualitative data collected by EIO will be available on the country level. The analysis of the country level data will be undertaken in the country briefs (see section 4.2.2.3) as well as in other major reports developed by the observatory where the objective is to compare and analyse country performance. The country briefs are, however, the only deliverable fully dedicated to analysing trends in a single country.

The country level data will be, on the one hand, the quantitative data available through the EIO database established under the WP2 and WP3. The availability of data across the EU27 will be determined in the ongoing data screening process. On the other hand, country experts responsible for preparing country briefs will collect further country level information on the relevant policy developments as well as on the good eco-innovation practices.

The policy measures monitored and analysed by the EIO will include both supply and demand measures particularly relevant to supporting eco-innovation. As such it will encompass both measures explicitly targeting eco-innovation as well as others identified as an important driver or barrier to the eco-innovation process.

The following typology will be used and further elaborated for the country brief template:

Supply-side measures:

- Equity support
- Research and development
- Demonstration and commercialisation
- Education and training
- Networks and partnerships
- Information services
- Provision of infrastructure

Demand-side measures:

- Regulations and standards
- Public procurement and demand support
- Awareness raising
- Technology Transfer

Improving strategic and policy making capacity

- Policy strategies on eco-innovation

- Eco-innovation-related monitoring and data collection activities
- Foresight activities
- Policy studies on eco-innovation

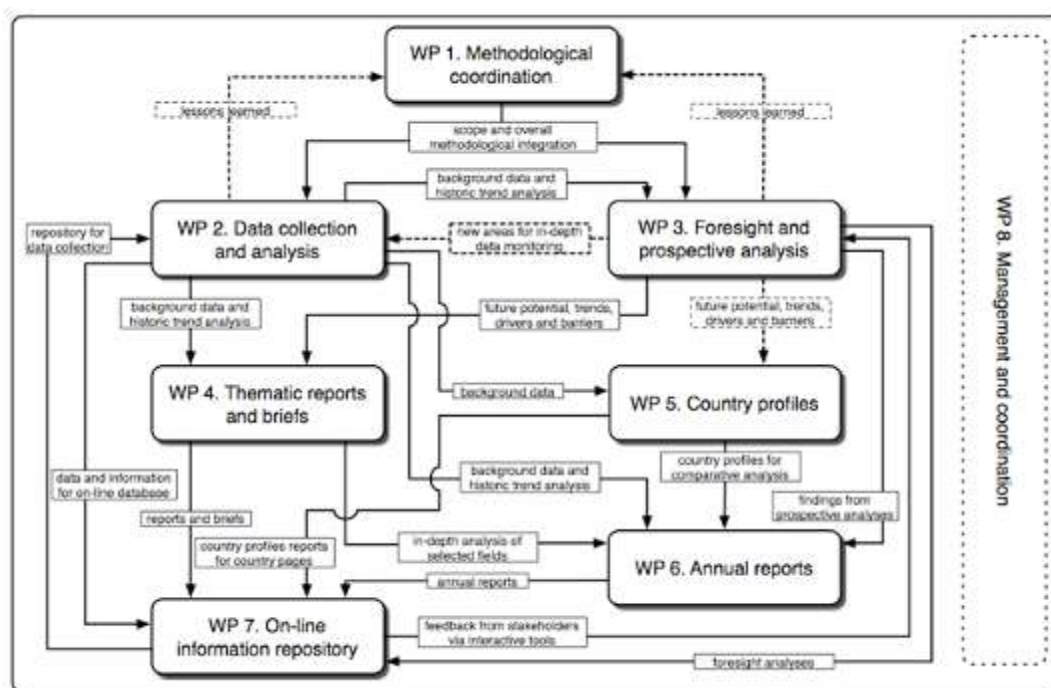
It will be a responsibility of the country experts to get detailed information on policy and good practices during their individual studies. Whenever possible, the latter process will be supported by the policy databases developed by OECD and by EU-funded PRO-INNO TrendChart-ERAWATCH projects as well as by other ongoing projects e.g. in the framework of Europe INNOVA initiative.

It has been planned that the work on country briefs will start with preparation of the annotated template (see section 4.2.2.3 and Annex II). The template will be tested in a pilot phase comprising the work on three country profiles, notably Germany, Austria and Hungary during September-October 2010.

### 3.5 Integrating findings from different activities

Given the sizable scope and the diversity of methods and approaches used by the EIO, an ongoing effort will be made to ensure an overall coordination of various activities. The focus will be notably on supporting the links between past data analysis and foresight activities of the observatory. Figure 3-3 depicts the principal relations and dependencies between the EIO's work packages.

**Figure 3-4. Relations and dependencies between WPs**



## 4. Outputs of observation

### 4.1 General overview of deliverables

The deliverables of the EIO project include a range of quantitative and qualitative information resources. These include the multi-dimensional database covering micro, meso, and macro data related to eco-innovations, the EU Eco-innovation scoreboard, annual reports presenting major project results, country briefs, thematic reports, foresight analysis reports, eco-innovation briefs, and the dynamic project website, which includes the above mentioned resources and project activity-related information, as well as interactive web-tools providing forums and blog spaces on knowledge and experience exchange, online surveys, maps, and feed-back systems.

Detailed descriptions of each deliverable, their content and the methodological and stepwise approach in producing these deliverables are presented below.

### 4.2 Presentation of deliverables

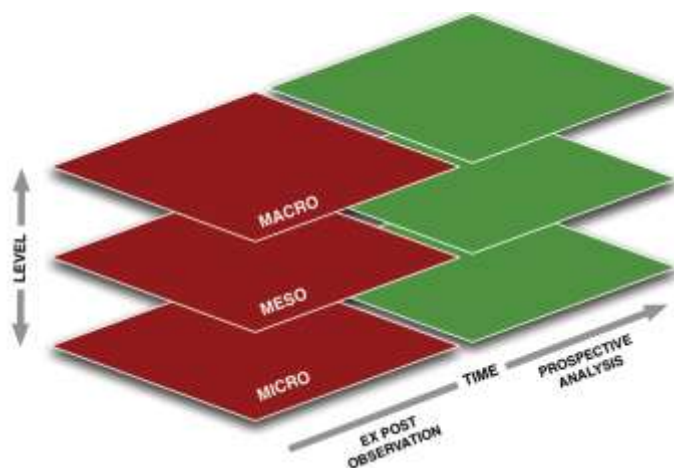
#### 4.2.1 Data and composite indicators

##### 4.2.1.1 On-line database

The on-line database will provide the repository for the data to be collected in WP2 and WP3, the 'input' as described in the earlier sections of this report, data that will subsequently be analysed to enable the production of the various reports that will be the main 'outputs' of the project. Section 3.5 and its sub-sections previously described the thematic scope of the database and the main areas of observation that will be included (Table 3-5). As such, the database structure will encompass three levels, addressing micro, meso and macro level performance and contextual indicators; each level will additionally have a temporal dimension; ex-post (1990 to present day / latest available information) and prospective (to 2030); Figure 4-1 illustrates this structure. A country marker will provide an additional dimension to each level.

While the core structure has been defined, it is also recognised that additional areas of observation are likely to be identified during the course of the project, and as such the database will be designed with the in-built flexibility to accommodate such necessary additions without requiring significant reworking.

**Figure 4-1. Database level structure**



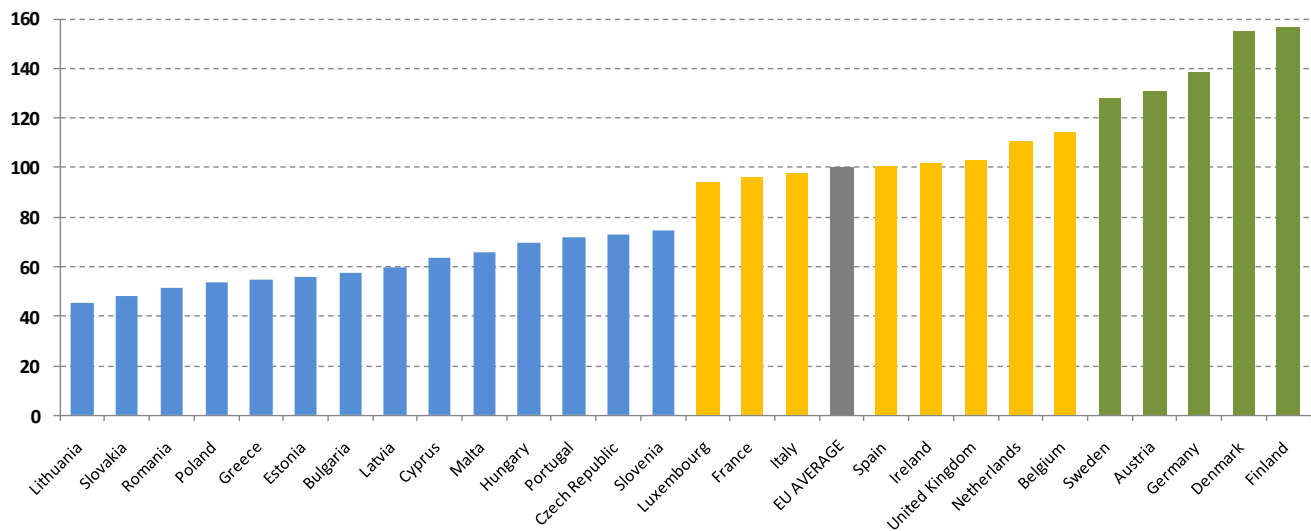
To enable meaningful analysis and reporting from the database, expert users will be able to define and create composite indicators drawing together sets of individual indicators to express a concept not otherwise measurable. This may enable, for example, data from one level to be used to populate gaps in another level of the database (e.g. macro to meso), or to conduct temporal analysis and explore the impact of trends over time (e.g. micro ex post to meso prospective). The eco-innovation scoreboard described in the following section is wholly generated using such composite indicators and could indeed be considered as an additional overarching level to the database.

#### 4.2.1.2 Eco-Innovation Scoreboard

The first version of the Eco-Innovation Scoreboard was presented in autumn 2010 and featured both in the 2010 Country Briefs and in the Annual Report.

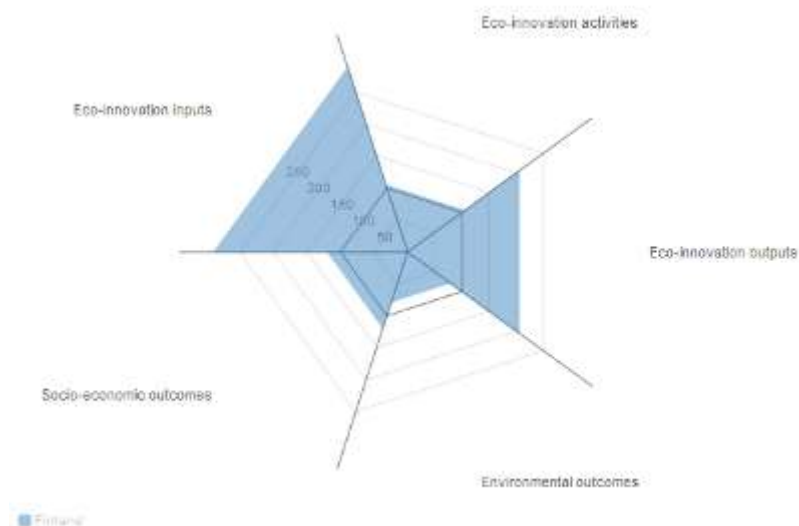
In the Annual Report, the Scoreboard was presented in the form of a bar chart, illustrating the three identified groups: eco-innovation leaders, eco-innovation followers and countries catching-up in eco-innovation.

Figure 4-2. Eco-innovation Scoreboard, 2010



For the EIO Country Briefs, the results of the five components of the Scoreboard are presented in the form of a radar diagram, illustrating the performance of the analysed country in comparison with the EU average performance (score of 100). The following figure illustrates the radar diagram for the best-performing country in the 2010 Scoreboard: Finland.

Figure 4-3. Composite Scoreboard Index, 2010



## 4.2.2 Reports and briefs

### 4.2.2.1 Annual reports

As the major deliverable of the EIO annual reports shall be the main voice of the observatory. They will be a flagship publication that presents all major findings and conclusions in a single report. All three of the annual reports will be a comprehensive and accessible document with many figures and tables, aimed especially at policy makers and enterprises, in particular SMEs.

The main objective of the annual reports are as to provide an annual update on recent trends and emerging markets, in particular highlighting issues of strategic relevance for the EU. Towards this aim, major findings from WP2 and WP3, as well as important themes from WP4 and WP5, will be summarized and rewritten for the target group. Ultimately, each annual report will draw overall conclusions and make policy recommendations.

A tentative outline follows:

- Executive summary (up to five pages incl. key figures, tables and findings)
- Introduction (1 page), shall also cover the definition and the scope of the EIO
- Main eco-innovation trends in Europe and beyond (10 - 15 pages, shall include the proposed Eco-Innovation Scoreboard, compare performance of EU countries and selected industries, give evidence on gaps towards main competitors, argue on competitive advantages)
- Future of eco-innovation in the EU (5 - 10 pages), shall include horizon scanning, scenarios and roadmaps
- Review of eco-innovation trends in selected areas
- at least the LMI areas of recycling, bio-based products and construction (5 pages each = 15 - 20 pages)
- Relevant activities on the national level including a synthetic comparative analysis of the EU27 (5 pages), which shall highlight best practices rather than assess countries
- Main barriers and drivers of eco-innovation (5 - 10 pages), shall deliver tailor made analysis at the target groups and comprise findings of WP 2 + 3 as well as manuals for them on 'who should look at what'
- Special feature (5 pages)

- Conclusions and policy recommendations (5 pages)
- Further reading and more information (2 pages)
- Technical annex with data, calculation and measurement issues

The special feature will highlight a selected issue of European relevance, which will be decided in advance with the Commission, such as sustainable construction or re-manufacturing, the interlinkages of resource efficiency with other sustainability issues or major events such as the Rio+20 Summit in 2012.

In addition to being published as a single document, the annual reports will also be made available in a wiki-style format online. This shall enable easy access that can be navigated by the reader, both enhancing their experience and allowing them to delve deeper into any subject that they so choose. Thus, it is linked to, as well as being, a pro-active part of the online service provided by the EIO.

#### 4.2.2.2 Thematic reports

It is envisaged to agree on a common general structure for all thematic reports. The reporting template for the thematic report on selected technology areas will follow the following structure:

- Summary (2 pages)  
The structure and the content of the report will briefly be outlined. This summary will also be placed on the website under the link to the report file, which will enable users to quickly scan information and identify interesting reports for more in-depth reading.
- Introduction (1 page)  
The reports start with an introductory part which presents the goals of the reports, context of the work, relevance of the topic and refers to the data collection process.
- The topic background (2 pages)  
This section provides the general information about the discussed technology including the description of its technical aspects, the areas of application, benefits and other issues.
- Current status and leading areas (15 pages)  
This section of the reports will provide a detailed description of the current situation, using selected data from the EIO database complemented by additional information specific to the thematic focus (e.g. from academic literature, government reports, desk and field study, information provided by the EIO steering and expert committees, etc.). It will have a section on leading products/technologies/services in the area and present good practices and example cases. This part will be accompanied with graphs, tables, photo-illustrations, exhibit boxes and interesting citations from the interviews or the literature.
- New trends and perspectives: areas on the rise (10 pages)  
For the thematic issue covered in each specific report, a general vision shall be created, indicating what the desired situation would look like and how eco-innovation could contribute to achieving this desired situation. This part of the report will very much draw on results generated through the foresight activities undertaken in WP 3. This part will have a section including good practices.
- Main barriers and drivers of eco-innovation in the analysed area (10 pages)

This section will analyse the main factors supporting or hindering the implementation of eco-innovations in the specific area, including economic, technological, social, regulatory or natural determinants.

- **Conclusions and policy recommendations (3 pages)**  
The final section of the thematic reports will draw conclusions from the observation and analysis provided in earlier chapters and derive recommendations for measures which could help redirect current trends towards the desired vision for the future, as well as to overcome barriers and instrumentalise drivers discussed in the report.
- **References**  
The list of the literature, data, internet sources used and references to the interviews with area experts will be provided here.

The reporting template will be adapted depending on the topic and available data. There will also be thematic reports addressing horizontal aspects of eco-innovation that may focus on organisational and other non-technological aspects. Examples of the topics can be access to finance, market introduction, knowledge diffusion and transfer, innovation management, branding and marketing, end demand and consumer acceptance, public procurement, standards, etc. The structure of the reports on horizontal issues will be proposed on the topic-to-topic basis.

The length of the individual sections proposed in the above outline is tentative. It is proposed that the reports will not be longer than 50 pages. All reports will be placed on the website of the project. The first and second thematic reports will be produced by the end of 2010 and by the end of the first quarter of 2011 respectively. ‘Sustainable construction’ may be a topic for the first thematic report; the final decision on this will be made during the Steering Committee meeting planned in early June.

#### **4.2.2.3 Country briefs**

The objectives of the country brief are to present an up to date overview of eco-innovation dynamics, relevant policy measures, good practice examples, and drivers and barriers in each EU member state. The target audience who will benefit from the information in the country briefs are mainly EU level and national level policy makers as well as representatives of business associations. Similar briefs may also be produced with examples from non-EU countries, such as the US, Japan, and China, which are important global players in creating and diffusing eco-innovations and whose experience can be useful for Europe.

The profile will include the following main sections:

- Introduction: innovation and environment in the country (0.5 - 1 page)
- Eco-innovation performance (1.5 page)
- Leading eco-innovation areas (including good practice examples) (1.5 - 2 pages)
- New trends: areas on the rise (including good practice examples) (1 – 1.5 pages)
- Public policy in support of eco-innovation (1- 1.5 pages)
- Understanding determinants of eco-innovations (1 page)

The country profiles will be produced as stand-alone material of about eight to twelve pages. The briefs will be available as web pages as well as PDF documents downloadable from the Eco-innovation Observatory website.

Good practice examples presented in the briefs will also feed the online EIO repository of good practices, which will be available at the website of the observatory.

The authors of briefs will be supported by a number of methodological aids including:

- annotated report template;
- pilot country briefs;
- quality review.

The detailed annotated country brief template is provided in the Annex II to this report. The final version of the template will be available both, as an online form and a Word document. Country correspondent will be offered an access to a dedicated on-line working space. The country profiles will be updated every year and new versions will be placed on the website.

The members of the core EIO team will assist the country correspondents in their work on country briefs. They will provide methodological guidance on planning and arranging the desk study, the use of the database and scoreboard, designing standardised tables and graphs, conducting interviews as well as on writing style. Country correspondents will be linked to the Environmental Technology Action Plan High Level Working Group (ETAP HLWG) members and encouraged to interview respective national expert.

Importantly, the pilot briefs will be provided as examples of complete work. In addition, the EIO team will do a diligent quality check of the draft briefs providing tailored comments to the authors.

The pre-final drafts of the briefs will be sent to the ETAP HLWG to receive their feedback and approval. After finalisation the brief will be published at the EIO website.

#### **4.2.2.4 Foresight reports**

##### **Horizon scanning reports**

Each version of the report will include a comprehensive list of scanned materials (databases, web portals, on-line reports, journals and magazines, etc.) and a list of used search tools including keyword lists and used keyword combinations. When possible, statistical information will be provided on the "hits", which will be provided in order to monitor the popularity of eco-innovations in different parts of the scanned material.

Each report will include findings considered as relevant within the scope and focus of the Observatory. The findings can be concrete examples of different types of eco-innovations defined in the scope of the Observatory, related trends and drivers and barriers, as well as the subcontracted part dealing with green branding. Horizon scanning reports do not include conclusive selections of results for the other foresight activities of the Observatory. These selections will be reported in the reports of the corresponding foresight activities.

##### **On-line Delphi reports**

The EIO will develop three annual Delphi reports. Since the On-line Delphi is a platform for gathering material for further foresight activities of the Observatory, the major content of these reports is the initial questionnaire and related statements based on the results of horizon scanning.

##### **Impact assessment and eco-innovation roadmap reports**

Reports will include the results from trend impact assessment and cross-impact analysis carried out on the basis of expert-based materials gathered during the On-line Delphi.

##### **Eco-innovation scenario reports**

Reports will include descriptions of all scenarios constructed on the basis of previous foresight activities of the Observatory including feedback received in the scenario workshops.

### **Other foresight reporting**

Based on the experience of eco-innovation foresight activities carried out in the Eco-Innovation Observatory, a methodological description of each applied foresight method, i.e. horizon scanning, On-line Delphi, impact assessment (including trend impact analysis and cross-impact analysis), eco-innovation roadmaps and eco-innovation scenarios will be used for updating this methodological report.

#### **4.2.2.5 Eco-innovation briefs**

The purpose of the Eco-innovation briefs is to deliver information about specific eco-innovation related topics that will be easily accessible to various groups including not only policy makers and SMEs, but also to the general public.

The briefs will cover a wider variety of relevant eco-innovation topics that will not be covered by the thematic reports in detail or will highlight the topics to be covered by the thematic reports in the future. The briefs could have a focus on both new eco-innovation trends and policy issues and may be prepared specifically for major events. They will also provide references to the external sources of information for those interested in following the topic further. In order to avoid duplications, the preparation of the briefs is planned to be done in close coordination and collaboration with other Europe INNOVA projects, in particular Europe INNOVA Communications and Sector Innovation Watch, as well as with ETAP and EcoAP. Decisions on the topics for the eco-Innovation briefs will be made at the latest one month in advance of the delivery.

The briefs will be a maximum 1-2 page stand-alone document produced on a monthly basis. The briefs are proposed to have a simple structure including an introduction, main text, diagrams and charts and a further reading section with useful links and references. Being a more flexible form of communication, the briefs will not be based on detailed uniform templates, but as with any deliverable they will go through a rigorous quality checking including an internal review of the draft brief and language editing. They will be available on the website in the news section. The first eco-innovation brief will be focused on presenting the EIO, its goals and short and long terms plans and services.

#### **4.2.3 Website and web-based reports**

The EIO project website will be the day-to-day dissemination route and communication platform for the project. A relevant and recognisable domain name will be utilised [www.eco-innovation.eu](http://www.eco-innovation.eu).

Combined with a strong visual identity, to be approved by DG Environment, and the development of a distinctive EIO logo, the Eco-Innovation Observatory aims to become a well-recognised and respected brand during the course of the project. By careful selection of keywords, establishing links with other websites and other such techniques, the EIO website will seek to be featured on the first page of search engine results for 'eco-innovation' for English-language searches.

The website will provide general users with a clear and easy to use portal to access the outputs of the Observatory; the aforementioned Annual, Thematic and Country briefs will form the core of the information available to general users, with registered users having access to additional functionality such as the ability to post their own input and generate customised reports and download data for their own research purposes.

The website's required functionality will be determined through early consultation with representatives of each of the key user groups, to ensure that the correct focus is applied and that actual rather than perceived benefits are provided.

The potential capabilities that will be considered include:

- Reference document library, both project generated and more general
- Wiki
- FAQ and Glossary/Acronym section
- Survey and Polls
- Podcasts and video links to the relevant content
- Events and Calendar of project and wider eco-innovation events
- Specific and dedicated URL links pages
- Public News and Alert area
- Public Blog area for the more technologically able
- Members only area with Forum and message boarding space
- RSS feeds

Where possible these activities will be 'moderated' by a dedicated person from the consortium.

## **5. Outreach and communication activity**

### **5.1 Objectives of outreach and communication**

Effective and widespread information gathering and dissemination by the Eco-Innovation Observatory is fundamental to the success of the project. The audience to be served by the activities of the Observatory is broad and diverse, covering; policy makers at European, member state national and regional levels; existing eco-innovation support providers; business organisations, in particular SMEs; universities and research organisations; and the general public.

The objective of EIO is to benchmark then develop an understanding of best practice within the EU MS regarding eco-Innovation using standardised and agreed criteria as set out earlier in chapters 2 and 3 of this report. The objective of the communication activity is to deliver this information to the various stakeholder and target groups across the EU27.

To communicate efficiently across the EU27 countries an on-line information service provided via the EIO web site will be developed and put in place. An on-line resource has the benefit of being both easily accessible to potential users in any EU member state (and beyond) and at the same time quick and cost effective to regularly update as further information becomes available. The incorporation of interactive elements, such as WIKI tools, will be employed as a means to encourage interaction with the wider user-base.

The on-line service will be dissemination biased and user focussed, with a format and layout designed to provide easily accessible information relevant to the target markets. The service will very much have a user-focus, with the content aimed at practitioners in industry, support networks, and policy makers. Layering of content will be employed to enable dissemination in a meaningful manner and at the appropriate level of detail for each different type of audience; providing at the foundation a strategic overview appropriate for informing senior management and EU policy makers, while successive layers above will provide more applied information of direct use to 'hands-on' practitioners.

To leverage the communication from the Observatory and engage more fully with key audience groups, particular with SMEs, eco-innovation 'champions' may be identified and enrolled to enthuse other organisations to the benefits of eco-innovation practices. Likewise, at policy maker level sponsors to communicate the Observatory's activities within each of the Directorate Generals will be sought.

### **5.2 Adapting to the needs of key target groups**

Broadly speaking, the EIO will address four target groups:

- Companies
- Intermediaries
- Researchers
- Policy makers

This approach will enable each audience type to self-select and access the appropriate level of information and knowledge for their particular needs. A further benefit is that it will allow EIO dissemination activity to be expanded as required for each audience type, based on the circumstances and location of the interaction.

### **5.2.1 Companies**

From the partner organisations experience of providing knowledge transfer activities to SMEs, it is appreciated that SMEs are generally very focussed on their immediate business delivery and commercial objectives, with limited time and resources available to spend on improving their knowledge. By their very nature, SMEs constitute the overwhelming majority of companies within the EU, numbering many millions of enterprises across the continent and therefore the largest market for the EIO in terms of members and prospective eco-innovation practitioners. This represents a major challenge in terms of communication and very much shapes the communication medium for the Observatory, particularly as SMEs are at not all at the same level in terms of their understanding and adoption of eco-innovation practices.

The Europe INNOVA REMake project has identified four levels of SMEs in this area, ranging from Non Eco-adopters (organisations totally disengaged from this agenda), through Slow Eco-adopters and Strategic Eco-adopters to Strategic Eco-innovators, organisations where eco-innovation is embedded in their business model as a key mechanism to sustain wealth creation. This varied and very large audience can most effectively be targeted through on-line services that allows for time shifting activity, enabling the user to access the information at a time (and location) that best suits them. Consequently, communication activity will primarily be based on easily digestible, on-line accessible information. The content will be distilled from the information gathered by the Observatory and reconstituted with industrial users in SMEs in particular in mind; concise fact sheets in a case study format being an example of an approach likely to be utilised.

To further enable the effective exploitation of the business opportunities provided by eco-innovation, a web-based tool kit addressing the needs of practitioners in SMEs and innovation support providers will be provided. This tool kit will utilise the evidence base and the findings of the various reports to provide self-study material.

The working language of the EIO will be English; it is acknowledged that in many EU countries SMEs are not at a level where working with documents in the English language is widely practiced; this therefore represents a barrier to reaching this audience. This is considered as being less of an issue for the other audiences that the Observatory is addressing, where working with English documentation is more accepted. To attempt to mitigate this barrier communications specifically targeting SMEs will be firstly written in an accessible form of English, devoid of unnecessary complication and embellishment and with as much information as possible communicated graphically in a clear and consistent EIO 'house' style. Secondly, consideration will be given to translating these key documents into major European languages. However, as the budget for the project is limited, employing this capability will be carefully considered. Recognising this, recent advances in automatic translation software will be reviewed with a view to adopting this capability if it is proven to be sufficiently accurate and reliable, to enable more widespread translation of the EIO information on an individual user by user basis.

### **5.2.2 Organisations providing innovation support**

In addition to the information to the companies a more detailed set of hard copy material will be developed for these organisations. These will include abstracts of the thematic reports. A more detailed workshop programme will be delivered in conjunction with project partners at key European events to help these organisations embed the eco-innovation principles and practices in their clients. There is potential for linking this activity with the outputs of the Europe INNOVA REMake project, which has a series of train-the-trainer workshops for eco-innovation support providers as one of its key deliverables. The European Enterprise Network is another suitable partner. As providing training courses can be considered as

adding value to the organisations receiving it, it is anticipated that these events will be partly funded by charging delegate fees for attendance. This has the advantage of protecting the EIO budget giving a value to the training delivered and providing a sustainability model to the EIO project in the future.

Whenever possible, the project partners will present key EIO deliverables at key national and international events. The project communication team will consider taking 'advertorial' space in key technical journals and national scientific publications.

### **5.2.3 Policy makers**

The key deliverables of the EIO, in particular annual reports, Eco-Innovation Scoreboard, foresight exercises and country briefs will be of interest to policy makers at both EU and national levels.

Furthermore, the database will be adapted so, whenever practicable, it includes the indicators used as policy targets at EU level. In addition, the selection of topics for thematic enquiries will be done in close collaboration with the European Commission.

### **5.2.4 Researchers and analysts**

Thanks to its innovative and comprehensive scope, the database will be of big interest to academic researchers. As such, it may become a basis of research activities undertaken outside the official activities of the EIO.

The innovative nature (e.g. combination diverse data sources, combination of data analysis and foresight exercises) and uniqueness of deliverables (e.g. country profiles, Eco-Innovation Scoreboard) of the project will attract critical attention. The EIO will actively engage in the debate also with the research community, possibly through participation in events and publications.

## Post script: EIO as an on-going methodological development process

### A robust and tested methodology

The EIO's methodological approach can be described as an on-going learning process. The analytical objectives and research methods of the observatory are innovative and ambitious and, therefore, will require a significant degree of testing and adapting in the course of implementation of the work programme.

The observatory will gradually elaborate elements of its methodology based on initial findings and on the implementation experience. In practical terms, the following actions will be taken to make the methodological basis as robust as possible:

- Periodical adaptations to the methodological report (annual basis);
- Technical papers developed for individual WPs, notably WP2 and WP3;
- Peer review and consultations of the major deliverables;
- Presentations of findings and main deliverables at professional and academic fora.

### Advisory bodies

In order to extend its learning capacity and the knowledge base, the EIO will establish advisory bodies bringing in external expertise and links to the relevant related initiatives. An, **expert group (ExG)** will be set up with the objective to:

- provide feedback on the methodological aspects of the initiative;
- comment and provide advise on how to further improve the quality of the main deliverables;
- recommend how to improve the development and delivery of market and policy intelligence linked to eco-innovation.

The ExG will meet annually and include selected experts, researchers and policy makers as well as representatives of the consortium and the Commission. In a longer term, it was also suggested to organise dedicated **working groups** complementing work of the ExG that will focus on specific areas.

The proposed working groups include:

- WG on Eco-Innovation Measurement and Indicators;
- WG on Market Intelligence (involving business associations, Technology platforms, etc);
- WG on Policy Intelligence;
- WG on Communications etc.

The Expert Group may also organise ad-hoc working groups if this is to support delivery of any major EIO products.

## Annex I. Selected indicators for EIO database

| Key features             | Main areas of observation (1) | Main areas of observation (2) | Main areas of observation (3)                             | Macro                                                                                            |                      | Meso      |         | Micro     |         |
|--------------------------|-------------------------------|-------------------------------|-----------------------------------------------------------|--------------------------------------------------------------------------------------------------|----------------------|-----------|---------|-----------|---------|
|                          |                               |                               |                                                           | Indicator                                                                                        | Sources              | Indicator | Sources | Indicator | Sources |
| Socio-economic framework | Economic performance          | Economic wealth               | GDP                                                       | GDP (absolute/growth)                                                                            | EUROSTAT             |           |         |           |         |
|                          |                               |                               |                                                           |                                                                                                  |                      |           |         |           |         |
|                          |                               | Competitiveness               | Competitiveness indices                                   |                                                                                                  | World Economic Forum |           |         |           |         |
|                          |                               |                               | Foreign investment                                        |                                                                                                  | UNCTAD               |           |         |           |         |
|                          |                               | Employment                    | Active population                                         | National Labour force                                                                            |                      |           |         |           |         |
|                          |                               |                               | Employment rate                                           | National employment rate                                                                         | AMECO / EUROSTAT     |           |         |           |         |
|                          |                               |                               | Unemployment rate                                         | National unemployment rate                                                                       | AMECO / EUROSTAT     |           |         |           |         |
|                          |                               |                               |                                                           |                                                                                                  |                      |           |         |           |         |
|                          | Social aspects                | Population                    | Size                                                      | Population (absolute/growth)                                                                     | EUROSTAT             |           |         |           |         |
|                          |                               |                               | Age                                                       | Population by age group                                                                          | EUROSTAT             |           |         |           |         |
|                          |                               |                               | Household profile                                         | Average size of households                                                                       |                      |           |         |           |         |
|                          |                               |                               |                                                           | Income of households                                                                             |                      |           |         |           |         |
|                          |                               | Education attainment          | Urban/rural                                               | Population in urban agglomerations of more than 1 million                                        | Worldbank            |           |         |           |         |
|                          |                               |                               | Higher education                                          | Absolute and share in total                                                                      | EUROSTAT             |           |         |           |         |
|                          |                               |                               | Secondary education                                       | Absolute and share in total                                                                      | EUROSTAT             |           |         |           |         |
|                          |                               |                               | Science and engineering                                   | Students enrolled in engineering, manufacturing and construction field - as % of all students.   | EUROSTAT             |           |         |           |         |
|                          |                               | Consumer choices              |                                                           | Students enrolled in science, mathematics and computing field - as % of all students             |                      |           |         |           |         |
|                          |                               |                               | Humanities                                                | Absolute and share in total                                                                      | EUROSTAT             |           |         |           |         |
|                          |                               |                               | Attitudes towards waste and recycling                     | Importance attached to recycling and minimising waste in solving environmental problems          |                      |           |         |           |         |
|                          |                               |                               | Attitudes towards eco-friendly production and consumption | Importance attached to eco-friendly products in solving environmental problems                   |                      |           |         |           |         |
|                          |                               |                               |                                                           | Importance attached to buying energy-efficient home appliances in solving environmental problems |                      |           |         |           |         |
|                          |                               |                               |                                                           | Importance attached to transport in solving environmental problems                               |                      |           |         |           |         |

|                     |                                         |                                      |                                                                  |                                                                     |                                 |                                           |                                                  |              |  |
|---------------------|-----------------------------------------|--------------------------------------|------------------------------------------------------------------|---------------------------------------------------------------------|---------------------------------|-------------------------------------------|--------------------------------------------------|--------------|--|
|                     |                                         |                                      |                                                                  | Importance attached to water use in solving environmental problems  |                                 |                                           |                                                  |              |  |
|                     |                                         |                                      |                                                                  | Awareness about the environmental impact of products used or bought |                                 |                                           |                                                  |              |  |
|                     |                                         | Quality of life                      | Objective and subjective aspects of quality of life / well-being | Indicators from National Accounts of Well-Being                     | New Economics Foundation        |                                           |                                                  |              |  |
|                     |                                         |                                      |                                                                  | Life satisfaction                                                   |                                 |                                           |                                                  |              |  |
|                     | Infrastructure                          | Buildings                            | New buildings (net addition to stocks)                           | New dwellings                                                       | Federcasa                       |                                           |                                                  |              |  |
|                     |                                         | Transport                            | Length of motorways                                              | Total length of motorways                                           |                                 |                                           |                                                  |              |  |
|                     |                                         | Energy                               | Grid                                                             | Length                                                              |                                 |                                           |                                                  |              |  |
|                     |                                         |                                      |                                                                  | Additional length per year                                          |                                 |                                           |                                                  |              |  |
|                     |                                         |                                      |                                                                  | Capacity                                                            |                                 |                                           |                                                  |              |  |
|                     |                                         |                                      |                                                                  | Capacity improvement per year                                       |                                 |                                           |                                                  |              |  |
|                     | General regulatory and policy framework | Demand side                          | Income tax                                                       | Top personal income rate (%)                                        |                                 |                                           |                                                  |              |  |
|                     |                                         |                                      | Public procurement                                               | Public procurement in % of GDP                                      | EUROSTAT                        |                                           |                                                  |              |  |
|                     |                                         | Supply side                          | Equity support (general)                                         | Public subsidies in % of GDP                                        |                                 |                                           |                                                  |              |  |
| Environment         | Resource inputs and consumption         | Materials                            | Material inputs                                                  | Direct Material Input (DMI) of countries                            | EUROSTAT                        | Direct material input of economic sectors | Exiopool / EIO input-output calculations         |              |  |
|                     |                                         |                                      |                                                                  | Total Material Requirement (TMR) of countries                       |                                 | Total material input of economic sectors  | Academic reports                                 |              |  |
| <b>Key features</b> | <b>Main areas of observation (1)</b>    | <b>Main areas of observation (2)</b> | <b>Main areas of observation (3)</b>                             | <b>Macro</b>                                                        |                                 | <b>Meso</b>                               |                                                  | <b>Micro</b> |  |
| Environment         | Resource inputs and consumption         | Materials                            | Material consumption                                             | Domestic Material Consumption (DMC) of countries                    | EUROSTAT / OECD                 |                                           |                                                  |              |  |
|                     |                                         |                                      |                                                                  | Total Material Consumption (TMC) of countries                       |                                 |                                           |                                                  |              |  |
|                     |                                         |                                      | Physical trade                                                   | Physical Trade Balance (PTB)                                        | EUROSTAT /                      |                                           |                                                  |              |  |
|                     |                                         |                                      | Productivity                                                     | Direct Material Productivity of countries (GDP/DMC)                 | Calculation: GDP/DMI / EUROSTAT | Value added per material input            | EIO input-output calculations / National studies |              |  |
|                     |                                         |                                      |                                                                  | Total Material Productivity of countries (GDP/TMC)                  |                                 | Total output per material input           | EIO input-output calculations / National studies |              |  |

|                     |                                      |                                      |                                      |                                                                          |            |                                                             |                                                                                                                                                 |                                                  |                  |
|---------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------------------------------------------|------------|-------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|------------------|
|                     |                                      |                                      | Primary raw material prices          | Metal price indices (overall index plus 5 sub-indices)                   | BGR        | Purchasing prices for different raw materials of industries | BGR (Bundesanstalt für Geowissenschaften und Rohstoffe) / USDI/USGS / Raw Materials Data metal and coal database / IMF Primary Commodity prices | Share of material costs in enterprises over time | National studies |
|                     |                                      |                                      |                                      | Prices of industrial minerals                                            |            |                                                             |                                                                                                                                                 |                                                  |                  |
|                     |                                      |                                      |                                      | Producer prices of crops and livestock products                          |            |                                                             |                                                                                                                                                 |                                                  |                  |
|                     |                                      |                                      |                                      | Share of material costs in enterprises                                   |            |                                                             |                                                                                                                                                 |                                                  |                  |
|                     |                                      |                                      | Secondary raw material prices        | Secondary raw material prices                                            |            | Purchasing prices for different raw materials of industries | National studies                                                                                                                                |                                                  |                  |
|                     |                                      |                                      | Material security                    | Resource reserves                                                        |            |                                                             |                                                                                                                                                 |                                                  |                  |
|                     |                                      |                                      |                                      | Resource reserves (minerals)                                             |            |                                                             |                                                                                                                                                 |                                                  |                  |
|                     |                                      |                                      |                                      | Share of imports in DMC/TMC of countries                                 |            | Share of imports in material input of industries            |                                                                                                                                                 |                                                  |                  |
|                     |                                      |                                      |                                      | Share of costs for raw material imports in GDP (%)                       |            |                                                             |                                                                                                                                                 |                                                  |                  |
|                     |                                      |                                      |                                      | Share of imports of critical raw materials in total raw material imports |            |                                                             |                                                                                                                                                 |                                                  |                  |
|                     |                                      | Energy                               | Production                           | Primary energy production of countries per energy source                 | EUROSTAT / | Energy supply of economic sectors                           | EUROSTAT / IEA                                                                                                                                  |                                                  |                  |
| <b>Key features</b> | <b>Main areas of observation (1)</b> | <b>Main areas of observation (2)</b> | <b>Main areas of observation (3)</b> | <b>Macro</b>                                                             |            | <b>Meso</b>                                                 |                                                                                                                                                 | <b>Micro</b>                                     |                  |
| Environment         | Resource inputs and consumption      | Energy                               | Consumption                          | Gross inland consumption of energy of countries                          | EUROSTAT   |                                                             |                                                                                                                                                 |                                                  |                  |
|                     |                                      |                                      | Productivity                         | Energy intensity of countries                                            | EUROSTAT / | Value added per energy input                                | National studies / EIO input-output calculations                                                                                                |                                                  |                  |
|                     |                                      |                                      | Renewables                           | Share of renewables in gross inland energy consumption                   | EUROSTAT   | Total output per energy input                               | National studies / EIO input-output calculations                                                                                                |                                                  |                  |
|                     |                                      |                                      | Energy prices                        | Electricity Price, domestic consumer                                     |            | Purchasing prices for energy of industries                  |                                                                                                                                                 |                                                  |                  |
|                     |                                      |                                      |                                      | Electricity Price, industrial consumer                                   |            |                                                             |                                                                                                                                                 |                                                  |                  |
|                     |                                      |                                      |                                      | Natural Gas Price, domestic consumer                                     |            |                                                             |                                                                                                                                                 |                                                  |                  |

|  |                       |           |                                   |                                                                   |                            |                                          |                                                      |  |  |
|--|-----------------------|-----------|-----------------------------------|-------------------------------------------------------------------|----------------------------|------------------------------------------|------------------------------------------------------|--|--|
|  |                       |           |                                   | Natural-gas Price, industrial consumer                            |                            |                                          |                                                      |  |  |
|  |                       |           |                                   | Consumer prices of petroleum products                             |                            |                                          |                                                      |  |  |
|  |                       |           | Energy security                   | Import Dependency: Share of imports in energy supply of countries |                            |                                          |                                                      |  |  |
|  |                       |           |                                   | Diversification (price effects)                                   |                            |                                          |                                                      |  |  |
|  |                       |           |                                   | Diversification (physical availability)                           |                            |                                          |                                                      |  |  |
|  |                       |           |                                   | Share of renewables in gross inland energy consumption            |                            |                                          |                                                      |  |  |
|  |                       | Water     | Consumption                       | Water consumption of countries                                    | Water Footprint            | Water consumption of sectors             |                                                      |  |  |
|  |                       |           | Productivity                      | Water productivity of countries                                   | EUROSTAT / Water Footprint | Value added per water consumption        |                                                      |  |  |
|  |                       |           |                                   |                                                                   |                            | Total output per water consumption       |                                                      |  |  |
|  |                       |           | Water prices                      |                                                                   |                            |                                          |                                                      |  |  |
|  | Outputs and emissions | Emissions | GHG emissions                     | GHG emissions of countries                                        | EUROSTAT                   | GHG emissions by sector                  | EUROSTAT - GHG emissions by sector / UNFCCC GHG data |  |  |
|  |                       |           | GHG intensity                     | GHG emission intensity of countries                               | EUROSTAT                   | Value added per output of GHG emissions  | EIO input-output calculations / National studies     |  |  |
|  |                       |           |                                   |                                                                   |                            | Total output per output of GHG emissions | EIO input-output calculations / National studies     |  |  |
|  |                       |           | Carbon prices                     | Carbon price (EU ETS)                                             |                            |                                          |                                                      |  |  |
|  |                       | Waste     | Industry / construction waste     | Waste generated                                                   | EUROSTAT EIONET            |                                          |                                                      |  |  |
|  |                       |           |                                   | Construction waste generated and recycled                         | EUROSTAT EIONET            |                                          |                                                      |  |  |
|  |                       |           | Household waste                   | Waste generated (absolute / per capita)                           | OECD / EUROSTAT            |                                          |                                                      |  |  |
|  |                       |           | Hazardous waste                   | Waste generated (absolute / percentage of total waste)            | EIONET / EUROSTAT          |                                          |                                                      |  |  |
|  |                       |           | Municipal waste                   | Municipal Waste Disposal (1000 tones)                             |                            |                                          |                                                      |  |  |
|  |                       | Recycling | Municipal waste                   | Recycling Quota (percentage of generated amount)                  | EUROSTAT                   |                                          |                                                      |  |  |
|  |                       |           | Construction and demolition waste | Recycling Quota (percentage of generated amount)                  |                            |                                          |                                                      |  |  |

|              |                               |                               |                                                      | Share of secondary materials in production                                                                                                     |          |                                                                                                                                   |                          |       |  |
|--------------|-------------------------------|-------------------------------|------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------------------------------------------------------------------------------------------------------------------------|--------------------------|-------|--|
| Key features | Main areas of observation (1) | Main areas of observation (2) | Main areas of observation (3)                        | Macro                                                                                                                                          |          | Meso                                                                                                                              |                          | Micro |  |
| Innovation   | Innovation inputs             | Finance and investments       | Government funding                                   | R&D expenditures by government, higher education (EUR, Eur/cap, %GDP)                                                                          | EUROSTAT | R&D expenditures by type of R&D, economic activity, field of science, & regions                                                   | EUROSTAT(R&D statistics) |       |  |
|              |                               |                               |                                                      | % companies that received public financial support for innovation from local, central government, and EU (yes/no for each source)              |          |                                                                                                                                   |                          |       |  |
|              |                               |                               | Overall R&D funding (GERD)                           | R&D expenditures as % of GDP                                                                                                                   | EUROSTAT |                                                                                                                                   |                          |       |  |
|              |                               | Finance and investments       | Expenditures by universities and research institutes | R&D expenditures by higher education institutes (% of GERD)                                                                                    |          | % companies that received public financial support for innovation from local, central government, and EU (yes/no for each source) | CIS - 2008 (Q5.3)        |       |  |
|              |                               |                               | business expenditures on innovation                  | R&D expenditures by business enterprise & private non-profit (EUR, Eur/cap, %GDP)                                                              |          | R&D expenditures by type of R&D, economic activity, field of science                                                              | EUROSTAT(R&D statistics) |       |  |
|              |                               |                               |                                                      | Average per/ company expenditures for in house R&D, purchase of external R&D, acquisition of software, acquisition of external knowledge (EUR) |          | Expenditures for inhouse R&D, purchase of external R&D, acquisition of software, acquisition of external knowledge (EUR)          | CIS - 2008 (Q5.2)        |       |  |
|              |                               |                               | R&D expenditure share from abroad                    | percentage of gross domestic expenditure on research and development (GERD) financed by foreign sources (abroad)                               | EUROSTAT |                                                                                                                                   |                          |       |  |
|              |                               |                               | Expenditures by private non-profit                   | R&D expenditures by private non-profit (% of GERD)                                                                                             |          |                                                                                                                                   |                          |       |  |
|              |                               |                               | venture and risk capital                             | % of environment-related investment; absolute amount of environment-related investment                                                         |          | % of environment-related investment; absolute amount of environment-related investment (sectoral level)                           | EVCA                     |       |  |
|              |                               |                               |                                                      | early stage and expansion statistics (% of GDP)                                                                                                |          |                                                                                                                                   |                          |       |  |
|              |                               |                               |                                                      | Venture capital investment for expansion and replacement stage, in percentage of GDP (%)                                                       | EUROSTAT |                                                                                                                                   |                          |       |  |
|              |                               |                               |                                                      | Venture capital investment on early stage of investments (seeds and start-ups) measured in percentage of GDP (%)                               | EUROSTAT |                                                                                                                                   |                          |       |  |

|                     |                                        |                                                                |                                                     |                                                                                                                                                                 |           |                                                                                                                             |                                      |              |  |
|---------------------|----------------------------------------|----------------------------------------------------------------|-----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------------------------------------------------------------------------------------------------------------------------|--------------------------------------|--------------|--|
|                     |                                        | Human resources                                                | Educational attainment                              | Education inflow (graduation and participation) from the education system (total)                                                                               |           | education inflow in specific domains (total /domain/country)                                                                | EUROSTAT (HRST section), UNESCO/OECD |              |  |
|                     |                                        |                                                                | Knowledge workers                                   | Human resources in S&T (stocks, job-to-job mobility, census data)                                                                                               |           | Human resources in specific areas of S&T (stocks, job-to-job mobility, census data)                                         | EUROSTAT (HRST section), UNESCO/OECD |              |  |
|                     |                                        |                                                                | Innovation training                                 | share of firms with training for innovative activities (%/country)                                                                                              | EUROSTAT  | share of firms with training for innovative activities (%/sector)                                                           | CIS 2008                             |              |  |
|                     |                                        |                                                                | Employment in knowledge-intensive service sectors   | Employment in knowledge-intensive service sectors (% of total employment)                                                                                       | EUROSTAT  |                                                                                                                             |                                      |              |  |
|                     |                                        |                                                                | Human resources in science and technology           | Human resources in science and technology as a share of labour force (%).                                                                                       | EUROSTAT  |                                                                                                                             |                                      |              |  |
|                     |                                        |                                                                | Tertiary education graduates                        | Number of graduates from tertiary education (University level, academic, vocational education, and university level studies leading to doctoral qualifications) | EUROSTAT  |                                                                                                                             |                                      |              |  |
|                     | Drivers and determinants of innovation | Objectives of firms developing product and process innovations | Increase range of goods or services                 | share of firms aiming to increase range of goods or services (% in each category low-high/not)                                                                  | EUROSTAT  | share of firms aiming to increase range of goods or services (% in each category low-high/not, sector level)                | CIS 2008                             |              |  |
|                     |                                        |                                                                | Replace outdated products or processes              | share of firms aiming to replace outdated products or processes (% scale category: low-high/ not)                                                               | EUROSTAT  | share of firms aiming to replace outdated products or processes (%scale category: low-high/ not, sector level)              | CIS 2008                             |              |  |
|                     |                                        |                                                                | Enter new markets                                   | share of firms targeting new markets (% in each scale category:low-high/not)                                                                                    | EUROSTAT  | share of firms targeting new markets (% in each scale category:low-high/not sector level)                                   | CIS 2008                             |              |  |
| <b>Key features</b> | <b>Main areas of observation (1)</b>   | <b>Main areas of observation (2)</b>                           | <b>Main areas of observation (3)</b>                | <b>Macro</b>                                                                                                                                                    |           | <b>Meso</b>                                                                                                                 |                                      | <b>Micro</b> |  |
| Innovation          | Drivers and determinants of innovation | Objectives of firms developing product and process innovations | Increase market share                               | share of firms aiming to increase market share (% in each scale:low-high/not)                                                                                   | EUROSTAT  | share of firms aiming to increase market share (% in each scale:low-high/not, sector level)                                 | CIS 2008                             |              |  |
|                     |                                        |                                                                | Improve quality of goods or services                | share of firms improving quality of goods or services (% in each scale:low-high/not)                                                                            | EUROSTAT  | share of firms improving quality of goods or services (% in each scale:low-high/not, sector level)                          | CIS 2008                             |              |  |
|                     |                                        |                                                                | Improve flexibility for producing goods or services | share of firms improving flexibility for producing goods or services (% in each scale category:low-high/not)                                                    | EUROSTAT) | share of firms improving flexibility for producing goods or services (% in each scale category:low-high/not , sector level) | CIS 2008                             |              |  |

|                     |                                        |                                         |                                                                                            |                                                                                                                                                      |          |                                                                                                                                                                    |          |              |  |
|---------------------|----------------------------------------|-----------------------------------------|--------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|--|
|                     |                                        |                                         | Increase capacity for producing goods or services                                          | share of firms increasing capacity for producing goods or services (% in each scale category: low-high/not)                                          | EUROSTAT | share of firms increasing capacity for producing goods or services (% in each scale category: low-high/not, sector level)                                          | CIS 2008 |              |  |
|                     |                                        |                                         | Improve health and safety                                                                  | share of firms improving health and safety (% in each scale category: low-high/not)                                                                  | EUROSTAT | share of firms improving health and safety (% in each scale category: low-high/not, sector level)                                                                  | CIS 2008 |              |  |
|                     |                                        |                                         | Reduce labour costs per unit output                                                        | share of firms reducing labour costs per unit output (% in each scale category: low-high/not)                                                        | EUROSTAT | share of firms reducing labour costs per unit output (% in each scale category: low-high/not, sector level, sector level)                                          | CIS 2008 |              |  |
|                     |                                        | Objectives of organisational innovation | Reduce time to respond to customer or supplier needs                                       | share of firms reducing time to respond to customer or supplier needs (% in each scale category: low-high/not)                                       | EUROSTAT | share of firms reducing time to respond to customer or supplier needs (% in each scale category: low-high/not, sector level)                                       | CIS 2008 |              |  |
|                     |                                        |                                         | Improve ability to develop new products or processes                                       | share of firms improving ability to develop new products or processes (% in each scale category: low-high/not)                                       | EUROSTAT | share of firms improving ability to develop new products or processes (% in each scale category: low-high/not, sector level)                                       | CIS 2008 |              |  |
|                     |                                        |                                         | Improve quality of goods or services                                                       | share of firms improving quality of goods or services (% in each scale category: low-high/not)                                                       | EUROSTAT | share of firms improving quality of goods or services (% in each scale category: low-high/not, sector level)                                                       | CIS 2008 |              |  |
|                     |                                        |                                         | Reduce costs per unit output                                                               | share of firms reducing costs per unit output (% in each scale category: low-high/not)                                                               | EUROSTAT | share of firms reducing costs per unit output (% in each scale category: low-high/not, sector level)                                                               | CIS 2008 |              |  |
| <b>Key features</b> | <b>Main areas of observation (1)</b>   | <b>Main areas of observation (2)</b>    | <b>Main areas of observation (3)</b>                                                       | <b>Macro</b>                                                                                                                                         |          | <b>Meso</b>                                                                                                                                                        |          | <b>Micro</b> |  |
| Innovation          | Drivers and determinants of innovation | Objectives of organisational innovation | Improve communication or information sharing within enterprise or with other organisations | share of firms improving communication or information sharing within enterprise or with other organisations (% in each scale category: low-high/not) | EUROSTAT | share of firms improving communication or information sharing within enterprise or with other organisations (% in each scale category: low-high/not, sector level) | CIS 2008 |              |  |
|                     | Innovation process                     | Innovation activity                     | In-house R&D                                                                               | in-house R&D by firms (EUR/country)                                                                                                                  | EUROSTAT | in-house R&D by firms (EUR/sector/country)                                                                                                                         | CIS 2008 |              |  |
|                     |                                        |                                         | External R&D                                                                               | purchase of external R&D by firms (EUR/country)                                                                                                      | EUROSTAT | purchase of external R&D by firms (EUR/sector/country)                                                                                                             | CIS 2008 |              |  |

|                     |                                      |                                      |                                                                                       |                                                                                                                   |          |                                                                                                                                    |                 |              |  |
|---------------------|--------------------------------------|--------------------------------------|---------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|----------|------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------|--|
|                     |                                      |                                      | Acquisition of machinery, equipment and software                                      | expenses for acquisition of machinery, equipment and software (EUR/country)                                       | EUROSTAT | expenses for acquisition of machinery, equipment and software (EUR/sector/country)                                                 | CIS 2008        |              |  |
|                     |                                      |                                      | Acquisition of external knowledge                                                     | expenses for purchase or licensing of patent/non-patents, knowhow, etc (EUR/country)                              | EUROSTAT | expenses for purchase or licensing of patent/non-patents, knowhow, etc (EUR/sector/country)                                        | CIS 2008        |              |  |
|                     |                                      |                                      | Training for innovative activities                                                    | share of firms providing training for personnel for innovative activities (%/country)                             | EUROSTAT | share of firms providing training for personnel for innovative activities (%/sector/country)                                       | CIS 2008        |              |  |
|                     |                                      |                                      | Market introduction of innovations                                                    | share of firms implementing activities for market introduction of new & improved products (%/country)             | EUROSTAT | share of firms implementing activities for market introduction of new & improved products (%/sector/country)                       | CIS 2008        |              |  |
|                     |                                      | Collaboration patterns               | Collaboration partner                                                                 | Number and share of firms collaborating with enterprises, clients, Universitys, etc. in EU, US, China/India, etc. | EUROSTAT | Number and share of firms collaborating with enterprises, clients, Universitys, etc. in EU, US, China/India, etc. (sectoral level) | CIS 2008        |              |  |
|                     |                                      |                                      | information source                                                                    | % of companies declaring a source according to the level of importance (scale:high-medium-low) (% / country)      | EUROSTAT | % of companies declaring a source according to the level of importance (scale:high-medium-low) (sectoral level)                    | CIS 2008 (Q6.1) |              |  |
|                     | Innovation outputs and impacts       | Innovations (types)                  | Product                                                                               | share of firms with product innovations (% /country)                                                              | EUROSTAT | share of firms with product innovations (% /sector/ country)                                                                       | CIS 2008        |              |  |
|                     |                                      |                                      | Process                                                                               | share of firms with process innovations (% / country)                                                             | EUROSTAT | share of firms with process innovations (% /sector/ country)                                                                       | CIS 2008        |              |  |
| <b>Key features</b> | <b>Main areas of observation (1)</b> | <b>Main areas of observation (2)</b> | <b>Main areas of observation (3)</b>                                                  | <b>Macro</b>                                                                                                      |          | <b>Meso</b>                                                                                                                        |                 | <b>Micro</b> |  |
| Innovation          | Innovation outputs and impacts       | Innovations (types)                  | Organisational                                                                        | share of firm with organizational innovation (%/ country)                                                         | EUROSTAT | share of firm with organizational innovation (%/ sector/ region/ country)                                                          | CIS 2008        |              |  |
|                     |                                      |                                      | Marketing                                                                             | share of firms with marketing innovations (% / country)                                                           | EUROSTAT | share of firms with marketing innovations (% / sector/ region/ country)                                                            | CIS 2008        |              |  |
|                     |                                      | Type of process innovation           | New or significantly improved methods of manufacturing or producing goods or services | share of firms that significantly improved methods of producing goods or services (% / country)                   | EUROSTAT | share of firms that significantly improve methods of producing goods or services (% /sector/ region/ country)                      | CIS 2008        |              |  |

|                     |                                      |                                                      |                                                                                                                                                            |                                                                                                                                                                                                                                 |          |                                                                                                                                                                                                                                         |               |              |  |
|---------------------|--------------------------------------|------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------------|--|
|                     |                                      |                                                      | New or significantly improved logistics or distribution methods                                                                                            | share of firms that improved logistics and distribution methods (%/country)                                                                                                                                                     | EUROSTAT | share of firms that improved logistics and distribution methods (%/sector/ region/country)                                                                                                                                              | CIS 2008      |              |  |
|                     |                                      |                                                      | New or significantly improved supporting activities                                                                                                        | share of firms that significantly improved supporting activities (%/ country)                                                                                                                                                   | EUROSTAT | share of firms that significantly improved supporting activities (%/sector/ region/ country)                                                                                                                                            | CIS 2008      |              |  |
|                     |                                      | Type of organisational innovation (expected effects) | New business practices for organising procedures (supply chain management, business re-engineering, knowledge management, lean production, etc)            | share of firms expecting (as a results of new business practices) reduced time, improved ability, improved product quality, improved service , reduced cost, improved communication/information sharing (% / country)           | EUROSTAT | share of firms expecting (as a results of new business practices) reduced time, improved ability, improved product quality, improved service , reduced cost, improved communication/information sharing (% / sector/ country)           | CIS 2008      |              |  |
|                     |                                      |                                                      | New methods of organising work responsibilities and decision making                                                                                        | share of firms expecting (as a results of new organization methods) reduced time, improved ability, improved product quality, improved service , reduced cost, improved communication/information sharing (% / country)         | EUROSTAT | share of firms expecting (as a results of new organization methods) reduced time, improved ability, improved product quality, improved service , reduced cost, improved communication (% / sector/ country)                             | CIS 2008      |              |  |
|                     |                                      |                                                      | New methods of organising external relations with other firms or public institutions (use of alliances, partnerships, outsourcing or sub-contracting, etc) | share of firms expecting (as a results of new external organization method) reduced time, improved ability, improved product quality, improved service , reduced cost, improved communication/information sharing ( %/ country) | EUROSTAT | share of firms expecting (as a results of new external organization method) reduced time, improved ability, improved product quality, improved service , reduced cost, improved communication/information sharing ( %/ sector/ country) | CIS 2008      |              |  |
| <b>Key features</b> | <b>Main areas of observation (1)</b> | <b>Main areas of observation (2)</b>                 | <b>Main areas of observation (3)</b>                                                                                                                       | <b>Macro</b>                                                                                                                                                                                                                    |          | <b>Meso</b>                                                                                                                                                                                                                             |               | <b>Micro</b> |  |
| Innovation          | Innovation outputs and impacts       | Knowledge creation (IPR)                             | EPO patents                                                                                                                                                | number of patents (total and per capita)                                                                                                                                                                                        |          | number of patents in specific areas/sectors/regions (total and per capita)                                                                                                                                                              | EPO, EUROSTAT |              |  |
|                     |                                      |                                                      | Community trademarks                                                                                                                                       | community trademarks per mln population                                                                                                                                                                                         | EUROSTAT |                                                                                                                                                                                                                                         |               |              |  |
|                     |                                      |                                                      | Community trade mark applications per country                                                                                                              | Number of community trademark applications to OHIM per year per country                                                                                                                                                         | OIHUM    |                                                                                                                                                                                                                                         |               |              |  |

|                |                              |                                           |                                              |                                                                                              |                             |                                                                                               |                             |  |  |
|----------------|------------------------------|-------------------------------------------|----------------------------------------------|----------------------------------------------------------------------------------------------|-----------------------------|-----------------------------------------------------------------------------------------------|-----------------------------|--|--|
|                |                              |                                           | Community trade marks registered per country | Number of community trademark applications registered at OHIM per year per country           | OIHM                        |                                                                                               |                             |  |  |
|                |                              |                                           | Community designs                            | community designs per million population                                                     | OHIM/EUROSTAT               |                                                                                               |                             |  |  |
|                |                              |                                           | Community design applications                | Country level data on design applications from companies in each EU country                  | OIHM                        |                                                                                               |                             |  |  |
|                |                              |                                           | Publications                                 | number of publications in engineering (total and per capita number)                          | Web of Science (Thomson DB) | number of publication in specific areas/sectors (total and per capita)                        | Web of Science (Thomson DB) |  |  |
|                |                              |                                           | Scientific publication output per country    | The country level data on aggregate number of publication in engineering and science fields. | SCOPUS                      |                                                                                               |                             |  |  |
|                |                              | Sales and exports                         | New-to-market sales                          | new-to-market sales (% of turnover)                                                          | EUROSTAT                    |                                                                                               |                             |  |  |
|                |                              |                                           | New-to-firm sales                            | new-to-firm sales (% of turnover)                                                            | EUROSTAT                    |                                                                                               |                             |  |  |
|                |                              |                                           | Medium and high tech exports                 | medium and hightech export (EUR, share in total exports)                                     | EUROSTAT, UN COMTRADE       | medium and hightech export in certain area/sector (EUR, share in total exports)               | EUROSTAT, UN COMTRADE       |  |  |
|                |                              |                                           | knowledge intensive services exports         | knowledge intensive service exports (EUR, share in total exports)                            | EUROSTAT, UN COMTRADE       | knowledge intensive service exports in certain area/sectors EUR, share in total exports)      | EUROSTAT, UN COMTRADE       |  |  |
|                | Social aspects of innovation | Social attitudes                          | Attitudes towards novelty                    | perception towards specific technologies (national statistics)                               | Eurobarometer               | perception towards specific technologies (sectoral statistics)                                | Eurobarometer               |  |  |
|                |                              |                                           |                                              | perception towards uncertainty in technology/innovation fields (national statistics)         | Eurobarometer               | perception towards uncertainty in technology/innovation fields (sectoral statistics)          | Eurobarometer               |  |  |
|                |                              |                                           |                                              | Demand for innovative products and services in the cluster (country level)                   |                             |                                                                                               |                             |  |  |
| Eco-innovation | Inputs into eco-innovation   | Finance and investments in eco-innovation | Government funding on environmental R&D      | Public expenditures for environmental related R&D, % total R&D                               | EUROSTAT                    |                                                                                               |                             |  |  |
|                |                              |                                           |                                              | Public expenditures for environmental related R&D, % of GDP                                  | EUROSTAT                    |                                                                                               |                             |  |  |
|                |                              |                                           | Business funding on environmental R&D        | Business expenditures for eco-innovation related R&D                                         |                             |                                                                                               |                             |  |  |
|                |                              |                                           | Government funding on eco-innovation         | Public expenditures for eco-innovation related R&D, % of total R&D                           | EUROSTAT                    | Size of eco-innovative R&D activities on public financed universities and research institutes |                             |  |  |
|                |                              |                                           |                                              | Public expenditures for eco-innovation related R&D, % of GDP                                 | EUROSTAT                    |                                                                                               |                             |  |  |

|                |                                            |                                |                                                                                                         | Number of publicly financed start-up companies in green technologies                                                            |                                                                     |                                                                                                                          |              |       |  |
|----------------|--------------------------------------------|--------------------------------|---------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|--------------|-------|--|
|                |                                            |                                | Private funding on eco-innovation                                                                       | Total value of new investments in green early stage investments (green funds, venture capital, private equity, business angels) |                                                                     | Sector specific value of new investments in green early stage investments (green funds, venture capital, private equity) |              |       |  |
|                |                                            |                                |                                                                                                         | Share of green lending of banks on total lending                                                                                |                                                                     |                                                                                                                          |              |       |  |
| Key features   | Main areas of observation (1)              | Main areas of observation (2)  | Main areas of observation (3)                                                                           | Macro                                                                                                                           |                                                                     | Meso                                                                                                                     |              | Micro |  |
| Eco-innovation | Inputs into eco-innovation                 | Human resources                | Educational attainment related to eco-innovation                                                        | number of graduates and PhDs dealing with environment and resource use                                                          | ACCA / CorporateRegister.com / Careers of Doctorate Holders Project |                                                                                                                          |              |       |  |
|                |                                            |                                | Employment                                                                                              | Employment in eco-innovation sectors                                                                                            |                                                                     |                                                                                                                          |              |       |  |
|                |                                            |                                | Knowledge workers in eco-industries                                                                     | Shares of knowledge workers (R&D personnel plus knowledge-intensive services) in total workforce by country                     |                                                                     |                                                                                                                          |              |       |  |
|                |                                            |                                | Eco-innovation training and "green skills"                                                              |                                                                                                                                 |                                                                     |                                                                                                                          |              |       |  |
|                | Drivers and determinants of eco-innovation | Determinants of eco-innovation | Existing environmental regulations or taxes on pollution                                                | % of companies declaring a determinant as relevant (yes/no)                                                                     | CIS (Q 10.2)                                                        | % of companies declaring a determinant as relevant (yes/no) (sectoral level)                                             | CIS (Q 10.2) |       |  |
|                |                                            |                                | Environmental regulations or taxes expected to be introduced in the future                              | % of companies declaring a determinant as relevant (yes/no)                                                                     | CIS (Q 10.2)                                                        | % of companies declaring a determinant as relevant (yes/no) (sectoral level)                                             | CIS (Q 10.2) |       |  |
|                |                                            |                                | Availability of government grants, subsidies or other financial incentives for environmental innovation | % of companies declaring a determinant as relevant (yes/no)                                                                     | CIS (Q 10.2)                                                        | % of companies declaring a determinant as relevant (yes/no) (sectoral level)                                             | CIS (Q 10.2) |       |  |
|                |                                            |                                | Current or expected market demand from customers for environmental innovations                          | % of companies declaring a determinant as relevant (yes/no)                                                                     | CIS (Q 10.2)                                                        | % of companies declaring a determinant as relevant (yes/no) (sectoral level)                                             | CIS (Q 10.2) |       |  |
|                |                                            |                                | Voluntary codes or agreements for environmental good practice within a sector                           | % of companies declaring a determinant as relevant (yes/no)                                                                     | CIS (Q 10.2)                                                        | % of companies declaring a determinant as relevant (yes/no) (sectoral level)                                             | CIS (Q 10.2) |       |  |

|                     |                                       |                                                  |                                                                                 |                                                                                                                   |          |             |  |              |  |
|---------------------|---------------------------------------|--------------------------------------------------|---------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|----------|-------------|--|--------------|--|
|                     |                                       | Eco-innovation strategy and procedures           | Presence of procedures implemented to identify and reduce environmental impacts | EMAS certificates per country;                                                                                    | EUROSTAT |             |  |              |  |
|                     |                                       |                                                  |                                                                                 | ISO 14001 certificates per country                                                                                | EUROSTAT |             |  |              |  |
|                     |                                       |                                                  |                                                                                 | Number of EMAS certificates for organisations                                                                     | EUROSTAT |             |  |              |  |
|                     |                                       |                                                  |                                                                                 | % companies with procedures in place to regularly identify and reduce environmental impacts                       |          |             |  |              |  |
|                     | Eco-innovation process                | Eco-innovation activity                          |                                                                                 | Share of innovators participating in eco-innovation                                                               |          |             |  |              |  |
|                     |                                       |                                                  |                                                                                 | Share of SMEs participating in eco-innovation                                                                     |          |             |  |              |  |
|                     |                                       | Collaboration patterns in eco-innovation process | Collaboration partner                                                           | Number and share of firms collaborating with enterprises, clients, Universitys, etc. in EU, US, China/India, etc. |          |             |  |              |  |
|                     |                                       |                                                  | information source                                                              | % of companies declaring a source according to the level of importance (scale:high-medium-low) (% / country)      |          |             |  |              |  |
|                     | Outputs and impacts of eco-innovation | Eco-innovations (types)                          | Product                                                                         | Derived indicators based on CIS and other sources (indicator to be determined)                                    |          |             |  |              |  |
|                     |                                       |                                                  | Process                                                                         | Derived indicators based on CIS and other sources (indicator to be determined)                                    |          |             |  |              |  |
|                     |                                       |                                                  | Organisational                                                                  | Derived indicators based on CIS and other sources (indicator to be determined)                                    |          |             |  |              |  |
| <b>Key features</b> | <b>Main areas of observation (1)</b>  | <b>Main areas of observation (2)</b>             | <b>Main areas of observation (3)</b>                                            | <b>Macro</b>                                                                                                      |          | <b>Meso</b> |  | <b>Micro</b> |  |
| Eco-innovation      | Outputs and impacts of eco-innovation | Eco-innovations (types)                          | Marketing                                                                       | Derived indicators based on CIS and other sources (indicator to be determined)                                    |          |             |  |              |  |
|                     |                                       |                                                  | Material flow innovation                                                        | Derived indicators based on different sources; Priorisation of materials                                          |          |             |  |              |  |

|                     |                                      |                                                                                            |                                                                 |                                                                                       |                                                   |                                                                                   |                   |              |  |
|---------------------|--------------------------------------|--------------------------------------------------------------------------------------------|-----------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------|-----------------------------------------------------------------------------------|-------------------|--------------|--|
|                     |                                      | Environmental benefits from process innovation (from the production of goods and services) | Reduced material input                                          | % companies with innovations leading to reduced material input                        | EUROSTAT                                          | % companies with innovations leading to reduced material input (sectoral level)   | CIS 2008 (Q 10.1) |              |  |
|                     |                                      |                                                                                            | Reduced energy input                                            | % companies with innovations leading to reduced energy input                          | EUROSTAT                                          | % companies with innovations leading to reduced energy input (sectoral level)     | CIS 2008 (Q 10.1) |              |  |
|                     |                                      |                                                                                            | Reduced CO2 emissions                                           | % companies with innovations leading to reduced CO2 emissions                         | EUROSTAT                                          | % companies with innovations leading to reduced CO2 emissions (sectoral level)    | CIS 2008 (Q 10.1) |              |  |
|                     |                                      |                                                                                            | Replaced materials with less polluting or hazardous substitutes | % companies with innovations leading to replacement of materials                      | EUROSTAT                                          | % companies with innovations leading to replacement of materials (sectoral level) | CIS 2008 (Q 10.1) |              |  |
|                     |                                      |                                                                                            | Reduced soil, water, noise or air pollution                     | % companies with innovations leading to reduced pollution                             | EUROSTAT                                          | % companies with innovations leading to reduced pollution (sectoral level)        | CIS 2008 (Q 10.1) |              |  |
|                     |                                      |                                                                                            | Recycled waste, water or materials                              | % companies with innovations leading to increased recycling                           | EUROSTAT                                          | % companies with innovations leading to increased recycling (sectoral level)      | CIS 2008 (Q 10.1) |              |  |
|                     |                                      |                                                                                            | Reduced energy use per unit output                              | Share of companies with innovations leading to reduced energy use per unit of output. | EUROSTAT                                          |                                                                                   |                   |              |  |
|                     |                                      | Environmental benefits from the use of goods or service                                    | Reduced energy use                                              | % companies with innovations leading to reduced energy use                            | EUROSTAT                                          | % companies with innovations leading to reduced energy use (sectoral level)       | CIS 2008 (Q 10.1) |              |  |
|                     |                                      |                                                                                            | Reduced soil, water, noise or air pollution                     | % companies with innovations leading to reduced pollution                             | EUROSTAT                                          | % companies with innovations leading to reduced pollution (sectoral level)        | CIS 2008 (Q 10.1) |              |  |
|                     |                                      |                                                                                            | Improved recycling of product after use                         | % companies with innovations leading to increased recycling                           | CIS 2008 (Q 10.1)                                 | % companies with innovations leading to increased recycling (sectoral level)      | CIS 2008 (Q 10.1) |              |  |
|                     |                                      | Eco-innovation relevant knowledge creation (IPR)                                           | EPO patents                                                     | Relative patent advantage of countries                                                | European Patent Office (EPO) / OECD / WIPO (2007) |                                                                                   |                   |              |  |
|                     |                                      |                                                                                            | Community trademarks                                            | Trademarks per 1000 population                                                        |                                                   |                                                                                   |                   |              |  |
|                     |                                      |                                                                                            | Community designs                                               | Designs per 1000 population                                                           |                                                   |                                                                                   |                   |              |  |
| <b>Key features</b> | <b>Main areas of observation (1)</b> | <b>Main areas of observation (2)</b>                                                       | <b>Main areas of observation (3)</b>                            | <b>Macro</b>                                                                          |                                                   | <b>Meso</b>                                                                       |                   | <b>Micro</b> |  |

|                |                                       |                                                  |                                             |                                                                                                                                      |                             |                                                        |                                                    |                                                               |  |
|----------------|---------------------------------------|--------------------------------------------------|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|--------------------------------------------------------|----------------------------------------------------|---------------------------------------------------------------|--|
| Eco-innovation | Outputs and impacts of eco-innovation | Eco-innovation relevant knowledge creation (IPR) | Publications                                | number of publications in environmental engineering, material and energy efficiency, new materials etc (total and per capita number) | Web of Science (Thomson DB) |                                                        |                                                    |                                                               |  |
|                | Eco-innovation market structure       | Eco-industries                                   | Size of eco-industry markets                |                                                                                                                                      |                             | Size and development of eco-industry markets           | Studies by Ecotec, Ernst & Young, Ecorys, EU KLEMS |                                                               |  |
|                |                                       |                                                  |                                             |                                                                                                                                      |                             | Cumulative average growth of eco-industry markets      | University of Groningen / BACH / EU KLEMS          | Cumulative average growth of specific eco-innovative products |  |
|                |                                       |                                                  | Turnover                                    |                                                                                                                                      |                             | Turnover in eco-industry markets                       | Studies by Ecotec, Ernst & Young, Ecorys           |                                                               |  |
|                |                                       |                                                  | Competitive advantage                       |                                                                                                                                      |                             | Revealed comparative advantage of eco-industry markets |                                                    |                                                               |  |
|                |                                       |                                                  |                                             |                                                                                                                                      |                             | Capital intensity of green sectors                     |                                                    |                                                               |  |
|                |                                       |                                                  |                                             |                                                                                                                                      |                             | Debt capital ratios of green sectors                   |                                                    |                                                               |  |
|                |                                       |                                                  | New-to-market sales (eco-industry sector)   | Average share of new-to-market sales (in eco-industries), on the product level                                                       |                             |                                                        |                                                    |                                                               |  |
|                |                                       |                                                  | New-to-firm sales (eco-industry)            | Share of new-to-firm sales (in eco-industries), on the product level                                                                 |                             |                                                        |                                                    |                                                               |  |
|                |                                       |                                                  | Medium and high tech exports (eco-industry) | Indicator to be determined                                                                                                           |                             |                                                        |                                                    |                                                               |  |
|                |                                       |                                                  |                                             | Indicator to be determined                                                                                                           |                             |                                                        |                                                    |                                                               |  |
|                |                                       | Eco-innovative firms                             | Global share                                | Shares of all companies                                                                                                              |                             |                                                        |                                                    |                                                               |  |
|                |                                       |                                                  | Sectoral shares                             | Shares of all companies                                                                                                              |                             |                                                        |                                                    |                                                               |  |
|                |                                       |                                                  | Start-ups                                   |                                                                                                                                      |                             | Ratio eco-start ups to incumbents in the market        |                                                    |                                                               |  |
|                | Social aspects of eco-innovation      | Social attitudes relevant to eco-innovation      | Attitudes towards environment of citizens   | Personal importance of environmental protection (%)                                                                                  |                             |                                                        |                                                    |                                                               |  |
|                |                                       |                                                  | Public awareness of environmental problems  | Level of feeling informed about environmental problems                                                                               | EC                          |                                                        |                                                    |                                                               |  |
|                |                                       |                                                  | Perception of "green brands" by consumers   | Importance of eco-labels in purchasing decisions (% of citizens)                                                                     | EC                          |                                                        |                                                    |                                                               |  |
| Key features   | Main areas of observation (1)         | Main areas of observation (2)                    | Main areas of observation (3)               | Macro                                                                                                                                |                             | Meso                                                   |                                                    | Micro                                                         |  |

|                |                                                   |                                                  |                                                                         |                                                                                      |                                                     |  |                                                  |                                            |                                      |
|----------------|---------------------------------------------------|--------------------------------------------------|-------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-----------------------------------------------------|--|--------------------------------------------------|--------------------------------------------|--------------------------------------|
| Eco-innovation | Social aspects of eco-innovation                  | Business attitudes relevant to eco-innovation    | Perceptions of environmental problems by business                       |                                                                                      |                                                     |  |                                                  |                                            |                                      |
|                |                                                   |                                                  | Perceptions of eco-innovation by business                               | % share of companies with actions undertaken to reduce environmental impacts         |                                                     |  |                                                  | Opinion of managers towards eco-innovation |                                      |
|                |                                                   |                                                  | Corporate Social Responsibility (CSR) and other voluntary codes         | Percentage of companies with CR reports                                              |                                                     |  |                                                  |                                            |                                      |
|                | Regulatory and policy framework of eco-innovation | Supply-side measures relevant for eco-innovation | Equity support for eco-innovation                                       | Monetary supply for Venture Capital Funds investing in eco-innovation                | COFGO data on environmental subsidies               |  |                                                  |                                            |                                      |
|                |                                                   |                                                  | R&D funds for eco-innovation                                            | Public expenditures for eco-innovation related R&D, % of total R&D                   | EUROSTAT                                            |  |                                                  |                                            |                                      |
|                |                                                   |                                                  | Demonstration and commercialisation support for eco-innovation          | Monetary supply for Eco-innovation first application and market replication projects |                                                     |  |                                                  |                                            |                                      |
|                |                                                   |                                                  | Support for eco-innovation PPPs                                         |                                                                                      |                                                     |  |                                                  |                                            |                                      |
|                |                                                   |                                                  | Specific advisory services on eco-innovation for enterprises            | Yes / no indicator                                                                   |                                                     |  |                                                  |                                            |                                      |
|                |                                                   | Demand-side measures relevant to eco-innovation  | Eco-innovation regulations                                              |                                                                                      |                                                     |  |                                                  |                                            |                                      |
|                |                                                   |                                                  | Eco-innovation fiscal measures                                          | Green taxes as a % of government budget                                              | EUROSTAT                                            |  |                                                  |                                            |                                      |
|                |                                                   |                                                  | Eco-innovation standards                                                |                                                                                      |                                                     |  |                                                  |                                            |                                      |
|                |                                                   |                                                  | Green Public Procurement                                                | Green public procurement as % of total procurement                                   | Studies by Pricewaterhouse Coopers (PwC) and others |  |                                                  |                                            |                                      |
|                |                                                   |                                                  | Eco-innovation TT                                                       |                                                                                      |                                                     |  |                                                  |                                            |                                      |
|                |                                                   | Eco-innovation policy intelligence               | Monitoring eco-innovation related policy impacts                        | Evaluation of policy impacts on eco-innovation on country level                      |                                                     |  |                                                  |                                            |                                      |
|                |                                                   |                                                  | Existing databases on environmental impacts of enterprises and industry | Information for links section on EIO website                                         |                                                     |  | EIPRO project, EXIOPOL project, National studies |                                            | ecoinvent database, JRC LCA database |

## Annex II. Template of the EIO country brief and guidelines

### Summary

(max 1 page)

Give summary of the following main points:

- eco-innovation performance based on part 2 (1 paragraph)
  - leading eco-innovation and upcoming areas and markets based on parts 3 and 4 (2 paragraphs)
  - eco-innovation in the policy domain based on part 5 (1 paragraph)
- 

### Part 1. Introduction

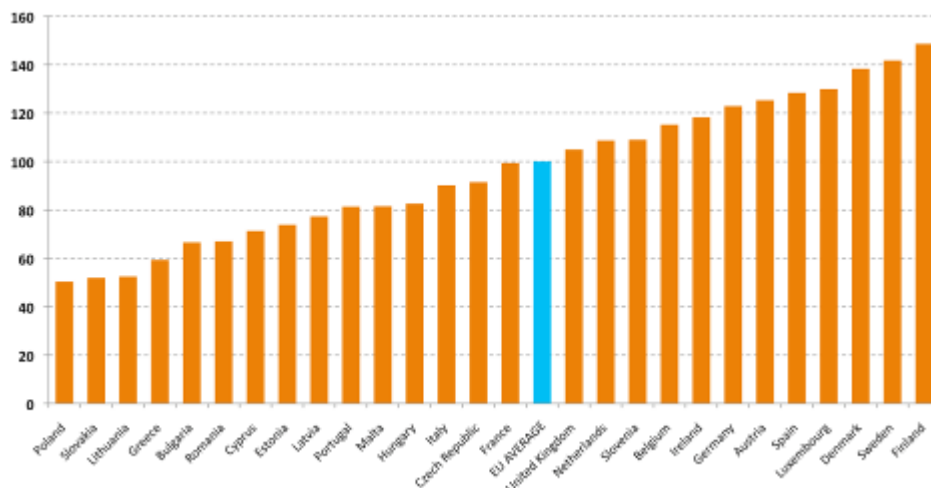
(0.5 – 1 page)

Provide overview of long standing environmental and economic issues, which pose main challenges for eco-innovation in your country. The purpose is to introduce main problem areas and sectors, which benefit or can benefit from eco-innovative solutions. Depending on the context, the problems may include environmental issues of harmful emissions and waste, resource scarcity, but also socio-economic problems such as resource inefficient production processes and construction methods as well as systemic problems of deficient industrial organisation, transportation systems, urban design, etc. The chapter is based on desk research. Please refer to reports and other publications (e.g. reports of Ministries of Environment, Environmental, Innovation, Economic policy Agencies, etc.)

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### Part 2. Eco-innovation performance (1 – 2 page)

Figure 2.1 EU27 Eco-innovation scoreboard 2011, composite index



The analysis in this section is based on the EU 27 Eco-innovation scoreboard (Eco-IS) for the year 2011. Eco-IS demonstrates the eco-innovation performance of a country compared with the EU average and other EU member states. The index is based on 16

indicators aggregated into five components: eco-innovation inputs, eco-innovation activities and eco-innovation outputs as well as environmental outcomes and socio-economic outcomes

Analyse and interpret the Eco-IS results for your country. Interpretation and analysis can be guided by the following questions:

- What do the Eco-IS results mean in context of the eco-innovation development in a specific country?
- How does each component (and some indicators) position the country in comparison to other EU countries?
- Has the components and indicators changed over one year? What can explain the change?

If possible bring examples or additional data (identified by you) supporting some indicators.

This part can also benefit from local or other data sources identified by the country experts. Additionally the national experts can access the EIO database at <http://database.eco-innovation.eu/> and search for additional data for their analysis. Spider diagrammes comparing 5 components of the composite index for individual country can be generated in the EIO database (see <http://database.eco-innovation.eu/indicators/index/area:72>).

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### **Part 3. Leading eco-innovation areas**

(max 2 pages excluding the good practice examples)

The purpose of this section is to:

1. present the current leading eco-innovation areas

The leading eco-innovation areas in your country are sectors or technology areas (e.g. construction, transport) as well as broader thematic/functional areas (e.g. mobility) where eco-innovation has been most successfully applied.

The leading areas can be selected based on their performance in resource and energy productivity as well as based on their market penetration, user acceptance, etc.

Please also note what has changed since the last year.

Provide one-three examples from each of the leading eco-innovation areas in the special template !!! Use the template for Good practice examples which is provided in a separate file

#### **Examples of good practices**

The good practices can be the most innovative and/or most successful eco-innovative products and services, technologies, business models or organisational management models. Special interest is on input-oriented eco-innovations, which reduce resource inputs and thus tackle environmental problems at their source rather than at “end-of-pipe” solutions. Material flows, resource productivity and decoupling should serve as indications of eco-innovative activity.

2. assess the current market for the eco-innovative products and services in the country

While discussing the national markets for eco-innovative products, services, practices, etc. please discuss the level of their diffusion, turnover, export, resource saving, cost

saving, social impact (e.g. employment generated, wellbeing improvement), user acceptance. It is acknowledged that the exact data might not be available, however in your interviews with the experts, consulting the information, please try to bring approximated information and data.

3. Discuss how/whether systemic (transformative/radical) eco-innovations have emerged in your country. Analyse their current and potential impact in terms of systemic/transformational change.

Examples could be novel radical solutions with very high environmental impact, new business models promoting shift from products to services, closed-loop production-consumption systems such as industrial symbiosis, smart cities/neighbourhoods, etc.

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#### **Part 4. New trends: areas and markets on the rise**

(1 -1.5 pages)

This section is to present the analysis of future promising eco-innovation areas. These could be products, technologies or services that are still at the research and development stage, but show major future diffusion potential. These could be emerging innovative practices in organizational management or new emerging business models. Discuss systemic (transformative/radical) eco-innovations expected in market in coming years.

Based on available studies and information analyse potential leading markets for the upcoming eco-innovation areas (possible diffusion and turnover, market penetration, user acceptance, etc.). The analysis will be based on screening the news, reports, national foresight studies, interviews with the key experts in the field, as well as the observations of the authors.

Please also note what has changed since last year.

Provide example(s) of emerging eco-innovations in the good practice template. ! A template for Good practice examples is provided in a separate file

---

#### **Part 5. Public policy in support of eco-innovation**

(1.5-2 page including the table in Figure 5.1. Table in ANNEX 1 to be provided additionally)

The purpose of this chapter is to map the policy support to eco-innovation your country (please keep in mind the aforementioned definition of eco-innovation).

Start your work with filling in the table in ANNEX 1. In the dedicated columns provide reference and a brief summary of specific policy measures, indicate what is the focus area of the measure (general innovations including eco-innovations, improvement of

energy efficiency, resources efficiency, reduction of emissions, e.g. CO<sub>2</sub>). Insert additional rows if necessary.

The information can be collected from national sources, interviews with ETAP HLWG and other national experts, as well as from international databases held by OECD, PRO-INNO Trend-Chart/ ERAWATCH

(<http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.home>).

Consult the resource efficiency country profiles prepared by European Environmental Agency (<http://www.eea.europa.eu/themes/economy/resource-efficiency/resource-efficiency-policies-country-profiles>) .

The table below (Figure 5.1) is to be based on the Table in ANNEX 1 and present summarised analysis.

The chapter should start from discussion on the overall importance of eco-innovation in the policies of your country. Mention major policy strategies or the policy measures that have the largest impact in promoting eco-innovations. Discuss whether “eco-innovation” is explicitly defined in the policy documents.

Based on mapping of policy measures as well as review of major national strategy documents, discuss whether and how specific strategies, policy measures, and targets support eco-innovation. Whenever possible, mention budgets devoted to eco-innovation support. Point at the gaps/problems and areas are not addressed by the current policies.

Figure 5.1 Policy measures addressing eco-innovations in (country)

|                   | Group of policy measures                      | Type of policy measure                                     | Focus of policy measures (tick if applies) |                                 |                               |                                              |                                                   |
|-------------------|-----------------------------------------------|------------------------------------------------------------|--------------------------------------------|---------------------------------|-------------------------------|----------------------------------------------|---------------------------------------------------|
|                   |                                               |                                                            | Generic focus on eco-innovation            | Resource efficiency improvement | Energy efficiency improvement | Reduction of emissions incl. CO <sub>2</sub> | Other relevant areas (e.g. renewable energy, etc) |
| SUPPLY SIDE FOCUS | Equity/business support                       | Venture capita funds                                       | X                                          |                                 | X                             | X                                            |                                                   |
|                   |                                               | Public guarantee funds                                     |                                            |                                 |                               |                                              |                                                   |
|                   | Support for R&D in public sector and industry | R&D funding                                                |                                            |                                 |                               |                                              |                                                   |
|                   |                                               | Collaborative grants                                       |                                            |                                 |                               |                                              |                                                   |
|                   |                                               | R&D infrastructure                                         |                                            |                                 |                               |                                              |                                                   |
|                   | Fiscal measures                               | Tax incentives for R&D and start-ups                       |                                            |                                 |                               |                                              |                                                   |
|                   |                                               | Tax incentives for R&D personnel                           |                                            |                                 |                               |                                              |                                                   |
|                   | Education, training and mobility              | Tailored training courses for companies, entrepreneurs     |                                            |                                 |                               |                                              |                                                   |
|                   |                                               | Advise/consulting for start ups, companies, entrepreneurs  |                                            |                                 |                               |                                              |                                                   |
|                   |                                               | Placement schemes for students                             |                                            |                                 |                               |                                              |                                                   |
|                   |                                               | Support for R&D workers recruitments                       |                                            |                                 |                               |                                              |                                                   |
|                   | Networks and partnerships                     | Competence centres, clusters, science-technology parks     |                                            |                                 |                               |                                              |                                                   |
|                   |                                               | Technology platforms and innovation networks               |                                            |                                 |                               |                                              |                                                   |
|                   |                                               | Foresight and common vision building                       |                                            |                                 |                               |                                              |                                                   |
|                   |                                               | Market intelligence and other forms of information sharing |                                            |                                 |                               |                                              |                                                   |
| DEMAND SIDE FOCUS | Regulations and standards                     | Regulations, targets, cap & trade schemes                  |                                            |                                 |                               |                                              |                                                   |
|                   |                                               | Performance standards, labeling, certification             |                                            |                                 |                               |                                              |                                                   |
|                   | Public procurement                            | “Green” public procurement of goods and services           |                                            |                                 |                               |                                              |                                                   |
|                   |                                               | R&D procurement                                            |                                            |                                 |                               |                                              |                                                   |

|  |                           |                                                                                                 |  |  |  |  |  |
|--|---------------------------|-------------------------------------------------------------------------------------------------|--|--|--|--|--|
|  | Technology Transfer       | Pre-commercial procurement                                                                      |  |  |  |  |  |
|  |                           | Advisory support for technology adopters                                                        |  |  |  |  |  |
|  |                           | Financial or fiscal support for technology adopters (e.g. grants for purchasing new technology) |  |  |  |  |  |
|  | Support of private demand | Tax incentives for consumers (e.g. for purchasing environmentally efficient products)           |  |  |  |  |  |
|  |                           | Tax reductions for products and services (e.g. VAT reductions)                                  |  |  |  |  |  |
|  |                           | Demand subsidies (e.g. eco-vouchers, consumer subsidies)                                        |  |  |  |  |  |
|  |                           | Awareness raising and information provision                                                     |  |  |  |  |  |

To conclude, discuss whether the policies in your country can be characterised as one of the approaches outlines below:

Policies support mostly innovative solutions improving pollution control and other end-of-pipe environmental technologies

Policies support eco-innovation resulting in greater resource and energy efficiency in production processes in companies. There is a realisation that eco-innovation can have both economic and environmental benefits.

Policies support systemic (transformative and radical) eco-innovations aiming at changing production and consumption patterns. Measures include value chain management, re-designing cities, industrial ecology, new business models providing alternative solutions (e.g. product service systems)

## Part 6. Main findings

(1-2 page)

Analyse the situation with eco-innovations in your country using SWOT tool (strength, weaknesses, opportunities and threats). Fill in the diagrammes in Figures 6.1 and 6.2. While doing SWOT analysis take into consideration the following factors:

Economic and financial factors (e.g. price and cost, market position, access to capital)

Technical and technological knowledge base (e.g. absorptive capacity, human capital, infrastructure, technological lock-ins)

Environmental factors (e.g. access to natural resources)

Socio-cultural factors (including elements of social capital understood as the ability to collaborate and to take collective action, as well as cultural capital e.g. attitudes towards change, risk)

Regulatory and policy framework (including environmental and innovation policies, taxes, standards and norms, legal system).

The preliminary sources of information for the analysis will be the interviews and consultations with national experts, policy and other industry representatives will be a very important source of information. Furthermore, published academic and policy studies and other resources will also be explored.

Figure 6.1 Strengths and Weaknesses of (... country) in promotion of eco-innovations

|           |            |
|-----------|------------|
| Strengths | Weaknesses |
|-----------|------------|

|   |   |
|---|---|
| - | - |
| - | - |
| - | - |

Figure 6.2 Opportunities and Threats for eco-innovations in (...country)

| Opportunities | Threats |
|---------------|---------|
| -             | -       |
| -             | -       |
| -             | -       |

---

## References

References to be provided in the end of the document (not in the footnotes) in the following format:

Author (e.g. Name, Agency/Organization), Year, Title of paper/document/ book /presentation, Number/Volume/Issues, Publisher (if available)/source (internet link)

For example:

Jansen, L., 2003, The challenge of sustainable development, Journal of Cleaner Production 11, 231–245

Belgian Building Research Institute, 2002, Opportunities for using recycled materials in the construction sector, Recyhouse, Presentation of the project – Numerical classification of the products

Federation of Enterprises in Belgium (FEB), 2010, Belgian Eco-solutions leading the way. Brochure of FEB, issue 03, 2010. Available at <http://www.vbo-feb.be/index.html?page=71>

OECD, 2009, Eco-innovation in Industry: Enabling green growth. OECD, Paris

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Annex 1. Policy measures addressing eco-innovations in ..... (linked to Part 5)

|                         | Group of policy measures                      | Type of policy measure                                    | Specific measure<br>Please provide reference to or brief summary of specific measures (national, regional)<br>add cells if necessary | Focus of policy measure (tick if relevant) |                                 |                               |                                  |                                          |
|-------------------------|-----------------------------------------------|-----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|---------------------------------|-------------------------------|----------------------------------|------------------------------------------|
|                         |                                               |                                                           |                                                                                                                                      | Generic eco-innovations                    | Resource efficiency improvement | Energy efficiency improvement | Reduction of emissions incl. CO2 | Other areas (e.g. renewable energy, etc) |
| SUPPLY<br>SIDE<br>FOCUS | Equity/business support                       | Venture capita funds                                      | -<br>-<br>-                                                                                                                          |                                            |                                 |                               |                                  |                                          |
|                         |                                               | Public guarantee funds                                    |                                                                                                                                      |                                            |                                 |                               |                                  |                                          |
|                         | Support for R&D in public sector and industry | R&D funding                                               |                                                                                                                                      |                                            |                                 |                               |                                  |                                          |
|                         |                                               | Collaborative grants                                      |                                                                                                                                      |                                            |                                 |                               |                                  |                                          |
|                         |                                               | R&D infrastructure                                        |                                                                                                                                      |                                            |                                 |                               |                                  |                                          |
|                         | Fiscal measures                               | Tax incentives for R&D and start-ups                      |                                                                                                                                      |                                            |                                 |                               |                                  |                                          |
|                         |                                               | Tax incentives for R&D personnel                          |                                                                                                                                      |                                            |                                 |                               |                                  |                                          |
|                         | Education, training and mobility              | Tailored training courses for companies, entrepreneurs    |                                                                                                                                      |                                            |                                 |                               |                                  |                                          |
|                         |                                               | Advise/consulting for start ups, companies, entrepreneurs |                                                                                                                                      |                                            |                                 |                               |                                  |                                          |
|                         |                                               | Placement schemes for students                            |                                                                                                                                      |                                            |                                 |                               |                                  |                                          |
|                         |                                               | Support for R&D workers recruitments                      |                                                                                                                                      |                                            |                                 |                               |                                  |                                          |
|                         | Networks and partnerships                     | Competence centres, clusters, science-technology parks    |                                                                                                                                      |                                            |                                 |                               |                                  |                                          |
|                         |                                               | Technology platforms and innovation networks              |                                                                                                                                      |                                            |                                 |                               |                                  |                                          |

|                         |                           |                                                                                                 |  |  |  |  |  |  |
|-------------------------|---------------------------|-------------------------------------------------------------------------------------------------|--|--|--|--|--|--|
|                         |                           |                                                                                                 |  |  |  |  |  |  |
|                         |                           | Foresight and common vision building                                                            |  |  |  |  |  |  |
|                         |                           | Market intelligence and other forms of information sharing                                      |  |  |  |  |  |  |
| DEMAND<br>SIDE<br>FOCUS | Regulations and standards | Regulations, targets, cap & trade schemes                                                       |  |  |  |  |  |  |
|                         |                           | Performance standards, labeling, certification                                                  |  |  |  |  |  |  |
|                         | Public procurement        | “Green” public procurement of goods and services                                                |  |  |  |  |  |  |
|                         |                           | R&D procurement                                                                                 |  |  |  |  |  |  |
|                         |                           | Pre-commercial procurement                                                                      |  |  |  |  |  |  |
|                         | Technology Transfer       | Advisory support for technology adopters                                                        |  |  |  |  |  |  |
|                         |                           | Financial or fiscal support for technology adopters (e.g. grants for purchasing new technology) |  |  |  |  |  |  |
|                         | Support of private demand | Tax incentives for consumers (e.g. for purchasing environmentally efficient products)           |  |  |  |  |  |  |
|                         |                           | Tax reductions for products and services (e.g. VAT reductions)                                  |  |  |  |  |  |  |
|                         |                           | Demand subsidies (e.g. eco-vouchers, consumer subsidies)                                        |  |  |  |  |  |  |
|                         |                           | Awareness raising and information provision                                                     |  |  |  |  |  |  |

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## About the Eco-Innovation Observatory (EIO)

The Eco-Innovation Observatory (EIO) is a 3-year initiative financed by the European Commission's Directorate-General for the Environment from the Competitiveness and Innovation framework Programme (CIP). The Observatory is developing an integrated information source and a series of analyses on eco-innovation trends and markets, targeting business, innovation service providers, policy makers as well as researchers and analysts. The EIO directly informs two major EU initiatives: the Environmental Technologies Action Plan (ETAP) and Europe INNOVA.

This thematic report explores how eco-innovation can contribute to resource efficiency in the construction sector. It argues that a more comprehensive approach to building and renovation is needed; one that looks at how both energy and materials can be efficiently used, and considers the trade-offs between them. Widening the perspective to resource efficiency enables the systemic approach needed to frame discussions about sustainable construction because this perspective makes economic, social and environmental sense.

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**[www.eco-innovation.eu](http://www.eco-innovation.eu)**