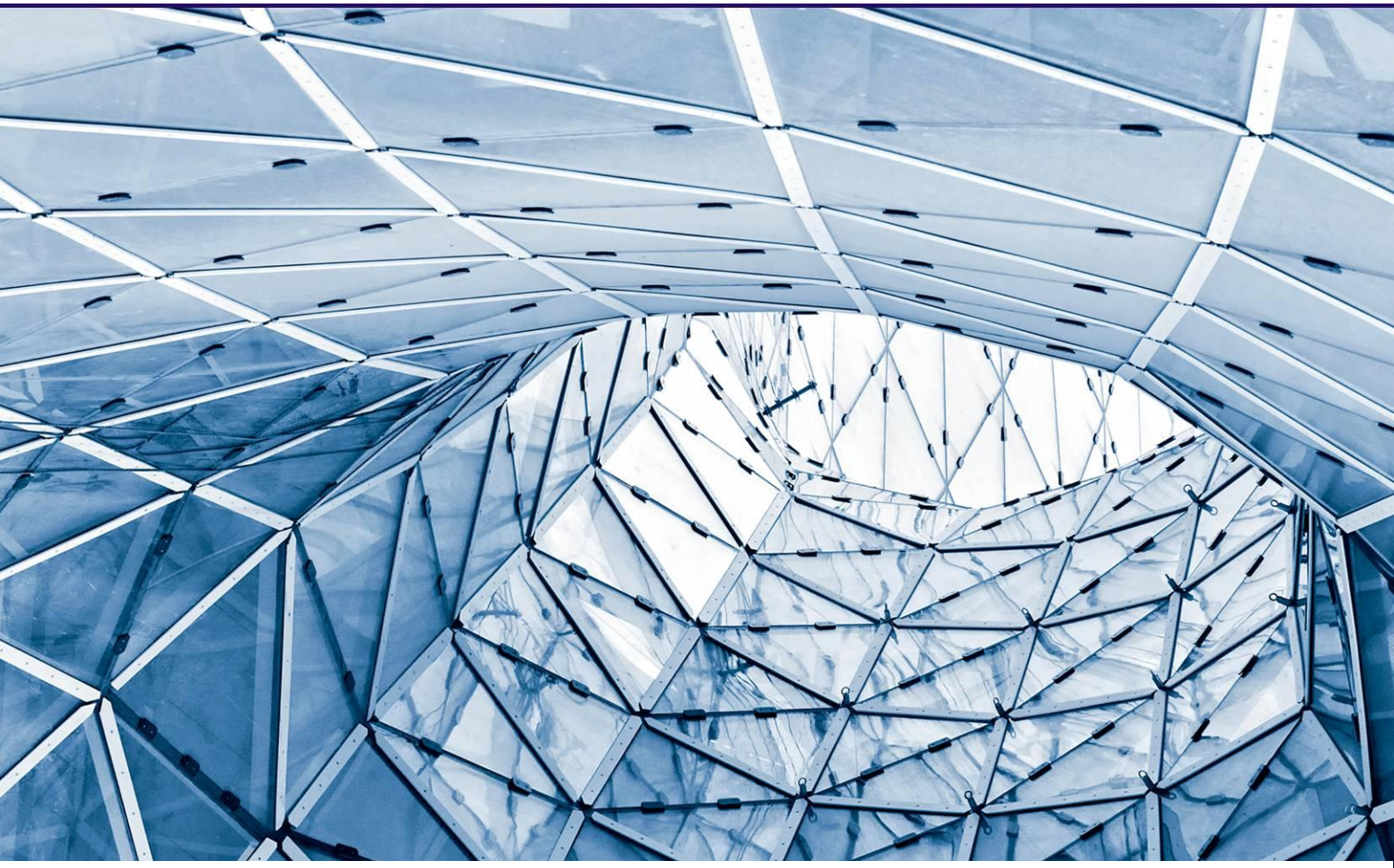
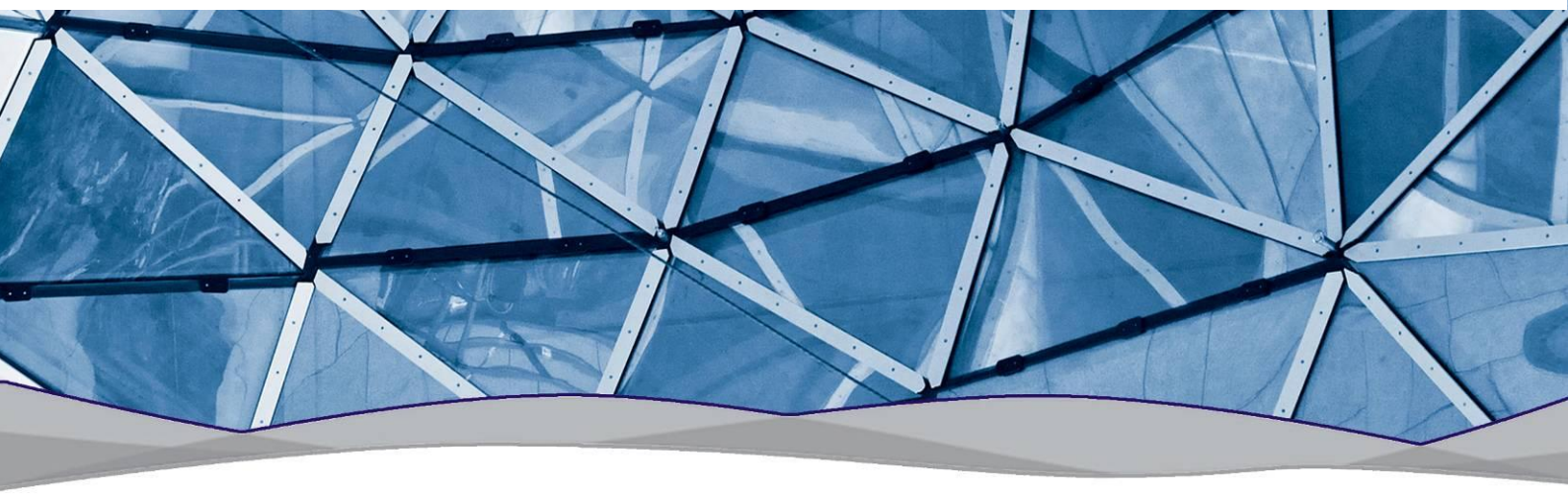
eco-innovation observatory



Eco-Innovation Observatory

Methodological report



EUROPEAN COMMISSION

eTAP Environmental Technologies Action Plan

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EUROPE INNOVA

environment

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

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

To find out more, visit www.eco-innovation.eu

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Eco-Innovation Observatory

Methodological report

Autumn 2010

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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 and sectors. Accepting such an approach has important consequences for the scope of the EIO. In this context, the observatory defines 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."

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 1-1. 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.

Structure of the report

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.

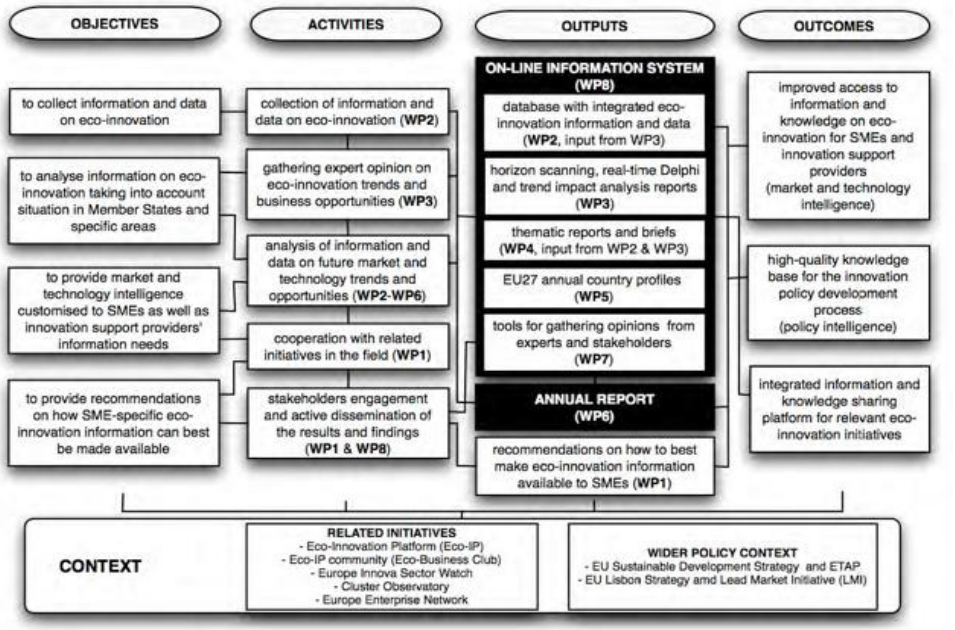
Chapter 3 explains how the observatory will deliver upon its purpose and describes the concrete data management and research methods that will be applied. For ex-post related analysis it describes the processes of data-base building, monitoring of eco-innovation trends, sourcing data for specific thematic 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 will be 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 1-1. Logical framework of the Eco-innovation Observatory



Acknowledgement

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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 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).

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 lower 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. Introducing the notion of various degrees of novelty, impact and levels will be used for analytical comparisons between alternative eco-innovative solutions (Kemp 2010).

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 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.

Radical innovations are those changes that lead to substantial improvements of products and processes that, however, do not necessarily lead to a systemic change. Radical innovations may in fact preserve the existing technological regime (Kemp 2010). Innovations that lead to shifts in a **paradigm** (Tidd and Bessant 2009) **or in the functioning of an entire system** are **disruptive innovations.** The latter 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, notably - to the extent available data allows– water. Energy efficiency aspects will also be included in the analysis and related to material productivity. 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 and solid waste. 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 (Schmidt-Bleek 1994; Bringezu and Bleischwitz 2009; Giljum et al. 2009; Lettenmeyer 2010);
- The input-oriented approach allows the interdependencies between inputs (energy, materials, water) 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, the payback periods are typically longer than many investors wish and other types of barriers exist (including low awareness of potential benefits from material efficient solutions), 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).

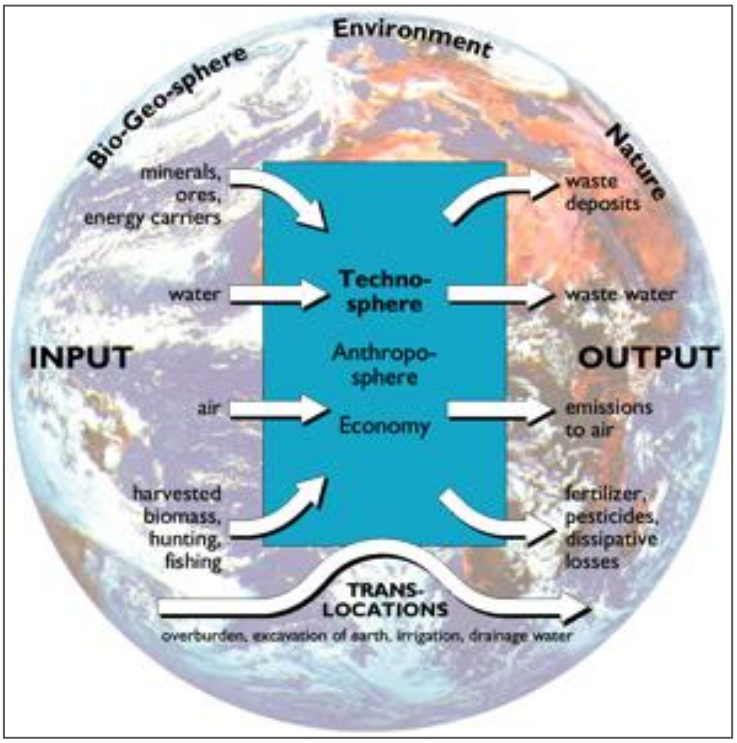
Four main types of natural resources can be defined as necessary inputs to economic systems, i.e. production and consumption processes: **raw materials (including energy carriers), water, air and (land and water) areas**.

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 1-2. 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. This approach was pioneered in 1990s at the Wuppertal Institute in Germany (Schmidt-Bleek 1992, 1993, 1993; Ernst Ulrich v. Weizsäcker 1997). Schmidt-Bleek called for an average factor 10 absolute reduction in the consumption of natural material among developed countries (Schmidt-Bleek 1992, 1993, 1994). Factor 4 was the level of dematerialization called for by Ernst Ulrich v. Weizsäcker (1997), recently updated to a Factor 5 (von Weizsäcker et al., 2009). 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

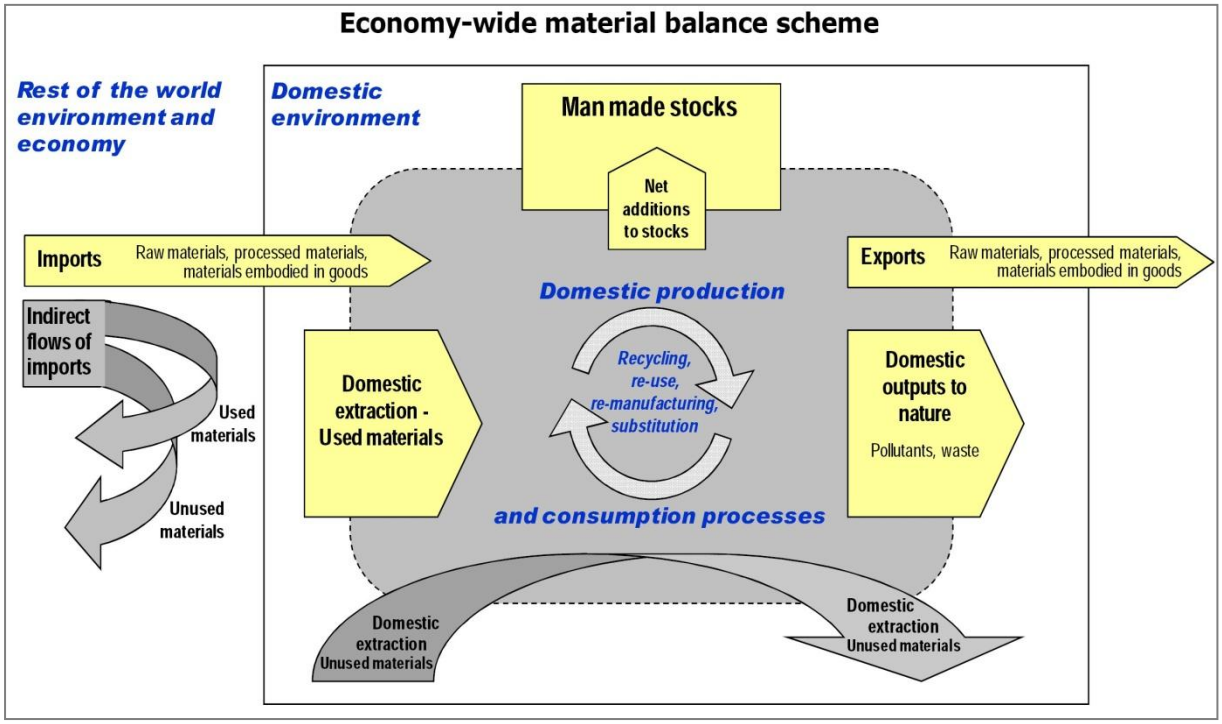
The resource category of "materials" comprises **all non-renewable and renewable materials**, which humans extract from the Earth's crust and ecosystems in order to produce goods and provide services. From a political perspective, knowledge of production, consumption and high import-dependencies have 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 1-3. Economy-wide material balance scheme



Source: (OECD, 2008)

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

- 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. At the same time, the mismanagement of soils are leading to alarming rates of erosion and degradation, increasing the pressure to further expand cropland to compensate for these losses. Cropland expansion is the biggest cause of deforestation worldwide, making it a timely and relevant issue of growing importance.

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. Efforts to fill this gap are ongoing at the Wuppertal Institute. Therefore, the dimension of land cover and land use will not be included in the EIO database, unless data is made available. The data situation will be re-evaluated annually.

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_2 emissions. On a country level, Bringezu et al. (2009: 141) found that CO_2 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 product 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 silicium, 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 relative and absolute 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 innovations across the material value chains of products and processes that lower 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). As such, organisational eco-innovation may also include an enquiry into various collaborative organisational forms and their potential eco-innovative qualities; this can range from business networks and clusters to advanced solutions in industrial symbiosis.

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.

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. Another important aspect is product sharing activities that may lead to an absolute decrease of material use without diminishing the quality of services they provide to users. 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.

2.2.1.7 Infrastructure eco-innovation

The EIO will also enquire about infrastructure that is about integrated systemic solutions for housing, urban parks, transport and other larger infrastructural forms. This is to better analyse the larger scale solutions that may provide the context for better understanding of the impacts of product, process or organisational changes.

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 system changes. Most end-of-pipe additive technologies are incremental innovations 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) covering all EU Member States.

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, pressure from communities, green ethos, and improving the company image. Horbach (2005, 2008) groups eco-innovation determinants into three groups: supply side, demand side, and institutional and political influences. Miedzinski and Reid (2008) adapt Horbach's approach adding fiscal policy that may influence pricing of eco-innovative goods and shape market demand.

Table 2-1. Determinants of eco-innovation according to Horbach (2008)

Supply side	• Technological (and management*) capabilities • Appropriation problem and market characteristics • Path dependencies (inefficient production systems, knowledge accumulation)
Demand side	• (Expected) market demand (demand pull hypothesis): state, consumers and firms • Social awareness of the need for clean production; environmental consciousness and preference for environmentally friendly products
Institutional and political influences	• Environmental policy (incentive based instruments or regulatory approaches) • Fiscal systems (pricing of eco-innovative goods and services)* • Institutional structure: e.g. political opportunities of environmentally oriented groups, organization of information flow, existence of innovation networks • International agreements

Source: adapted from Horbach (2005; 2008)

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 of 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.

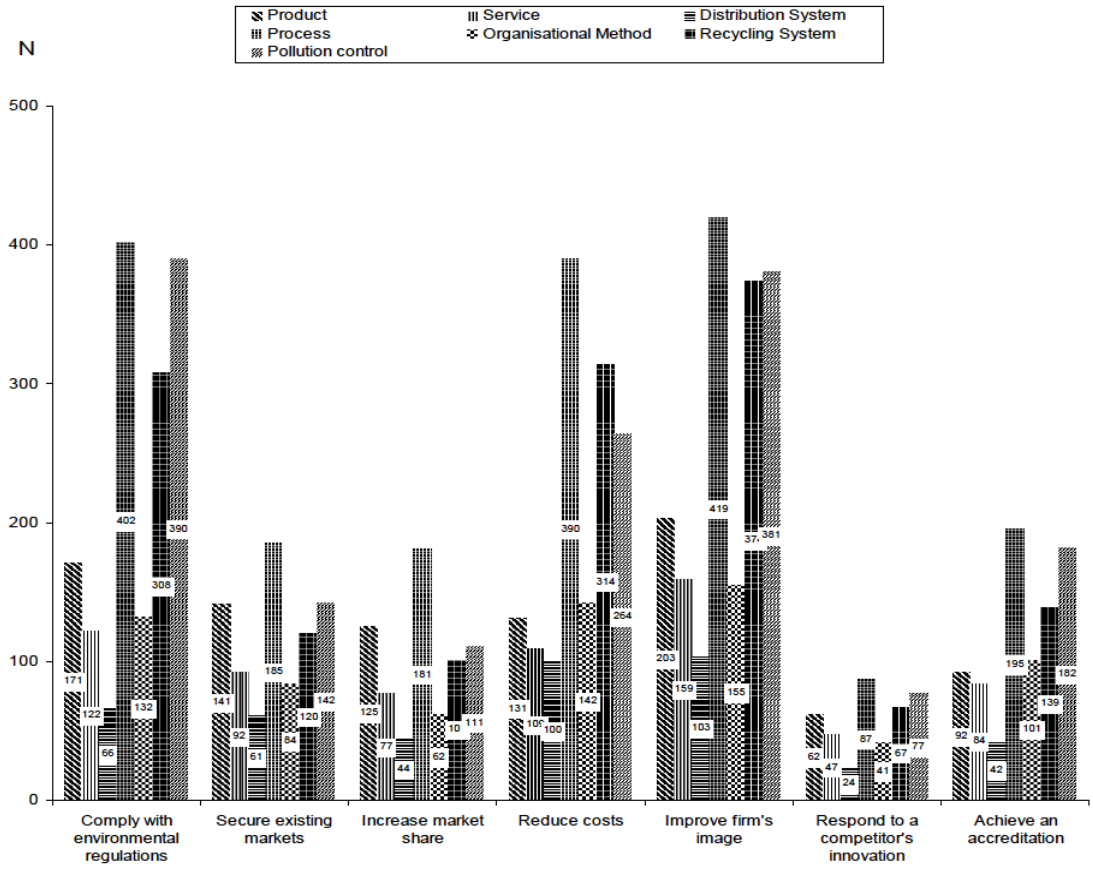
Table 2-2. Factors hampering innovation activities (OECD 2005)

Relevant for:	Product innovations	Process innovations	Organisational innovations	Marketing innovations
Cost factors:				
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	*	*	*	*
Knowledge factors:				
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	*	*		
Market factors:				
Uncertain demand for innovative goods or services	*			*
Potential market dominated by established enterprises	*			*
Institutional factors:				
Lack of infrastructure	*	*		*
Weakness of property rights	*			*
Legislation, regulations, standards, taxation	*	*		*
Other reasons for not innovating:				
No need to innovate due to earlier innovations	*	*	*	*
No need because of lack of demand for innovations	*			*

Source: Oslo Manual (2005)

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:

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.

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.

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.

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.

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.

Supplier-related barriers:

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

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.

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

			Indigenous		**Exogenous**	
			Barriers	Drivers	Barriers	Drivers
Level and dimensions of analysis	**Micro (firm)**	Economic capital				
		Technical capital				
		Natural capital				
		Social capital				
		Regulatory and policy framework				
	Sub-system (sector, value chain, product system)	Economic capital				
		Technical capital				
		Natural capital				
		Social capital				
		Regulatory and policy framework				
	Socio-economic system	Economic capital				
		Technical capital				
		Natural capital				
		Social capital				
		Regulatory and policy framework				

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. The focus will be also on the importance of the competition from well-developed products that have benefitted from scale and learning economies and societies being adapted to their use as a barrier to eco-innovation (Kemp, 1994).

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 to be 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, there will be yearly data 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. Whenever possible, however, the EIO database will aim to comprise data for the entire 20 year-time period. The database will be 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 On-line Delphi and other foresight activities.

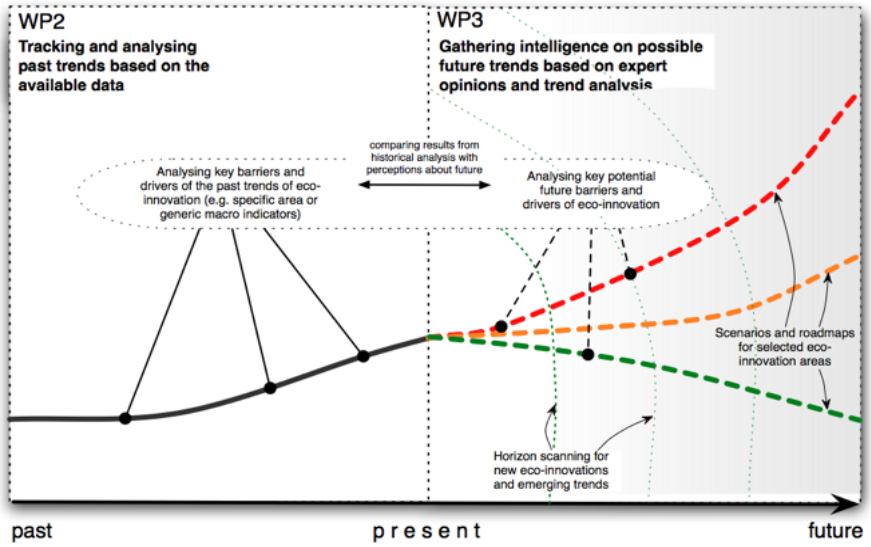
Since the future development of eco-innovations may not be linear due to changes in drivers and/or barriers, foresight activities of the Observatory will construct eco-innovation scenarios, each of them including both a state of the future and a path to it. Scenario work will be carried out for selected eco-innovations, and expert opinions for scenario paths in particular as well as for roadmaps and impact assessment will be collected for a few years between today and 2030 (e.g. for 2015, 2020 and 2025) in the On-line Delphi.

2.4.3 Links between ex post and foresight analysis

The ex-post analysis will provide an important starting point for the foresight activities of the project. The findings will be used as a main input in the foresight activities of the observatory including horizon scanning, Delphi, scenario development and roadmapping. Also trend extrapolations will be performed for selected indicators. Thus, the EIO team working on data analysis will assure information flow to the EIO foresight team.

On the other hand, foresight activity will provide 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 and thematic analyses will contain:

- General eco-innovation data for analysis on the country level as well as for cross-sectoral analysis thereby serving as the key information base for the country briefs and the annual reports;
- 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 part of the EIO database containing general eco-innovation data. Both WP 2 and WP 3 will deliver inputs to this part of the database for past trends and future outlooks, respectively. Section 2.5.2 contains the description of the specific thematic areas and sectors, which will be 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, 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 shall also enable correlations between eco-innovation and environmental performance, innovativeness, and the socio-economic conditions to be further explored.

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. In the course of work, data will be screened and indicators for the relevant areas of observation will be defined specific to the three levels of analysis:

- Micro level indicators (companies, processes, products/services)
- Meso level indicators (sectors, supply chains)
- Macro level indicators (countries, country groups)

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 is a working table, it serves to demonstrate the 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 will be 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 3.7.2.2) 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	Main areas of observation (1)	Main areas of observation (2)	Main areas of observation (3)
Socio-economic framework	**Economic performance**	**Economic wealth**	GDP
		Competitiveness	Competitiveness indices
			Foreign investment
		Employment	Active population
			Employment rate
			Unemployment rate
	Social aspects	**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)
Environment	**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
			Renewables
			Productivity
			Energy prices
			Energy security

		Water	Consumption
			Productivity
			Water prices
	Outputs and emissions	**Emissions**	GHG emissions
			GHG intensity
			Carbon prices
		Waste	Industry / construction waste
			Household waste
			Hazardous waste
		Recycling	Municipal waste
			Construction and demolition waste
Innovation	**Innovation inputs**	**Finance and investments**	Overall R&D funding (GERD)
			Government funding
			Expenditures by universities and research institutes
			Business expenditures on innovation
			Expenditures by private non-profit
			Venture and risk capital
		Human resources	Educational attainment
			Knowledge workers
			Innovation training
	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
			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
			New methods of organising work responsibilities and decision making
			New methods of organising external relations with other firms or public institutions
		Knowledge creation (IPR)	EPO patents
			Community trademarks
			Community designs
			Publications
		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
Eco-innovation	**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 eco-innovation	Reduced material input
			Reduced energy input
			Reduced CO2 emmissions
			Replaced materials with less polluting or hazardous substitutes
			Reduced soil, water, noise or air pollution
			Recycled waste, water or materials
		Environmental benefits from the use of goods or service	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 structure	**Eco-industries**	Size of eco-industry markets
			Turnover
			Competitive advantage
			New-to-market sales (eco-products, 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 Responsibilty (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 (public-private partnerships)
			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 (Technology transfer)
		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 will set up a comprehensive database covering the micro, meso and macro levels as the empirical basis for analysing eco-innovation performance as well as drivers and barriers in the EU. Setting-up this database will allow 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 will be 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

The screening and evaluation of possible data sources to calculate each of the indicators listed in the Table 3-5 above will be undertaken in Work Package 2. The WP 2 team already developed a template with a standardised set of criteria, in order to evaluate the suitability of each possible data source for the calculation of an indicator included in the EIO database. This evaluation scheme comprises 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 will 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).

It is likely that in many cases more than one possible source for each of the indicators can be identified. Based on the assessment of each possible source for one indicator, the WP 2 team will 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) will be derived. The result of step 1 will be clear recommendations 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 will be performed as part of work undertaken in WP 2.2. The steps will not be performed in a linear way for all of the indicators and will therefore overlap or procedures will be repeated iteratively, if necessary, in order to achieve a high quality standard.

Step 2 will extract the data from the primary source recommended in Step 1 and import them into the EIO data working files, which will be MS Excel-bases. This will be done preferably in electronic formats (e.g. download of data in MS Excel format or a format importable to MS Excel) or, if necessary, 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 will perform a number of tests including:

- *Check of plausibility of time trends*: if data are available in time series, the team will test 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 will cross-check 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 will apply estimation methods to fill data gaps (e.g. data interpolation).
- *Aggregation checks to test consistency across scales*: several indicators will be collected on more than one level (macro, meso, micro). We intend to cross-check the plausibility of indicators on different levels 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 will be primary data sets, quality tested and consistent, which will be 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 (micro, meso, macro), in order to address a number of questions within each of the defined eco-innovation themes. Step 3 will take the primary data sets developed in Step 2 and will perform the calculation of the respective indicators.

In many cases, no additional calculation procedures will be 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 on eco-innovation). In other cases, simple calculations will be 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").

The calculation of some of the desired indicators will require setting up more comprehensive calculation procedures or even calculation models. For example, the WP 2 team aims at performing 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 will deliver 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 will be the set of eco-innovation 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 web database

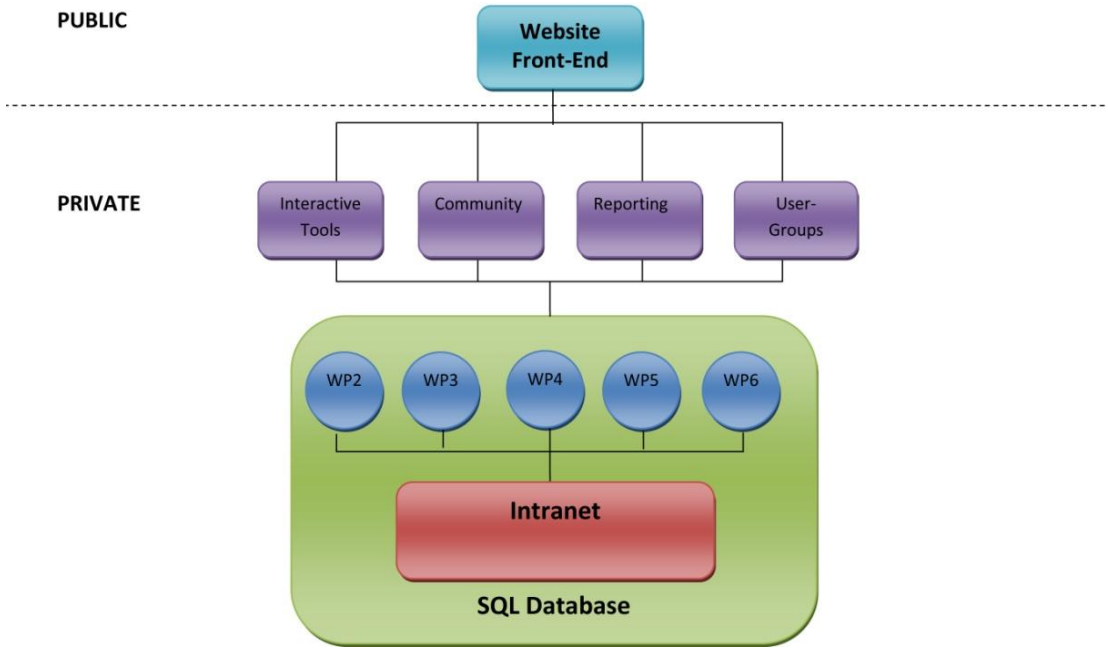
All indicators compiled in the EIO project will be made available for further analysis and downloadable by third party users through the EIO web portal. In conjunction with WP 7, WP 2 will set up a structure for the database, determine the software to be used for the on-line data base and export the data sets into the 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) 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 part of 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. It performs as a comprehensive database and as the main programming language is SQL, 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 will address 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.

For this type of analysis, the WP 2 team will 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 using these software packages:

- 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 will be 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 will be applied in EIO in order to analyse the statistical relationships between two or more variables or observed data values. The most commonly used correlation coefficient is the "Pearson product-moment correlation coefficient", which has a value between -1 and +1. Such correlation analyses will be undertaken to investigate the questions indicated above.

Feedback loops between the analysis undertaken in Step 5 and Steps 2 and 3 will be 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 will 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 will 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 will be also considered 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 will focus on aspects related to the promotion or hindering of eco-innovation. The project proposal indicates the possible themes and areas. The topics will be 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 will 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 will be partly driven by data availability in certain areas. The exact topics of the thematic reports will be agreed as early as possible each year to allow the research team enough time to deliver both data and analysis.

The annotated template will be developed to ensure a standardised format and quality of the thematic reports. The preliminary 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 will be discussed with the key stakeholders and agreed upon with the client. The template will include clear instructions on the main questions to be tackled in each section of the report. Additionally the experts will have access to the methodological help desk established in the EIO secretariat. The authors will receive a written feedback on the first draft of the report from two reviewers indicated by the WP leader. The WP leader will take a decision whether the final draft can be submitted to the client.

3.1.3 Composite indicators: Eco-Innovation Scoreboard

This section briefly reviews existing composite indicators and scoreboards and their use, and derives a first outline of the structure of the Eco-Innovation Scoreboard. The structure will be further elaborated for presentation at the first Steering Committee Meeting in June 2010. The first full version of the Eco-Innovation Scoreboard will be developed after incorporating the feedback from the Steering Committee Meeting.

3.1.3.1 Composite Indicators and existing scoreboards

A "**composite indicator**" is an aggregation of a set of indicators. It is also often called an "index". A composite indicator measures multi-dimensional concepts (e.g. competitiveness, energy efficiency or environmental quality) which cannot be captured comprehensively by one single indicator. Often, the sub-indicators included in a composite indicator do not have a common meaningful unit of measurement and in most cases there is no obvious way of weighting and aggregating them. The individual indicators are therefore compiled into a composite indicator on the basis of an underlying model reflecting the multi-dimensional concept that is being measured. Ideally, a composite indicator should be based on a theoretical framework or definition, which allows individual indicators or variables to be selected, combined and weighted in a manner which reflects the dimensions or structure of the phenomena being measured (OECD and JRC, 2008).

Under some circumstances a composite indicator may prove unsuitable, for example, in cases, where key information is being lost through the aggregation procedure. To allow comparison of trends and

performances between a set of variables (e.g. products, companies, sectors or countries), a **scoreboard** (also called scorecard or dashboard) is a useful alternative. In contrast to an index (or composite indicator), a scoreboard in general is an un-aggregated presentation of several indicators or variables, which can be communicated in different ways. Most scoreboards serve as benchmarking tools and to keep interested parties as well as the public informed about progress made. Although a useful tool, it should be recognised that summary quantitative information such as presented in existing scoreboards does not always provide the full picture of the progress being made in a certain area. For in-depth analyses of specific trends and correlations, the full range of indicators available in the Eco-Innovation Database should therefore be used.

In the following, we briefly present some examples of existing scoreboards in different thematic areas. A more elaborated review will be undertaken in a forthcoming discussion paper which will be circulated and discussed at the Steering Committee Meeting in June 2010. The elaboration of the discussion paper will be part of work package 2.4.

European Innovation Scoreboard
(http://www.proinno-europe.eu)

The European Innovation Scoreboard (EIS) is an instrument of the European Commission to provide a comparative assessment of the innovation performance of EU Member States. The scoreboard concentrates on presenting the figures. Its purpose is to enable Member States to identify their strengths and weaknesses and thus help them in formulating policies and programmes. High scoring Member States may increasingly become sources of good practice as users of the scoreboard aim at adopting what has worked elsewhere.

Global Innovation Scoreboard
(http://www.proinno-europe.eu/page/global-innovation-scoreboard-1)

The Global Innovation Scoreboard (GIS) compares the innovation performance of the EU25 to that of the other major R&D spenders and emerging economies in the world: Argentina, Australia, Brazil, Canada, China, Hong Kong, India, Israel, Japan, New Zealand, Republic of Korea, Mexico, Russian Federation, Singapore, South Africa and the US. The comparison is based on a more limited set of indicators than those used in the European Innovation Scoreboard (12 out of 25). Innovation performance is measured by the use of a composite indicator, the Global Summary Innovation Index (GSII) decomposed into 5 composite indices measuring 5 key innovation dimensions: Innovation drivers, Knowledge creation, Diffusion, Applications and Intellectual property. Based on the ranking of their GSII scores, the countries analysed can be divided into four groups: global innovation leaders, next-best performers, follower countries, and lagging countries.

JRC Dashboard of Sustainability
(http://esl.jrc.it/envind/dashbrds.htm)

The Dashboard of Sustainability is an application containing a number of composite indicators which allow presenting complex relationships between economic, social and environmental issues in a communicative format. The dashboard includes maps of all continents and can be developed using one's own data set. It can help answer typical questions such as: What is the situation of a country compared to others? What are the specific strengths and weaknesses of a continent/country? How are certain indicators linked to each other?

OECD Science, Technology and Industry Scoreboard
(http://www.oecd.org/document/10/0,3343,en_2649_33703_39493962_1_1_1_1,00.html)

The OECD Science, Technology and Industry (STI) Scoreboard brings together internationally comparable indicators. It is published every two years. The 2009 edition focuses on five key areas: (i) responding to the economic crisis; (ii) targeting new growth areas; (iii) competing in the world economy; (iv) Connecting to global research; and (v) investing in the knowledge economy. While the OECD scoreboard contains a number of single illustrations, it neither aggregates the different indicators nor shows them in a joint format.

Climate Interactive - The Climate Scoreboard
(http://climateinteractive.org/scoreboard)

The Climate Scoreboard by the Sustainability Institute was launched at the UN Climate Conference in Copenhagen in December 2009. It is an online tool that allows the public, journalists and other interested parties to track progress in the ongoing negotiations to produce an international climate treaty. The Scoreboard automatically reports, on a daily basis, whether proposals in the treaty process commit countries to enough greenhouse gas emissions reductions to achieve widely expressed goals, such as limiting future warming to 1.5 to 2.0°C above pre-industrial temperatures. The results of the Climate Scoreboard are illustrated using a virtual thermometer, illustrating the potential impact of climate measures on the estimated global temperature in the year 2100.

IEA Scoreboard 2009 - 35 Key Energy Trends over 35 Years
(www.oecd.org/de/ieascoreboard)

The IEA Scoreboard 2009 is a first attempt to compare what has been achieved by member countries in diversifying their energy mix, in promoting non-fossil fuels and energy efficiency, in encouraging research and development, and, more generally, in creating a policy framework consistent with their shared policy goals. Since the IEA Scoreboard 2009 was published in conjunction with the 35th anniversary of the IEA, 35 themes, ranging from diversification to prices, show how IEA member countries have performed in their efforts to attain energy security, environmental protection and economic growth. It is not a single scoreboard but instead a number of rankings of the different IEA

member countries which provides an overview of energy developments in IEA member countries over the last 35 years, for example the development of renewable energy production (IEA, 2009).

Environmental Sustainability Index (ESI)
(sedac.ciesin.columbia.edu/es/esi)

The ESI was developed by Yale and Columbia Universities and sponsored by the World Economic Forum and the European Commission Joint Research Centre (Esty et al., 2005). The 2005 ESI report benchmarks the ability of nations to protect the environment over the next several decades. It integrates 76 data sets (including the Ecological Footprint) tracking natural resource endowments, past and present pollution levels, environmental management efforts, and a society's capacity to improve its environmental performance into 21 indicators of environmental sustainability. These indicators permit comparison across the following five fundamental components of sustainability: Environmental Systems; Environmental Stresses; Human Vulnerability to Environmental Stresses; Societal Capacity to Respond to Environmental Challenges; and Global Stewardship.

3.1.3.2 The Eco-Innovation scoreboard

The Eco-Innovation Scoreboard constructed in WP 2.4 will be 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. This communication should be easily understandable and highly transparent to be able to reach a number of different stakeholders, including policy makers, business, media and the general public. The scoreboard should complement other measurement approaches of innovativeness of the EU and EU countries, notably the European Innovation Scoreboard, and promote a more holistic view on economic, environmental and social performance. It may also play a role regarding "distance-to-target" once targets on resource efficiency (as a proxy for eco-innovation, see the EU 2020 programme) will be formulated.

The Scoreboard should be one of the "red lines" across the large number of deliverables and reports produced in the EIO project and should become one important element of the "corporate visual identity" of the EIO.
Given its prominent position in the project, it is of key importance to design the scoreboard effectively and select the indicators carefully and in a transparent way.

In general, the scoreboard's major objective is to support comparative analyses (across countries and selected sectors). This implies that the scoreboard will mainly use data, which is collected in the general eco-innovation data block (WP 2.2). It shall also be utilised to develop scenarios and roadmaps within WP 3.

We suggest the following principal structural properties of the EIO scoreboard:

- Two layers: one aggregated layer (one number or a very small set of indicators), one disaggregated layer with several indicators. The exact number of indicators included in the scoreboard will be decided after the first experiences with the pilot country reports have been made and it has been tested with sensitivity analyses, how the inclusion or exclusion of specific indicators change the overall performance profile of one country.
- Two basic scoreboards: one for the comparison of countries (from 2010), one for the comparison of industries (from 2011);
- Two (or three) categories: 1.) "Structural profile" and 2.) "Performance profile" (and possibly 3.) "Relational profile", linking 1) and 2). The performance indicators shall form the focus of the scoreboard. The pilot phase of the country briefs will be used to test, to what extent structural indicators will be included in addition to the performance indicators.

The division into a "structural profile" and a "performance profile" will allow a more systemic approach to the analysis and help us to:

- understand structural determinants and conditions of eco-innovation performance (note that structural profiles will not change substantially from year to year),
- monitor current trends of eco-innovation performance;
- analyse how the current process relate to the structural framework. Perhaps in many years we could observe how eco-innovation "performance" influences the "structural profiles" (e.g. high and continued innovation activities in material efficiency/dematerialised technologies could overt time result into an overall decrease of material consumption).

3.2 Prospective analysis and future trends

This chapter describes the foresight methodology of the Eco-Innovation Observatory. Applied methods include horizon scanning (4.2.1), On-line Delphi (4.2.2), scenarios (4.2.3) as well as impact assessment and roadmaps (4.2.4). Combination of several different foresight methods is a learning process for the Observatory. Due to this, updates to this methodological report are expected. Updates will be introduced on the basis of experience gained during the foresight activities in practice.

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 thematic scope of the Observatory defined above.

Special attention will be paid to the three selected LMI areas relevant from the eco-innovation perspective, i.e. material re-use and recycling, bio-based products, and sustainable construction, and other areas belonging to the 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 closely connected to the LMI areas, e.g. in the field of industrial processes (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

The activity of horizon scanning will start with a few expert interviews in the three LMI-areas and other thematic areas defined in the scope of the Observatory. In the context of these expert interviews in-depth-knowledge sources will be discussed and evaluated. The interviews will also provide key terms and concept definitions to be used as keywords in the actual horizon scanning. The tools used in the horizon scanning include internet search engines and internal search tools available in the context of specific online materials.

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 the Observatory defined earlier in particular. 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 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
- Sustainability
- Environment
- Environmental impacts
- Eco-product
- Eco-service
- Eco-efficiency
- Eco-competitiveness
- Eco-labelling
- Environmental labelling
- Packaging
- Industrial ecology
- Urban ecology
- Transport
- Synthetic biotechnology
- *more to be added*

The keyword list for general horizon scanning will be improved by suggestions from the EIO consortium partners, the FFRC team and the interviewed experts. These improvements will be updated to this methodological report regularly.

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 (available in web, list to be provided)
- selected business journals and magazines (available in web, list to be provided)
- popular science magazines: (available in web, list to be provided)
- reports from major international, EU and national institutions (available in web, list to be provided)
- reports from research institutes and think tanks (available in web, list to be provided)

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:

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

Material recycling and re-use

A tentative list of keywords related to the theme material recycling and re-use includes the following keywords:

- Material recycling
- Material re-use
- Material intensity
- Material efficiency
- Recycling process
- Re-use process
- Recycled material
- Re-manufacturing
- Waste management
- Material system
- Recycling system
- Re-use system
- Recycling industry
- Material innovation
- more to be added

Bio-based products

A tentative list of keywords related to the theme material recycling and re-use includes the following keywords:

- Bio-based product, material
- Bio-product, biomaterial
- Bio-economy
- Renewable material

- Innovative manufacturing
- Material innovation
- Bio-innovation
- Substitution
- more to be added

Sustainable construction

A tentative list of keywords related to the theme sustainable construction includes the following keywords:

- Sustainable construction
- Building
- Insulation
- Ventilation
- Passive solar
- Construction material
- Construction product
- Energy efficiency
- Material efficiency
- Innovative manufacturing
- more to be added

Phosphorous and sustainable nutrient flows

A tentative list of keywords related to the theme phosphorous and sustainable nutrition flows includes the following keywords:

- Phosphorous
- Nutrition flows
- Sustainable
- more to be added

Critical metals

A tentative list of keywords related to the theme critical metals includes the following keywords:

- Critical metals
- Substitution
- Aluminium
- Copper

- Gallium
- Gold
- Indium
- Lithium
- Manganese
- Magnesium
- Molybdenum
- Neodymium
- Palladium
- Platinum
- Ruthenium
- Rhodium
- Iridium
- Silver
- Tantalum
- Titanium
- Tungsten
- Vanadium
- more to be added

The keywords lists above will be further 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. Improvements to the keyword lists will be updated to this methodological report regularly, at least in the context of the annual update of this living document.

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

3.2.1.4 Step 4: Green branding analysis

An innovative element of this activity will be to monitor and analyse marketing and branding strategies that companies apply to eco-innovative products and services. The brand-related analysis part of the horizon scanning process will be subcontracted and a restricted call of bids will be organized. Identifying the materials for this activity and selecting the materials/companies/brands for the green branding analysis will be carried out as a part of the horizon scanning. The need for additional activities in relation to the green branding analysis will be evaluated when preparing the call of bids. Taking this, the subcontracted activity will take place after delivering the first horizon scanning report. In practice this means that the green branding analysis will be included in the second horizon scanning report which will be delivered in the second year of the Observatory. At this stage, the methodological part of green brand analysis will be described in more detail and added to this methodological report.

3.2.2 On-line 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 On-line 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, i.e. selected LMI areas and other thematic areas of the Observatory in addition to corporate environmental management and innovation. 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.

The major challenge of the foresight activity is the success of the On-line Delphi. Motivating all participants for an activity lasting three years is not necessarily a realistic alternative. WP3 relies quite heavily on the Delphi participants, and this may make the process quite time consuming for them. Thus, the participants' willingness to continue the process will be checked after each "round" and the

invitation process will be repeated when necessary. To motivate the participants, the results and outputs of the Observatory should be made available and disseminated to them regularly.

3.2.2.2 Step 2: Design of On-line 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, On-line Delphi is foremost a platform for other foresight activities, i.e. scenario construction, impact assessment and eco-innovation roadmaps.

The initial On-line Delphi questionnaire will be built on the results of the horizon scanning as well as data analysis undertaken in WP2. The content of the statements and questions will be formulated based on the information needs of scenarios, impact assessment and roadmaps. The survey will include statements on the importance and potential of a number of eco-innovation fields (material recycling and re-use, sustainable construction and bio-based products) and processes taking place on micro (e.g. a company), meso (e.g. sector or a cluster) and macro (a region or a country) level. 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), and impacts (for the impact assessment).

3.2.2.3 Step 3: On-line Delphi in practice

In order to be able to involve a high number of stakeholders, WP3.2 will use the On-line Delphi approach. On-line Delphi is based on on-line surveys and does not include face-to-face meetings. The responders 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 integrate the findings of other foresight activities of the Observatory, i.e. results from horizon scanning and expert views gathered in On-line Delphi. Another important point of departure for scenario construction is the data collected in WP2.

WP 3.4 of the Eco-Innovation Observatory will construct eco-innovation scenarios. Both general and thematic scenarios will be constructed for selected eco-innovation fields belonging to the scope of the Observatory. 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 On-line Delphi such as drivers and barriers of eco-innovations. Scenarios can be made 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 On-line 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 process. 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 of the selected LMI areas with eco-innovation potential.

The backcasting scenario activity will use a generic approach developed in the EU FP6 project FORESCENE (http://www.forescene.eu). This framework estimates the probability of scenario outcomes which allows combining "hard" functional relations between measured parameters and the "soft" estimates of expert judgment.

3.2.3.3 Step 3: Feedback and evaluation: Scenario workshops

Results of the scenario work will be presented and evaluated annually in specific scenario workshops. The purpose of the scenario workshops is to get feedback from the experts in the eco-innovation

field. These experts may be the same or different from the participants of On-line Delphi. The dates and locations of the scenario workshops will be decided later.

Scenarios will be modified after receiving feedback from scenario workshops when necessary. Feedback received in the scenario workshops will be included in the scenario reports. Possible outcomes of the scenario work include a set of alternatives for eco-innovations in general and more specific ones for selected eco-innovation areas or individual technologies.

3.2.4 Impact assessment and roadmapping

The purpose of impact assessment and roadmaps is to process and refine the results from horizon scanning and On-line Delphi, with a focus on selected eco-innovations 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 on the basis of horizon scanning results and the On-line Delphi. Material for impact assessment and roadmaps will be gathered from the experts participating in the On-line Delphi which is the expert forum for all foresight activities except horizon scanning. The roadmaps will be constructed for selected examples of relevant and potential eco-innovations 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 On-line 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 extrapolation (based e.g. on data collected in WP2), identification of future events that may affect this scenario (On-line Delphi; probability of occurrence and degree of impact), 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.

Expert judgments will be provided by On-line Delphi and horizon scanning. The future events are related to selected areas/topics and, should they occur, they can cause deviations from a trend

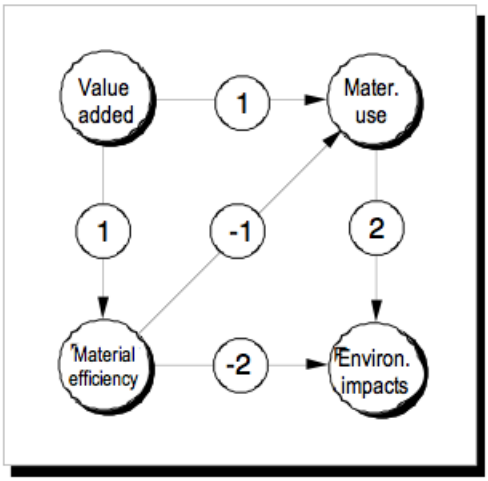
suggested by trend extrapolation of historical data. For each such event, experts judge the probability of occurrence as a function of time and its expected impact, should the event occur, on the future trend. An event with high impact is expected to swing the trend relatively far, in a positive or negative 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, rather than examining each one separately. It will strengthen the findings from On-line Delphi and, notably, 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 On-line 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 ≤ value ≤ 3 where negative values refers to decrease or increase), see example in the figure below. Impacts between descriptors constitute a cross-impact matrix, in the simplified matrix many cross-impacts have been assumed to be zero (= no impact).

Figure 3-2. Simple cross-impact matrix



Descriptors	1.	2.	3.	4.
1. Value added	0	0	0	0
2. Material use	1	0	-1	0
3. Mat. efficiency	1	0	0	0
4. Env. impacts	0	2	-2	0

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 experts participating in On-line Delphi, and data for the actual cross-impact analysis will be provided by cluster analysis, which groups answers on the basis of their similarity to clusters. Cross-impact analysis will then be carried out for different cluster types by using “typical” values (mean value or median) for cross-impacts a priori probabilities and impact strengths.

3.2.4.4 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. Science and technology roadmaps communicate visions, attract resources from business and government, stimulate investigations and monitor progress. They become the inventory of possibilities for the eco-innovation field. 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-innovations; following the general focus of the Observatory. Constructing the roadmaps will use the results of all other foresight activities of the Observatory. In practice, the baseline of eco-innovation roadmaps will be more or less the same as the most probable scenario.

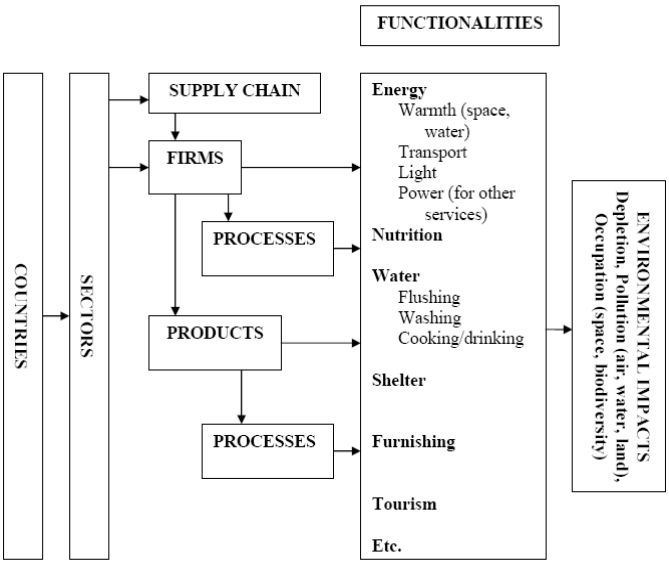
3.3 Conducting analysis of different types of eco-innovation

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 5.2.2.3) 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

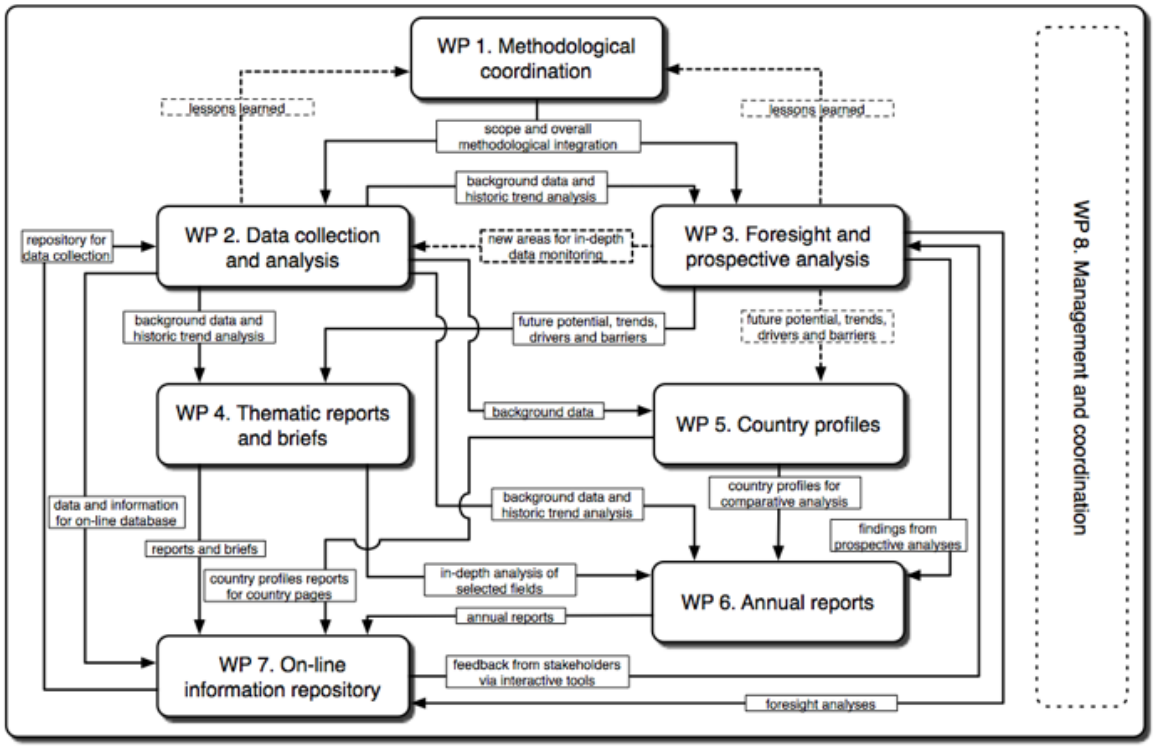
It will be a responsibility of the country experts to get detailed information on policy and good practices during their individual studies. Whenever possible, the latter process will be supported by the policy databases developed by OECD and by EU-funded PRO-INNO TrendChart-ERAWATCH projects as well 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 5.2.2.3 and Annex II). The template will be tested in a pilot phase comprising the work on three country profiles, notably Germany, Austria and the Netherlands during June-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*Figure 3-3 depicts the principal relations and dependencies between the EIO's work packages.

Figure 3-4. Relations and dependencies between WPs



Outputs of observation

3.6 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.

3.7 Presentation of deliverables

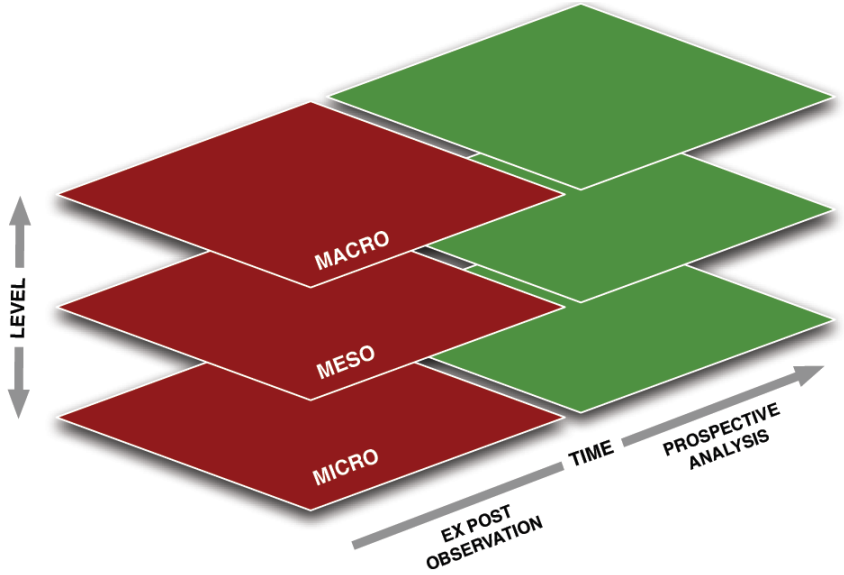
3.7.1 Data and composite indicators

3.7.1.1 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 with 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 3-5. 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.

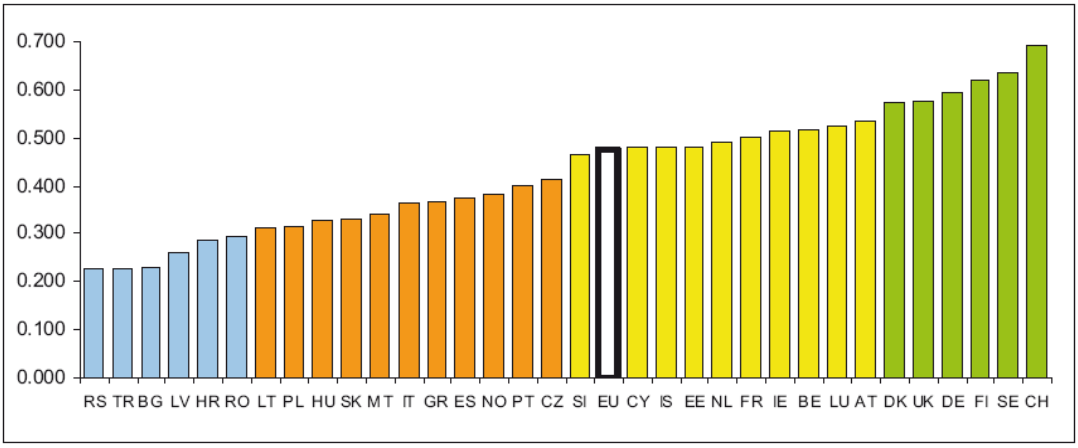
A Database User Manual will be produced, initially for use by the projects internal experts, describing how to populate the database, add areas of observation, define indicators and how to use the database for research. The manual will be developed as an on-line resource that will subsequently also be made available to support external registered users.

3.7.1.2 Eco-Innovation Scoreboard

As explained in chapter 4, the Eco-Innovation Scoreboard will be constructed and presented in several layers.

For the aggregated eco-innovation index, simple illustration forms may be used, such as bar diagrams. Such bar diagrams are used also in other scoreboards, such as the European Innovation Scoreboard or the EIA energy scoreboards. This type of illustration allows communicating simple, aggregated messages also to non-experts and can also easily taken up by media. The following figure provides an example taken from the European Innovation Scoreboard, where European countries are clustered in four performer groups.

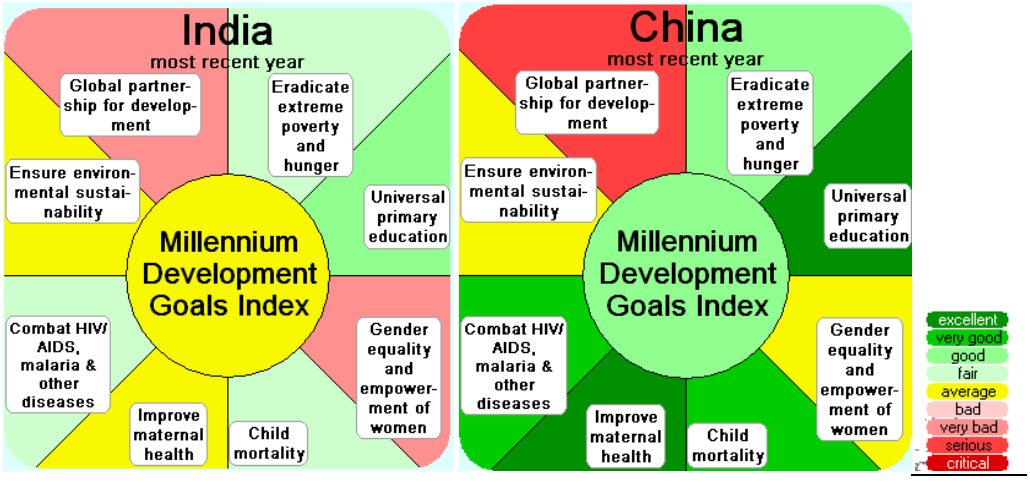
Figure 3-6. Summary Innovation Index (European Innovation Scoreboard)



Source: (PRO INNO Europe, 2009)

The second layer of the Eco-Innovation Scoreboard will be a scoreboard composed of a set of indicators, which will allow identifying main areas of strong or weak eco-innovation performance in different EU countries (and industries). For communication of this type of scoreboard we intend to use other, more innovative visualisation and presentation formats. Guiding examples are the work undertaken by JRC on sustainability dashboards (see Figure 2 below). These dashboards work with a colour spectrum from green to yellow to red, in order to illustrate the performance of a country related to specific targets (in the example below, these targets refer to the Millennium Development Goals).

Figure 3-7. JRC Dashboards: Example for Millennium Development Goals Index

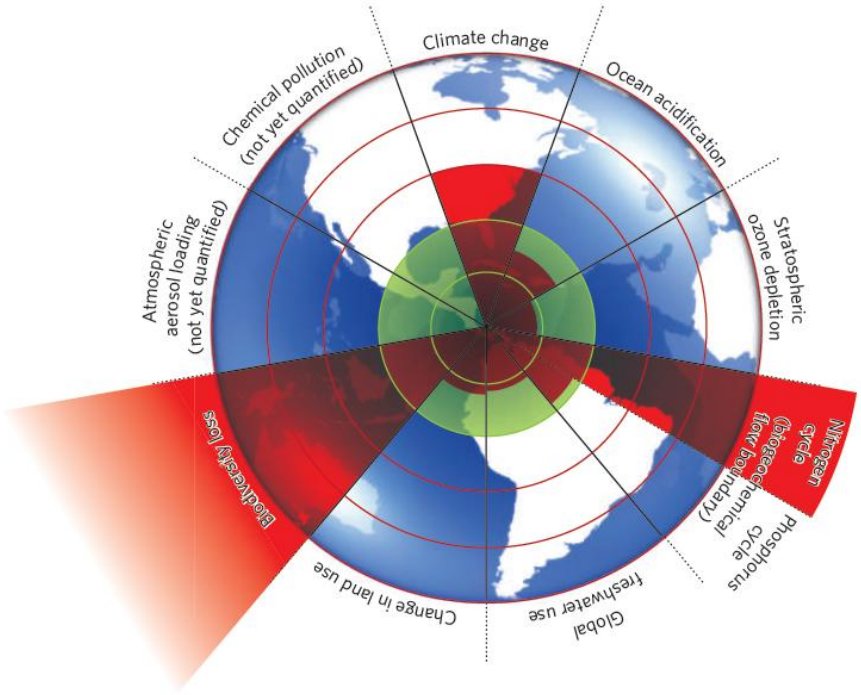


Source: esl.jrc.it/envind/dashbrds.htm

Another example are spider-diagram-like approaches, which allow illustrating multi-dimensional results. An example for the second type is the recently presented indicator set for environmental

thresholds (Rockström et al., 2009). The green area illustrates the respective environmental thresholds. Red areas outside the green boundary illustrate that current environmental pressures are beyond the threshold.

Figure 3-8. Spider-diagram for visualisation of multi-dimensional results



Source: (Rockström et al., 2009)

The discussion paper on the Eco-Innovation Scoreboard prepared for the Committee Meetings in June 2010 will also include a more detailed suggestion on how the different existing visualisation formats will be used, adapted or advanced for the Eco-Innovation Scoreboard.

3.7.2 Reports and briefs

3.7.2.1 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.

3.7.2.2 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.

3.7.2.3 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:

- General profile of the country: economy and environment (0.5 - 1 page)
- Eco-innovation performance (1 – 1.5 page)
- Main barriers and drivers of eco-innovation (1 page)
- Leading eco-innovation areas (including good practices) (1.5 - 2 pages)
- New trends: areas on the rise (including good practices) (0.5 – 1 pages)
- Public policy in support of eco-innovation (1.5 - 2 pages)
- Conclusions and prospects for the future (0.5 page)

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

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

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

The draft version of the detailed annotated country brief template is provided in the Annex II to this report. The annotated country profile template will be finalised following the pilot phase when three briefs will be developed. The final version of the template will be web-based. Country experts 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.

To compliment the template, the methodological manual will be developed to assist the national experts in their work on country briefs. The manual will include detailed 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. Importantly, the manual will have pilot briefs attached as examples of complete work. In addition, the members of the core EIO team will do a diligent quality check of the draft briefs providing tailored comments to the authors.

3.7.2.4 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.

3.7.2.5 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.

3.7.3 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, currently efforts are progressing to enable the use of the **eco-innovation.eu** domain previously adopted by the FP6 Ecodrive project.

Combined with a strong visual identity, based on the DG Environment visual guidelines, and the development of a distinctive EIO logo, the 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’.

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 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 necessary these activities will be ‘moderated’ by a dedicated person from the consortium.

4. Outreach and communication activity

4.1 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 stakeholders 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.

4.2 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.

4.2.1 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.

4.2.2 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.

4.2.3 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.

4.2.4 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.

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

6.1 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.

6.2 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	
				Indicator	Source	Indicator	Source
Socio-economic framework	**Economic performance**	**Economic wealth**	GDP	GDP at market prices (absolute/growth)	EUROSTAT	Value added by sector	EUROSTAT
						Total output by sector	EUROSTAT
		Competitiveness	Competitiveness indices	Competitiveness	WEF	Competitiveness	EU Klems
			Foreign investment	FDI	UNCTAD	Sectoral FDI	UNCTAD / FDI-STAT database
		Employment	Active population	National Labour fource	AMECO		
			Employment rate	National employment rate	AMECO	Sectoral employment rate	ILO
			Unemployment rate	National unemployment rate	AMECO		
	Social aspects	**Population**	Size	Total population (absolute/growth)	EUROSTAT		
			Age	Population by age group	EUROSTAT		
			Household profile	Average size of households	EUROSTAT		
				Income of households			
			Urban/rural	Population in urban agglomerations of more than 1 million	World Bank		
		Education attainment	Higher education	Absolute and share in total	EUROSTAT		
			Secondary education	Absolute and share in total	EUROSTAT		
			Science and engineering	Absolute and share in total			
			Humanities	Absolute and share in total			
		Consumer choices	Attitudes towards waste and recycling	Importance attached to recycling and minimising waste in solving environmental problems	EUROBAROMETER		
			Attitudes towards eco-friendly production and consumption	Importance attached to recycling and minimising waste in solving environmental problems	EUROBAROMETER		
				Importance attached to eco-friendly products in solving environmental problems	EUROBAROMETER		
				Importance attached to buying energy-efficient home appliances in solving environmental problems	EUROBAROMETER		
				Importance attached to transport in solving environmental problems	EUROBAROMETER		
				Importance attached to water use in solving environmental problems	EUROBAROMETER		
				Awareness about the environmental impact of products used or bought	EUROBAROMETER		
		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	EC - DG Communication		
	Infrastructure	**Buildings**	New buildings (net addition to stocks)	New dwellings	EUROSTAT		
		Transport	Length of motorways	Total length of motorways	EUROSTAT		
		Energy	Grid	Length	GENI (national sources)		
				Additional length per year	ENTSO-E		
				Capacity	EUROSTAT		
				Capacity improvement per year	EUROSTAT		
	General regulatory and policy framework	**Demand side**	Income tax	Top personal income rate (%)	EUROSTAT		
			Public procurement	Public procurement (% of GDP)	EUROSTAT		
		Supply side	Equity support (general)	Public subsidies in % of GDP	EUROSTAT		
				Public debts to companies	ECB		
				Share of total financing of public banks on (non-financial)companies	ECB		

Environment	**Resource inputs and consumption**	**Materials**	Material inputs	Direct Material Input (DMI) of countries	EUROSTAT	Direct material input of economic sectors	Possibly: EIO input-output calculations / National studies
				Total Material Requirement (TMR) of countries	Wuppertal Institute / national sources	Total material input of economic sectors	Possibly: EIO input-output calculations / National studies
			Material consumption	Domestic Material Consumption (DMC) of countries	EUROSTAT		
				Total Material Consumption (TMC) of countries	Wuppertal Institute / national sources		
			Physical trade	Physical Trade Balance (PTB)	Derived from DMI and DMC		
				Total Physical Trade Balance	Derived from TMR and TMC		
			Productivity	Direct Material Productivity of countries (GDP/DMI)	Calculation: GDP/DMI	Value added per material input	Possibly: EIO input-output calculations / National studies
				Total Material Productivity of countries (GDP/TMR)	Calculation: GDP/TMR	Total output per material input	Possibly: EIO input-output calculations / National studies
			Primary raw material prices	Metal prices	BGR	Purchasing prices for different raw materials of industries	
				Prices of industrial minerals	BGR		
				Producer prices of crops and lifestock products	FAOSTAT		
				Share of material costs in enterprises			
			Secondary raw material prices	Secondary raw material prices	scrapindex.com		
			Material security	Resource reserves (fossil fuels)	BP		
				Resource reserves (minerals)	USGS		
				Share of imports in DMC/TMC of countries	Derived from DMI/DMC and TMR/TMC	Share of imports in material input of industries	Derived from input indicators
				Share of costs for raw material imports in GDP (%)	Calculated from Eurostat Comext		
				Share of imports of critical raw materials in total raw material imports (%)	Calculated from Eurostat Comext & EC / BGR	Vulnerability of industries	Raw Materials Supply Group
		Energy	Production	Primary energy production of countries per energy source	EUROSTAT		
			Consumption	Gross inland energy consumption, by fuel	EUROSTAT	Final energy consumption, by sector	EUROSTAT
			Renewables	Share of renewables in gross inland energy consumption	EUROSTAT	Share of renewables in final energy consumptio	
			Productivity	Energy intensity of countries	EUROSTAT	Value added per energy consumption	Calculated based on sectoral economic and energy data
						Total output per energy consumption	Calculated based on sectoral economic and energy data
			Energy prices	Electricity Price, domestic consumer	EUROSTAT		
				Electricity Price, industrial consumer	EUROSTAT		
				Natural Gas Price, domestic consumer	EUROSTAT		
				Natural-gas Price, industrial consumer	EUROSTAT		
				Consumer prices of petroleum products	Europe's Energy Portal		
			Energy security	Import Dependency: Share of imports in energy supply of countries	EUROSTAT		
				Diversification (price effects)	Calculations based on IEA		
				Diversification (physical availability)	Calculations based on IEA		
				Share of renewables in gross inland energy consumption	EUROSTAT		
		Water	Consumption	Water consumption of countries	Water Footprint Network	Water abstraction of sectors	EUROSTAT
			Productivity	Water productivity of countries	Calculation GDP/water consumption	Value added per water abstraction	Calculation value added/water abstraction
			Water prices				

	Outputs and emissions	**Emissions**	GHG emissions	GHG emissions of countries	EUROSTAT	GHG emisssions by sector	EUROSTAT
			GHG intensity	GHG emission intensity of countries	Calculation GHG emissions / GDP	Value added per output of GHG emissions	Calculation based on sectoral economic and emission dat
			Carbon prices	Carbon price (EU ETS)	European Climate Exchange		
		Waste	Industry / construction waste	Waste generated	EUROSTAT	Waste generated by sector	EUROSTAT
			Household waste	Waste generated (absolute / per capita)	EUROSTAT		
			Hazardous waste	Waste generated (absolute / percentage of total waste)	EUROSTAT	Hazardous waste generated by sector	EUROSTAT
		Recycling	Municipal waste	Recycling Quota (percentage of generated amount)	EEA ETC/SCP	Recycling Quota	
			Construction and demolition waste	Recycling Quota (percentage of generated amount)	EEA ETC/SCP		
				Share of secondary materials in production	World Bureau of Metal Statistics	Share of secondary materials in production	Prognos AG
Innovation	**Innovation inputs**	**Finance and investments**	Overall R&D funding (GERD)	R&D expenditures as % of GDP	EUROSTAT (R&D statistics)		
			Government funding	R&D expenditures by government (% of GERD)	EUROSTAT (R&D statistics)		
				% companies that received public financial support for innovation from local, central government, and EU (yes/no for each source)	CIS - 2008 (Q5.3)	% companies that received public financial support for innovation from local, central government, and EU (yes/no for each source) sectoral division	CIS - 2008 (Q5.3)
			Expenditures by universities and research institutes	R&D expenditures by higher education institutes (% of GERD)	EUROSTAT (R&D statistics)		
			Business expenditures on innovation	R&D expenditures by business enterprise (% of GERD)	EUROSTAT (R&D statistics)		
				Average per/ company expenditures for in house R&D, purchase of external R&D, acquisition of soft&hardware, acquisition of external knowledge (EUR)	CIS - 2008 (Q5.2)	Average per company per sector expenditures for in house R&D, purchaise of external R&D, acquisition of soft&hardware, acquisition of external knowledge (EUR) sectoral division	CIS - 2008 (Q5.2)
			Expenditures by private non-profit	R&D expenditures by privat non-profit (% of GERD)	EUROSTAT (R&D statistics)		
			Venture and risk capital	% of environment-related investment; absolute amount of environment-related investment	EVCA	% of environment-related investment; absolute amount of environment-related investment (sectoral level)	EVCA
				Early stage and expansion statistics (% of DGP)	OECD S&T scoreboard		
		Human resources	Educational attainment	Education inflow (graduation and participation) from the eductation system (total numbers)	EUROSTAT (HRST section), UNESCO/OECD	Education inflow in some domains of study (total numbers/domain/country)	EUROSTAT (HRST section)
			Knowledge workers	Human resources in S&T (stocks, job-to-job mobility, census data)	EUROSTAT (HRST section), UNESCO/OECD	Human resources in specific areas of S&T (stocks, job-to-job mobility, census data)	EUROSTAT (HRST section)
			Innovation training	Share of firms with training for innovative activities (%/country)	CIS 2008 (Q 5.1)	Share of firms with training for innovative activities (%/sector/country)	CIS 2008
	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)	CIS 2008 (Q 7.1)	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 (% in each scale category: low-high/ not)	CIS 2008 (Q 7.1)	Share of firms aiming to replace outdated products or processes (% in each 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)	CIS 2008 (Q 7.1)	Share of firms targeting new markets (% in each scale category:low-high/not sector level)	CIS 2008
			Increase market share	Share of firms aiming to increase market share (% in each scale:low-high/not)	CIS 2008 (Q 7.1)	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)	CIS 2008 (Q 7.1)	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)	CIS 2008 (Q 7.1)	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)	CIS 2008 (Q 7.1)	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)	CIS 2008 (Q 7.1)	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)	CIS 2008 (Q 7.1)	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)	CIS 2008 (Q 8.2)	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)	CIS 2008 (Q 8.2)	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)	CIS 2008 (Q 8.2)	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)	CIS 2008 (Q 8.2)	Share of firms reducing costs per unit output (% in each scale category:low-high/not, sector level)	CIS 2008
				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)	CIS 2008 (Q 8.2)	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)	CIS 2008 (Q5.2)	In-house R&D by firms (EUR/sector/country)	CIS 2008
				External R&D	Purchase of external R&D by firms (EUR/country)	CIS 2008 (Q5.2)	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)	CIS 2008 (Q5.2)	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)	CIS 2008 (Q5.2)	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)	CIS 2008 (Q5.1)	Share of firms providing training for personnel for innovative activities (%/sector/region/country)	CIS 2008
				Market introduction of innovations	Share of firms implementing activities for market introduction of new & improved products (%/country)	CIS 2008 (Q5.1)	Share of firms implementing activities for market introduction of new & improved products (%/sector/region/country)	CIS 2008
			Collaboration patterns	Collaboration partner	Number and share of firms collaborating with enterprises, clients, Universitys, etc. in EU, US, China/India, etc.	CIS 2008 (Q6.1, 6.3)	Share of firms collaborating with enterprises, clients, Universitys, etc. in EU, US, China/India, etc. (sectoral/regional level)	CIS 2008
				Information source	% of companies declaring a source according to the level of importance (scale:high-medium-low) (% / country)	CIS 2008 (Q6.1)	% 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 introducing new/improved good and service (% /country)	CIS 2008	Share of firms with product innovations (% /sector/ region/country)	CIS 2008
				Process	Share of firms with process innovations (% / country)	CIS 2008 (Q3.1,3.2 3.3)	Share of firms with process innovations (% /sector/ region/ country)	CIS 2008
				Organisational	Share of firm with organizational innovation (%/ country)	CIS 2008 (Q8.1, 8.2)	Share of firm with organizational innovation (%/ sector/ country)	CIS 2008
				Marketing	Share of firms with marketing innovations (% / country)	CIS 2008 (Q9.1, 9.2)	Share of firms with marketing innovations (% / sector/ 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)	CIS 2008	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 ligistics and distribution methods (%/country)	CIS 2008	Share of firms that improved ligistics and distribution methods (%/sector/ country)	CIS 2008
				New or significantly improved supporting activities	Share of firms that significantly improved supporting activities (%/ country)	CIS 2008	Share of firms that significantly improved supporting activities (%/sector/ 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)	CIS 2008 (Q 8.2)	Share of firms expecting (as a results of new bsiness practices) reduced time, improved ability, improved product quality, improved service , reduced cost, improved communication/information sharing (% / 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)	CIS 2008 (Q 8.2)	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 (% / 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)	CIS 2008 (Q 8.2)	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
			Knowledge creation (IPR)	EPO patents	Number of patents (per mln population)	EUROSTAT (EPO)	Number of patents in specific areas/sectors (total and per capita)	EPO, EUROSTAT
				Community trademarks	Community trademarks per million population	OHIM/EUROSTAT		
				Community designs	Community designs per million population	OHIM/EUROSTAT		
				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)
			Sales and exports	New-to-market sales	New-to-market sales (% of turnover)	EUROSTAT (Eur Innov-Scoreboard)		
				New-to-firm sales	New-to-firm sales (% of turnover)	EUROSTAT (Eur Innov-Scoreboard)		
				Medium and high tech exports	Medium and high tech exports (EUR, share in total exports)	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)	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
					Demand for innovative products and services in the cluster (country level)	Eurobarometer/ Innobarometer on Clusters	Demand for innovative products and services in the cluster (sectoral division: hightech, lowtech, knowl intensive, less knowledge intensive)	Eurobarometer/ Innobarometer on Clusters
					Perception towards uncertainty in technology/innovation fields (national statistics)	Eurobarometer	Perception towards uncertainty in technology/innovation fields (sectoral statistics)	Eurobarometer

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			
				Public expenditures for environmental related R&D, % of GDP			
			Business funding on environmental R&D	Business expenditures for eco-innovation related R&D	EUROSTAT		
			Government funding on eco-innovation	Public expenditures for eco-innovation related R&D, % of total R&D		Size of eco-innovative R&D activities on public financed universities and research institutes	
				Public expenditures for eco-innovation related R&D, % of GDP			
				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)	EVCA	Sector specific value of new investments in green early stage investments (green funds, venture capital, private equity)	EVCA
				Share of green lending of banks on total lending	EIB, Worldbank		
		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-industries	Studies by Ecotec, Ernst & Young, Ecorys
			Knowledge workers in eco-industries	Shares of knowledge workers (R&D personnel plus knowledge-intensive services) in total workforce by country	EUROSTAT	Shares of knowledge workers (R&D personnel plus knowledge-intensive services) in eco-industries by country	EUROSTAT
			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	DG Environment	EMAS certificates per sector	DG Environment
				ISO 14001 certificates per country	ISO	ISO 14001 certificates per sector	ISO
				% companies with procedures in place to regularly identify and reduce environmental impacts	CIS (Q10.3)	% companies with procedures in place to regularly identify and reduce environmental impacts (sectoral level)	CIS (Q 10.3)
	Eco-innovation process	**Eco-innovation activity**		Share of innovators participating in eco-innovation	CIS (chapter 5; Q 10.1)		CIS (chapter 5; Q 10.1)
				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.	CIS	Number and share of eco-innovative firms collaborating with enterprises, clients, Universitys, etc. in EU, US, China/India, etc. (sectoral/regional level)	CIS
			Information source	% of companies declaring a source according to the level of importance (scale:high-medium-low) (% / country)	CIS	% of eco-innovative companies declaring a source according to the level of importance (scale:high-medium-low) (sectoral level)	CIS

	Outputs and impacts of eco-innovation	**Eco-innovations (types)**	Product	Derived indicators based on CIS and other sources (indicator to be determined)	CIS (section 10 & previous section in questionnaire); EEA & OECD data, plus technology studies, etc.		
			Process	Derived indicators based on CIS and other sources (indicator to be determined)	CIS (section 10 & previous section in questionnaire); EEA & OECD data, plus technology studies, etc.		
			Organisational	Derived indicators based on CIS and other sources (indicator to be determined)	CIS (section 10 & previous section in questionnaire); EEA & OECD data, plus technology studies, etc.		
			Marketing	Derived indicators based on CIS and other sources (indicator to be determined)	CIS (section 10 & previous section in questionnaire); EEA & OECD data, plus technology studies, etc.		
			Material flow innovation	Derived indicators based on different sources; Priorisation of materials	Mix of data from different sources		
		Environmental benefits from process eco-innovation (from the production of goods and services)	Reduced material input	% companies with innovations leading to reduced material input	CIS 2008 (Q 10.1)	% 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	CIS 2008 (Q 10.1)	% companies with innovations leading to reduced energy input (sectoral level)	CIS 2008 (Q 10.1)
			Reduced CO2 emmissions	% companies with innovations leading to reduced CO2 emissions	CIS 2008 (Q 10.1)	% 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	CIS 2008 (Q 10.1)	% 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	CIS 2008 (Q 10.1)	% 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	CIS 2008 (Q 10.1)	% companies with innovations leading to increased recycling (sectoral level)	CIS 2008 (Q 10.1)
		Environmental benefits from the use of goods or service	Reduced energy use	% companies with innovations leading to reduced energy use	CIS 2008 (Q 10.1)	% 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	CIS 2008 (Q 10.1)	% companies with innovations leading to reduced pollution (sectoral level)	CIS 2008 (Q 10.1)
			Improved recycling of product after use	% companiess with innovations leading to increased recycling	CIS 2008 (Q 10.1)	% companiess 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 for specific technologies	OECD		
			Community trademarks	Trademarks per 1000 population	OHIM		EUROSTAT (on NACE level)
			Community designs	Designs per 1000 population	OHIM		EUROSTAT (on NACE level)
			Publications	Number of publications in eco-technologies and eco-innovation fields	Web of Science, Scopus, Thompson (?)		
	Eco-innovation market structure	**Eco-industries**	Size of eco-industry markets			Size and development of eco-industry markets	Studies by Ecotec (2002), Ernst & Young (2006), Ecorys (2009); based on Eurostat
						Cumulative average growth of eco-industry markets	Eurostat; further sources to be defined based on seleted market
			Turnover			Turnover in eco-industry markets	Studies by Ecotec (2002), Ernst & Young (2006), Ecorys (2009); based on Eurostat
			Competitive advantage			Revealed comparative advantage of eco-industry markets	UN Comtrade

						Fixed assets (in green sectors, NACE level) / gross value added	Eurostat (on NACE level)
						Debt capital ratios of green sectors (Debt capital ./. Fixed assets)	Eurostat, ECB (on Nace level)
			New-to-market sales (eco-products, material flow innovation etc.)	Average share of new-to-market sales (in eco-industries), on the product level	Derived from CIS (section 2.3), plotting this section with eco-innovation section		On NACE level
			New-to-firm sales (eco-products, material flow innovation etc.)	Share of new-to-firm sales (in eco-industries), on the product level	Derived from CIS (section 2.3), plotting this section with eco-innovation section		On NACE level
			Medium and high tech exports (eco-industry)	Indicator to be determined	EUROSTAT		
			knowledge intensive services exports	Indicator to be determined	EUROSTAT		
		Eco-innovative firms	Global share	Shares of all companies	CIS (plot it with eco-innovation section)	Shares of sectors	CIS
			Sectoral shares	Shares of all companies	CIS (plot it with eco-innovation section)	Shares of sectors	CIS
			Start-ups		EUROSTAT/ National sources / European Business Register?	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 (%)	Eurobarometer		
			Public awareness of environmental problems	Level of feeling informed about environmental problems	Eurobarometer		
			Perception of "green brands" by consumers	Importance of eco-labels in purchasing decisions (% of citizens)	Eurobarometer		
		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	OECD		
			Corporate Social Responsibilty (CSR) and other voluntary codes	Percentage of companies with CR reports	KPMG		
	Regulatory and policy framework of eco-innovation	**Supply-side measures relevant to eco-innovation**	Equity support for eco-innovation	Monetary supply for Venture Capital Funds investing in eco-innovation	European Commission / CIP		
			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	European Commission / CIP		
			Support for eco-innovation PPPs (public-private partnerships)		EUROSTAT / OECD database on policy measures / Country reports (by experts)		
			Specific advisory services on eco-innovation for enterprises	Yes / no indicator	Country reports (by experts) / EUROPE INNOVA		
		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	Pricewatherhouse Coopers (PwC)		
			Eco-innovation TT (Technology transfer)				
		Eco-innovation policy intelligence	Monitoring eco-innovation related policy impacts	Evaluation of policy impacts on eco-innovation on country level	National sources/studies to go into EIO library		
			Existing databases on environmental impacts of enterprises and industry	Information for links section on EIO website	Various sources (to be collected along the way)		EIPRO project, EXIOPOL project, National studies

Annex II. Draft template of the EIO country brief

Part 1. General profile of the country: economy & environment (0.5 – 1 page)

This part is an introduction providing background information about the country and its economic and innovation performance. It overviews its major economic sectors, natural resources, major environmental issues that are related to resource use and pollution as well as main national goals in addressing these environmental problems. This will be done in light of the comparison with the situation in other EU countries.

The information will mostly be done in a descriptive form without involvement of graphs and tables. The main source of information is national (e.g. reports of Ministries of Environment, Environmental Agencies, etc.)

Part 2. Eco-innovation performance (1 – 1.5 page)

This section will overview the national eco-innovation performance based on the country level data. The data will be sourced from the EIO database as well as selected results of horizon scanning and eco-innovation road mapping. This part can also benefit from national data sources identified by the country experts.

The eco-innovation performance and trends will be presented in graphs, charts and tables, most of which will be centrally developed by the EIO team. The briefs will share the same charts representing the performance of a country in the Eco-Innovation Scoreboard. The annotated template will have clear instructions and examples of the graphs/charts/tables to be designed by the country experts.

Apart from the uniform charts, depending on their availability across countries the following indicators will be made available through the database to the country correspondents:

Resource efficiency:

- Resource and Energy use & intensity
- Import dependency in major material & energy resources
- Resource access vulnerability
- Waste and recycling

- Prices of raw materials

R&D and technological capabilities in eco-innovations:

- R&D outputs (patents, publications, trademarks)
- R&D investment by government and business
- Human capital relevant to eco-industries (number of graduates from eco-industry related fields)
- Eco-industry share, turnover, competitive advantage

Firm level eco-innovation (based on CIS survey data):

- Reduction of material use
- Reduction of energy use
- GHG emissions
- Adoption of environmental management instruments

Part 3. Main barriers and drivers of eco-innovation (1 page)

Analysis and description of the determinants of eco-innovation performance will provide the explanation of the country performance. The approach will be based on the framework and methodology developed by the project leaders and described in the methodological manual.

The framework will include the analysis of the following categories of determinants:

- Economic capital
- Technical and technological capital
- Natural capital
- Social capital
    - Human and knowledge capital
    - Organisational capital
    - Network capital
    - Cultural capital
- Regulatory and policy framework (legal system, standards and norms, IPR law, fiscal policies, public procurement, etc)

The preliminary sources of information for the analysis will be the project database; in particular the indicators on drivers and barriers (based on CIS survey data). The interviews and consultations with national experts, eco-industry 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.

*Part 4. Leading eco-innovation areas (*1.5 – 2 pages)

The aim of this section is to present the leading eco-innovation areas in the country. This will include the rationale behind the selection as well as descriptions of several good eco-innovation practices implemented in the area. The leading areas should be selected based on their performance in resource and energy productivity as well as in regards to market penetration, cost savings, user acceptance, etc.

The good practices can be the most innovative and/or most successful eco-innovative products and services, technologies, or organisational changes. Policies, instruments, as well as other drivers of the success of these cases will be discussed. Institutes and companies involved in R&D and marketing will be mentioned in the description. Additionally the clusters with particular eco-innovative potential can be described too. The final country brief template will include a format for a good practice description.

The national eco-innovation profile developed in part 2 and the eco-innovation scoreboard will help to indicate the leading areas. The leading areas should be selected based on evidence in professional journals and reports. The text should be accompanied with pictures and interesting quotations.

Part 5. New trends: areas on the rise (0.5 - 1 pages)

This section will present a brief analysis of new market trends in a particular country, with specific focus on promising areas of eco-innovations and emerging lead markets.

The analysis will be based on national studies as well as supported by the results of EIO foresight activities (WP3). This work will be based on a review of national information sources, foresight studies, and interviews with key experts. The country experts will receive clear instructions on how to use and draw analysis from EIO data from the horizon scanning, market trends data, Real Time Delphi survey and Road Mapping exercises.

Several examples of emerging eco-innovations will be described in more detail (they can be presented in boxes within the text). The final country brief template will include a format for this description.

Part 6. Public policy in support of eco-innovation (1.5 -2 pages)

This section will provides a brief overview of:

- Key national strategies promoting eco-innovations, including ETAP roadmaps;
- The most relevant national measures supporting eco-innovations including regulatory and market based instruments promoting eco-innovation development and application.

Where possible, the text will refer to results, as well as to environmental, economic, and social impacts of the programs and instruments.

The information will be collected from national sources as well as from international databases held by OECD, PRO-INNO Trend-Chart, ERAWATCH (support measures database). Additionally there might be other resources identified by the country experts. In presenting the results the interesting cases can be highlighted in boxes.

Conclusions (0.5 page)

This section will summarise the main highlights of the brief. It will provide benchmarking with average EU performance in eco-innovation (this will be done through narrative, without presenting any graphs or tables). It will also present conclusions with policy suggestions based on the analysis of barriers and drivers, best practices and foresight analysis.

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