Eco-innovation - putting the EU on the path to a resource and energy efficient economy

Bleischwitz, Raimund

Wuppertal Institute

March 2009

Wuppertal Institute
for Climate, Environment
and Energy

SERI
Sustainable Europe
Research Institute

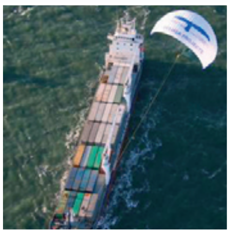
cscp
UNEP/WUPPERTAL INSTITUTE COLLABORATING
CENTRE ON SUSTAINABLE
CONSUMPTION AND PRODUCTION

10
Factor Ten Institute

Raimund Bleischwitz
Stefan Giljum
Michael Kuhndt
Friedrich Schmidt-Bleek
et al.

Eco-innovation – putting the EU on the path to a resource and energy efficient economy

WUPPERTAL SPEZIAL 38



EP administrators name: Ms. Camilla Bursi
Policy Department Economy and Science
DG Internal Policies
European Parliament, Rue Wiertz 60 - ATR 00L0xx, B-1047 Brussels

Only published in English.

Authors:
Wuppertal Institute for Climate, Environment and Energy
Prof. Dr. Raimund Bleischwitz (Coordination and lead chapter 4)
Mail: raimund.bleischwitz@wupperinst.org
Bettina Bahn-Walkowiak
Dr. Wolfgang Irrek
Dr. Phillip Schepelmann

Factor 10 Institute
Prof. Dr. Friedrich Schmidt-Bleek (Lead Chapter 5)

SERI Nachhaltigkeitsforschung und Kommunikations GmbH
Dr. Stefan Giljum (Lead Chapter 2)
Stephan Lutter
Lisa Bohunovski
Dr. Friedrich Hinterberger

UNEP/Wuppertal Institute Collaborating Centre
on Sustainable Consumption and Production gGmbH (CSCP)
Elizabeth Hawkins
Michael Kuhndt (Lead Chapter 3)
Dr. Nadine Pratt

Manuscript completed in March 2009.

Cover: VisLab Wuppertal Institue

ISBN: 978-3-929944-77-8

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF BOXES

EXECUTIVE SUMMARY

The objective of this study is to support the European Parliament's ITRE Committee in its work on the EU's industrial and energy policy and to give advice on the following issues: Why is the issue of resource scarcity back on the agenda? What are the strategic conclusions for the EU? What can the EU expect from eco-innovation in a large range of industrial sectors? Are existing measures meeting the EU aims and expectations, and what new policy initiatives should be set forward? To meet these objectives, this study is structured as follows: Chapter 2 will give an overview on resource scarcities. Chapter 3 elaborates on eco-innovation, including trends, barriers and driving forces. Chapter 4 outlines proposals for future EU policies. Chapter 5 sketches out a possible vision for the future.

Chapter 2 reveals recent findings on resource scarcity:
Global extraction of natural resource is steadily increasing. Since 1980, global extraction of abiotic (fossil fuels, minerals) and biotic (agriculture, forestry, fishing) resources has augmented from 40 to 58 billion tonnes in 2005. Scenarios anticipate a total resource extraction of around 80 billion tonnes in 2020 (200 % of the 1980-value), necessary to sustain the worldwide economic growth.
On average, a European consumes per year around three times the amount of resources of a citizen in the emerging countries while producing twice as much.
Analysis on patterns of current resource use (direct and indirect use) is still in its infancy and shows data gaps. Based on country studies, however, one can arrive at tentative conclusions. A recent study on Germany reveals that ten production sectors account for more than 50 % of German Total Material Requirements (TMR). Industries of three areas are of strategic importance because here a huge number of technological interactions among production sectors take place:

- Stones, construction, and housing = housing
- Metals and car manufacturing = mobility
- Agriculture, food and nutrition = food.

The rapidly increasing demand for resources has led to an unprecedented boost in resource prices, especially during the last five years until the breakout of the financial crisis in Fall 2008.
The EU is the world region that outsources the biggest part of resource extraction.
In comparison to the overall global growth rate (45 % over the last 25 years), Europe's resource extraction grew only by 3 %, but studies show that these domestic raw materials are increasingly substituted by imports from other world regions.
World reserves in fossil fuels and metals are unevenly distributed across the world regions. Additionally, for various commodities, the peak of extraction has already been reached or is currently about to be reached. Not only for oil and gas, but also for critical metals such as Antimon, Gallium, Indium, Platinum and others the supply for European industry is at risk. Natural gas cannot replace oil as main energy source, once the latter is depleted.

From this, the following main conclusions are derived:

- The European economy is increasingly dependent on resource imports from other world regions.
- Scarcity of 'Critical metals' will affect the European economy more subtle, but further-reaching. High-tech industries, in particular the electronic industry, will be affected by de-

clining availability of precious metals. Also the development of new eco-technologies, such as photovoltaic electricity generation, could be slowed down by resource scarcity.

- It can be expected that worldwide competition for these resources will significantly increase in the near future, potentially leading to serious conflicts related to the access to resource reserves.
- In order to deal with this increased scarcity of natural resources, a significant reduction of the worldwide resource use will be necessary.

Chapter 3 gives a definition of eco-innovation as well as an overview of different types of eco-innovation and deals with measurement issues. Furthermore, it illustrates selected eco-innovations in key areas, and highlights also trends, drivers and barriers analysed for these examples and illustrated by fishbone diagrams. The scrutinised eco-innovations and the regarding key conclusions are

(1) In the area of housing
  a. "Deep Renovation", which enables a minimisation of negative impacts on environment and health by system design and choice of components and is possible in nearly every building, though standardisation is limited, and
  b. "Smart Metering", for which there is worldwide evidence that giving consumers appropriate, relevant information on their energy and water use is an important basis for additional measures leading to a reduction in this use and thus in GHG emissions.

(2) In the area of mobility
  a. the "Green Electric Car" and
  b. "Car sharing";

(3) In the area of food and drink
  (a) the "Community Supported Agriculture" (CSA) and
  (b) "Sustainable Sourcing of Retailers".

The chapter concludes that eco-innovation has a crucial role to play in putting the EU on the path to a resource and energy efficient economy and thus significantly reducing the environmental impacts in each of the areas, housing, mobility and food and drink. Experts estimate that this is likely to become an $800 billion market worldwide by 2015 and a $ trillion market afterwards.

Overcoming the barriers and building up eco-industries for energy and resource efficiency however calls for an active European Union. It requires the engagement of many different actors in society, and strategies should be implemented from many different sides. For an eco-innovation to be fully accepted and diffused into wider society, a concerted effort must be made to engage people and target the emotional and psychological aspects required to reinforce its uptake.

Chapter 4 (How to speed up eco-innovation in the EU) undertakes an attempt to analyse existing EU policies and initiatives; selected member states' efforts are also considered. This is done via a comparative methodology with a joint format. The annex to this study contains three further briefing notes on this issue written by other authors. The following policies, initiatives and instruments are considered in this study:

- The Eco-design Directive (2005/32/EU) – focuses on energy use for a number of products and neglects other environmental dimensions, functional innovation and system innovation are not yet covered;

- The Competitiveness and Innovation Framework Programme (CIP) – first experience suggests a bias in favour of recycling technologies and energy along existing technology trajectories, less visibility of resource efficiency and new pathways;
- The Seventh Framework Programme for research and technological development (FP7);
- The Environmental Technology Action Plan (ETAP) – Despite many achievements, environmental technologies still remain a niche market; further green procurement, greater financial investments, the establishment of technology verification and performance targets systems, and focussing on sectors with high gains is needed;
- The Directive on the energy performance of buildings (EPBD) – good ambitions, but a lack of implementation in many Member states, implementation requires both a speeding up and a scaling up, addressing the resource efficiency of buildings is desirable;
- The European Union Action Plan on Sustainable Consumption and Production and Sustainable Industrial Policy
- The European Directive on Waste from Electrical and Electronic Equipment (WEEE)
- The UK Aggregates Levy and Aggregates Levy Sustainability Fund (ALSF)
- Environment-driven Business Development in Sweden
- The European Union Energy Label.

The analysis identifies specific gaps in the areas of entrepreneurship, pre-commercialisation and mass market development; in addition, the opportunities to refurbish buildings in Europe have not fully been deployed yet (see Figure 1). Based on this and supported by an expert workshop conducted by the ITRE on 12 November 08, the study formulates proposals that could support the EU to speed up eco-innovation. They promote market-based incentives and the reform of existing initiatives; in addition, new proposals are presented that address specific gaps in the areas of entrepreneurship, pre-commercialisation as well as the opportunities to refurbish buildings in Europe.

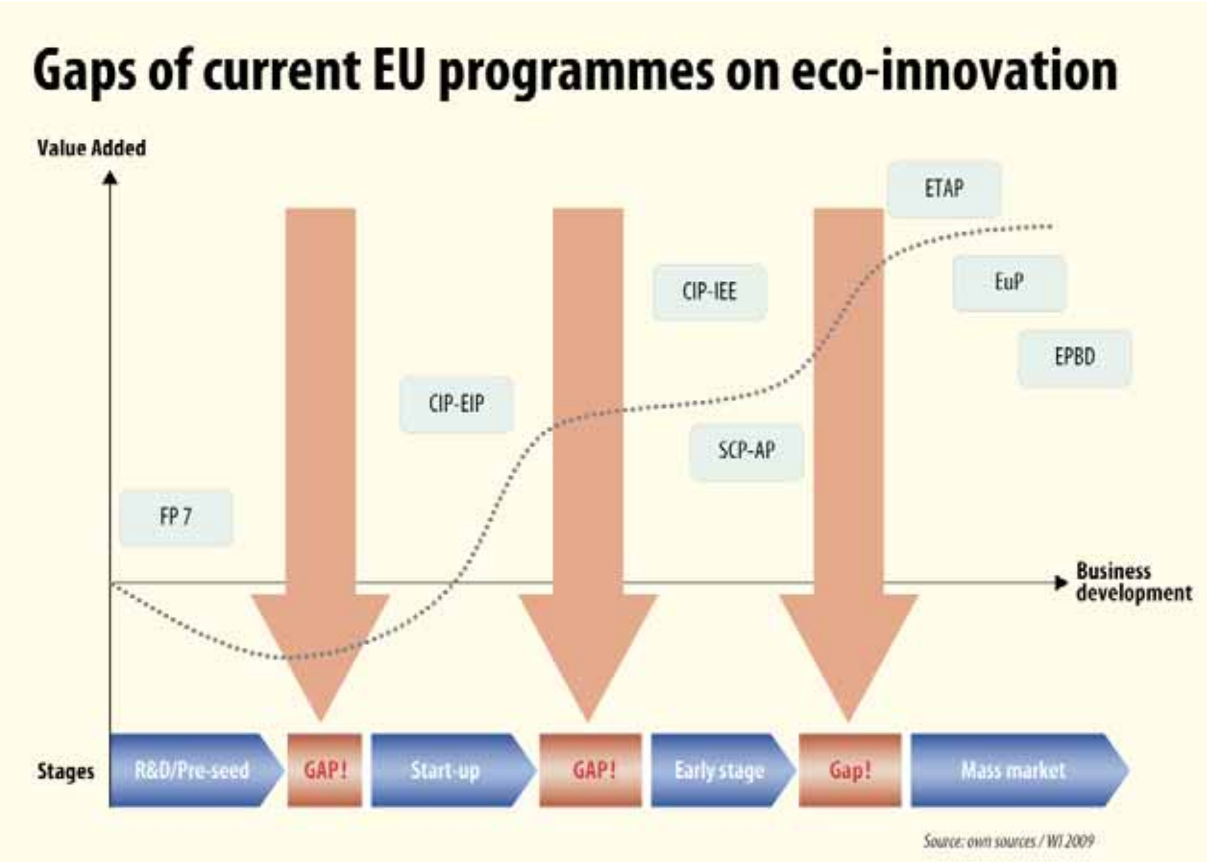
Bearing in mind the importance of construction as a driving forces of resource use, the relevance of the construction industry in the EU Lead market Strategy and current deficits, and the overall success of market-based instruments, this study proposes to extend the existing eco-tax base in Europe by establishing a **minimum tax directive on construction minerals**. It is expected to drive up eco-innovation because it gives incentives to improve resource efficiency and to refurbish old buildings. In addition, it generates revenues, which can be utilized for specific eco-innovation programmes.

A **greening of the EU budget** would be the material basis for speeding up eco-innovation beyond 2009. This would have to follow two strategic lines: on the one hand unsustainable spending would have to be cut, on the other hand the money saved by this activity could be shifted to support investments in structural eco-innovation. A budgetary strategy could include the following elements:

- Further redirecting CAP from direct payments towards integrated rural development schemes, which support eco-innovation in the area of sustainable production of high-quality food and biomass. These integrated rural development schemes should include integrated logistical, economic and technological strategies for adapted sustainable natural resource management in the landscape (food, water, soil, biodiversity and closed-loop biomass production and use). These strategies would have to be highly adapted to local economies and landscape conditions thus inducing local eco-innovation and employment schemes.

* Rigorous environmental appraisal and reduction of Regional Policy schemes for large infrastructure projects which could support long-term unsustainable development paths, shifting towards funding for eco-innovation e.g. in the area of decentralized electricity grids (supporting green electric cars and renewable energies) and lighthouse projects on resource efficient construction and resource recovery.
* Redirection of Regional Funds from end-of-pipe technologies towards integrated solutions and eco-innovation (e.g. decentralized water treatment)
* More advanced schemes for improving energy and material productivity of economies would require an implementation of the CREST guidelines for improved coordination between Structural Funds, the Research Framework Program and the Competitiveness and Innovation Programme (CIP). Only such a concentration of forces could achieve a measurable improvement of resource productivity in Europe by means of regional eco-innovation clusters and a European network of regional resource efficiency agencies.
* Integration spending of the European Investment Bank (EIB) for improved co-financing of eco-innovation

Figure 1: Gaps of current EU programmes on eco-innovation



Engaging industry in developing eco innovation for sustainable ways of living is considered to be essential. The study identifies six strategy areas where industry can act:

1. Strategy Area 1: Creating and satisfying demand for green and fair products
2. Strategy Area 2: Communicating for low impact product use
3. Strategy Area 3: Innovative after sales services
4. Strategy Area 4: Product and service innovations

5. Strategy Area 5: Service-oriented business models
6. Strategy Area 6: Leadership for social change and socially responsible business

The study formulates proposals to strengthen the **SCP Action Plan** accordingly, with a special focus on a framework for smarter consumption and leaner production. green public procurement and international processes.

Following the gaps identified above, the study also proposes to establish three new initiatives:

- **A European Trust Funds for Eco-Entrepreneurship**, intended to support system innovation driven by new companies;
- **A Technology Platform for Resource-light industries**, intended to develop new markets for European manufacturing industries;
- **A Programme to foster energy and resource efficiency in the building sector**, intended to foster
- The deployment of existing opportunities in that area.

Finally, a few thoughts are given to the international dimension of eco-innovation and a possible vision of an eco-innovative Europe.

1. BACKGROUND AND SCOPE

Evidence is growing that pressure on the availability of natural resources is causing a strain on the environment as well as affecting our economy. The inefficient resource-use at a time of growing demand is leading to increasing environmental pressure and resources scarcity that will affect Europe and other parts of the world over the next years and decades. Prices for global commodities like oil, raw materials and wheat have been increasing over the past five years though the current financial crisis has temporarily led to lowering demand for natural resources.

Achieving resource efficiency and a low carbon society are key challenges for the future of EU's economy, its industrial and service sector, and its citizens. Increasing energy and resource efficiency will lead to lowering material purchasing costs throughout the industry. It thus enhances competitiveness and offers opportunities to innovate. Eco-innovation – putting the EU on the path to a resource and energy efficient economy – can be seen as a key to enhancing Europe's strategic position on world markets of tomorrow. In this regard, the current bail out of the financial crisis ought to be seen as a starting point for the build up of eco-innovation and eco-industries in the EU.

The objective of this study is to support the Committee on Industry, Research and Energy in its work on the EU's industrial and energy policy and to give advice on the following issues:

- What EU policies are needed for the EU to on the one hand reduce its needs for resources and energy and on the other hand through eco-innovation create solutions, which will also drive innovation in a large range of industrial sectors?
- Are existing measures delivering the set objectives and what improvements/ new instruments should be set forward?

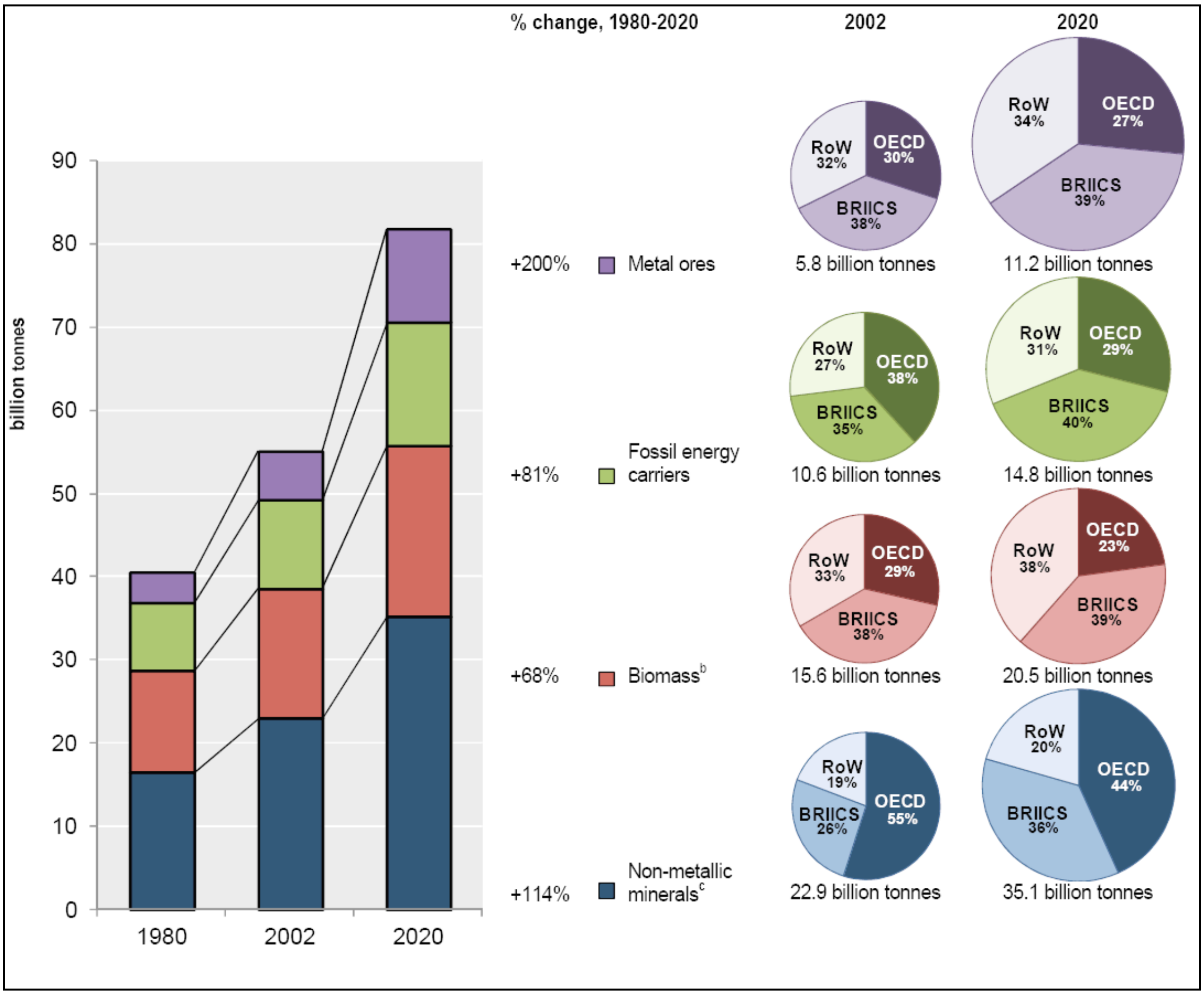
To meet these objectives, this study is structured as follows: Chapter 2 will give an overview on resource scarcities. Chapter 3 elaborates on eco-innovation, including trends, barriers and driving forces. Chapter 4 develops proposals for EU policies.

2. Resources scarcity

2.1. Scenarios of possible resource scarcities (including energy)

Global extraction of natural resource is steadily increasing. Since 1980, global extraction of abiotic (fossil fuels, minerals) and biotic (agriculture, forestry, fishing) resources has augmented from 40 to 58 billion tonnes in 2005. Scenarios anticipate a total resource extraction of around 80 billion tonnes in 2020 (200 % of the 1980-value), necessary to sustain the worldwide economic growth (Giljum et al., 2008). Depending on the level of economic development, trade patterns and industrial structures, growth rates and extraction intensities vary between different world regions, as illustrated in Figure 1 for the three regions of OECD, the BRIICS countries (Brazil, Russia, India, Indonesia, China and South Africa), and the rest of the world. Strongest growth will be observed in the BRIICS countries, while the share if the OECD countries in total global resource extraction will shrink.

Figure 2: Global resource extraction, by major groups of resources and regions

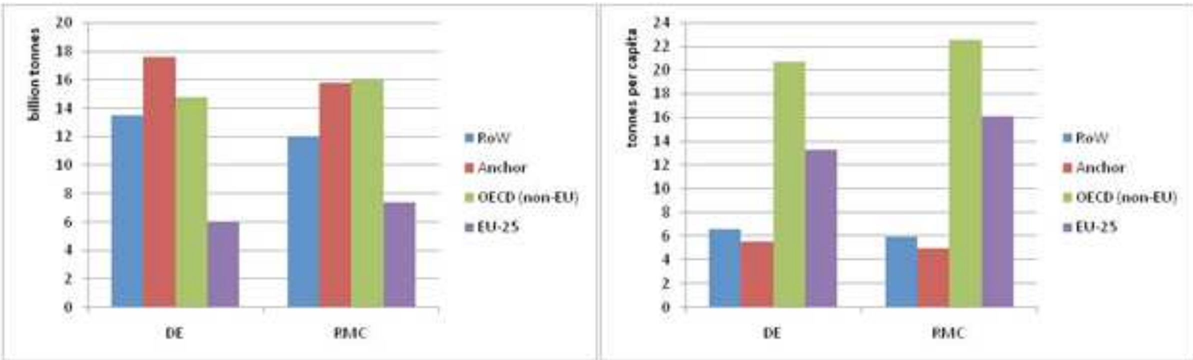


Source: OECD (2008), based on SERI MFA database at http://www.materialflows.net and Giljum, et al. (2008)

The European economy is increasingly dependent on resource imports from other world regions. In comparison to the overall global growth rate (45 % over the last 25 years), Europe's resource extraction grew only by 3 %, but studies show that these domestic raw materials are increasingly substituted by imports from other world regions. Latin America, for instance, is specialising noticeably in the export of resource-intensive products, such as metal ores or biomass for biofuels. In 2005, Chile extracted fivefold the amount of copper of 1980, Brazil threefold the amount of sugar cane – being the raw material for ethanol fuel.

On the one hand, this development leads to a considerable dependency of Europe on the imports of other countries, which may put industry at risks of higher prices and more difficult access. On the other hand, it also leads to an "outsourcing" of the environmental burden, connected to resource extraction and processing activities to other world regions. The statement just made can be illustrated by comparing the indicators of Domestic Extraction (DE) and Raw Material Consumption (RMC) of natural resources in different world regions. While DE illustrates, where the resources are extracted, RMC shows where the products are finally consumed, which are produced based on the extracted resources.

Figure 3: Domestic Extraction (DE) and Raw Material Consumption (RMC) in different world regions (absolute numbers, left diagram and per capita, right diagram), in 2000

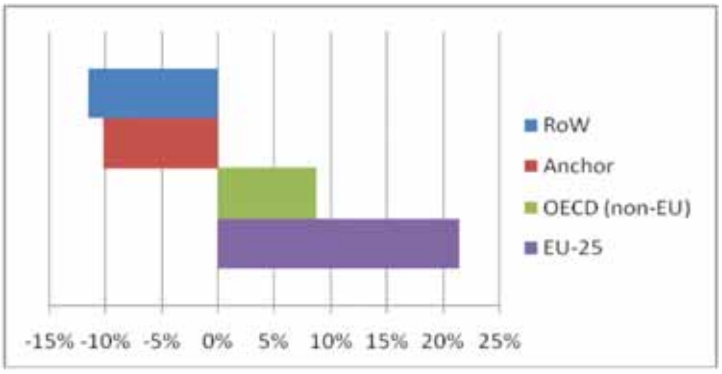


Note: "Anchor countries" is the group of emerging economies: Argentina, Brazil, China, Indonesia, India, México, Philippines, Russia, Thailand, and South Africa. Source: Giljum et al., 2008

On average a European consumes per year around three times the amount of resources of a citizen in the emerging countries while producing twice as much. In absolute numbers (left diagram) the EU's DE, as well as the RMC, is significantly lower compared to other world regions; however it is noticeable that the EU-25 consume more resources than they extract, illustrating the net-imports of natural resources. The picture changes considerably when turning to a per capita perspective (right diagram). The domestic extraction per capita in EU-25 countries is significantly higher compared to the other world regions; the Anchor countries (the group of emerging economies: Argentina, Brazil, China, Indonesia, India, México, Philippines, Russia, Thailand, and South Africa), counting almost 3.2 billion inhabitants, which lead the list of resource extracting world regions, still fall far behind all other regions when investigating per capita values.

The EU is the world region that outsources the biggest part of resource extraction. Relating net-trade flows of materials to levels of domestic extraction enables to illustrate to what extent different world regions are outsourcing material and energy-intensive production processes to other world regions. Figure 4 shows that the EU is the world region that outsources the biggest part of resource extraction required to produce goods for final demand (private and public consumption and investment), thus exceeding a potential self-sufficiency of natural resource use.

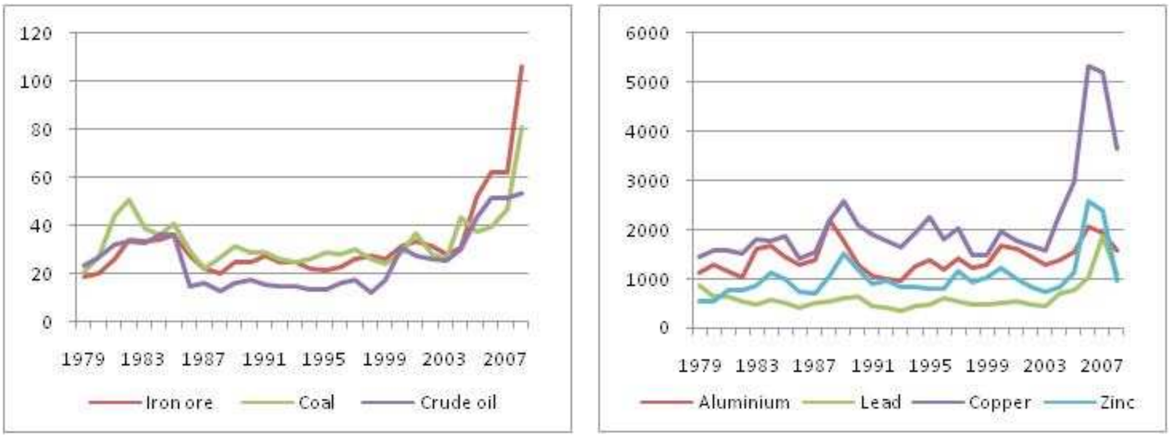
Figure 4: Net-trade flows in relation to domestic extraction



Source: Giljum et al., 2008

The rapidly increasing demand for resources has lead to an unprecedented boost in resource prices, especially during the last five years. While countries with large raw material deposits use these revenues to finance their public expenditures, countries or regions with relative resource scarcity, are especially affected by this development. Consequently, in the future these countries will face increasing competition for resources, for which they will have to pay high (and likely still augmenting) prices. Figure 4 illustrates the price development of the main metals and fossil fuels for the past 30 years (quite recent development has not yet been taken into account). With increasing demand, and consequently extraction, more and more material with lower concentrations is extracted as increasing prices make this extraction profitable. This leads to higher process costs, higher energy consumption, and more transportation from remote areas and higher amounts of overburden. Furthermore, to extract and process the crude ore more and more machinery is required, causing even higher pressure on resources and leading to an increase in production costs.

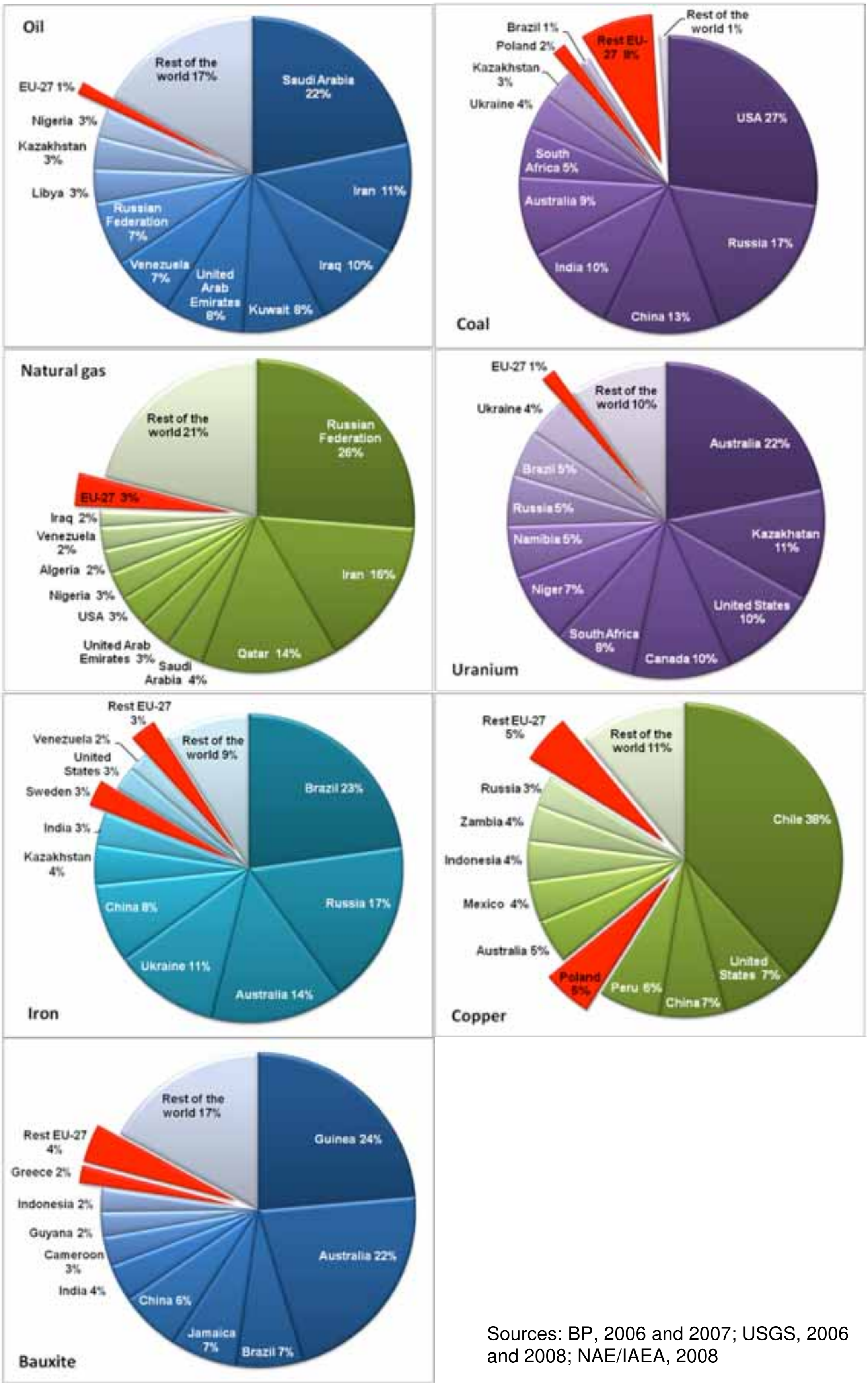
Figure 5: Commodity prices in €/t and €/barrel respectively



Note: Tin and nickel do not appear in these diagrams, as their current prices range around 11.000 €/t (tin), and 9.000€/t (nickel), respectively. While the first is steadily increasing, the latter almost tripled in the years 2003-2007 and is now again at the 2003-level. Source: HWWI Commodity Price Index..

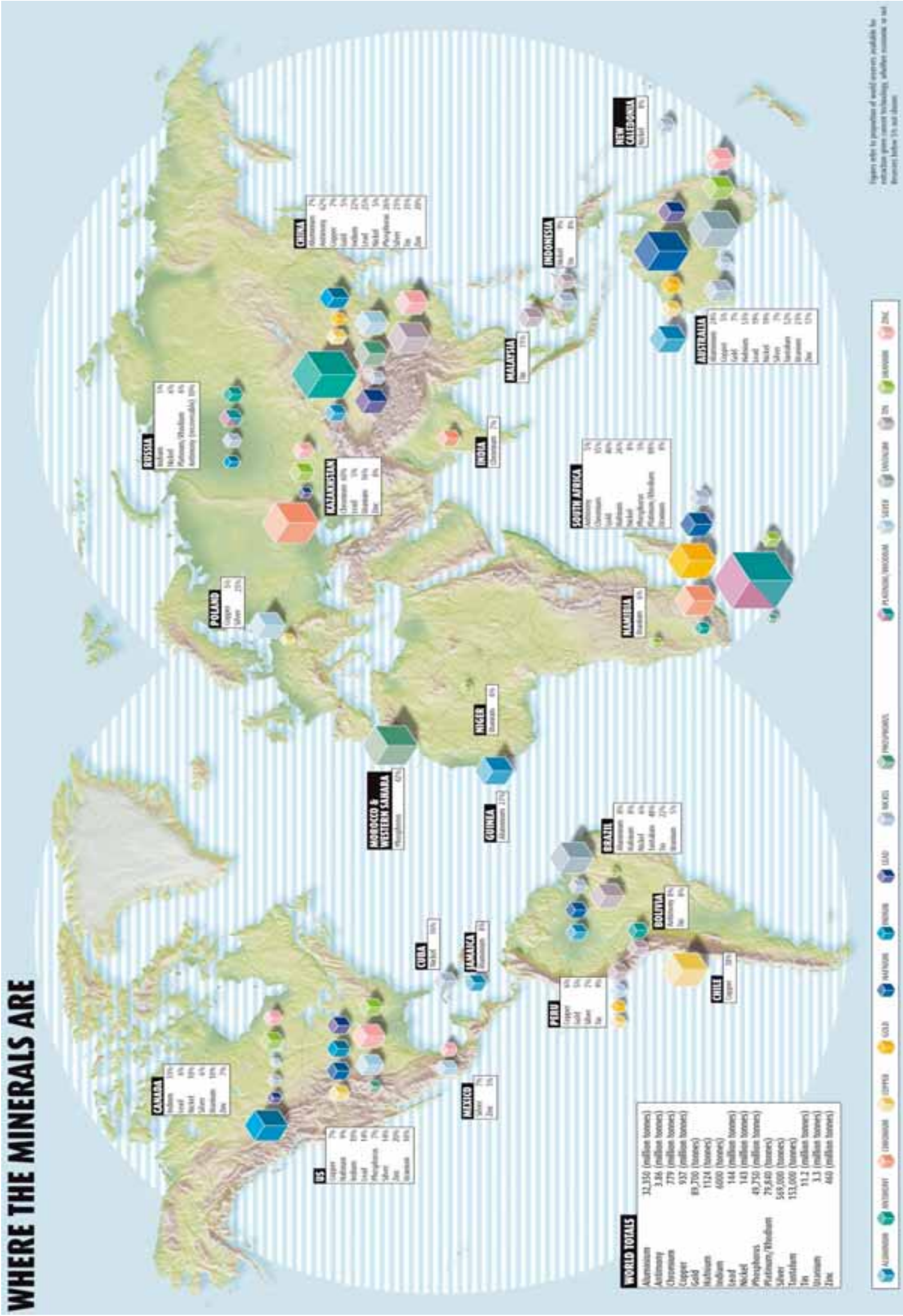
World reserves in fossil fuels and metals are unevenly distributed across the world regions. Precariously, especially countries with a highly developed economy, such as the EU or the USA, but also those with emerging economies, such as China or Brazil, which have a rapidly growing demand for resources, do not possess large domestic deposits. Figure 6 illustrates exemplarily the worldwide distribution of the reserves of the main fossil fuels (oil, gas, coal), of uranium as well as of the three quantitatively most important metals (iron, bauxite, copper). Figure 7 additionally reports selected precious metals as well as some minerals such as phosphorous. All such numbers however should be taken with care since high prices lead to new exploration activities and extraction activities in areas, which are known but have not been economical in previous years.

Figure 6: Worldwide distribution of reserves of the main energy carriers and metals



Sources: BP, 2006 and 2007; USGS, 2006 and 2008; NAE/IAEA, 2008

Figure 7: Worldwide distribution of reserves of selected minerals and precious metals



Source: Cohen (2007) in: New Scientist.

Only very small reserves of the main energy sources and metals are found in Europe. As Figures 4 and 5 show, Europe will rely heavily on imports from abroad in the future in order to ensure a stable access to fossil and nuclear energy as well as to metals. From this perspective, adhering to conventional energy sources like oil and gas or reviving nuclear energy would move Europe into even higher dependency of other countries with oftentimes precarious political and social circumstances.

Additionally, for various commodities, the peak of extraction has already been reached or is currently about to be reached, signifying a future decrease of extraction, and constricted availability respectively. However, data on commodity reserves and expiration dates diverge significantly. On the one hand, this is due to different assumptions and estimation methodologies; on the other hand, political and economic strategies often influence the results of such predictions. Table 1.1 shows an overview of prognoses concerning the anticipated peak and a possible depletion of different fuels and metals, and their main area of use. One may note however that "peak" usually refers to oil production and the supplies of minerals need to take into account criteria such as co-production, recycling, and substitutability.

Table 1: Predicted peak and depletion of different fuels and metals, and main area of usage

Commodity	Peak	Depletion	Main area of usage
Oil	2006-2026	2055-2100	Energy generation Chemical industry and pharmaceuticals Construction
Natural gas	2010-2025	2075	Energy generation
Coal	2100	2160-2210	Energy generation
Antimony	-	2020-2035	Metal alloys
Copper	-	2040-2070	Energy transport Piping Electronics
Gallium	may have passed	-	Electronics (mobile phones, solar cells)
Indium	-	2015-2020	Electronics (LCDs, solar cells)
Lead	Passed	2030	Automobile industry Chemical industry
Platinum	-	2020	Electronics (printer, etc) Industry (plug, catalyser, glass production) Medicine (pacemaker)
Silver	-	2020-2030	Electronics Pharmaceuticals
Tantalum	-	2025-2035	Electronics (mobile phone, automobiles) Pharmaceuticals Chemical industry
Uranium	-	2035-2045	Energy generation
Zinc	-	2030	Anticorrosives Energy storage (batteries)

Note that out of the variety of different results, the authors derived the time spans with the largest overlaps; the list of sources can be found in Annex 1. For some metals, no information about peak extraction could be found (marked with -).

Natural gas cannot replace oil as main energy source, once the latter is depleted. By now, "peak oil" is widely accepted as reality. Nonetheless, the assumption that worldwide huge gas reserves will help to overcome this shortage is critical, as it ignores various important aspects: first, a considerable share in the gas exploited today is associated with oil production – ceasing oil production, hence, leads to a decrease in produced gas. Second, gas production is strongly limited by cost and time needed to build gas gathering, recovery, and transport infrastructures. Third but not least is, again, the dependency issue; apart from Russia – already at the edge of Peak Gas – the world's biggest remaining gas reserves are located in politically critical countries such as Iraq, Iran, UAE, Qatar, Turkmenistan, Nigeria and Venezuela. Generally, it is important to understand the interrelationship between oil, gas, and electricity; a change in the production of one will always affect the supply with the other (McKillop, 2006).

'Critical metals' will affect the European economy more subtle, but further-reaching. The European economy is an industrial and service-oriented economy, depending highly on different raw materials, to produce high-end processed products. As the examples in Table 1.1 show, an uncountable number of goods of daily use and application contain small, but critical amounts of certain metals, the depletion of which would cause the cessation of a whole sector, and considerable interventions in accustomed life styles of European citizens. Apart from the main energy sources, such as coal and gas, the handling of these materials will become decisive in the future, as their increasing scarcity will lead to an even more accentuated augmentation of their prices, and consequently the costs for producing processed goods downstream.

2.2. Patterns of resource use in different sectors of the EU

Quantifying resource use on a sectoral level requires observation regarding two different aspects: direct and indirect resource use. Direct use refers to the actual weight of the products, which are traded between different sectors and countries, and thus does not take into account the life-cycle dimension of production chains. Indirect flows, however, indicate all materials that have been required for manufacturing a final product (also called up-stream resource requirements). For instance, concerning the car production sector, the indirect flows comprise all the materials already used by providers of raw materials (steel, plastics), component suppliers, etc.

The flows of goods and transactions between economic activities, both within a national economy and with the rest of the world, can be illustrated in so-called input-output tables (IOTs). These tables are used for the investigation of economic structures of national economies and the analysis of the direct and indirect effects of changes in final demand, prices, and wages on the entire economy as well as its individual components.

Detailed analyses of sectoral resource use are only scarcely available for some EU countries and so far missing for the EU. So-called "physical input-output tables (or PIOTs)" are valuable tools to analyse direct resource use of different sectors in an economy. PIOTs describe the flow of materials from nature into the economy and back to nature through the economic activities of processing and consumption. Using mass units, the principle of the conservation of matter can be applied: resources cannot be created or destroyed in any physical process.

In the following, the results of three different studies are discussed, in order to illustrate similarities or differences in the resource use of different EU member states. No reliable physical input-output table is so far available for the European Union as a whole.

1. **Direct resource use: example Germany**: The German Federal Statistical Office (2005) elaborated a PIOT for Germany in the year 1995 with 99 types of materials and

60 different producing sectors. Not surprisingly, stones and construction, coal, chemical products, metals and semi-finished metal products, glass, ceramics and food have been identified as the most material-intensive material groups. Note that the 'Residuals'-section includes water use. However, also without accounting for the water usage during production, these groups (in slightly changed order) would be among the most resource-intensive sectors.

2. **Direct resource use: example Finland**: Several studies (Mäenpää, 2001, 2002, and 2008) exist, which elaborated and analysed a physical input-output table for Finland. Starting on a very high resolution - 190 industries and 1300 products, orientated at the monetary input-output tables available for Finland - several service industries were aggregated and the number of industries reduced to 151 due to lack of physical data. In his recent work, Mäenpää (2008) shows that in 2002 the most material intense (and hence less material productive) sector was "Mining and quarrying" with 124 kg/€, followed by "Forestry" (25 kg/€) and "Construction" (10 kg/€). Hence, in comparison with the German values, these results are far higher, indicating a more resource-intensive economy in Finland.

   Direct resource use: example Denmark: Gravgård Pedersen (1999) created a PIOT for Denmark in the year 1990. Originally, the resolution of the Danish PIOTs was of about 117 industries and 2940 commodities. In order to simplify calculations, the 117 sectors were aggregated to 27 industries. The results showed that the greatest consumer of intermediate consumption materials was the construction industry with 58.7 million tonnes, followed by "mining and quarrying" (45.7 mill. tonnes), and "agriculture and horticulture" (25.5 mill. tonnes). No information was given regarding material intensities of the different sectors.

The comparison of the results of different countries is not as straightforward as it may seem. As stated before, and as demonstrated by means of the examples above, available PIOTs of specific countries often differ in terms of number of economic sectors and products. Moreover, due to the enormous amount of work associated with the compilation of PIOTs, PIOT publication periods vary significantly between different countries. Not surprisingly, sectors related to primary resource extraction (such as mining and agriculture) as well as sectors at the first stages of processing (metal industry, chemical industry) and the construction industry are the most resource intensive sectors regarding direct resource use. As regards to eco-innovation however downstream processes need to be considered as well.

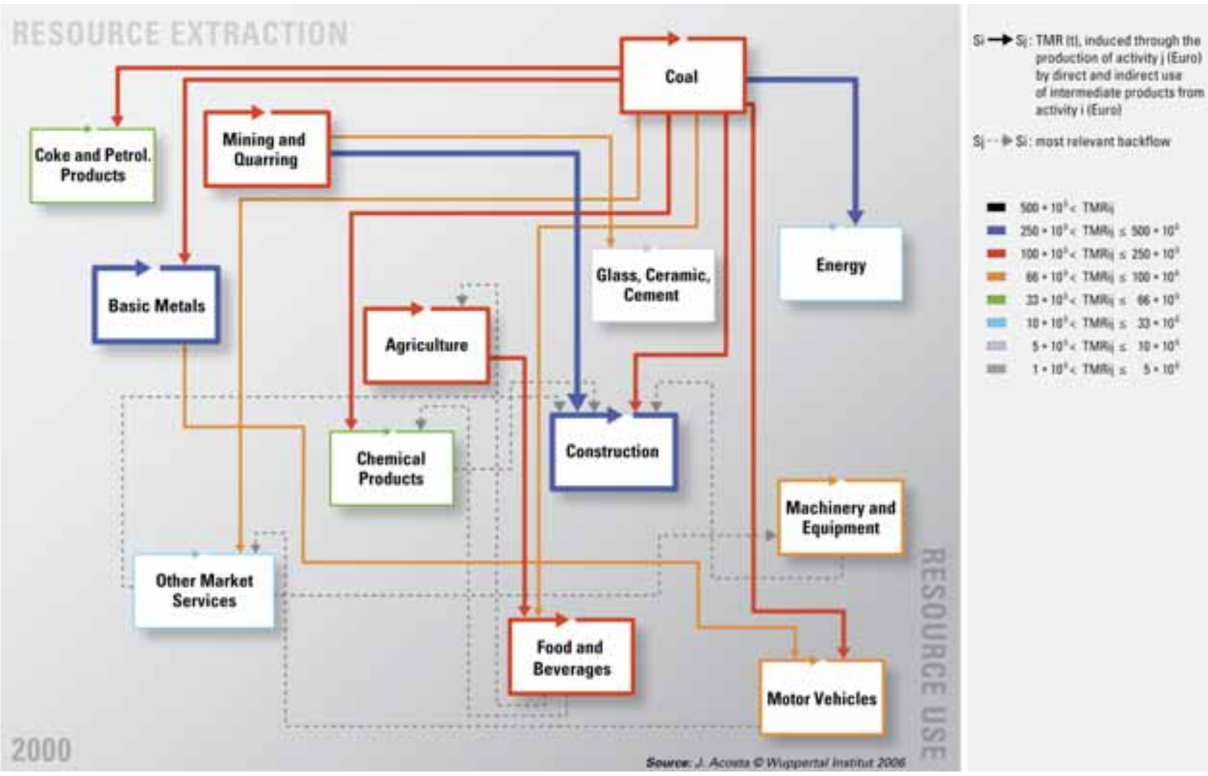
Economic-environmental models and statistical analysis can quantify the indirect resource use on a sectoral level. As stated above, in addition to direct resource use, also the indirect resources necessary to produce products for final demand can be analysed. Thereby, interdependencies of different sectors are taken into account and consequently the total amount of resources required to produce final products is illustrated. These findings reflect economic activities and final demand for goods in monetary terms, which are extended by environmental data in order to calculate environmental pressures, such as material use, emissions, etc. Consequently, the material requirements along the whole production chain of a given final-demand product can be determined.

Direct plus indirect resource use: example Germany. The German Federal Statistical Office (2005) elaborated a model of 71 different economic sectors for 70 different products and analysed the development of the German abiotic resource use in the years 1995-2002. It was shown that direct resource use (domestic extraction plus net imports) decreased by 8.8 % in that time period. While the domestic use itself was reduced, another reason for the decrease was the fact that material exports increased to a higher degree than imports. Direct abiotic resource use in Germany decreased from 1448 million tonnes in 1995 to 1321 millions of tons in 2002. Based on the economic-environmental model, also the total use of abiotic products by sectors was calculated.
Research done at the Wuppertal Institute (Acosta et al. 2007) reveals that ten production sectors account for more than 50 % of German Total Material Requirements (TMR). Three areas are of strategic importance because here a huge number of technological interactions among production sectors take place:

- stones, construction, and housing (i.e.: construction)
- metals and car manufacturing (i.e.: mobility)
- agriculture, food and nutrition (i.e.: food).

The following figure illustrates the share, which each of the sectors directly and indirectly uses to produce the outputs.

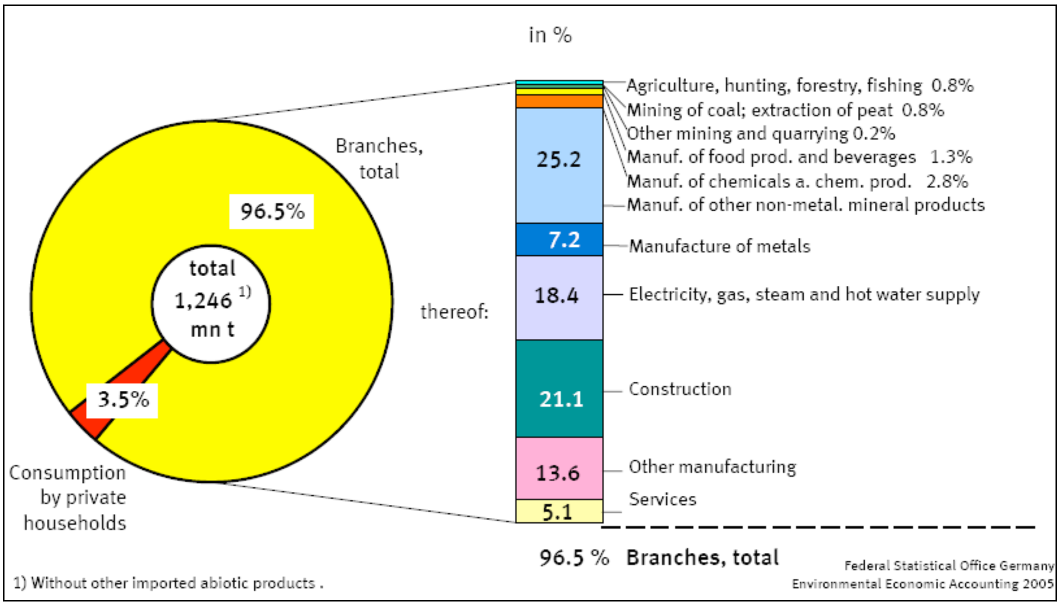
Figure 8: Direct and indirect resource use by economic activities in Germany in 2000



Source: Acosta et al. 2007.

The use of primary material in Germany is concentrated in just a few branches, which determine the overall level of resource use. Statistically, the share of the consumption of the private households is relatively small (only 3.5 %), whereas 96.5% of the abiotic resources are used in the production sectors. Compared with the analysis of direct resource use above, it can be noted that the resource extraction sectors have a much lower share, as they deliver almost all resources to other sectors, which further process primary materials. According to Destatis (2005) (Figure 9) "Manufacturing of other non-metallic products" leads the list of resource-intensive sectors with a share of 25.2%, followed by "Construction" (21.1%) and "Electricity, gas, steam and hot water supply" (18.4 %). Services, on the other hand, only use 5.1% of the total abiotic resources. According to Acosta et al. (2007), "construction" accounts for 18 %, "metals" for 9 %, "food" for 9 %, "energy for 8 %, "automotive" for 6 % of direct and indirect sectoral TMR in 2000.

Figure 9: Domestic use of abiotic primary material by economic activities in Germany in 2002



Source: Destatis, 2005

Absolute numbers of sectoral resource use and sectoral resource productivity are closely linked. In addition to the absolute numbers, the German Destatis study identified the most resource-intensive producing sectors: "Production of glass and ceramics, processing of stones and earth" with 21.5 kg/€, "Construction" (2.9 kg/€), "Production and distribution of energy" (7.6 kg/€), and "Metal production" (1.8 kg/€); which together account for around 70 % of the used materials. The strong concentration of primary materials use in a few sectors indicated that the macroeconomic development concerning absolute material consumption and resource productivity is highly marked by the development in these few sectors. One may note that other methodologies might lead to slightly differing results.

To sum up, the issue of resource scarcity deserves full political attention. In this regard, the areas of housing, mobility and food are of strategic relevance for eco-innovation.

2.3. Sectors affected by resource scarcity

Part one of this section focussed on resources, which are likely to become scarce in the short to middle term. It was shown that, apart from oil and gas – today the main energy sources worldwide – there exist various "critical materials" which are not used in big absolute quantities, but are crucial for important sectors as, for instance, electronics or chemistry and are likely to deplete in the short to medium run. From the analysis of the second part, specifying sectors with especially high resource use in absolute numbers, it can be deducted that the materials directly or indirectly used in large quantities are mainly construction materials and metals regarding abiotic resources and agricultural harvest for the food processing industries regarding biotic resources. In this final section, we present the conclusions, which can be drawn from the previous analysis.

Literature dealing with the impacts of resource scarcity on different economic sectors is hardly available. Studies dealing with reserves and the likely production peak of different resources are available as are studies analysing patterns of (direct and indirect) resource use on the sectoral level. However, studies trying to quantify the vulnerability of different sectors due to expected resource scarcities in the future do not seem to exist yet and should be subject for further research. Available studies provide their analysis on a very general level; see for example an analysis done for the ITC industry (German EPA 2007). Therefore, also this study will only derive some tentative general conclusions.

Oil plays a crucial role for all sectors, both in its energetic and non-energetic use. "Peak oil" is expected within the next years and oil depletion will occur somewhere around the middle of this century. Further shortage of oil as the main energy source for many manufacturing sectors, the construction sector, and in particular also the transport sector, will cause negative economic impacts in the form of further rise of prices of final goods, if no alternatives are developed in time and transition towards a non-oil based economy can be governed in a structured way. Also other sectors, which use oil as a primary raw material for production, such as the chemical and the pharmaceutical sector, would be heavily affected by a further shortage of oil.

Further shrinking of the primary extraction sectors in Europe is likely but exceptions may be possible. The past 30 years saw a continuous shrinking of the European extraction sectors, in particular in the mining of fossil fuels and metal ores. As the reserves of these raw materials are mainly located outside Europe, it can be expected that these primary extraction sectors will further decline in the next decades and that Europe will face growing dependence on resource imports from other world regions. One may note however that, firstly, Scandinavian States and others have started to conduct feasibility studies on renewing extraction activities at certain sites and, secondly, the extractive sector in Europe is likely to remain strong in the area of industrial (non-metal) minerals.

High-tech industries, in particular the electronic industry, will be affected by declining availability of precious metals. Some particular industries, which have boomed in the past few years, such as the information and communication industry or the entertainment electronics industry are highly dependent on the availability of precious metals (such as Antimony, Indium or Tantalum) necessary for producing processors, screens or other electronic parts. It can be expected that worldwide competition for these resources will significantly increase in the near future, as several of these precious metals have already reached its extraction peak.

Also the development of new technologies, such as photovoltaic electricity generation, could be slowed down by resource scarcity. One example are solar cells, for which gallium and indium is yet required to produce indium gallium arsenide, the semiconducting material which is at the heart of a new generation of solar cells. A second case for a critical material might be platinum. Given the critical supply of some raw metals, more in-depth research on the nexus between materials and renewable energies is needed to clarify possible limitations.

2.4. Summary

While, on the one hand, Europe is one of the world regions with the highest per-capita resource consumption, on the other hand, the catching-up of other world regions and emerging economies, respectively, is leading to enormous rapidly growing demand on energy, metals, construction minerals, etc. Precariously, the reserves of the most important resources are located outside of Europe, causing a critical dependency relationship of Europe with other countries and regions.

So far, the world's economy has been strongly dependent on oil as main energy source and as important raw material for industrial sectors, such as the chemical and the pharmaceutical industry. Consequently, as peak oil is expected for the very near future, a further shortage will cause negative economic impacts in the form of further rise of prices of final goods, if no alternatives are developed in time and transition towards a non-oil based economy can be governed in a structured way. Additionally, the expected decline in the availability of precious metals will strongly influence high-tech industries. It can be expected that worldwide competition for these resources will significantly increase in the near future, potentially leading to serious conflicts related to the access to resource reserves.

Hence, in order to deal with this increased scarcity of natural resources, a significant reduction of the worldwide resource use will be necessary.

3. ECO-INNOVATION: CURRENT STATUS AND OPPORTUNITIES

3.1. Definition and Scope

A demand for eco-innovation has arisen because of the need to address today's pressing environmental challenges. A comprehensive definition of eco-innovation was recently given by Reid and Miedzinski (2008) in the ‚Sectoral Innovation Watch in Europe: Eco-Innovation' report, and this definition will also be used for the purpose of this report. The definition states that eco-innovation is "the creation of novel and competitively priced goods, processes, systems, services, and procedures designed to satisfy human needs and provide a better quality of life for everyone with a whole-life-cycle minimal use of natural resources (materials including energy and surface area) per unit output, and a minimal release of toxic substances".

Important to note is that eco-innovation is not simply an end of the pipeline ‚curative' technology. Eco-innovation can be considered at any stage of a product or service lifecycle. However, when considering the impact eco-innovation can have on resource or energy efficiency, the most gains are to be made when tackling the ‚upstream' or production part of the supply chain, for example, improving the efficiency of manufacturing and using materials.
It is nevertheless important to emphasise that eco-innovations, which reduce energy and resource consumption at any stage of the life-cycle are important, and applying an holistic and multifaceted approach to furthering eco-innovation is necessary. This means not simply focusing on technological innovations but also on the ‚human' element of ecoinnovation such as those innovations involving behavioural and lifestyle change.

3.1.1. Different types and levels of Eco-Innovation

The different types of eco-innovations can generally be grouped into three main categories; *process, product* and *system* innovations.

Process Innovations: a process innovation is the implementation of a new or significantly improved production or delivery method. Production-integrated environmental management (PIUS) captures manifold approaches of process innovation. 'Organisational' innovation (which can also fall into the category of process innovation) can describe the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations. Such innovation is closely linked to learning and education (see Bleischwitz 2003; Davenport, Bruce, 2002; Easterby-Smith, Araujo, Burgoyne 1999; Lane, Bachmann 2002). An organisation's innovativeness and advanced learning processes are widely based on identical elements. A final aspect of process innovation includes ‚marketing' innovations (product design, packaging, product placement, promotion) such as eco-labelling. Key words in this area include cleaner production, zero emissions, zero waste, and material efficiency.

Product Innovations: product eco-innovations include any novel and significantly improved product or service, produced in a way that means its overall impact on the environment is minimised. This, however, usually implies risks for the company since customers need to be convinced to purchase the new product. Adding services to selling a product also can be categorised here. Keywords in this area include the concepts of eco-design (Brezet, van Hemel 1997), technological sustainability innovations, environmental technology, and the dematerialisation of products.

System innovations: this type of innovation does not only refer to technological systems, but also to radical and disruptive technologies that alter the market conditions (such as hydrogen and fuel cells) as well as all types of system changes such as industrial, societal or behavioural changes. Key words in this area include the concepts of life-cycle analysis, cradle-to-cradle, material flow analysis, integrated environmental assessment, integrated sustainability assessment, closed-loop-material-cycles, decoupling, factor 4 and factor ten, sustainable production and consumption, eco-sufficiency and immaterialisation, user-oriented systems and sustainable lifestyles.

Measuring eco-innovation and material flows

There is currently little research into methodological approaches to measuring eco-innovation. A number of methods for measuring eco-innovation such as survey analysis, patent analysis and digital and documentary source analysis, are highlighted by Kemp and Pearson (2008). There has also been some reference to adapting innovation systems theory and indicators to the measurement of eco-innovation (Foxton, Pearson and Spears, 2008). However, the former study confirms that the general knowledge base for eco-innovation is poor. Reid and Miedzinski (2008) argue that the primary objective of eco-innovation should be to reduce material flows. There are a number of approaches to deal with analysing material flows, resource productivity and decoupling (highlighted in box 1). Excessive man-made material flows increase welfare, but also have detrimental effects on the environment. Therefore eco-innovation should be concerned with reducing these material flows and furthering sustainability objectives (Reid & Miedzinski, 2008).

Box 1: Decoupling Indicators

Since it is impossible to manage a system without metrics, appropriate decoupling indicatorswith proper accounting for resources must be used. The OECD (2008) has now released a handbook on material flows and resource productivity. This includes an overview of the main material flow indicators grouped according to the purpose of their description. The main categories include: ‚input indicators' such as Domestic Extraction Used (DEU), Direct Material Input (DMI) and Total Material Requirement (TMR); ‚consumption indicators' for example, Domestic Material Consumption (DMC) and Total Material Consumption (TMR); ‚balance indicators' including Net Addition to Stock (NAS) and Physical Trade Balance (PTB); ‚output indicators' which are Domestic Processed Output (DPO) and Total Domestic Output (TDO); finally efficiency indicators which refer to GDP per DMI, GDP per DMC and GDP per TMR. As to the ecological dimensions of sustainability, calculations of material input – from cradle to cradle - per unit of service (MIPS), and ecological rucksack measurements have also been developed.

Source: OECD 2008

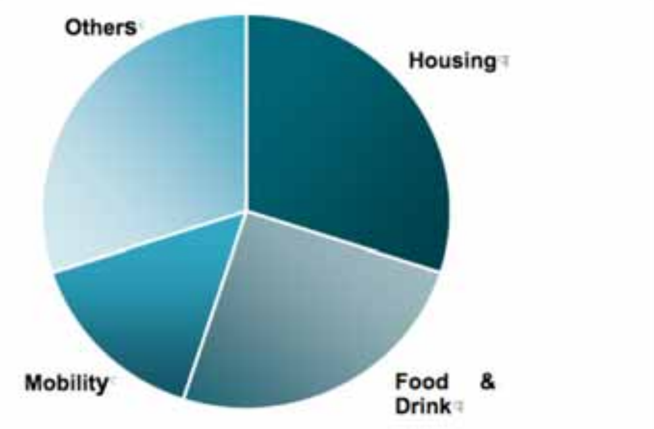
3.1.2. Eco-innovation and resource-efficiency

Resource-efficiency can be considered a key strategy of eco-efficiency because of its huge potentials for cost savings and innovation. German Federal Statistical Agency estimates that roughly 40 % of Gross Production Costs in manufacturing industry stems from purchsing materials. Surprisingly however, little research has been done on the potential resource savings through eco-innovations. According to a study by the consultancy Arthur D'Little, The Wuppertal Institute and the Fraunhofer ISI (2005), there is a robust potential for resource efficiency in branches such as manufacturing of metal products, of systems for electricity generation/distribution and similar, chemical industry (excluding primary industry), manufacturing of synthetic goods, and construction industry. This is estimated in the order of 10 – 20 % of current material use, amounting to total between 5.3 and 11.1 billion Euro per year in Germany alone. Eco innovation opens up a new field of innovation activities, and there are huge opportunities available, not just in terms of saving on material costs but also by finding alternative options for scarce resources.

3.2. Examples of eco-innovations in key areas

The areas of housing, mobility, and food and drink have been identified by the European Commission and the EEA as having the highest environmental impact throughout their full life cycle (EIPRO Study 2006, forthcoming NAMEA Study, see also chapter 2). This means that altogether, these fields of demand account for approximately 70-80% of environmental impacts arising from all products over their life cycles. The environmental impacts within these areas are multifaceted, ranging from planetary problems as divergent as global warming, acidification, and photochemical ozone formation, to localised pollution leading to eutrophication or species loss (EEA, CSCP, 2008). The figure illustrates the relative proportion of environmental impact from each of the three impact areas and these areas are discussed in more detail below. Furthering eco-innovation in each of the three areas is of particular interest, since eco-innovation has great potential to help reduce the use of resources and lower environmental impacts.

Figure 10: The three areas with the highest environmental impact



*Source: EIPRO Study 2006, NAMEA Study 2006, WI 1998

Housing: refers to environmental impacts from aspects relating to extraction and production of aggregates and construction materials, use of chemicals, maintenance services, finance services, design of buildings, use of renewable energy sources, energy efficiency in buildings (public and commercial as well private), household appliances, water use, construction, reuse of demolition and household waste, etc.

Food and Drink: refers to environmental impacts from aspects relating to agricultural production, food processing, use of chemicals, energy use, packaging, logistics, retailers, consumer choices, waste, food services such catering and restaurants, etc.

Mobility: refers to environmental impacts from aspects relating to extraction and production of metals and other materials, public and private transportation, freight transportation, railway service, aviation, disposal of vehicles, alternative vehicles and fuels, resource use and emission etc.

In such a framework, more specific resource and energy intensive sectors can be identified and subordinated to those areas. These sectors, such as coal, peat, chemical products, stones and earths, other quarrying activities, metals and semi-finished products, construction, food, feed and beverages, glass ceramics, manufactured stones and earths (also discussed earlier in Chapter 2.3) fall into the broader areas described above because they deliver materials to those areas.

In the following section, major trends in each of the areas housing, mobility and food and drink are summarised, and concrete examples of eco-innovations in each of these areas are given. These examples have been chosen based on both desktop studies and practical experience and have an illustrative purpose. Each case is presented as a table, including information about the name and concept of the ecoinnovation, the goal, as well as project, examples and evaluation where relevant.

3.2.1. Area Housing: Deep Renovation and Smart Metering

Analysing and examining the trends in the area of housing, allows needs and gaps in eco-innovation to be recognised. In this area, there have been several key trends in recent years, which contribute to the case for eco-innovation in this area. These trends are summarised and explained in box 2 below. One may note that these trends partly offset environmental policies and lead to additional demand for action – which can be responded to via eco-innovation.

Box 2: AREA HOUSING – Main Trends

High-impact use of construction materials: the construction and renovation of buildings is highly material and energy intensive (especially when materials are evaluated from a life cycle perspective). Prices for key material inputs have also risen significantly in the past years (Wallbaum/Kaiser 2006)

Access to appropriate and affordable housing: access to safe, decent and affordable housing for low-income groups remains a challenge in many countries (SP/HUMI 2005, Boverket 2005). High incidental energy expenditure from inefficient energy use also plays a part in this.

Growing demand for housing space: houses are growing in size and number. Increased single occupancies, multi-property ownership and expectation of living space are all conributing factors. This trend also reinforces urban sprawl and is linked to higher energy consumption (EEA 2001, UNECE 2006).

Urban sprawl and lower urban density: increasing urbanisation and expectations of living close to a city, whilst still having access to the countryside has increased urban sprawl. This has repercussions on transport patterns and other sustainability impacts (EEA 2006).

Energy consumption in the housing use phase: household heating and other use-phase energy contribute to different environmental impacts (in cold climates typically 80-90 % of total life cycle energy use is consumed during the use phase of the building) (EIPRO-Study 2006).

Furthering eco-innovation in the area of housing has the potential to slow or reverse some or all of these trends. The following two examples of eco-innovations offer solutions to some of the unsustainable trends described above as well as attempting to improve resource and energy efficiency. The respective eco-innovation is described followed by its goal, project examples and an evaluation.

Name and concept of eco-innovation	Sectors
DEEP RENOVATION (refurbishment of old buildings)	construction, installation, planners and architects, mining and quarrying, non-metallic mineral products, chemical products, wood industry, manufacturing services
System innovation	

Deep renovation means the refurbishment of older buildings to ensure maximum use of recyclable building materials and minimum energy input into production of building materials.

Goals of the eco-innovation:

- To significantly reduce greenhouse gas emissions from buildings
- To reduce energy input in building materials
- To implement a high recycling quota by using renewable raw materials
- To improve the indoor air quality
- To reduce the health risks caused by building materials for example, through fulfilment of ecological/biological ("baubiologische") construction criteria
- To reduce costs of construction through the standardisation of components of the building shell and of the required technical equipment

Selected project examples and results:

There is not yet a well-documented comprehensive project example that achieves all of the goals mentioned above to a maximum extent. However, there are several examples of new or refurbished, residential and non-residential passive houses (< 15 kWh/m2/year useful heat demand) or energy-plus houses that nearly fulfil all the criteria.

A few of these include:

- Refurbishment of a school in Austria according to passive house requirements (<15 kWh/m2year useful heat demand) (for more information see www.umweltschutz-news.de, 04/11/2008)
- Ecological passive house building in Durlach/Germany, constructed in 2007/2008: mainly made from loam and wood; ecological colours (for more information see www.eza-allgaeu.de, 17/10/2008).
- Passive house building in Laßnitzhöhe/Austria, constructed in 1997: mainly made from stones, wood and recycled pulp; no chemical protection of wood, no CFC-free, polyuretan-free, PVC-free, no mineral insulation (for more information see www.energytech.at, 17/10/2008).
- Sonnenschiff ("sunship") in Freiburg/Germany, office building constructed in 2005: energy-plus passive house; ecological materials, e.g., floor cover made of natural rubber, PVC-free; mobility infrastructure suitable for bicycles (for more information see www.sonnenschiff.de, 20/10/2008)

Overall evaluation of the eco-innovation

Environmental and health aspects: Impacts can be minimised by system design and choice of components (cf., e.g., www.dgnb.de or www.worldgbc.org for evaluation criteria)

Technical aspects: deep renovation is possible in nearly every building; standardisation is limited. Quality strongly depends on know-how of architects, planners and installers, and on quality control systems.

Economic and marketing aspects: Compared to BAU refurbishment, additional costs of deep refurbishment are limited and often pay off, particularly if available financial or fiscal support is taken into account. Different financial and fiscal support must be complementary. For example, a tax on construction materials (see chapter 4) can be considered favourable for deep renovation buildings projects instead of new dwellings with primary materials; however it must be made compatible with VAT abatement. Comfort gains should be highlighted in marketing.

Socio-cultural and organisational aspects: High user acceptance due to excellent indoor air quality and low running costs. Reduced pressure on user's behaviour, because this is not a very decisive factor anymore.

Name and concept of eco-innovation	Sectors
SMART METERING Product innovation	energy (electricity, gas), manufacturing services, appliances, installers, energy services

Currently, the majority of existing electricity and gas meters are hidden from view and provide little information for the customer on energy usage. Smart metering is a system which measures the individual energy or water consumption of households and communicates the information to the local utility for monitoring and billing purposes and often to the user, too. Smart meters use less energy than conventional meters, which is however more than compensated by the energy consumption of the additional information and communication technology needed. Nevertheless, by tracking usage patterns and increasing awareness of energy use, smart metering can stimulate energy saving measures, particularly if directly combined with additional energy efficiency services (energy advice or audit, installation or optimisation of energy efficiency technology, energy performance contracting, etc.). Smart Meters can provide data on how much gas, heat, electricity or water is consumed, how much it costs and what impact the consumption has on greenhouse gas emissions. In addition, an advanced metering infrastructure offers the possibility for additional energy-related load management services such as demand side management and realisation of virtual power plants (a cluster of distributed generation installations and load reduction possibilities on the demand side which are collectively run by a central control entity) and respective incentive programmes and/or time-differentiated tariffs.

Goals of the eco-innovation:

- To promote awareness of energy consumption, energy costs and greenhouse gases emissions
- To stimulate customers to monitor energy consumption and to take additional action to save money on their energy bills
- To decrease the running costs of metering and billing
- To create the technical basis for being able to cope with peak demand challenges

Selected project examples and results:

Smart Meter projects have been tested, for example, in the USA, Italy, Sweden and Australia. For more information see www.esma-home.eu/smartMetering/caseStudies.asp, (6/11/2008). However, a systematic combination of smart meters with stimulating energy efficiency measures (programmes or services) and load management is rare, and there is no well-documented example available.

One smart metering example with significant short-term impact on energy consumption was in Bath (UK), where energy consumption was monitored over a 9-month period and compared to the previous years' consumption. Participants received feedback in various forms, i.e. consumption compared to previous consumption, energy saving tips in leaflets or on a computer, or feedback relating to financial or environmental costs. The advice given to the consumer included, home visits and energy saving tips in leaflets. The results indicated firstly that most households reduced their consumption of electricity and gas, and secondly that income and demographic features were able to predict the historic energy consumption but not the changes in consumption during the field study, where environmental attitudes and feedback were influential. The study showed that the installation of computers helped to reduce consumption most markedly (ESMA, 1999).

Overall evaluation of the eco-innovation

Environmental and health aspects: There is worldwide evidence that giving consumers appropriate, relevant information on their energy and water use is an important basis for additional measures leading to a reduction in this use and thus in GHG emissions. Demand-response leads to energy savings and more efficient use of electricity generation capacity and the electricity grid.

Technical aspects: Smart Metering for households does not include any manual processing required for standard meters. Smart Metering enables remote reading of energy and water meters. With Electricity Display Devices (EDDs), smart metering can provide accurate information on energy use, time of use and costs to customers, and information about greenhouse gas emissions and historical consumption data for comparison. Technical possibilities to use a Smart Meter in an efficient way include power line carriers, wireless modems, radio frequency and internet connection. Since smart metering is heavily

reliant on ICT, this could present problems, as precious metals for electronic devices become more scarce. Better re-use of precious metals from ICT products is a suitable eco-innovation strategy (see experience from UK in the briefing note written by Arnold Black). On the other hand, it could be a driver for the development of alternative technologies in the electronics industry.
Economic and marketing aspects: Smart metering provides the possibility for residential customers to obtain more accurate bills and prepayment options, and it enables an easier switch of energy suppliers. Metering companies save costs of manual meter readings and data processing. Smart metering also reduces customer complaints about mistakes in meter readings, which then brings cost savings at call centres. For energy suppliers, smart metering offers an easier disconnection of customers and an easier alteration in tariff structure. Smart metering also provides commercial value to additional energy services like customer capturing and customer retention. Furthermore, consumers can participate in electricity spot markets via "time-of-use pricing" and realize load hifts, especially ic combined with smart home technologies and new smart grids two-way control systems to integrate distributed generators).

3.2.2. Area Mobility: the Green Electric Car and Car sharing

Analysing and examining the trends in the area of mobility allows needs and gaps in eco-innovation to be recognised. In this area, there have been several key trends in recent years, which contribute to the case for eco-innovation. One may note that these trends partly offset environmental policies and lead to additional demand for action – which can be responded via eco-innovation These trends are summarised and explained in the box below.

Box 3: AREA MOBILITY – Main Trends

Increasing freight transport: More goods are being transported over longer distances and more frequently. The freight transport volume has grown by 43% since 1992, outpacing the rate of economic growth. Demand for freight transport is also expected to increase by around 50% between 2000 and 2020 in the EU-25. The growth in freight transport is dominated by road transport and these low transport costs have resulted in growing distances between consumers and producers (EEA, 2007).

Increasing fuel price & application of alternative fuels: The price of standard crude oil had tripled since 2003 until October 2008. This has led to increasing demand of more fuel-efficient cars (hybrid and diesel) as well as alternative fuels becoming more competitive. This raises questions about the potential negative effect of biofuels on biodiversity and food production (EEA, 2007).

Increasing long-distance leisure & air travel: Passenger transport (km/person) in the EU-25 is projected to increase by 53% between 2000 and 2030. This is partly due to the increasing popularity of low-cost carriers, and the aviation's share of total passenger-km now almost matches that of rail transport (EEA, 2005).

Deteriorating quality of public transport: There has been a significant shift from the use of public transport towards the private car in the EU-15 in recent decades. The share of private car use is now around 80%. There is also a deterioration in the quality of public transport in some countries, and public transport fares have increased faster than the costs of private car use (EEA, 2005).

Increasing personal mobility/increase in car ownership: In 2004, the number of passenger cars in EU-25 reached 216 million and since 1990, the total number of cars has increased by 38%. Cars now make up three-quarters of journeys travelled in the EU-25 (European Commission 2006; EU/UNEP, 2005).

Fostering eco-innovation in the area of mobility has the potential to slow or reverse some or all of these trends. The following two examples of eco-innovations describe solutions to some of the trends described above, as well as attempting to improve resource and energy efficiency. The concept of the eco-innovation is described, followed by its goal, project examples and an evaluation.

Name and concept of eco-innovation	**Sectors**
GREEN ELECTRIC CAR	mining and quarrying, metallic and non-metallic mineral products, chemical and petroleum industries, automotive and suppliers (esp. electronic industry), automobile trade, mobility services, power industry
Product innovation	

Possibilities for electric vehicles include cars that utilise an electric motor powered by battery packs charged from an electricity grid, hybrid cars that combine an electric drive and a combustion engine, plug-in hybrid cars that can be connected to the electricity grid, and hydrogen and fuel cell cars (see e.g. www.roads2hy.com). They can be called “green electric cars”, if electricity is produced from renewable energies in a sustainable manner (i.e. at least from low carbon and low risk sources).

Goals of the eco-innovation:

- Continue with the concept of personal mobility, i.e. to fullfil the increasing demand for cars without increasing the environmental impact.
- Reduce dependence on fossil fuels and GHG emissions by the use of renewable energies
- Reduce local air pollutants.

Selected Project examples and results: E-mobility
This is a project involving the German energy provider RWE AG and the German automobile manufacturer Daimler AG, however there are similar projects also organised by Renault, Nissan and small and medium sized enterprises such as ‚Betterplace’ (see www.betterplace.com). E-mobility was started in Berlin and includes all components for an efficient use of electric vehicles. In the first step, Daimler AG will provide 100 electric cars and RWE AG is responsible or the supply of the electricity and the development, installation and operation of 500 charging points. Later on the project will be extended and launched in other cities. The charging points will be installed at the customer’s home, at the workplace and in public areas. The appropriate charging infrastructure, the affordable prices as well as an easy payment transaction make the electric car suitable for everyday use, and various customer groups. The project is supported by the German federal government and shows an innovative example of what can be achieved if policy makers, energy suppliers and the automobile industry work together in order to contribute to clean and sustainable mobility solutions.

Overall evaluation of the eco-innovation
Environmental and health aspects: Electric cars increase the demand for power plants. With modern coal-fired power plants, energy consumption of an electric car consuming 20 kWh_{el} per 100 km sums up to an equivalent of 5 to 6 litre gasoline (Pehnt/Höpfner/Merten 2007). For the electric car to be truly efficient and produce low CO2 emissions, the electricity must come from renewable sources. However, with additional increase in electricity demand by cars, avoiding new fossil fuel-fired power plants becomes even more difficult than today, even with strong increases in energy efficiency in other areas. In addition, the noiselessness of the electric car can make it dangerous for pedestrians, meaning perhaps an increase in accidents.
Technical aspects: the concept strongly depends on the development of batteries and a strong increase in the supply of electricity from renewable energies. In addition, although the technology for electric cars exists, changes in infrastructure, predominantly concerning providing access to charging stations will need to be made before electric cars can be used by widespread civil society; travelling distances without refuelling service are still very low.
Economic and marketing aspects: recent decline in car sales due to the current financial situation is

helping to push the development of electric cars by car manufacturers
Socio-cultural and organisational aspects: consumers will be mislead by electric cars offered to them which look "green" due to the fact that emissions are not visible, but that lead to high GHG emissions in total because of conventional electricity used. With regard to the costs of electric cars, financial incentives/disincentives are likely to play a significant role in the general uptake of electric vehicles. When the consumer perceives the costs of running an electric car as being higher than a gasoline fuelled vehicle then the electric car will be less appealing. Furthermore, currently the time needed to re-charge a vehicle is longer than to fill up a petrol tank; the frequency is also likely considered to be high (50 – 200 km range).

Name and concept of eco-innovation	**Sectors**
CAR SHARING	construction, mining and quarrying, non-metallic mineral products, chemical products, automotive and suppliers (esp. electronic industry), automobile trade, mobility services, rental services
System innovation	

Carsharing is the idea of renting a car every time there is the need to use one instead of possessing it. The organised joint use of a vehicle makes it possible for several people to share one car. A carsharing organisation owns and operates a fleet of vehicles that can be picked up and returned by the customer in several designated places of the respective city.

Goals of the eco-innovation:

- Reduce maintenance and fixed expenses for the customer arising from car ownership
- Raise awareness of 'single driver' habits and the apparent necessity of using a vehicle
- Reduce the annual vehicle miles of car drivers who coordinate their trips by using the option of carsharing
- Reduce private car ownership
- Reduce space needed for parking through decreased vehicle use
- Decrease the traffic in the cities
- Reduce the energy input and the raw material charge of car manufacturing
- Decrease significantly CO2 emissions through reduced car use

Selected Project examples and results: Greenwheels Carsharing
There are many examples of carsharing initiatives in Europe and it is beyond the scope of this project to name all of them. In Germany, in 2004, there were about 65,000 car sharing users in total (Wilke, 2004). Greenwheels is just one of the existing initiatives and it offers a fully automated carsharing service that started in 1994 as one of the earliest carsharing initiatives in Europe. It now offers services in 65 cities in the Netherlands and in Germany with more than 1000 locations where vehicles are available. In order to become a member of Greenwheels you are required to pay a monthly subscription as well as a deposit. Thereafter the customer is allowed to make reservations in any place and at any time. The charges are calculated according to the number of kilometres driven. Greenwheels vehicles are parked at special pick-up points in designated cities. After use, they can easily be returned to their reserved parking place so that the customer does not have to look for a parking space. It is reported that Greenwheel customers reduce between 30 to 45 percent of their annual vehicle miles. Furthermore every second Greenwheels client uses the carsharing option as a replacement for previous private car ownership.

Overall evaluation of the eco-innovation
Environmental and health aspects: car sharing reduces the number of vehicles on the road and therefore the environmental impacts caused by car use. It also reduces car usage, as consumers are confronted with per-usage cost of driving, and vehicles are not as accessible as personally owned vehicles.
Technical aspects: using technologies for easy access to shared vehicles, such as smartcard technologies, where the customer can make reservations, pay and secure vehicles from theft can be expensive for car sharing companies to implement**.**

Economic and marketing aspects: a carsharing organisation needs the utilisation to be high and intensive in order to keep per-use costs low. At the moment, car sharing is only economically attractive to consumers who do not use vehicles intensively.
Socio-cultural and organisational aspects: car sharing must be viewed as a mode of transport between long-distance transportation i.e. trains and short distance light-transport i.e. bicycles. It has the advantage of offering a large range of vehicles with fewer ownership responsibilities. It requires convenient and easily accessible pick-up and drop-off stations (Shaheen, Aperling & Wagner, 1999).

3.2.3. Area Food and Drink: Community Supported Agriculture (CSA) and Sustainable Sourcing of Retailers

Analysing and examining the trends in the area of food and drink allows needs and gaps in eco-innovation to be recognised. In this area, there have been several key trends in recent years, which contribute to the case for eco-innovation. One may note that these trends partly offset environmental policies and lead to additional demand for action – which can be responded via eco-innovation These trends are summarised and explained in the box below.

Box 4: AREA FOOD AND DRINK – Main Trends

Intensive farming & heavy land use: Intensive farming, due to increase in consumption of pig and poultry meat, fish and seafood and cheese, has been the pre-dominant trend in most EU-15 regions for several decades (EEA, 2005a). Land use efficiency of meat production is also considerably low compared to other protein sources. For example, usable protein yield per acre for beef is supposed to be 15times less than that of soybeans (Rosegrant et al. 2001).

Centralisation and concentration of sales: Companies are centralising their purchasing at group level and opening retail outlets with large floor areas. (Sarasin, 2006). Market restructuring into closed 'value chains' is a global phenomenon. More than 50% of growth in global food retail markets is expected to come from emerging markets (Vorley, 2003).

Increasing packaging waste: A shift towards the purchase of fresh food all year round from all over the world and of pre-prepared and convenience food has resulted in large streams of packaging waste, on average 160 kg per person per year in EU-15 (EEA, 2005b).

Increasing food miles: Increasing demand for non-seasonal food and exotic food is leading to a large increase in the distance food travels from farm to fork, known as 'food miles'. Transport of food by air has thehighest CO2 emissions per tonne, and is the fastest growing mode (Smith, et. al., 2005).

Furthering eco-innovation in the area of mobility has the potential to slow or reverse some or all of these trends. The following two examples of eco-innovations describe solutions to some of the trends described above, as well as attempting to improve resource and energy efficiency. The concept of the eco-innovation is described, followed by its goal, project examples and an evaluation.

Name and concept of eco-innovation	Sectors
COMMUNITY SUPPORTED AGRICULTURE (CSA)	Food, beverage and tobacco manufacture, chemical products, agriculture and horticulture, retailers.
System innovation	

CSA is a partnership of mutual commitment between a farm and a community of supporters that provides a direct link between the production and consumption of food. Supporters cover a farm's yearly operating budget by purchasing a share of the season's harvest. CSA members make a commitment to support the farm throughout the season, and assume the costs, risks and bounty of growing food along with the farmer or grower. Members help pay for seeds, fertiliser, water, equipment maintenance, labour, etc. In return, the farm provides, to the best of its ability, a healthy supply of seasonal fresh produce throughout the growing season**.**

Goals:

- Foster organic agriculture practices (reduced use of hazardous fertilisers etc.)
- Decrease CO2 emissions from transport though local sourcing,
- Increase customer awareness of sustainable food & drink lifestyles by creating dialogue opportunities with local farmers.
- Support the biodiversity of a given area and the diversity of agriculture through the preservation of small farms producing a wide variety of crops.
- Create a sense of social responsibility and stewardship of local land among producers and customers.

Project examples and results: Stroud Community Agriculture Ltd (SCA), Stroud, England.
In 2001, a group of people came together to find a more sustainable way of obtaining their food. Within 3 months they were renting an acre of land and employing a vegetable grower. Within 2 years they had set up Stroud Community Agriculture (SCA) as an Industrial and Provident Society, were renting 23 acres of land, providing vegetables and meat to 60 families and making profit. At the end of 2007 SCA was:

- renting 50 acres,
- employing 2 full time farmers/growers,
- providing vegetables and meat to 189 households
- making enough profit to pay a bonus to its farmers/growers,
- paying for a part-time treasurer and membership administrator,
- buying in citrus fruit and olive oil from a sister CSA in Spain,
- maintaining a regular programme of social and working events.

Further information about Stroud community Agriculture Ltd can be found at
http://www.stroudcommunityagriculture.org/index.php

Overall evaluation of the eco-innovation
Environmental and health aspects: able to address environmental issues on a small scale i.e. reduced fuel consumption from transporting food long distances and reduce chemical usage. CSA can help people develop healthier eating habits.
Technical aspects: the degree of choice of products from CSA is significantly lower for consumers used to the convenience and choice of big supermarkets. Successful food production is more dependent on seasons than mass-produced supermarket food. High turnover of CSA members means that new members must constantly be found (Perez, Allen & Brown, 2003).
Economic and marketing aspects: CSA is likely to be more appealing if it is available to consumers for a lower price than other produce of a similar quality. The lack of choice makes the option not so appealing.
Socio-cultural and organisational aspects: CSA is educational because it connects consumers to other aspects of the food system. It requires consumers to give up more time to prepare the food available to them (Perez, Allen & Brown, 2003).

Name and concept of eco-innovation	Sectors
Sustainable Sourcing practices of retailers	Food, beverage and tobacco manufacture, chemical products, agriculture and horticulture, energy.
System innovation	

‘Sustainable sourcing practices’ of retailers means that retailers select products that have been shown to be comparatively less damaging to the environment or to human health. To assess this for a product, all of the following stages are considered; primary production, processing, transport, packaging and their storage in the retailers shelves. Sustainable sourcing emphasises communication, collaboration, and coordination among the retailers supply chain of the product, and on the shops interior design level (CSCP, UNEP, 2007).

Goals:

- Enhance the fuel, energy and resource efficiency of transport, logistics and storage, for example by switching to local sourcing
- Decrease vehicle CO2 emissions in the delivery fleet
- Reduce maintenance costs of the delivery fleet
- Switch to cleaner fuel (e.g. bio diesel) and energy sources in the shops and warehouses.
- Invest in carbon offsetting
- Purchase sustainably produced, processed and packaged products and shop equipment

Selected project examples and results: UK Retailer Sainsbury's* use of biopackaging

Besides other aspects of sustainable sourcing of retailers such as improvement of energy or light efficiency or increase in sourcing of socially and environmentally friendly products, biopackaging is one way in which retailers can source sustainably. Biopackaging refers to packaging that is either biodegradable (it will break down or compost), or sustainable (it is made from a renewable resource such as corn). It can be used for a wide variety of applications, including flexible films, bags, trays, punnets, netting, bottles, cups, labels, tubs and blister packs. Sainsbury's uses biopackaging for various fresh products, including fruit, vegetables and prepared salads. As part of its organic standards, the retailer aims to use compostable biopackaging for 100 % of its fresh products in 2009. The biodegradable materials used by Sainsbury's are starch-based, and are sourced from various suppliers based in Europe and East Asia. For example, Sainsbury’s uses NatureFlex, which is a glossy, transparent film manufactured from renewable wood pulp, sourced from managed plantations and is certified to EU and US standards for industrial and home composting. Sainsbury’s use of biopackaging has various positive implications:

- The retailer gets the opportunity to target a growing, environmentally-conscious consumer group.
- Supermarkets create the demand for a certain material, which in turn dictates the supply - if the demand from supermarkets is not there, there is little incentive for food and packaging manufacturers to develop and use biodegradable packaging.
- If a large supermarket chain like Sainsbury’s were to make the change to biopackaging across its entire fresh produces range, this would have a significant effect on the biopackaging industry, pushing it further towards the mainstream.
- It can save the retailer money in packaging taxes and gives it an easy way of disposing of fresh produce that is too old to remain on the shelves.
- It allows the retailer to compost old produce along with its packaging, saving the time and money spent separating the produce from the packaging.

*** This is merely one illustrative example and many retailers across Europe are also conducting similar projects.**

Overall evaluation of the eco-innovation **Environmental and health aspects:** encouraging retailers to engage in sustainable sourcing has great potential to reduce environmental impacts from the food and drink sector, since retailers can have an influence on all aspects of a product life-cycle (CSCP et al, 2008). **Technical aspects:** retailers need to make some technical adjustments, since the latest evidence shows adopting information technologies is the most effective way of achieving sustainable sourcing. As in the case of smart metering, the reliance of sustainable sourcing of retailers on ICT could present problems as precious metals in the electronic industry become more scarce. The alternative scenario is that the increased demand for ICT pushes innovation in the electronics industry, helping to develop new technology not requiring the scarce precious metals. **Economic and marketing aspects:** retailers are required to market the internal as well as external costs of their products so that consumers are able to fully understand where the product comes from and its environmental and social implications. **Socio-cultural and organisational aspects:** customers need to adjust to new and simpler ways of displaying produce in supermarkets.

3.3. Drivers and Barriers of eco-innovation

In order for the potentials of eco-innovation to unfold, drivers and barriers for ecoinnovation need to be known. Many innovations have failed because they were unable to overcome the manifold barriers (Bleischwitz 2007: 38ff.). For this report, an overview will be given. In addition, the drivers and barriers of the specific examples (discussed in Chapter 3.2) in each of the areas housing, mobility and food and drink, will briefly be discussed.

3.3.1. Drivers and Barriers – an overview

Drivers are generally understood as specific and evident agents or factors leading to increased or reduced pressure on the environment. Barriers can be considered as those forms of market imperfections that hinder markets from adopting eco-innovations. Both can be viewed either from the demand or supply side of eco-innovation (see Table 2). Indeed, it needs to be underlined that internalisation of negative externalities is not only a legitimate principle for environmental policy but also a major driver of eco-innovation, especially when it leads to stable expectations in favour of long-term goals such as CO2 reduction.

Table 2: Summary of determinants of eco-innovation, i.e. sources of potential barriers and drivers for eco-innovative activities

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 new products, environmental consciousness and preference for system innovation
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)

Demand side: drivers and barriers here are a result of individual choice, sociocultural and other external factors. Many psychological studies have been carried out to investigate the interaction between attitudes and behaviour, or why some people behave pro-environmentally and while others do not. Table 3 summarises the demand factors affecting the acceptance of an eco-innovation.

Supply side: drivers and barriers for producers or eco-innovative companies, such as high costs, perceived economic risks or lack of access to investment or finance. Eco-innovative companies explore to a high degree uncharted waters, as they have to cope with uncertainty about market conditions and technological solutions to achieve high environmental performance of products and processes

Table 3: Drivers and barriers for acceptance of an eco-innovation

Drivers for acceptance	Barriers for acceptance
• „feel good factor“ • applicability of social norm • individual benefits (financial outlay, health) • ease of implementation • being part of something	• external constraints (infrastructure, costs, working patterns, demands on time) • habit • scepticism • disempowerment
Specific lifestyle/self-identity (can be both a motivator and a barrier, depending on where people are starting from)	

Source: DEFRA, 2007.

In addition to viewing barriers and drivers in terms of supply and demand, it is possible to classify barriers and drivers into categories such as political, informational, financial etc. In terms of these categories, informational and financial barriers present particular problems to furthering eco-innovation in the EU. Informational barriers come about because there is an asymmetric distribution of knowledge about material and resource efficiency amongst users and producers or experts. Specifically, the informational problems include lack of competence in the areas of material and resource efficiency, the perception that recycling is a method of waste reduction rather than a recovery of materials, the underestimation of the potential market value of material and resource efficiency, and the lack of understanding of the benefits of long-term payback. Companies frequently expect short payback periods for investments and overlook, in the medium-term, potentials for cost reduction (the expectation in SMEs frequently lie under 2 years).

Financially, there are often problems of split incentives. This can be, for example, simply between the user and investor, or within a company itself, where investing and costing are often carried out in different departments or reflect differing interests of the leaser or property owner. In addition, when material and resource efficiency is a market advantage, it often will not be communicated actively between different companies because of competitiveness concerns.

Another relevant barrier is the gap between research, development and market launch: Due to competition, companies have an incentive to continuously enhance their processes and products and therewith gain price and/or quality advantages against their competitors. However, also risks are associated with the expenses for research and development ('sunk costs'): market success is uncertain. Companies, therefore, have an incentive to be the 'first mover' only with a sufficient patent protection. Given real uncertainties, it is rational behaviour of companies to wait and see initially in order to benefit as a 'second mover' from the pioneer's efforts of market development. Due to these positive externalities, the expenses on research and development fall short of the socially optimal level. According to recent analyses of the EU innovation panel (Europe Innova 2008:72 et seqq.), competition processes are to be considered ambivalent; the relation between competition and innovation follows an inverse U-curve. From a certain point on, competition intensity hinders innovation activity of companies for they have to fear not to be able to realize a margin necessary to cover the costs of the innovation process.

Environmental innovations even underlie a **double externality**, since environmental quality exhibits the characteristics of a public good and thus an enhanced environmental quality does not inure to the benefit of the innovator solely (Rennings 2000). Information and cognitions on raw material supply and on consequences for the environment have the characteristics of a public good; material properties can be interpreted at least as a club good.
In addition, it can be stated a gap between the successful testing of a single application and its market launch: besides deficits in the area of financing (FUNDETEC 2007), deficits in market development have to be considered. According to analyses by Jacobsson & Bergek (2004: 818) in the energy sector, an innovation system has to fulfil the following functions in order to assure a successful market launch (see also briefing note written by Gert v.d. Veen);:

a. Creation and diffusion of new knowledge (see above statements regarding information deficits);
b. Orientation and stabile commitments of policy trends;
c. Provision of financial resources and required capacities;
d. Mediation of division of benefits from positive externalities;
e. Creation of new markets (e.g. as niche markets by dint of trustworthy certification and signalling of quality, abatement of administrative restraints, public procurement, lead market policy and others).

Hence, policy should not restrict itself to enhanced research and technology supply policy, but also about the development of competences, about an active innovation policy and about the creation of lead markets. Lead markets can be supported and developed by strengthening current EU policies in this field (see chapter 4 and the briefing notes about current EU programmes and for proposals).

Box 5: Selected sectoral barriers

Barriers result from information deficits, splitted incentives, externalities; they can be associated with technical, economical, political and social factors. In addition, sectoral barriers are relevant such as:

- o In the building sector the architects' fees increase with the complexity of the building. In addition the widespread underground economy leads to 'flub in building' with high material deployment;

- o ‘Culture of nondisclosure’ in chemical industry restrains transfer of know-how concerning material efficiency;
- o Efficiency gains by dint of pigment-rich printing ink in printing sector is compensated by the clients’ demand for more coloured magazines;
- o The wood-processing industry is strongly stamped by conventionalized production processes and high transaction costs for new machines;
- o In areas as optical, medical, measuring as well as information and communication technology, product innovation and fast market entry attract the most attention of decision makers; design and visual appearance requirements are overemphasized; products’ useful economic life is decreasing in many areas; expertise on and feedback loops to material efficiency are thereby additionally hindered;
- o Regulatory risks concerning the recovery of material from LCDs; in Great Britain this area has not been approached to not call the regulatory authority’s (WEEE) attention to this problem; a moderated process within the scope of the REFLATED-project identified a potential market volume amounting to about 40 m £, enough for cost recovery of the required recycling industry (see briefing note written by Arnold Black).

Finally, the ‘rebound effect’ (Alcott 2005; Greening / Greene / Difiglio 2000; Herring 2008) should be mentioned: efficiency gains are thwarted at least partly by higher demand; this effect can be explained to large extend by price mechanisms (decreasing price induces growing demand). This occurs on a micro- and macroeconomic scale within an economy as well as internationally. It also calls for additional policies that enable markets to realise the full potential of eco-innovation.

Political action is thus basically legitimate. Furthermore, numerous case studies on eco-innovations document that the comparative advantages associated with market launch and diffusion can be promoted by appropriate governmental regulation (Jänicke 2008; Jacob et al. 2005; German Institute for Economic Research (DIW), Fraunhofer Institute for System and Innovation research et al. 2007; Ernst & Young 2006). Hence, the issue is not whether the government ought to intervene at all, but by what means the EU can be efficient and achieve a long-term effectiveness (Rocholl et al. 2007).

In the following section, the specific drivers and barriers for the examples presented earlier; deep renovation, smart metering, the green electric car, carsharing, community supported agriculture and the sustainable sourcing of retailers, will be discussed.

Box 6: Presentation of the Fish-Bone Diagrams

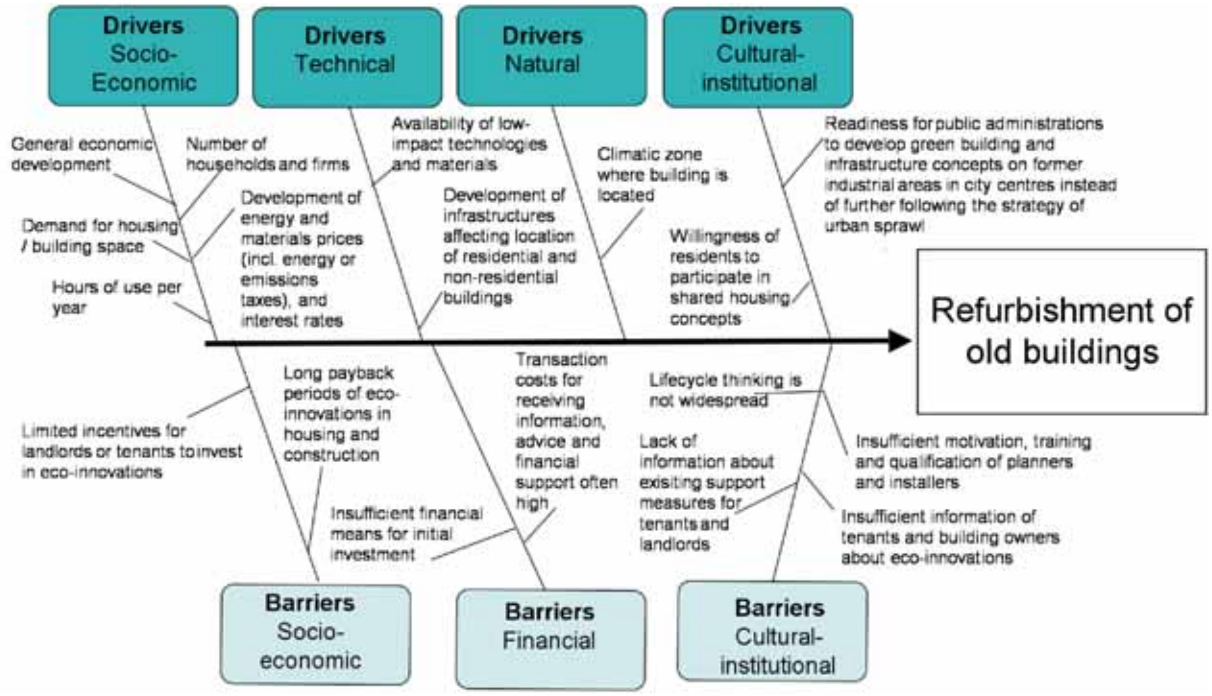
There are numerous ways of structuring, presenting and discussing drivers and barriers in eco-innovation, and this highlights the complexity of the issue. The fish-bone diagrams used below are graphical representations of the main drivers and barriers for the specified example. The main categories of drivers and barriers are shown in the boxes either side of the main axis, which points to the name of the eco innovation. Along the branches, the specific driver or barrier is described. It is important to note that the diagram indicates no prioritisation of importance for the barriers or drivers listed. The categories can differ for each case depending on which are relevant for the specific example. Additionally, in terms of categories, only ‘political’ drivers or barriers specific to the example are discussed because political drivers such as CO2 emission reduction, or air quality control are viewed as extremely prominent and overarching.

3.3.2. Deep Renovation (the refurbishment of old buildings)

The main barriers to ‚deep renovation' can be classified broadly as financial, socio-economic and cultural-institutional. The most significant financial barriers include the split incentives between landlords and building users, and the long payback rates which discourage old residents to renovate their home. Despite there being a general interest in investing in renovation, there is currently a lack of financial incentive to invest specifically in eco-innovations. This is due to lack of investment support, or knowledge about advice schemes about auditing/planning, investment and implementation. Socio-economic barriers include the insufficient motivation, training and qualification of planners and installers. Cultural-institutional barriers are the lack of willingness of public administrations to develop innovative infrastructure and housing development concepts that reduce environmental burdens and enhance the living quality of inner-city areas since these concepts require new thinking and willingness of residents to accept shared housing concepts.

The main drivers of ‚deep renovation' can be broadly classified as socio-economic, technical, natural and cultural-institutional. Within these categories, the most important drivers are the increasing availability and development of low impact technology and building materials, and the combination of materials with planning and installation techniques. Also, the need for more affordable and safe housing for low income groups is helping to increase the rate of refurbishment (SP/HUMI 2005, Boverket, 2005). The demand for housing space and size is also pushing for more renovation of existing older buildings (Wilson &Boehland, 2005). The drivers and barriers discussed are included, amongst others, in the fishbone diagram below.

Figure 11: Drivers and Barriers of Deep Renovation

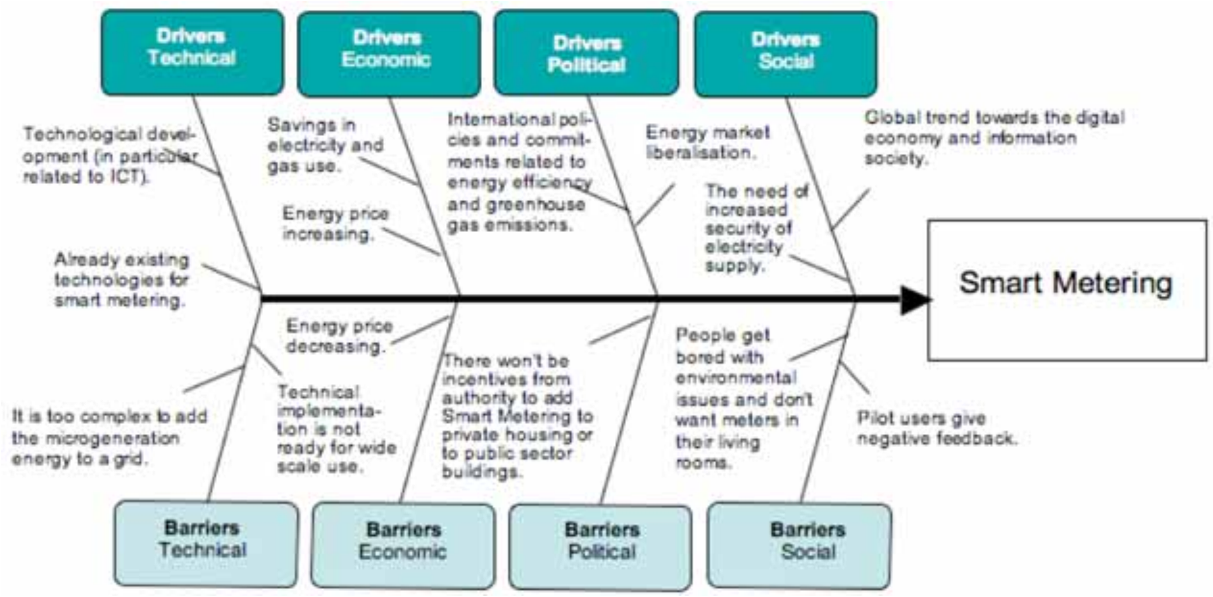


3.3.3. Smart Metering

The main barriers to ‚smart metering' are a combination of technical and political. In terms of technical problems, the technology for smart metering is difficult to implement on a wide scale; however Italy has recently made a rapid progress. It is also currently too complex to integrate microgeneration into the energy grid. The need to advance smart metering technologically is also not supported politically since there are no incentives for fitting smart metering to private housing or public sector buildings. Socially there has also been some negative feedback from pilot studies.

The main drivers for smart metering are a combination of economic, political and social. Economically there is a public interest in smart metering when it produces as incentive to save money, especially as the energy prices continue to increase. Politically, there are international commitments specifically relating to energy efficiency, and socially the need to increase security of energy supply makes the concept of smart metering more appealing as users are able to see regularly how much energy they use. The drivers and barriers discussed are included, amongst others, in the fishbone diagram below.

Figure 12: Drivers and Barriers of Smart Metering



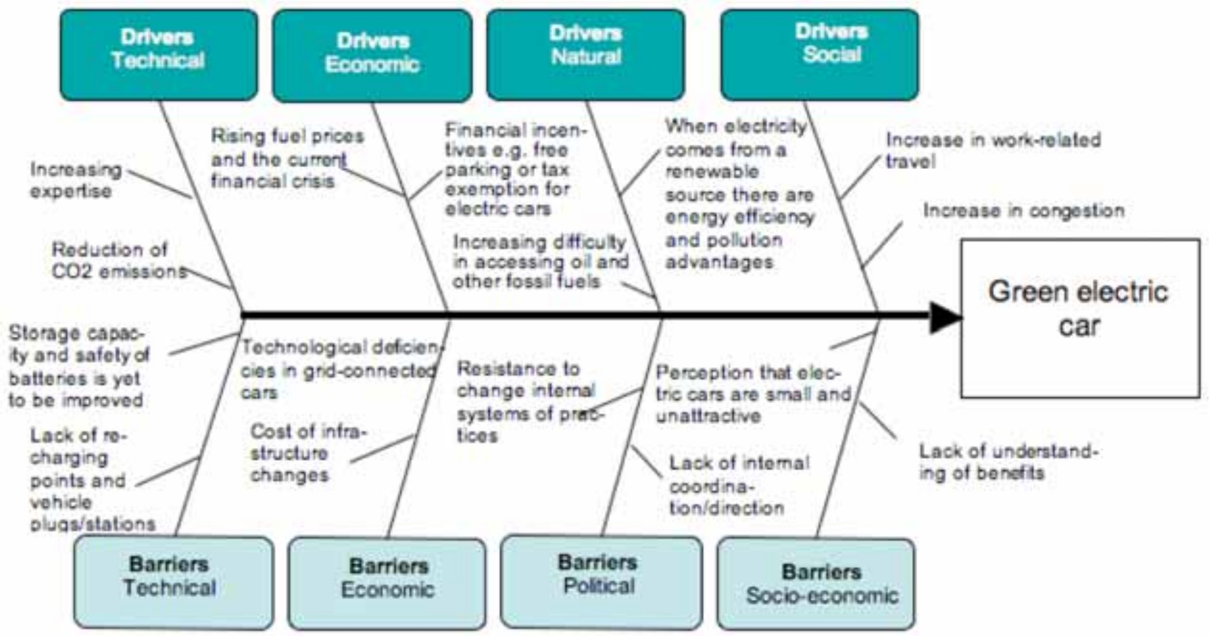
Note that the technological feasibility may differ between countries.

3.3.4. Green Electric Car

The main barriers inhibiting the mainstream use of the electric car can be listed broadly as technical, economic, cultural/institutional and socio-economic. In terms of technical barriers, a current problem is that the batteries used in electric vehicles must be improved in terms of energy storage capacity and safety. Another technical problem is that there are not enough electric vehicle plugs or stations where the vehicle can be refuelled. Cultural/institutional barriers include the lack of coordinating programmes, such as that of RWE and Daimler, illustrated in the example, able to further the infrastructure changes needed to accommodate electric cars. Electric vehicles are also perceived as being small, and unattractive, which presents a barrier to making the eco-innovation marketable for the mainstream.

The main drivers for the green electric car include natural drivers, such as the increasing difficulty in accessing oil and other fossil fuels due to their scarcity. When clean power generation is used to produce the electricity for electric vehicles, this will also make the electric car competitive in terms of energy efficiency and pollution reduction potential. Economically, the current financial crisis making consumers more reluctant to spend money on petroleum fuelled vehicles, they are looking for alternatives which may be more cost efficient in the long-run (Kendall, 2008). Also, planned financial incentives such as free-parking or exemption of car related taxes are stimulating a consumer interest in electric vehicles. **The drivers and barriers discussed are included, amongst others, in the fishbone diagram below.**

Figure 13: Drivers and Barriers of the Green Electric Car

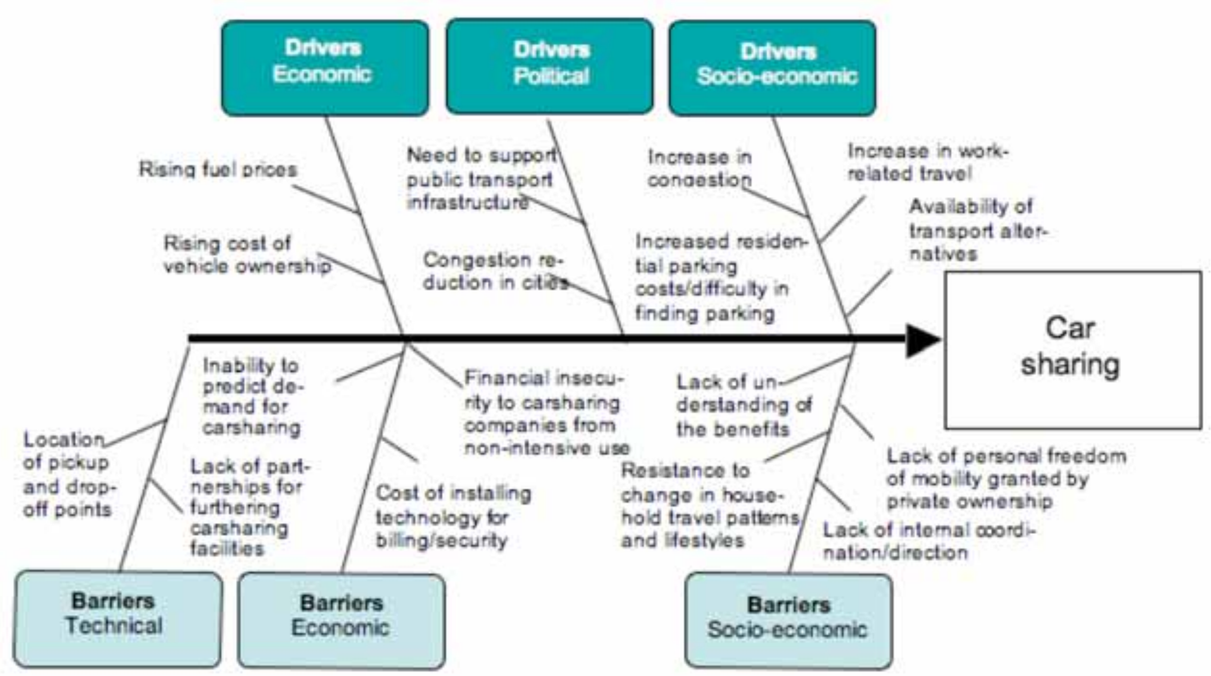


3.3.5. Carsharing

The main barriers to 'carsharing' are technical, economic, and socio-economic. Technical barriers include the limitations of current available car sharing services, such as inadequate pick-up and drop-off points, or lack of partnerships between transit operators, large employers, neighbourhoods and car sharing companies. Economic barriers include the inability to predict the demand for carsharing, as well as costs to potential car sharing companies, since for the company, carsharing is only financially viable when consumers use the cars intensively. Additionally, the cost of installing the appropriate technology such as 'smart' cards for billing and securing the vehicle can be a barrier for carsharing companies. Socio-economic barriers include reluctance from consumers to try carsharing since converting to using a shared vehicle might require substantial changes in household travel patterns and lifestyles (Shaheen, Aperling and Wagner, 1999).

Drivers for carsharing are mainly economic and socio-economic. When the cost of owning and running a car becomes more expensive than using a shared car, carsharing facilities will be favoured and demanded. In terms of socio-economic drivers, as disincentives for driving increase, for example increased costs for parking, decreased available parking spaces, people will be more inclined to use a car sharing facility. An important factor is also whether alternative modes of transport to driving are readily available. When public transport is also available people will feel less of a need to own a vehicle and be more inclined to try carsharing. **The drivers and barriers discussed are included, amongst others, in the fishbone diagram below.**

Figure 14: Drivers and Barriers of Car Sharing

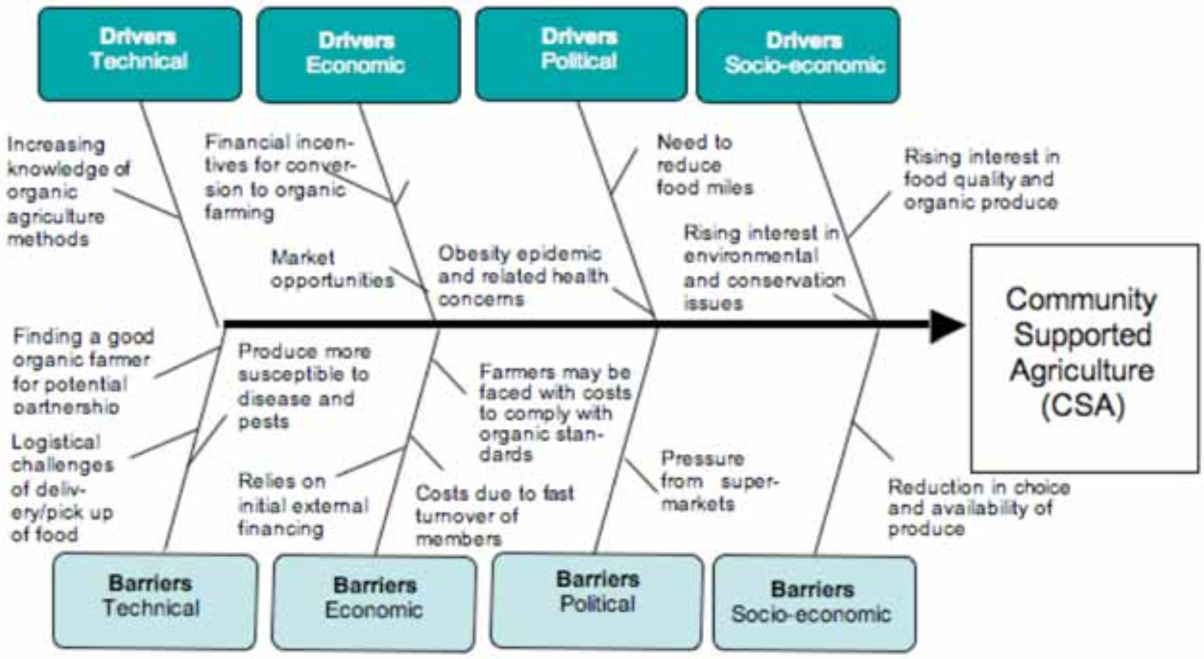


3.3.6. Community supported agriculture (CSA)

The main barriers to CSA are economic, technical, socio-economic and cultural/institutional. An important economic barrier to CSA is that initial external financing is often required for a farm or community to set up a CSA project. A technical barrier to CSA is that it can only implemented on a small scale, since for it to work effectively it requires a relationship between the farmer and consumer. The produce from CSA projects may also be more susceptible to disease and other pests, since the use of chemical fertilisers is normally minimised in CSA. Other main barriers are cultural/institutional. In areas where consumers are used to a convenience and choice culture, currently offered by large supermarkets, CSA cannot offer consumers the range of choice they are used to, since the produce is locally produced and dependent on the climate and seasons of the area. For the CSA projects, this often leads to a high and fast turnover of customers, putting financial and logistical pressure on the farm as they are constantly required to recruit new members.

Significant drivers for CSA are technical, economic, socio-economic and cultural/institutional. The most important of these include the increased technical knowledge of organic farming methods, the rising interest in environmental and conservation issues, and the need to reduce 'food miles'. A socio-economic driver is also public and governmental interest in health as a result of the global obesity epidemic, since CSA helps people think more about where their food comes from and develop healthier eating habits. **The drivers and barriers discussed are included, amongst others, in the fishbone diagram below.**

Figure 15: Drivers and Barriers of CSA

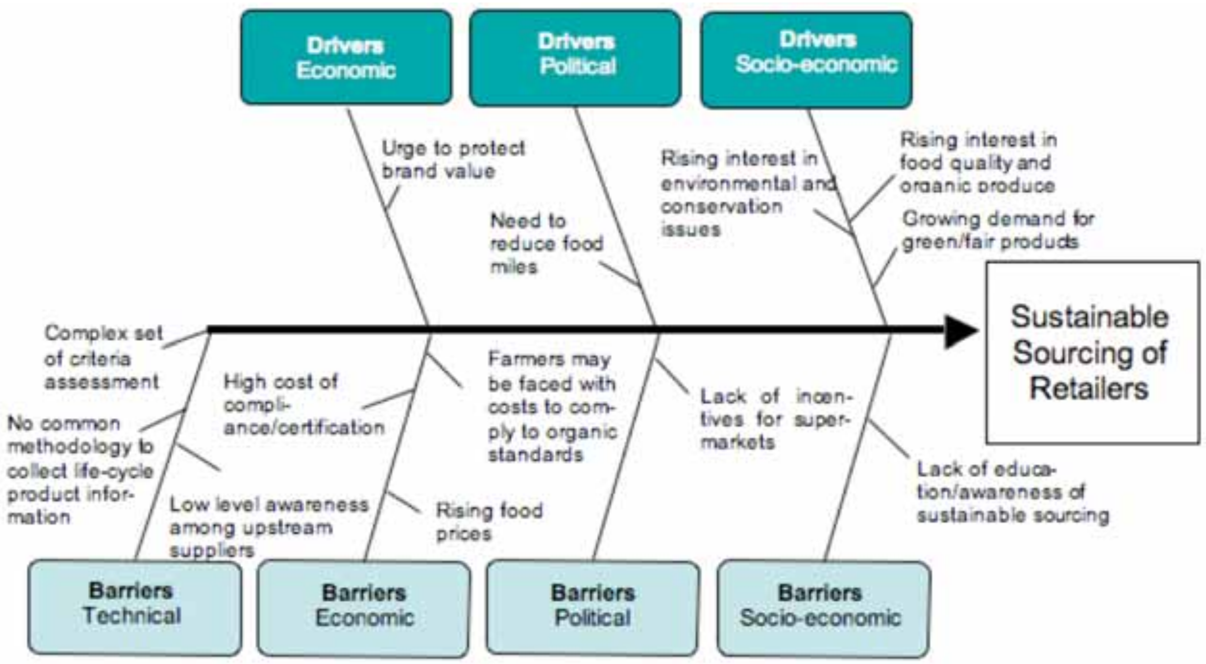


3.3.7. Sustainable Sourcing of retailers

The main barriers for the sustainable sourcing of retailers are technical and economic. The technical barriers for retailers are the lack of common methodology available about product lifecycle information, as well as the complex sets of criteria available for assessment of product lifecycles. This lack of consistency leads to much misinformation and confusion among both retailers and consumers. Since sustainable sourcing for retailers also necessarily means considering all aspects of the supply chain, a barrier to this process also includes lack of awareness among upstream suppliers. The primary economic barrier is then a lack of financial incentive for supermarkets to start sourcing sustainably, and the high costs of complying with sustainability certification schemes (CSCP et al, 2008).

Important drivers for the 'sustainable sourcing of retailers' are currently socio-economic. The rising interest from consumers in organically sourced food and improved food quality, as well as environmental and social issue (e.g. fair trade) is driving supermarkets to consider sustainability practices also further up the supply chain, and protect their brand value (CSCP, 2007). **The drivers and barriers discussed are included, amongst others, in the fishbone diagram below.**

Figure 16: Drivers and Barriers of Sustainable Sourcing of Retailers



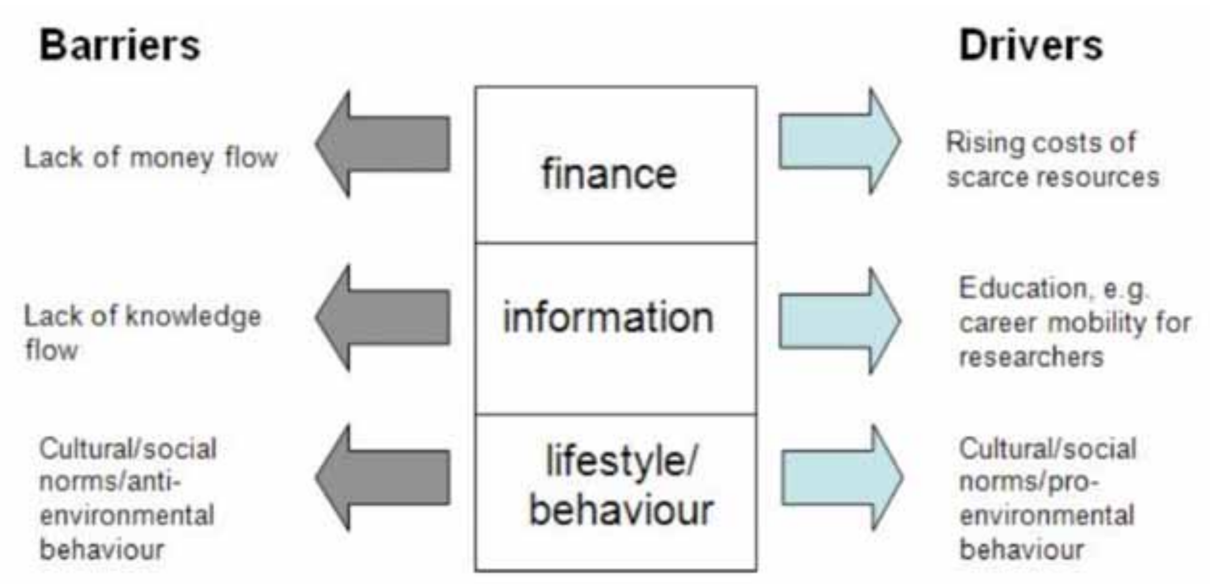
3.4. Conclusions

Eco-innovation has a crucial role to play in putting the EU on the path to a resource and energy efficient economy and thus significantly reducing the environmental impacts in each of the areas, housing, mobility and food and drink (discussed in this chapter). Experts estimate that this is likely to become an $800 billion market worldwide by 2015 and a $ trillion market afterwards.[1]

As mentioned, eco-innovations can be used and integrated on three different levels, as processes, products and systems. ‘Processes’ are the easiest to change, since these entail only a few adaptations to a method of production or industrial procedure, and can be achieved through methodology such as cleaner production, zero emissions, zero waste or material efficiency. Reducing the environmental impact of ‘products’ presents an increased degree of difficulty because the lifecycle of the product, from the design to the disposal, may need to be adapted. Finally, changing an entire system to become more energy and resource efficient is most challenging, since the entire sphere within which processes and products exist must be modified. In this case, techniques such as life-cycle analysis, cradle-to-cradle material flow analysis, integrated environmental assessment or decoupling factor 4 or 10 must be used.

The examples given in this chapter cover these angles of eco-innovation. As illustrated, there are multi-dimensional drivers and barriers to the eco-innovations mentioned in this chapter. The most important include financial, informational, and lifestyle or behavioural drivers and barriers. Other drivers and barriers are associated with availability of resources and time for the implementation of the eco-innovation. A main conclusion therefore is, that the markets for eco-innovation are enormous. However, political backing and enabling policies is fundamental.

Figure 17: Overview on drivers and barriers for eco-innovation



[1] See e.g. the recent German report on eco-industry: BMU (2009), Umweltwirtschaftsbericht, Berlin or the UNEP initiative ‚Towards a Green Economy’ launched in October 2008.

Overcoming the barriers and embracing the drivers to build up eco-industries for energy and resource efficiency requires the engagement of many different actors in society, and strategies should be implemented from many different sides. Strengthening EU policy, for example, in the creation of lead markets, can help overcome some of the financial and informational barriers. The next chapter elaborates on how European policy can unleash the market forces for eco-innovation.

Eco-innovations as processes and products cannot be separated from the part they play in the broader system. Of course technical barriers need to be overcome, and the development and production of an eco-innovation must be financed. However, for an eco-innovation to be fully accepted and diffused into wider society, a concerted effort must be made to engage people and target the emotional and psychological aspects required to reinforce its uptake. For example, although the technology for a green electric car is available, for civil society to adapt to 'charging' a car instead of filling it with gasoline will take time and require social marketing strategies and community development before it can become a trusted part of everyday life. The ideas presented here lead into Chapter 4, which discusses in more detail and concretises the specific proposals to speed up eco-innovation in the EU.

4. HOW TO SPEED UP ECO-INNOVATION IN THE EU

The final part of the study describes how to speed up eco-innovation in the EU. After a short introduction to EU programmes on eco-innovation, their impact and effectiveness will be assessed. Based on the assessment of EU programmes the study will conclude and formulate proposals on a future EU framework on eco-innovation. Furthermore, the chapter is enriched with selected best practice examples of promoting eco-innovation. The annex to this study contains further documents on practical examples.

4.1. Impact and effectiveness of EU programmes

The objective of this part is to give an overview on evaluations of the impacts and effectiveness of ongoing selected EU programmes related to eco-innovation. The analysis undertaken in this task has not been based on new formal impact assessments, appraisals or evaluations, as this would be beyond the scope of this project. The impact and effectiveness of different policy programmes therefore has been assessed by analysing the objectives of the programmes, their structure and the plausibility, and consistency of implemented or designed measures in relation to speeding up eco-innovation in the EU. The analysis is based on (1) original documents concerning the selected programmes (work programmes, action plans, directives), on (2) accompanying literature (such as reports, background documents, etc.) and (3) opinions from scientific experts and stakeholders (internet review of comments, feedback). In order to work with a consistent method, each programme has been described and assessed along a set of specific criteria.

4.1.1. Eco-design Directive

Title, timeframe
Energy using Products Directive (2005/32/EU; Eco-design Directive). First mandatory requirements will probably become effective in spring 2009. Existing working programme for 2009 – 2011. Two possible extensions under discussion for the time after: (a) products that do not use energy during use phase, but are relevant for energy consumption, e.g., windows, insulation or shower heads; (b) products that neither consume energy nor are relevant for energy consumption.
Objective and structure
Establishing a framework for setting ecodesign requirements that products must fulfil in order to receive the “CE” label, that allows to place them on the market and/or put them into service in the EU (mandatory standards or self-regulation by industry; added by requirements with regard to energy labelling; links to Energy Labelling Directive and to voluntary eco-labels). While the Directive was originally initiated to address all kinds of products and to achieve an integrated product design according to a broad range of ecological or sustainability criteria, the current Directive now focuses on energy-using products with annual sales of indicatively more than 200,000 units only, not including products in the transport sector. Moreover, it is literally not really an ecodesign directive, but puts a strong emphasis on energy efficiency or maximum energy consumption requirements. This more narrowed perspective is reflected in the methodology determined for preparatory studies preparing im-

plementing measures, which set requirements for specific product groups, as well as in the results and recommendations of studies already carried out and in the existing proposals for implementing measures.
Mechanisms
The political-administrative mechanism applied with this Directive is new and interesting. Instead of having separate Directives setting specific requirements for specific product groups, there is now only one framework directive defining procedures, rules, conditions and criteria for setting ecodesign requirements. Within this framework, the European Commission, in interaction with a consultation forum and a regulatory committee, defines product groups to be worked on in preparatory studies, and, in particular, the implementing measures, which are usually based on the preparatory studies and finally set qualitative and/or quantitative requirements for these product groups. Up to the end of January 2009, for 30 product groups and further sub-groups, preparatory studies have been put to tender, started or already finalised. For the first product groups, mandatory requirements have been already decided on, further will follow before the EP elections. Additional product groups will be covered in further steps in 2009 to 2011, and after 2011.
Innovation and market effects
The environmental, economic and social impact of the implementation of the Eco-design Directive, and its particular impact on stimulating eco-innovations, of course, strongly depends on the methodological framework, the product groups selected and the political-administrative process of setting ecodesign requirements. Based on the experiences with preparatory studies and proposals for implementing measures so far, it can be stated that the Eco-Design Directive still neglects non-energy aspects, rather concentrates on cutting off the worst products from the market and market transformation (dissemination) of existing products than stimulating eco-innovative "top runners" (for the "top runner approach", cf. Federal Environment Agency/Wuppertal Institute/UNEP-CSCP 2008), and does not yet explicitly stimulate the development of eco-innovations. However, indirect impacts on eco-innovations are possible, but not estimated yet.
Impact on energy and resource efficiency
Following the stepwise procedure described above, in the end, all energy-using products that are important with regard to their volume of market sales per year and their CO_2 emission reduction potentials might be covered. Boilers and water heaters are currently the product groups with the highest GHG emissions reduction potential for which implementing measures are already discussed. Other resource efficiency aspects are mostly neglected.
Practical experience and barriers
• The defined scope, methodology and political-administrative process of the Eco-design Directive focuses on energy-using products in their use phase. Other aspects that are important with regard to eco-innovation are neglected so far, as well as addition, coherence and interactions of the eco-design policy with other product policies (RoHS, WEEE) and with the Energy Performance of Buildings Directive. • In general, while the European Commission is very ambitious in designing eco-design requirements that reduce life-cycle costs, energy consumption and emissions during use

phase of the respective product groups to a large extent, the reality of the Eco-design Directive rather focuses on energy-efficient products available today than eco-innovations.

- For realising innovation effects, the dynamic relationship within the policy-mix ("push and pull") becomes important and is already partly addressed in proposed implementing measures. In this context, e.g., the proposed labelling schemes should allow to integrate new eco-innovations easily. Furthermore, the whole package of policies and measures has to be adapted continuously to market development and research results, so that it drives further eco-innovations. Against this background, timing of the different policy instruments becomes important.
- The recommendations given by the preparatory studies and the implementing measures proposed by the Commission partly follow a rather technology-specific approach. In contrast, a service-oriented approach would be more adequate, which focuses on optimising sustainability aspects of specific functionalities the products offer. For example, consumers or buyers of products in general are not interested in the technology itself (e.g. the technology of a refrigerator), but in the service or functionality they offer (e.g., cooling/freezing). From an environmental perspective, the environmental impact related to a certain service or functionality provided by a product should be considered. The service-orientation would help to focus on the orientation towards the best performing products with regard to the services the buyer's need, instead of just comparing different products within a specific technological category. The service-orientation would furthermore allow the development of new eco-innovative products that fulfil the general requirements for the respective product functionality, but might be different to existing technology.

4.1.2. The Competitiveness and Innovation Framework Programme (CIP)

Title, timeframe
The Competitiveness and Innovation Framework Programme (CIP). Programme period 2007-2013
Objective and structure
The general aim of the CIP programme is to boost the competitiveness and productivity of European businesses, and to promote innovation activities by financing and delivering business support services. Main target group are small and medium-sized enterprises (SMEs), the programme period runs from 2007-2013. The total budget sums up to €3.6 billion. The CIP programme is divided into three operational programmes: • Entrepreneurship and Innovation Programme (EIP) - € 2.17 billion • Information Communication Technologies Policy support Programme (ICT PSP) - €730 million • Intelligent Energy Europe (IEE) - €730 million. Eco-innovation is not a topic within the ICT PSP, but both two other sub-programmes are relevant for this evaluation: EIP's main objectives are to support SMEs regarding start-up, cooperation and all kind of innovation. EIP consists of several action fields, one of which is "Eco-innovation" (in the following "Eco-innovation/EIP"), which aims at supporting the first application and further

market uptake of some of the best eco-innovative products. The four priority areas of this call are materials recycling, building & construction, food & drink, greening business & 'smart' purchasing. EIP is financially by far the biggest part of the CIP, as it holds for about 60% of the total CIP programme. The funds for the Eco-innovation/EIP action are €430 of the €2166 million (i.e. about half the budget of IEE).

The work programme 2008 of Eco-innovation/EIP foresees an evaluation, with an expected report in February 2009. The evaluation should provide recommendations regarding the effectiveness and efficiency of the EIP, on whether or not there is a need to readjust to the implementing methods and/or means, and on improving the quality and utility of programme monitoring.

IEE II is the EU's tool for funding action for fostering more efficient forms of energy production and consumption and the adoption of new renewable energy sources. The IEE programme does not fund technical RTD projects. Existing measures are 'SAVE' (energy efficiency and rational use of energy), 'ALTENER' (new and renewable energy sources), 'STEER' (energy in transport) and integrated initiatives.

IEE II follows a bottom-up approach to evaluate its impact. Impact related programme indicators are to be built up from individual project indicators plus complementary activities on harmonisation, rationalisation and estimation of the knock-on impact. Performance indicators are named in the work programme to assess the effectiveness of the Programme which illustrate

- a balanced participation by public and private, non-profit and profit-making beneficiaries, appropriate to fulfil the pre-competitive objectives of the IEE II Programme,
- the involvement of previously identified stakeholders relevant to the action,
- a high proportion of SMEs among the private beneficiaries,
- active participation by applicants from all participating countries,
- a good proportion of new beneficiaries applying to and succeeding in IEE II, particularly from Member States that acceded to the EU in 2004 and 2007 and countries with just a few organisations participating so far,
- and more active involvement of beneficiaries from new Member States, reaching out to new local and regional authorities.

The report will concentrate on two parts of the CIP programme: the IEE, as the main energy-related programme and the Eco-innovation/EIP, as it concentrates on the issue of the evaluation and covers a large part of the overall budget.

Mechanisms

Within Eco-innovation/EIP projects are funded with 40 to 60% of total eligible costs, in order to help bridging the gap between research & development and the market place for eco-friendly products, technologies, services, processes and management methods across Europe. Calls are issued every year within the programme period.

The IEE II Programme is implemented by grants (call for proposals or concerted action) and Procurement (calls for tender). In general, a maximum of 75% of the total eligible cost will be reimbursed for promotion and dissemination projects.

Innovation and market effects
Eco-innovation/EIP: The Eco-innovation/EIP programme supports the first application and further market uptake of eco-innovative products and services with high potential in Europe, and aims at helping to overcome those critical barriers that still hamper their commercial success. Thus it has the potential to be a major instrument to speed-up eco-innovation within the European Union. Some sources indicate that there might be a bias in favour of recycling technologies in Mediterranean countries, due to many applications from that industry, which might not yet fully exploit the potential strengths of that programme. *IEE* The IEE measures aim at supporting the use of renewable energy sources and the rational use of energy not through the development of new technologies (see FP7), but it rather aims at changing the legal and societal framework conditions for initiating a change (optimal implementation and preparation of legalisation). The work programme stresses that projects have to build on well-tested strategies and technologies and rather aim at removing non-technological market barriers than develop new pathways. Thus it aims at transformations on the system level. 'Market transformation' and 'change of behaviour' are frequently used keywords within IEE. Awareness raising campaigns and capacity building on the population level, but also on the level of key stakeholders (industry, trade) are one means aimed at to set off behavioural changes. Moreover it is intended to lead by example (of public authorities).
Impact on energy and resource efficiency
Eco-innovation/EIP The budget of the eco-innovation programme (total of € 430 million) is more than half the budget of the IEE programme, which seems quite ambitious. In 2008 only €28 million were foreseen for the eco-innovation action. The programme of "eco-innovation" includes very diverse approaches on the product and process level (e.g. eco-friendly design and production of high quality consumer goods, green building techniques or cleaner and more efficient processing of food and drink) and partly also on the system level (knowledge sharing, cooperation, criteria implementation). While the aims of the waste, food and building/construction areas of the eco-innovation programme aim at very specific fields and rather target the process and product level, the greening business and 'smart purchasing' area covers a very wide range of topics (which are rather on a more general, knowledge-management oriented level). *IEE* Eco-innovation within IEE is focused to the field of energy. No link to material efficiency seems to be planned yet. Nevertheless, the issue of innovation for energy efficiency and new (renewable) resources is broadly covered within the sub-programmes. Besides the key actions, which are mainly organised within traditional areas (such as buildings, products, heating, cooling, vehicles) there are also a few integrative calls available.

4.1.3. The Seventh Framework Programme for research and technological development (FP7)

Title, timeframe
The Seventh Framework Programme for research and technological development (FP7) Programme period 2007-2013
Objective and structure
The Seventh Framework Programme for research and technological development (FP7) is the largest research programme in the world, running from 2007 to 2013. It bundles all research-related EU initiatives in order to play a crucial role to develop the European research area (ERA) and to reach the goals of the European Union's Lisbon Strategy: growth, competitiveness and employment. It consists of four basic components: cooperation (€ 32 billion), ideas (€ 7.5 billion), people (€ 4.7 billion) and capacities (€ 4.1 billion). Each of these is the subject of a 'Specific programme’. In addition, there will be a 'Specific programme' for the Joint Research Centre (non-nuclear activities) and one for Euratom nuclear research and training activities.
Mechanisms
(Co-)Funding is granted for projects that are proposed following calls for project proposals in accordance with the requirements laid down in the relevant specific programmes and work programmes. Collaborative research constitutes the bulk and the core of EU research funding. Moreover Joint Technology Initiatives (JTIs) address fields of major European public interest, focussed on well-defined areas of strategic importance for the competitiveness of European industry. Besides these initiatives, international cooperation is possible under the 7th FP.
Innovation and market effects
In the programme there are several measures and projects, which are directly related to eco-innovation. Within the ten distinct themes of the largest FP7 component “cooperation” (total € 32 billion) several have a strong reference to eco-innovation in their work programmes. The final dimension of this topic within the FP7 research remains still open. The “Nanoproduction” work programme aims at ensuring a transformation of the economy from a resource-intensive to a knowledge-intensive base, by creating step changes through research and implementing decisive knowledge for new applications at the crossroads between different technologies and disciplines. Research aims at the product and process level, enforcing the generation of high added-value products and related processes and technologies. The first of the series of calls included in the Work Programme 2009 deals with research in the field of bio-refineries, published jointly with other themes. The work programme of the “Energy” theme states as its overall topics the adaptation of the current energy system into a more sustainable one with a broad range of topics such as reducing the dependency on imported fuels, increase diversification of energy sources, enhancing energy efficiency, etc. The work programme focuses on technologies identified in the strategic energy plan as key challenges for the next 10 years, i.e. second generation biofuels (in particular biorefineries), CO2 capture and storage, solar energy, offshore wind and smart

electricity grids, thus mainly on the micro (product) level. Besides what is called "Long and medium term research", which follow a problem solving approach, there are also „Demonstration" projects funded, which are more industrially oriented. The work programme for "Food, Agriculture and Fisheries, and Biotechnology" names as key objective to build a European Knowledge Based Bio-Economy (KBBE), including the need for 'sustainable use and production of renewable bio-resources'. Within the calls for January 2009 it demands for projects within the topic 'Innovative biotechnology approaches as eco-efficient alternative to industrial processes". The objective of this topic will be to foster novel alternative eco-efficient processing routes for established industrial processes using biotechnology enabled approaches. The expected project should have strong industrial contribution and should foster innovative breakthrough biotechnology applications aimed to more eco-efficiency approaches on the core of multi-disciplinary research developed in an industrial context. Measurement of the eco-efficiency or sustainability of the proposed products and process alternatives should be taken on board within the project. The "Environment" work programme aims at advancing our knowledge on the interactions between the biosphere, ecosystems and human activities, but also on developing 'new technologies, tools and services, in order to address in an integrated way global environmental issues'. Within its first two calls a focus will be laid on understanding and assessing, later on the focus shall be shifted to responding. Demonstration is not a key issue. The issue of energy efficiency is also tackled within the research for SMEs, which aims at supporting SME associations to develop technical solutions to problems common to a large number of SMEs in specific industrial sectors or segments of the value chain through research.
Impact on energy and resource efficiency
Under the 7th Framework Programme it is estimated that up to 30% of the €32 billion budget will address environmental technologies. This includes: hydrogen and fuel cells, clean production processes, alternative energy sources, CO_2 sequestration, bio-fuels and bio-refineries, energy efficiency, information technologies for sustainable growth, clean and efficient transport, water technologies, soil and waste management, and environmentally friendly materials. The work programmes of the FP7 topics discussed above mainly aim at the development of new green technologies (product level) or new production chains (process level). No special focus on the understanding of the economic and social driving forces behind unsustainable patterns of natural resources use (system level) could be found yet.
Practical experience and barriers
The 2nd report on the implementation of the ETAP states that further channelling and harnessing research under the 7th Framework Programme could optimise outcomes. Synergies should be established between research themes, technology platforms, emerging lead markets and regulation.

4.1.4. The Environmental Technology Action Plan (ETAP)

Title, timeframe
Environmental Technology Action Plan (ETAP) Since 2004
Objective and structure
The main policy in Europe to stimulate the development and uptake of environmental technologies on a broad scale is ETAP. It complements the DG's regulatory approaches and directly addresses the three dimensions of the Lisbon strategy: growth, jobs and the environment. The Action Plan's objectives are: 1. to remove the obstacles so as to tap the full potential of environmental technologies for protecting the environment while contributing to competitiveness and economic growth; 2. to ensure that over the coming years the EU takes a leading role in developing and applying environmental technologies; 3. to mobilise all stakeholders in support of these objectives. The achievements of ETAP are reported every two years to the European Council and the European Parliament. So far, two reports are available: the first report in 2004, the second report in 2007.
Mechanisms
ETAP consists of a sequence of 28 actions following the order announced in the Commission's Communication on ETAP published on 28 January 2004. They can be grouped in nine sections: • Research and Development: strengthening research (see also FP7) • Technology platforms, public/private partnerships on a specific research topic. • Verification of technologies: establishing networks of testing centres, drafting catalogues of existing environmental technologies • Definition of Performance Targets: studies have been carried out to set up a performance target scheme based on best environmental performance, while being realistic from an economic viewpoint. • Mobilisation of Financing: e.g. improving financing of environmental technologies by introducing enhanced funding and risk sharing mechanisms, such as CIP (see below), LIFE, or via the European Investment Bank or the Cohesion policy; • Market-based Instruments: reviewing cohesion funds, state aid guidelines, environmentally harmful subsidies, and market based instruments • Procurement of environmental technologies: e.g. using life-cycle costing or technology procurement; promotion via Commission's handbook on Green Procurement or Member States action plans. • Business and Consumer Awareness raising and targeted training, e.g. via the ETAP website and newsletters; • Acting Globally: promoting environmental technologies in developing countries and countries in economic transition via global financing opportunities and responsible investment and trade.

Dissemination of experiences is guaranteed through national roadmaps (22 completed so far) that show promising schemes and the Forum on Eco-Innovation, a stakeholder platform that met five times until October 2008.
Innovation and market effects
ETAP focuses on actions from promoting research to changing (international) markets: • Getting from research to markets: actions aim to improve the innovation process and to take inventions out of laboratories and onto the market via FP7, technology platforms and Environmental Technology Verification; • Improving market conditions: Besides providing financial support (RTD funding, loans, guarantee mechanisms) ETAP tackles the setting of a performance target scheme, market based instruments, green procurement and awareness raising. • Acting globally: this includes provision of capital for eco-efficiency projects worldwide, as well as responsible trade and investment in order to support eco-technologies in developing countries, and promoting foreign investment
Impact on energy and resource efficiency
Given the wide range of policy areas involved in the implementation of ETAP (research and technology development; public procurement; corporate social responsibility; development aid, etc.), ETAP could be one of the key policy frameworks to realize substantial improvements in resource and energy efficiency in Europe. As no technological development per se is aimed for within ETAP, impact will mainly be achieved at the macro-level.
Practical experience and barriers
The 2nd ETAP report lists the progress made in the reporting period, such as funds available for environmental technology within the 6th and 7th FP, technology platforms launched, financing instruments, etc. Despite these achievements it admits that environmental technologies still remain a niche market and that new driving forces are needed to encourage further diffusion and up-take on a broad scale. The report suggests a focus on increasing demand for environmental technologies by further green procurement, greater financial investments, the establishment of technology verification and performance targets systems, by building on promising practice of Member States and by focussing on sectors with high gains (e.g. buildings, food and drink, private transport, recycling and waste water industries). Second, a focus on support measures is emphasised, including ensuring strategic knowledge, promoting awareness and participation, harnessing research.

4.1.5. Directive on the energy performance of buildings (EPBD)

Title, timeframe

Directive on the Energy Performance of Buildings (EPBD; 2002/91/EC) of the European Parliament and of the Council of 16 December 2002.
Existing Directive had to be fully applied by Member States by January 2009.
European Commission's proposal of 13 November 2008 for a recast of the EPBD currently under discussion.

Objective and structure

Main legislative instrument affecting energy use and efficiency in the buildings sector in the EU. It aims at minimising the energy consumption of residential and tertiary buildings in the EU Member States through a number of requirements:

- Development of a general framework for a methodology of calculation of the integrated energy performance of buildings taking into account national and climatic circumstances;
- Application of minimum requirements on the energy performance of new buildings taking into account national and climatic circumstances;
- Application of minimum requirements on the energy performance of large existing buildings (>1000 m2) that are subject to major renovation taking into account national and climatic circumstances;
- Energy performance certification of buildings which have to be presented when the building is rented out, sold or constructed;
- Regular inspections of boilers and air-conditioning systems above minimum sizes in buildings, and in addition an assessment of the heating installation in which the boilers are more than 15 years old;
- Requirements for experts and inspectors for the certification of buildings, the drafting of the accompanying recommendations and the inspection of boilers and air-conditioning systems.

Mechanisms

Does not directly address building owners or users, planners or installers; requirements had to be implemented by the individual member states until the beginning of the year 2006 (subsidiarity principle), (implementation of inspection systems and requirements for experts and inspectors by beginning of 2009).

Innovation and market effects

In countries with ambitious implementation of the EPBD, and similar measures having been implemented already in the years before, rather strong requirements concerning the energy performance of buildings and expected even stronger requirements announced for coming years resulted in eco-innovations like, e.g., nano-gel insulation, vacuum insulation, heat pumps with high coefficient of performance (COP), micro-CHP solutions, innovative passive house or energy-plus house concepts, or the revival of renewable building materials like wood, loam or straw, with these old materials fulfilling modern fire protection requirements.

The energy efficiency measures in buildings reduce energy imports and thus retain purchasing power and stimulate growth within the EU, while at the same time creating new jobs in the construction and production sector, and reducing jobs in the energy industry. The minimum total gross direct impact of the options identified by the Commission as being most beneficial, and which are therefore included in the Commission's draft of the recast proposal of the EPBD is 280,000 (to 450,000) potential new jobs by 2020, not including secondary job effects yet (European Commission 2008).

Impact on energy and resource efficiency

The EPBD acknowledges the fact that the buildings sector is responsible for about 40% of the EU's final energy consumption. Furthermore, buildings account for 38% of the EU's CO_2 emissions and 45% of the EU's energy costs (Koskimäki/Lechtenböhmer 2008); the construction sector is by far the most resource-intensive sector in the EU, see chap. 2. The EU Action Plan for Energy Efficiency identified energy efficiency in the building sector as one of its top priorities. The EPBD is assigned a key role in realising the savings potential in the building sector in the EU. A meta-comparison of EU scenario analyses shows that the overall potential for CO_2 mitigation in the building sector by 2020 is about 200 to 300 Mt CO_2 (without renewables). Depending on the scenario and the measures assumed in other sectors, heating and cooling of residential and commercial buildings (including sanitary hot water generation) account for about 29% to 63% of the EU's total final energy savings achievable vs. BAU (Koskimäki/Lechtenböhmer 2008). Refurbishment of existing buildings and replacement of existing heating technology accounts for the largest part of these potentials. The (recast of the) EPBD together with the respective subsidiary national legislations and the mainly national support schemes for building renovation, and together with the implementing measures of the Eco-design Directive for technical building equipment, forms the main policy instrument to realise the potentials (Wuppertal Institute 2008).

The impact the EPBD has achieved so far on energy and material use is difficult to estimate, partly because of difficulties in comparing the different degrees of implementation and the different calculation methods of the energy performance of buildings in the different Member States. The minimum total impact of the options identified by the Commission as being most beneficial, and which are therefore included in the Commission's draft of the recast proposal of the EPBD is 60-80 Mtoe/year energy savings by 2020 (i.e. reduction of 5-6% of the EU final energy in 2020) and 160-210 Mt/year CO_2 emissions reduction by 2020 (i.e. 4-5% from EU total CO_2 emissions in 2020)(European Commission 2008).

Practical experience and barriers

- There is a lack of implementation of the EPBD by a number of EU member states. Reasons for this include the difficulty of technical implementation due to the segmentation of the potential, a lack of proper national administration or a shortage of qualified experts for audits, inspections and certification. It has taken more time than anticipated to revise national building regulations, set up certification and inspections schemes and train experts. Furthermore, governments want to keep costs down, supporting systems for implementing the EPBD were not in place in many cases and there is a lack of incentives to spur stakeholders to act. Finally, there is almost no monitoring of the impact of the EPBD on actual energy savings. Due to these facts, the implementation of the EPBD is behind schedule in some EU member states.

- Differences in implementation on Member State level leads to large heterogeneity of mandatory standards, technical norms and respective calculation methods, with resulting inconsistencies between the national and the European level, e.g., between the implementation of the Eco-design Directive and the EPBD (however, the proposal for a recast of the EPBD addresses some links between both directives). The uneven standards, norms and methodologies might hinder the European-wide development and market introduction of eco-innovations, which might be good practice solutions in one country, but less relevant in others due to different degrees of ambitiousness of the political-administrative framework.
- The national roadmaps on low/zero carbon and energy buildings, such as passive houses, proposed as a requirement for the recast of the EPBD (European Commission 2008), will set reliable time frames and thus increase confidence of market actors to invest into eco-innovation for new buildings. However, such roadmaps should be required for the dynamic setting of energy performance requirements of buildings in general, and particularly for the refurbishment of existing buildings.
- The proposal for a recast of the EPBD does not address non-energy issues, and thus misses a chance to stimulate eco-innovations in the area of resource efficiency and recycling. In particular, with regard to the expected increase in insulation with non-renewable materials, recycling problems will become strongly evident in a few decades. Issues such as integrated functionality of different materials and "urban mining" also ought to be considered when a "resource performance of buildings" will be envisaged.

4.1.6. The Action Plan on Sustainable Consumption and Production and Sustainable Industrial Policy

The European Commission SCP Action Plan, launched in 2008, is an outline of actions aimed at furthering SCP within the EU. Although, one of the current main commitments to SCP, it forms part of other strategies taken by the EU and the EC towards SCP. Historically, in the EU, both the EC and member states promote the transition towards SCP in several ways. However, these may or may not be directly labelled using the term 'SCP'. Such strategies include both top down (i.e. broader strategic frameworks and initiatives) and bottom-up approaches (i.e. pieces of legislation, thematic initiatives) as well as coordination between the two. One major step in particular, was the formulation of the EU sustainable development strategy (SDS 2006), which identified SCP as one of the seven key challenges to be tackled by implementation action.[2]

In addition to this, the SCP Action Plan can be seen as a response to the Marrakech Process (2003), which was created by the United Nations within the Johannesburg plan of implementation (JPOI) and is a '10 Year Framework of Programmes' in support of regional and national initiatives to accelerate the shift towards SCP.[3]

Despite the efforts already made through the Action Plan on SCP, the EU has the potential to foster its contribution to meeting our environmental needs through a much more ambitious

[2] EEA Technical Report No 1/2008: Time for Action – towards sustainable consumption and production in Europe, CSCP, EEA and Republic of Slovenia Ministry of the Environment and Spatial Planning
[3] Idem.

strategy, where capturing eco-innovation and turning environmental challenges into economic opportunities is the central doctrine.

4.2. Other approaches and best-practices of promoting eco-innovation

In order to bridge the gap between an analysis of ongoing EU activities and proposals, the following subchapter lays down a few other approaches and best-practice examples of policies promoting eco-innovation. The examples partly stem from EU member states and from experiences outside the EU. They cover the full range of policy instruments available and will be clustered according to the usual typology of instruments, taking into account recent debates about new policy instruments and governance (Bleischwitz 2007).

4.2.1. Regulatory instruments

These are instruments, relating to norms and standards, environmental liability, environmental control and enforcement. The WEEE has been selected because it offers an innovative regulatory approach, which might be used for other purposes of material stewardship.

European Directive on Waste from Electrical and Electronic Equipment (WEEE)[4] (Part of EU member state national law since August 2004)	
Objectives and Structure	Studies predict that e-waste will rise by 2.5-2.7 % per year from 10.3 million tonnes in 2005 to 12.3 million tonnes per year by 2020. The objective of WEEE is to reduce the amount of waste from electronic and electrical equipment through establishing legal criteria and standards for its collection, treatment, recycling and recovery. The WEEE can be viewed alongside two other EU directives; the 'Directive on Restriction of the Use of Certain Hazardous Substances', and the 'Directive for the Setting of Eco-Design Requirements for Energy Using Products' which together are an attempt at implementation of the EU Integrated Product Policy (IPP) The WEEE affects producers, retailers/distributors and private households and prescribes a waste collection rate of 4 kg per capita.
Mechanisms	The WEEE affects producers, retailers/distributors and private households and includes 10 categories of product such as, large/small household appliances, IT & Telecommunication equipment. For each product category, producers, retailers/distributors and private households are obliged, via differing mechanisms, to collect and recycle prescribed quantities of electrical and electronic equipment (quantity depends on the category).
Innovation and Market effects	The WEEE aims to increase the producers' incentive and responsibility to minimise life-cycle impacts, and finance recycling and disposal of electrical and electronic equipment, while at the same time providing a market incentive for producers to consider product end of life issues in design.
Impact on energy and resource efficiency	The WEEE has resulted in new standards for the phase out of toxic substances and recycling possibilities. Yet, its impact on energy and resource efficiency can be considered low.

[4] GTZ, CSCP, Wuppertal Institute (2006), Policy Instruments for Resource Efficiency: towards Sustainable Consumption and Production

Practical experience and barriers	Collection of WEEE began in 2005 and because of discrepancies in the implementation, a review was called for in 2006. To date, studies have shown that there is a low rate of awareness and a general low collection rate of electrical and electronic equipment (EEE) (UN University, 2007)[5]. There have been differences in collection rates between EU member states, and it has been observed that the target of 4 kg collection of EEE per capita can easily be met by wealthier states, but it remains a challenge for new member states. Issues also become more complex when applying WEEE to trade involving non-EU states. There is also no measure in place to prevent exports to developing countries where regulation and capacity to deal with the waste is not so high. Although the implementation process spans around 10 years, many local governments and smaller companies have not been prepared for WEEE and are unable to implement it effectively, also a large number of SMEs are unaware of legal obligations under WEEE. Based on the findings of a recent study, a number of suggestions for improvement have been made. These include; better emphasis of regulation of all parts of the recycling chain, splitting legal framework and key responsibilities from operational standards, simplification and harmonisation of regulations throughout the EU27, and fostering consumer awareness to stimulate sector levels of e-waste collection

4.2.2. Economic instruments

These are instruments which may influence environmental outcomes by changing the cost and benefits of alternative actions open to economic agents. They aim to do so by making the environmentally preferred action financially more attractive. Considering economic instruments for unleashing eco-innovation, it is important to look at the current state of the art and draw conclusions. Typically, the options to be considered are eco-taxes, tradable permits and subsidies. The case example considered in this respect is a taxation of Construction Materials (aggregates).

Construction materials are quite relevant for the area of housing – and taxed in a number of EU member states (EEA 2008). All European countries collect environmental taxes, which can be divided into four categories: energy, transport, pollution and resource taxes. The weighted average of the revenue by environmental taxes in EU-27 constitutes 2.6% of the Gross Domestic Product (GDP) in 2005. Besides, the trend shows a declining course, at least in EU-15. Resource taxes are only marginal in Europe: they amount to 4.1% of the total of the environmental taxes (Eurostat / EC 2007). The overwhelming part of environmental taxes is usually generated by energy taxes. Some countries however tax construction materials, for instance UK, Sweden, Italy and the Czech Republic. Different tax bases (such as quantity extracted or quantity sold or size of the mining area), coverages, levy forms (centralised or decentralised), recipients (central government, state government, local government), administrative procedures and, last but not least, the rate of the tax cause differently intense resource reducing and material substitution effects.

[5] UN University (2007): Great Potential to Improve Collection, Recycling of Europe's Electronic Waste, http://www.vie.unu.edu/file/UNU_ZEF2007+pr+english.pdf?menu=27 accessed 29/01/09

Scheme of UK Aggregates Levy and Aggregates Levy Sustainability Fund (ALSF)	
Objectives and Structure	In UK, a construction materials tax, the so-called "Aggregates Levy", was introduced in April 2002 with the objectives to • reduce the demand for primary materials (sand, gravel, rock), • organise the extraction and transport more environmentally friendly, • compensate communities and municipalities for the environmental damages of the extraction activities and increase the proportion of recycled material used in construction activities. It was not the scarcity of the resource which was in the foreground but the internalisation of external costs such as noise and dust emissions from transport, visible landscape changes, the loss of biodiversity, groundwater pollution, etc. associated with the extraction and mining processes.
Mechanisms	For commercial mining or import of primary materials in or to UK (including its associated coastal and water territory), £ 1.60 per tonne were rated until April 2008, £ 1.95 per tonne since then and £ 2.00 per tonne from April 2009 on. This rate is roughly 30% of the total price per tonne (HM Revenue & Customs 2008). The Aggregates Levy Sustainability Fund (ALSF), which has been implemented simultaneously to the tax in April 2002 at the UK Department for Environment, Food and Rural Affairs (Defra), uses a part of the tax revenues for external costs associated with the degradation processes that are linked to the mining processes as well as for selected research and development projects. The funds are distributed by various organisations, e.g. by the Department for Transport.
Innovation and Market effects	The construction materials tax in UK has still rather low direct effects (reduction of 6 million tonnes of aggregates of 275 million tonnes extraction altogether in 2005), but - through the increased use of recycled building materials - it has triggered indirect consumption reductions. It has galvanised the business with recycling materials enormously (up to a share of recycled materials of 25%; wrap 2008) through diversification and innovations and it has induced a rising of standards of the quality of secondary materials. At the same time, it has also set trade incentives in the border region of countries which do not have a construction materials tax yet (here Republic of Ireland) and thus partly forwarded increased shipment volumes.
Impact on resource efficiency	Besides the effected shift towards the use of recycled materials, in particular the ALSF induced a further spin-off as regards resource efficiency. For the period 2005/7, around £ 840,000 were used for the assessment and consulting of some 400 companies (such as site-specific advice to improve energy efficiency and competitiveness during transport, while improving the environmental performance and safety) (Department for Transport 2008).
Practical experience and barriers	As the example of the UK's construction materials tax shows, the steering effect of an economic instrument can gain plausibility when the instrument is transparent. The transparent coupling with an earmarked sustainability fund precludes acceptance problems and opens up financial resources for the internalisation of environmental damages and counselling and compensation programmes.

4.2.3. Informational instruments (incl. knowledge-creation, research and education, cooperation)

This covers a potentially huge and interesting area when certain target groups including SMEs ought to be approached and learning effects are to be stimulated. The case examples selected here are the following:

Environment-driven Business Development in Sweden[6] Organised by the Swedish Agency for Economic and Regional Growth (NUTEK) between 2001-2004	
Objectives and Structure	The objective was to stimulate product and business development from sustainability perspectives and thus strengthen the competitiveness of domestic small and medium sized enterprises (SMEs). Divided into two themes • environmentally sound products as a competitive advice • operational development focusing on continuous improvements. The main aims were to develop new environmentally sound products whilst improving leadership, management, stakeholder engagement and communications in SMEs.
Mechanisms	There was a preparation phase, which involved two rounds of project proposals from SMEs. It involved a preliminary study, which connected project concepts with company needs. The second stage of the project was then implementation. This involved regional development organisations, municipalities, consultants, universities and other research institutions. A total of 390 SMEs took part in the programme, all of whom were already active in environmental management, but were looking for ways to create new market values through environmental innovation. NUTEK as a government agency co-financed SEK 28 million (on average 32 % of the costs of each project) and the input of participating companies in terms of time and money was around SEK 50 million.
Innovation and Market effects	More than half of the companies indicated an increase in their competitiveness by working on environmental issues more strategically
Impact on energy and resource efficiency	As a result of the programme, around 60 products and services have been made more environmentally sound and more than 100 companies have ensured a system of continuous improvement.
Practical experience and barriers	Conducting the preliminary studies allowed committed and motivated companies to be found and therefore minimised the risks of project failures or delays. Project results were documented and disseminated among other networks as well as websites, industry associations, seminars and publications. Further information about the initiative can be obtained at http://www.nutek.se

[6] GTZ, CSCP, Wuppertal Institute (2006), policy Instruments for Resource Efficiency: towards Sustainable Consumption and Production

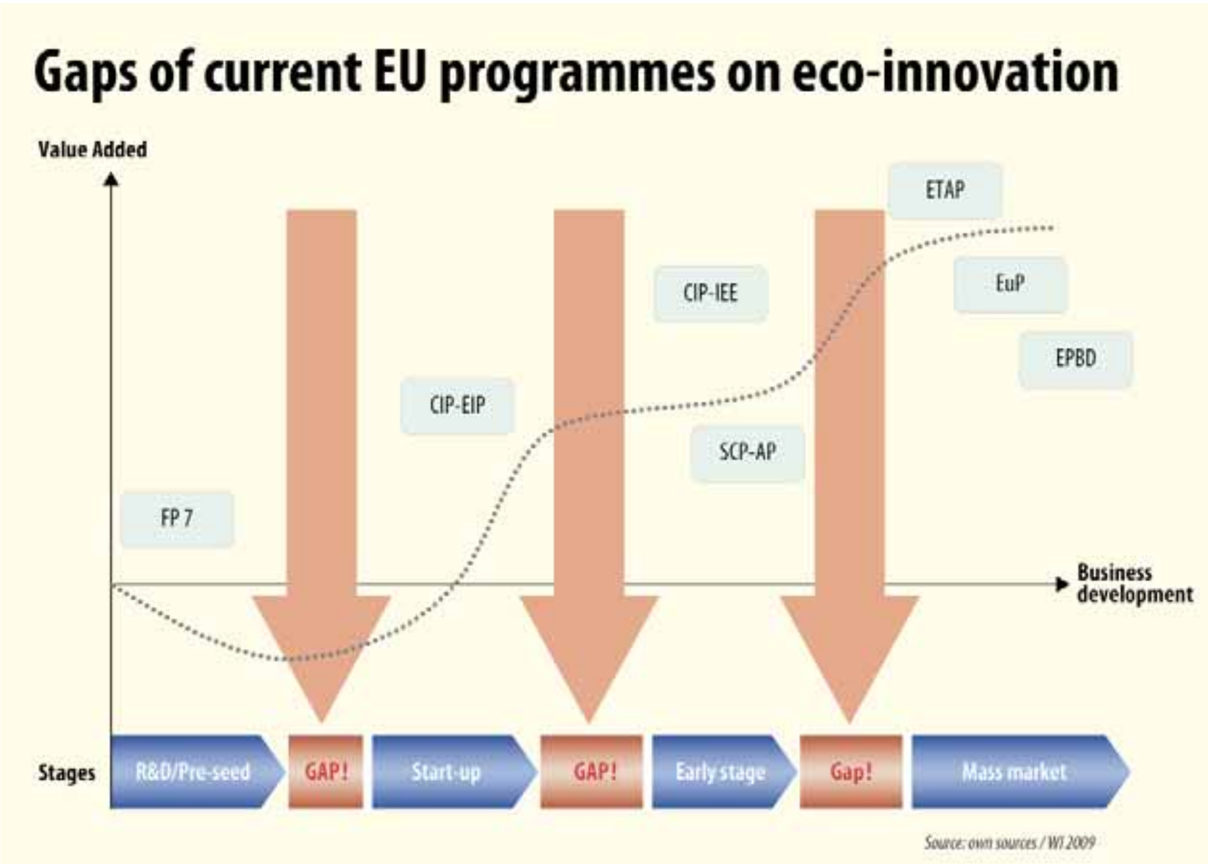
European Union Energy Label

Energy labelling in a dynamic "top runner" policy-mix	
Objective and structure	The European Union (EU) Energy Label rates electric household appliances, currently from A (the most energy efficient) to G (the least energy efficient), within a class of products and provides additional information such as the volumetric capacity of the refrigerator or freezer and the washing and spinning performance of washing machines. The label must be shown on all refrigerators, freezers, refrigerator-freezers, washing machines, tumble dryers, washer dryers, dishwashers and light bulb packaging by law. The EU Energy Label is a mandatory label for selected household appliances with application to products also sold for non-household uses. Furthermore, for circulators, it is used in a voluntary approach of the pump industry. The objective of the EU Energy Label is to inform consumers about the energy performance of products. The publication of information on the consumption of energy and of other essential resources by household appliances allows consumers to choose appliances on the basis of their energy efficiency. and further aspects (e.g., water efficiency, noise, detergency)
Mechanisms	The energy labelling particularly unfolds its power in the combination with other policy instruments within a consistent and comprehensive policy-mix for the respective field of application. Other policy instruments suitable for combination with energy labelling are minimum energy efficiency standards, voluntary product labelling like the European eco-label ("EU flower"), or fiscal or financial incentives (e. g. rebate programmes). In such a way, it can contribute to an effective "push and pull" strategy, also named as a dynamic "top runner" approach following the principle idea of the respective Japanese approach to support the market transformation towards the most energy-efficient products, but transferring this approach to the European cultural, economic and legal conditions.
Innovation and market effects	Evidence from different product groups shows that the energy labelling has contributed to the development of eco-innovations, i.e. to more products that fulfil class A requirements or are even more efficient than class A, which in turn lead to the introduction of new energy classes ("A+; A++"), and to the rethinking of the naming and dynamic revision of the classes of an energy label in the current political discussion on EU level (cf. the discussion within the preparatory studies of the Eco-design Directive; and CECED 2007). However, the environmental aspects considered with energy labelling are just end-use energy and water consumption. Other environmental aspects are neglected.
Practical experience: Impact on energy and resource efficiency	The combination of a rebate scheme with information on energy labelling in the Netherlands in the period 1995 – 2004 resulted in annual energy savings of 0.2 PJ (Irrek/Jarczynski 2007). Impact on resource efficiency has not yet been explored.

4.3. Proposals for a future EU framework on eco-innovation

Based on the previous chapters and the assessments in section 4.1 and 4.2 as well as the briefing notes the following proposals shall support the EU to speed up eco-innovation. They address the specific gaps identified in the areas of entrepreneurship, pre-commercialisation as well as the opportunities to remake buildings in Europe (see Figure 18). In line with the cross-cutting barrier of currently distorted incentives, the proposals promote market-based incentives and the reform of existing initiatives; in addition, new proposals are presented that should help to unleash the potential of eco-innovation in a focused way.

Figure 18: Gaps of current EU programmes on eco-innovation



4.3.1. Market-based instruments for the heavy weights: taxing construction minerals

All European countries collect any environmental taxes. They can be divided into four categories, energy, transport, pollution and resource taxes. The weighted average of the revenue by environmental taxes in EU-27 constitutes 2.6% of the Gross Domestic Product (GDP) in 2005. However, the trend shows a declining course, at least in EU-15. Resource taxes are only marginal in Europe. They amount to 4.1% of the total of environmental taxes (Eurostat / EC 2007). The overwhelming part of environmental taxes is usually generated by energy taxes. Against the background of those rather low environmental taxes in Europe that are, in addition, dominated by energy taxes, it is recommendable to expand the tax base gradually to non-energy resources (construction minerals, metal materials, industrial minerals, other fossil fuels). Due to their great importance within the economic system of almost all European Member States and since the demand for construction minerals is relatively inelastic, a plausible initial option for resource taxes could be the European-wide taxation or charging of construction minerals. Such a scheme could contribute to a long-term restructuring of the tax system: the establishment of a two-pillar tax system with less weight on wage taxes culminating in a strong pillar of material input and land use taxes in future decades.

Construction minerals such as sand, gravel and rock (called aggregates) are coarse-grained materials that are extracted relatively near to the surface. They are usually not regarded as a hot spot of environmental policy or eco-innovation while they are very important for the economic process because they serve as essential ingredients for the entire value chain of the construction and housing sector (cement production, structural and civil engineering, road and railway construction, reconstruction and renovation). Due to huge mining volumes the material and environmental intensity (land use conflicts, landscape alterations in the extraction phase, soil sealing and contribution to an unbroken net addition to stock in the construction phase, energy consumption and emissions during extraction, transportation and use phase, to a lesser extent resource depletion) should not be underestimated. Regarding the absolute weight, the aggregates industry can actually be considered the most resource-intensive sector throughout Europe. According to the European Environment Agency, they represent more than 44% of the Direct Material Consumption (DMC) in the European economy while mineral fuels represent another 25% (Eurostat 2008). In 2004, this came up to 2,862 million tons[7] in EU-15, compared to 1,432 million tons of fossil fuels (Eurostat 2008). Despite predominant regional self-sufficiency in the realm of construction minerals first regional shortages have emerged and triggered trade, so that the material is becoming increasingly relevant for the EU environmental policy. Spain, France and Germany are currently the largest producers of sand, gravel and rock and the largest net exporter in the Central European area is Germany, followed by the United Kingdom and Norway. In fact, the Netherlands and Belgium-Luxembourg are even larger exporters but they are the largest importers at the same time (BGS 2008). Both countries seem to be subject to cross-border trade proceeding in order to avoid long domestic transport routes of the bulky and portage sensitive material.

Practical experiences with the effect of taxes on aggregates have been gained in some EU Member States (in particular in UK, Sweden, Italy and Czech Republic), which all levy taxes or charges for sand, gravel and/or crushed rock (EEA 2008). Unequal design, administrative procedures and assessment bases, such as the quantity extracted, the value produced or the mining area covered, show completely different resource use reducing and material substitution effects and as instruments they work differently efficient. Moreover, it seems to be important whether the tax or charge is centrally or decentrally levied, i.e., who is the beneficiary or the recipient of the tax/charge (central government, state government, local government). The German system, for example, is federal. Tax beneficiaries of a mining charge are the federal states. The German mining law leaves it up to the single federal states either to exempt certain industries from the levy or to charge them depending on the economic situation of the respective region. This has led to an extensive drop out of the mining charge in Germany. The comparison of the four systems showed in contrast that the UK system was comparatively effective and efficient. Referring to the UK example of an aggregates levy (see chapter 4.2.2) a delineation of a European scheme shall thus be developed and a rough calculation of the

[7] including industrial minerals which amount to 5-6% of domestic material consumption

revenues that could be generated by an analogue European construction materials tax shall be carried out in the following.

Due to different tax systems in the single Member States and the unanimity requirement for tax issues within the European Union it is not possible to design a European Aggregates Levy. It is however possible to draw on the European Council Directive restructuring the Community framework for the taxation of energy products and electricity (2003/96/EC of 27 October 2003). This directive was set up in order to harmonise the market-conditions and thus lays the foundation stone for a further expansion and harmonisation of environmental incentives hence reducing market distortions and the competition that occurs on the grounds of different environmental regulations within Europe. A directive like the Energy Tax Directive concurrently gives necessary flexibility to each Member State to introduce and enforce the specifications according to the individual national and political context. This may also include a constitution as a charge wherever a tax seems not realisable due to a particular taxation law. The elements of a directive on the structuring of the Community framework for the taxation of construction materials have to include some main elements. These are (a) scope of the directive, (b) the application range, (c) the tax or charges base, (d) a potential review process, (e) the validity period and (f) the minimum levels of taxation/charging. They can be qualified as follows:

As (a) scope a directive should comprise all European Member States and (b) be applied to primary aggregates, i.e., sand, gravel and crushed rock. The directive should also apply to aggregates imported into the EU as it could otherwise set a trade incentive and distort markets; eventually a border tax adjustment needs to be made. The tax/charge base (c) is tons produced, i.e., extracted and extradited. The directive should come into effect as soon as possible. If it could be enforced, for instance, from January 2010 on, a review process (d) should be established to reappraise the effects of the instrument after a four-year period (2014). The directive should be valid unlimited in principle but (e) at least until the revision mechanism has proved an effective levy of the tax/charge and an efficient change of resource use, either through increase of substitution materials (such as wood) or increase of recycling materials. The minimum levels could start from 1.5 € per metric ton. Table 4 shows the production statistics of 23 of 27 EU-Member States and roughly calculates what could be received through a minimum taxation/charging of aggregates by 1.5 € or 2 € per country.

It has to be examined to what extent the budget generated could be earmarked and follow an analogue target through, for example, a resource efficiency fund, resource efficiency programs, etc. The earmarking of revenues gained by taxation, as successfully introduced in the UK system, raises constitutional objections in some other EU Member States. In some cases it is required that taxpayer and recipient of an earmarked fund have to be the very same; a directive could include the option to choose a charge system instead. A charge system however does not appear in the government budget like a tax and thus may contribute to an intransparent shadow budget which is more vulnerable to misapplication. Another option could therefore be to set up a support programme for innovations or a research budget increase in the realm of construction materials and substitution. A minimum taxation on construction minerals could further help to reduce unintentional trade incentives and competition distortions. It will be most important to control the implementation and acceptance problems, which occurred in the wake of the introduction of the ecological tax reforms in Europe when dealing with fiscal incentives to increase the environmental performance. A fiscal approach, when specifically used to increase the resource productivity in the medium term, should therefore keep exceptional rules and tax exemptions as few as possible.

Table 4: Production of primary aggregates (sand and gravel and crushed rock) in 2006 in Europe and potential revenues of an aggregates tax/charge on the basis of tons produced

Country	Absolute in million tonnes	Production share in percent	Potential revenue in million € (for 1.5 €/ton)	Potential revenue in million € (for 2€/ton)
Spain*	415.0	15.5	€ 622.50	€ 830.00
France	407.5	15.3	€ 611.25	€ 815.00
Germany	398.7	14.9	€ 598.05	€ 797.40
Italy [(a)]	248.5	9.3	€ 372.75	€ 497.00
United Kingdom [(e)]	237.7	8.9	€ 356.55	€ 475.40
Irish Republic*	160.0	6.0	€ 240.00	€ 320.00
Poland* [(f)]	128.8	4.8	€ 193.20	€ 257.60
Finland	100.0	3.7	€ 150.00	€ 200.00
Sweden	92.0	3.4	€ 138.00	€ 184.00
Denmark	72.5	2.7	€ 108.75	€ 145.00
Netherlands	72.2	2.7	€ 108.30	€ 144.40
Hungary	64.4	2.4	€ 96.60	€ 128.80
Austria [(a)]	54.4	2.0	€ 81.60	€ 108.80
Czech Republic	51.7	1.9	€ 77.55	€ 103.40
Belgium [(b)(c)(d)]	48.6	1.8	€ 72.90	€ 97.20
Slovenia	32.1	1.2	€ 48.15	€ 64.20
Slovakia	22.8	0.9	€ 34.20	€ 45.60
Bulgaria	19.9	0.7	€ 29.85	€ 39.80
Lithuania	12.9	0.5	€ 19.35	€ 25.80
Estonia	12.5	0.5	€ 18.75	€ 25.00
Cyprus	12.2	0.5	€ 18.30	€ 24.40
Latvia	5.8	0.2	€ 8.70	€ 11.60
Romania*	1.6	0.1	€ 2.40	€ 3.20
Total EU-23	2671.8	100.0	€ 4,007.70	€ 5,343.60

Source: BGS 2008 and own calculation
no data for Greece, Luxembourg, Malta, Portugal
* (Partly) estimated
(a) Sales
(b) Deliveries
(c) Includes construction sand and silica sand, excludes gravel
(d) Includes gravel
(e) Includes small quantities for other purposes in Northern Ireland
(f) Includes an estimate for small producers

4.3.2. Greening the EU budget towards eco-innovation

The European Commission claims that the 2009 budget will have the highest spending for growth and employment[8]: "The proposal presented today also highlights the growing trend to gear policy spending towards the energy and environment, with a massive 10% of the budget going on environment".

[8] http://ec.europa.eu/budget/budget_detail/next_year_en.htm

Figure 19: 2009 Budget Proposal

Where the money could go

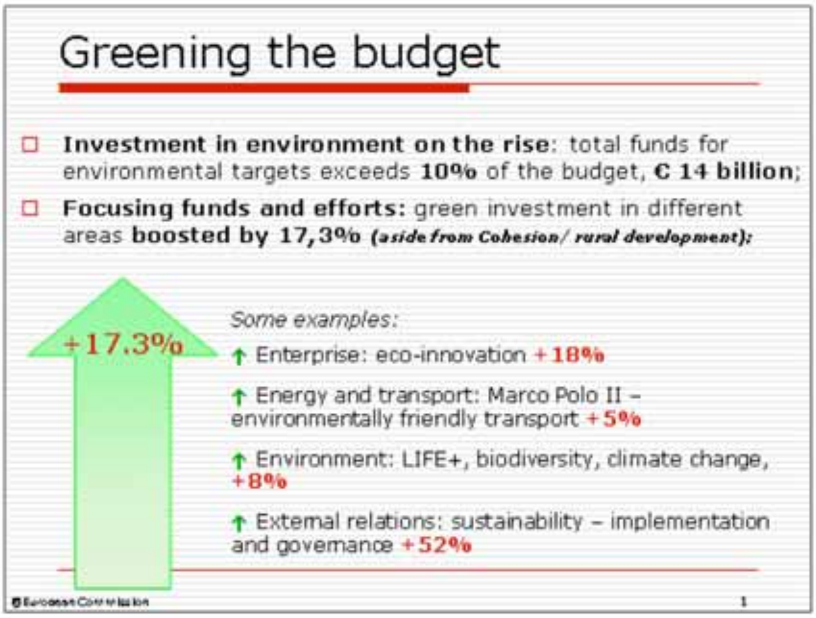
COMMITMENT APPROPRIATIONS BY HEADING	Billion €	% of total budget	% change from 2008
1. Sustainable growth:	**60.1**	**44.7**	**+3.0**
Competitiveness	*11.7*	*8.7*	+5.5
Cohesion	*48.4*	*36.0*	+2.5
2. Preservation and management of natural resources:	**57.5**	**42.8**	**+3.5**
Direct payments & market related expenditure	*42.9*	*31.9*	+4.5
Rural development, environment, fisheries	*14.6*	*10.9*	+0.8
3. Citizenship, freedom, security and justice *	**1.5**	**1.1**	**+8.6**
Freedom, Security and Justice	*0.9*	*0.6*	*+15.0*
Citizenship	*0.6*	*0.5*	*+1.0*
4. The EU as a global partner	**7.4**	**5.5**	**+1.8**
5. Administrative expenditure (for all EU institutions)	**7.6**	**5.7**	**+5.0**
of which Commission	*3.6*	*2.7*	+4.5
6. Compensation for Bulgaria & Romania	**0.2**	**0.2**	**+1.2**
Total commitments	**€ 134.4**	**100.0**	**+3.1**
In % of EU-27 GNI	**1.04**		

* Excluding Solidarity Fund

©European Commission 1

Source: European Commission

Figure 20: Greening the budget according to the European Commission



Source: European Commission

Despite additional efforts of supporting eco-innovation an analysis of the EU budget shows that eco-innovation in the EU will be determined by whether the EU will manage a greening of the largest spending blocs which are Regional Policy and the Common Agricultural Policy (CAP). In 2009 the spending for the CAP will remain around €60 billion and the programmes to support cohesion across Europe will receive a total of around €50 billion. Thus, Regional and Agricultural Policy still cover almost 80% of the EU budget. Although the Commission presents a rather conservative approach with new headings such as "sustainable growth" (Regional Policy) and "sustainable management of natural resources" (CAP), it remains to be seen whether the largest EU policies can be sufficiently steered towards eco-innovation.

CAP

Over the past fifty years intensification of agriculture often supported by the CAP has increased overall environmental pressure on landscapes and biodiversity. Agriculture has contributed to soil degradation, water pollution and loss of biodiversity (EEA 2007). Sustainable agro-environmental development and cross-compliance schemes show that farming and protection of the consumer and the environment can be harmonized. By setting goals towards a diversified agriculture, taking the specific territorial characteristics in account, this would not just aim to increase its productivity, but also seek to minimize the external inputs and guarantee quality and food safety through a productive re-organization and the adoption of high level of technological innovation (Bringezu, S., et. al, 2007). Thus, a greening of the CAP can be a potential driver of sustainable consumption and production by improving the quality of our food while protecting Europe's landscapes and biodiversity.

Regional Policy

From 2007 on, half of the budget for Regional Policy will be dedicated to the development of the new member states and acceding countries of Central and Eastern Europe. Huge financial injections will result in structural interventions, which shape the long-term development of these countries. Schepelmann 2005 has shown that Regional Policy could boost eco-innovation. Like no other EU policy it can set a frame for research, technological development and the creation of markets by connecting public and private drivers of eco-innovation. Regional governments cannot only use the Regional Funds to increase overall eco-efficiency of their industry, but create regional clusters of eco-innovation (Schepelmann, Ph. 2005). Nevertheless, most of the funds seem to be dedicated to traditional regional economic development schemes. Large conventional road transportation schemes will increase pressure on the environment. Although most of the environmental related spending of the EU happens in the framework of Regional Policy most of the money is still dedicated to end-of-the pipe environmental protection.

For improving eco-innovation regional planning for research, economic development and environment would have to be integrated. A concrete proposal for improving this kind of policy integration would be the guidelines by the Scientific and Technical Research Committee of the European Union (CREST). The Commission has published a report based on the CREST guidelines on using synergies between Structural Funds, the Research Framework Program and the Competitiveness and Innovation Programme (CIP)[9]. Such an advanced scheme for using of the EU budget could be the material foundation for developing a "triple-helix" consisting of stakeholders from enterprises, the public sector, research and teaching who could drive and implement eco-innovation in the regions.

Proposal for speeding up eco-innovation beyond 2009

A greening of the budget would be the material basis for speeding up eco-innovation beyond 2009. This would have to follow two strategic lines: on the one hand unsustainable spending would have to be cut, on the other hand the money saved by this activity could be shifted to

[9] COM (2007) 474 final

support investments in structural eco-innovation. A budgetary strategy could include the following elements:

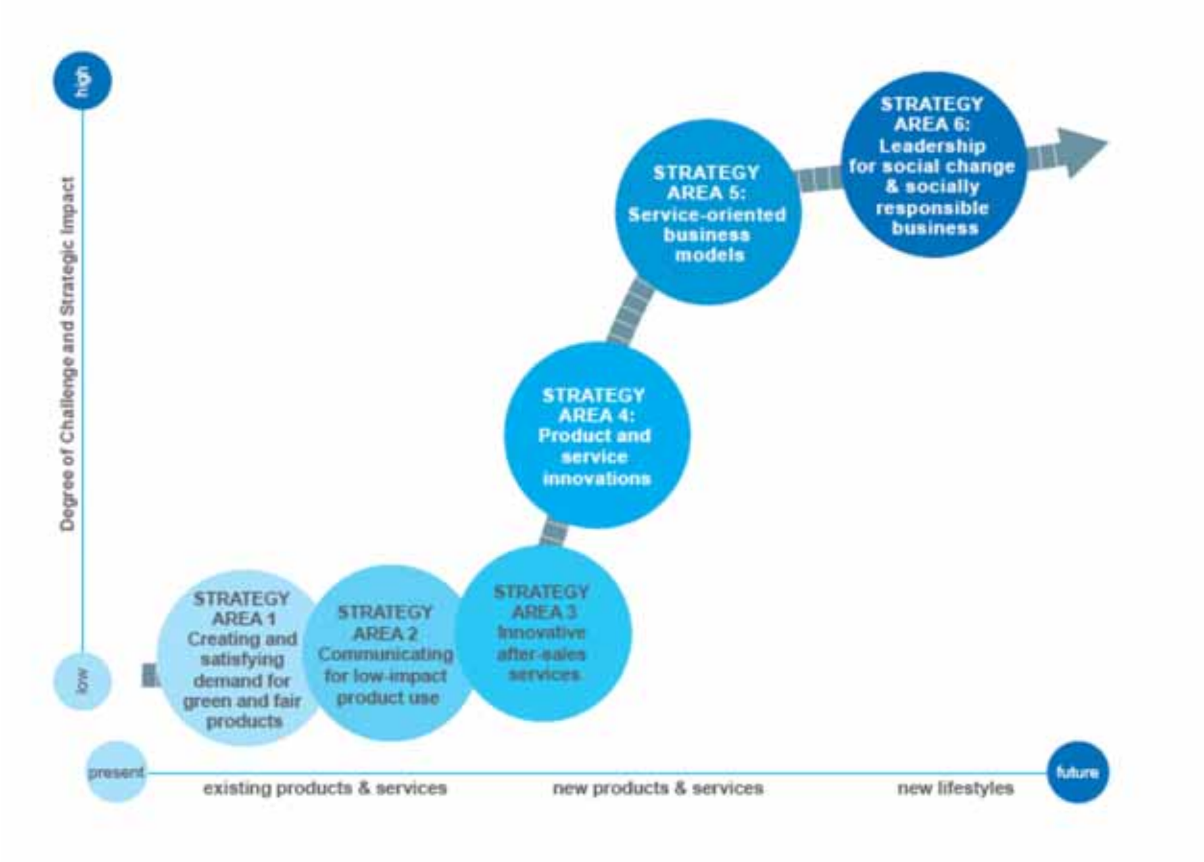
- Further redirecting CAP from direct payments towards integrated rural development schemes which support eco-innovation in the area of sustainable production of high-quality food and biomass. These integrated rural development schemes should include integrated logistical, economic and technological strategies for adapted sustainable natural resource management in the landscape (food, water, soil, biodiversity and closed-loop biomass production and use). These strategies would have to be highly adapted to local economies and landscape conditions thus inducing local eco-innovation and employment schemes.
- Rigorous environmental appraisal and reduction of Regional Policy schemes for large infrastructure projects which could support long-term unsustainable development paths and shifting towards funding for eco-innovation e.g. in the area of decentralized electricity grids (supporting green electric cars and renewable energies) and lighthouse projects on resource efficient construction and resource recovery.
- Redirection of Regional Funds from end-of-pipe technologies towards integrated solutions (e.g. decentralized water treatment) and eco-innovation.
- More advanced schemes for improving energy and material productivity of economies would require an implementation of the CREST guidelines for improved co-ordination between Structural Funds, the Research Framework Program and the Competitiveness and Innovation Programme (CIP). Only such a concentration of forces could achieve a measurable improvement of resource productivity in Europe by means of regional eco-innovation clusters and a European network of regional resource efficiency agencies.
- Integration spending of the European Investment Bank (EIB) for improved co-financing of eco-innovation

4.3.3. Engaging industry in developing eco innovation for sustainable ways of living

Industry has a huge role to play in encouraging sustainable ways of living. By reaching consumers through markets, business can do a lot to communicate and enable sustainable choices. To tackle the enormous challenge of climate change, simply improving efficiency in the production of goods and services will not be sufficient. It is vital that business looks beyond promoting more sales of low-carbon products and services.

There is an urgent need to transform markets by replacing high-carbon and resource intensive consumption patterns with low-carbon/resource efficient ones. But what strategies and policy interventions can help business tap these opportunities? The following suggestions can be classified into six strategy areas. As illustrated in Figure 21, the more willing a company is to take the challenge of sustainable consumption, the more potential for value creation and differentiation from competitors a company has.

Figure 21: Diagram illustrating the degree of challenge and strategic impact of each strategy area



Source CSCP (2008)

The Strategy Areas[10]

Strategy Area 1: Creating and satisfying demand for green and fair products. Businesses implement environmentally and socially responsible supply chain management and promote these practices to consumers. Companies can employ tactics such as choice-editing, the elimination of harmful substances in products, communication and marketing strategies, or the utilisation of eco-labels and fair trade labels to promote their products. The policy-maker can support these approaches by engaging in related initiatives, for example, by setting up an eco-entrepreneur fund.

Strategy Area 2: Communicating for low impact product use. Businesses communicate the environmental and social impacts associated with product use to their stakeholders. In economic terms this means explaining and addressing the hidden costs of product ownership. Companies can increase consumption efficiency by raising awareness and educating consumers on how to reduce the use-phase impacts of what they purchase, such as through energy use of electronic devices or waste avoidance on product disposal. A lot is still to be done to improve product and corporate reporting and labelling of sustainable products. There is still no ‘sustainability’ label and policy-makers can help to develop and implement concepts such as a ‘product pass’ for products which meet sustainability criteria.

[10] CSCP (2008) Making the Business Case Towards Low Carbon and Resource Efficient Lifestyles - Booklet Series

Strategy Area 3: Innovative after sales services. Businesses focus on prolonging product life and the end-of-life management for products. Companies can set-up after-sales services to warrant the durability of their products or run 'take-back' schemes for closing resource loops (re-use or re-cycle). Policy-makers can improve and expand schemes such as the automobile directive (ELV) towards full recovery of precious metals.

Strategy Area 4: Product and service innovations. Businesses can take a more radical and revolutionary approach, whereby products and services are (re-)designed to meet future customer demands, and catalyse drastic environmental and social improvements. Designing for sustainability would be a common tool used to put this strategy area in practice. This can be further supported by the incorporation of social aspects into the eco-design directive. A common framework for putting sustainability criteria into the design process needs to be established.

Strategy Area 5: Service-oriented business models. Companies aim to serve very specific needs instead of selling units of products. Sometimes, this strategy requires a radical shift in companies' thinking. Such as, how the needs of target customers are served, or the product in sale is designed. A focus on services with a wide range of partnerships to satisfy the ultimate need of customers, such as being a mobility provider, rather than an automotive company, lies at the heart of this strategy, and it carries high potential for dematerialisation. A law regulating the resources taken and used from nature such as a 'materials saving law' can ensure that there is a core shift in levies and taxes on labour and materials to give strong incentives to the production sector for minimising the use of natural resources.

Strategy Area 6: Leadership for social change and socially responsible business. This is a level of ambition for companies, eager to address the underlying drivers of ever increasing levels of resource use and environmental degradation i.e. the paradigm of our materialistic societies. This is a highly exploratory area in which companies can engage in the debate about whether "more is always better". They can also experiment with business models aiming at encouraging sustainable lifestyles and achieving well-being for all within planetary limits. Partnerships can be formed between governments and business to ensure business has good advice on how to achieve sustainability and administer continuing advisory and technical support, promote marketing to support sustainable business products and services and to mainstream sustainability into business development programmes.

For most of the strategic areas, besides the policy interventions mentioned above, adopting a sectoral approach in the development, promotion and application of eco-innovation will be needed. Market opportunities for eco-innovations within a particular sector and across a sector can be identified and pushed in different companies. A value of the sectoral approach is the opportunity to collect and harmonise data and measurement schemes from specific sectors which can in turn result in a sector-wide reporting mechanism. In the EU, this could result in a set of standards and benchmarks on energy and resource efficiency respectively sustainable production and consumption that can be formulated for specific sectors but also for certain demand areas including different industries. This set of standards could have a number of repercussions along the supply chain and also on the consumption side – i.e. outside Europe and not putting the competitiveness of firms at risk. A method of engaging a whole industrial sector (e.g. cement, steel, automobile, building and metal manufacturing sectors) and breaking it down in production and but also on the consumption side in different demand areas (e.g.

food, mobility and housing) will help to unleash eco-innovation. It will be of vital importance to pursue such an approach, not only with regard to climate change, but also with regards to resource efficiency.

4.3.4. How the SCP Action plan can further support eco-innovation in the EU

The SCP Action Plan has been instrumental in drawing the attention to existing and starting initiatives with relevant for eco-innovation, including the EMAS revision and the eco-design directive described in this document. The public consultation organised by DG Environment and the civil society consultation jointly conducted by the EEA and the CSCP has provided a showcase how stakeholder opinions can be integrated into drafting a strategic guiding document to coordinate existing initiatives, an approach that could be applied in the eco-innovation field.

For the SCP Action Plan to more effectively support eco-innovation, concrete perspectives for its further development and the impacts of its implementation are instrumental. A role of an advanced SCP Action Plan could be to clarify the relationship between different initiatives existing in the eco-innovation field, thus creating demand economies of scale across different user groups (e.g. private customers, public procurement and B2B) and security regarding market framework conditions for long-term investments in eco-innovation.

To strengthen the implementation, the nature of the "dynamic framework" in the SCP Action Plan (COM(2008) 397 final) could be clarified: Table 5 provides an overview how the different areas of the SCP Action Plan can be linked to eco-innovation systematically.

A continuous monitoring of the various specific initiatives[11] covered by the SCP Action Plan, in a complementary fashion to the existing implementation mechanisms for these initiatives.

Table 5: Furthering the incorporation of eco-innovation into the SCP Action Plan

SCP Action Plan Area	Leverage for eco-innovation and market transformation
A Dynamic Policy Framework for Smarter Consumption and Better Products The Ecodesign Directive / The Labeling of Products / Incentives / Consistent data and methods on products / Promote Green Public Procurement / Work with Retailers and Consumers	Aligning demand-side incentives for eco-innovation would lead to higher standardisation of requirements for emerging eco-technology markets, reduced risks in eco-innovation investments, reduced transaction costs in pursuing innovation opportunities across countries and sectors. The SCP Action Plan could reach this alignment of incentives by - assuring that labelling and data requirements are consistent across customer groups (by coordinating the standard setting by retailers and green public procurement); - promoting the acceptance and active marketing of new eco-design standards by main customer groups to improve the business case for compliance and lower industry resistance; - lowering the cost of Green Public Procurement by achieving consistency with other labelling and measurement procedures; - reducing market distortions and intra-community trade through multiple and conflicting standards.

[11] See COM(2008) 397 final or http://ec.europa.eu/environment/eussd/escp_en.htm for the specific initiatives to be coordinated and further developed by the SCP Action Plan; see also EEA Technical Report No 1/2008: Time for Action – towards sustainable consumption and production in Europe, CSCP, EEA and Republic of Slovenia Ministry of the Environment and Spatial Planning

Leaner Production Boosting resource efficiency / Supporting eco-innovation / Enhancing the environmental potential of industry	Beyond the alignment of demand side incentives, the SCP Action Plan can promote eco-innovation by measures directly addressing businesses. These would include - setting clear overall targets for resource efficiency and eco-innovation to allow planning security for businesses; - streamline regulatory framework conditions with Lead Market initiatives; - support adaptation processes and innovation processes of SMEs by providing human and financial resources for research and innovation activities;
Works Towards Global Markets for Sustainable Products	Besides incentives on the European market, eco-innovation can be fostered by global incentives, proposed within the SCP Action plan for - developing international markets for eco-innovations through new flexible mechanisms in future versions of the Kyoto Protocol, e.g. negotiable sector baselines; - promoting new application areas for eco-innovation in developing countries through technology transfer programmes and development cooperation programmes (SWITCH); - assuring that investments can be regained on international markets for environmentally friendly goods and services through preferential trade agreements;

4.3.5. A European Trust Funds for Eco-Entrepreneurship

In an effort to support entrepreneurship and to address the critical shortage of finance at the stage of pre-commercialisation,[12] the EU should establish a European Trust Fund for Eco-Entrepreneurship. The aim of such a Trust Funds shall be to leverage investment in those start up companies with early success on regional markets or niche markets with the aim to go Europe or international. Being an informed investor, the focus shall be on system innovation for resource efficiency and low carbon emissions. The Funds shall have a mandate to approach institutional investors and companies seeking for an investor relationship. Thereby it shall facilitate to ramp up commercially promising eco-technologies through partnerships, funding, expert advice and large-scale demonstrations. It shall entail a specific window for capacity building in the new member states. Delivering practical solutions, it shall also be able to offer financial support such as contingent grants,[13] interest-free loans, convertible loans, mezzanine financing,[14] equity and venture capital, guarantees. It may typically invest between 100 K€ and 1.000 K€ in any early stage business. An early estimation for the overall budget is in the order of 10 bn €.

The Carbon Trust established by the UK government may serve as a model for such a fund (e.g. Carbon Trust 2008).

[12] See also the briefing note written by Birgit Eggl/ forseo / and Fundetec (2007).

[13] Contingent grants are provided without interest or repayment requirements until technologies and intellectual property have been successfully implemented. Before revenue is generated contingent grants are useful mechanisms for SMEs to address specific aspects of business development. The grant is repaid as soon as the business activity provides returns.

[14] Mezzanine financing addresses typical SME financing obstacles such as weak balance sheets and small transaction size when they seek for working capital for operations and growth capital loans to expand. Mezzanine finance groups together a variety of structures positioned between the high risk / high upside, pure equity position and the lower risk / fixed returns, senior debt position. Mezzanine financing usually is converted in equity when a repayment is critical.

Coordination with national governments should be promoted as well, especially with regard to investment tax incentives, revenue support and national programmes as well as for general consistency of easing administrative procedures.
In addition, an alignement with green public purchasing strategies and green saving accounts will be required.
Involvement of regional agencies for eco-innovation will be crucial; they serve important functions for the early start up period, tasks of identifying stakeholders, aligning an innovation with customers and regional needs, allocating seed money, making use of public funding.
The current EU's Entrepreneurship and Innovation Programme (EIP, funded with € 2.17 billion as part of the EU's Competitiveness and Innovation Programme CIP) will be evaluated in Febraury 2009; its existing priority areas materials recycling, building & construction, food & drink, greening business & 'smart' purchasing have a strong component on eco-innovation. Strong features of the EIP programme shall be aligned with the new European Trust Fund for Eco-Entrepreneurship.

4.3.6. A Technology Platform for Resource-light industries

For quite some time, the main focus of eco-technologies has been on pollution control. The main message of this report – to focus on energy and resource efficiency – leads to the proposal of establishing a technology platform for resource-light industries, with a focus on automobiles and construction. Given the undoubtful success of the EU Hydrogen and Fuel Cell Technology Platform, which has resulted in the establishment of a Joint Technology Initiative with great commitments, this mechanism seems especially suited to bridge the gap between R&D and pre-commercialisation of mass markets. One may also note the synergies with the other proposals made in this study.
The aim of such a technology platform is to develop new materials and combinations of materials that fit into mass markets for goods in areas which have been classified as being resource-intensive (see chapter 2). Such a Technology Platform will not only bring car manufacturers, main suppliers and independent producers together, but also a broad spectrum of metal industry, other material-producing industries (e.g. chemical industry), recycling industry, product designer, material science and applied research. Involving SMEs will therefore be of crucial importance: additional incentives for them to join may also come from EU FP7 and the CIP programme. Following a recent evaluation (IDEA consult 2008), formulation visions and including the socio-economic dimension and stakeholders outside the industry should be part of such a new technology platform, i.e. support to formulating a vision and strategic aims towards deployment e.g. through roadmapping and foresight exercises.
Indeed, a life-cycle perspective and integrated assessments will be essential to prepare industry for the markets of tomorrow. The platform thus shall also be used to lower the carbon intensity of energy-intensive industrial processes upstream, which are often operated outside the EU (e.g. aluminum melters). Two snapshots may illustrate the usefulness of such new technology platform:

- Why should a European car of the future weigh more than 500 kg? In the long run, CO_2 reduction is unlikely to come from new engines alone but will need to be addressed in such a comprehensive manner. Any such car of the future will become an integrated part of service oriented mobility systems comprising a mix of carriers (busses, trains, ships, trucks etc.) and related infrastructures.
- In a similar way, a European building of the future may not only produce energy from renewable sources and via stationary CHPs but integrate different functions in a new architecture with new materials and new products such as super windows and thin layer photovoltaics to use facades as solar absorber: micro structure materials and a light, flex-

ible and floating architecture may over time lead to a new face of European cities, with "Solar trees" combining photovoltaic with battery and LED technology for lightening services.

In developing such visions and bringing them closer to implementation, the new technology platform has a role to play for the market entry of new industries such as industrial photosynthesis, soft biochemistry, and white biotechnology and their cooperation with modernized established industries.

4.3.7. A Programme for refurbishing and upgrading existent buildings in the EU

The current EU legislation on buildings (see section on the EPBD above) is poorly implemented, currently unlikely to deliver long-term carbon reduction targets, and it does not yet address the issue of resource efficiency. Given the promising examples of the "Intelligent Energy for Europe" programme, some programmes in some member states (see the case study of the Austrian deep renovation programme above) and the potential to unleash eco-innovation, there is a case for a European programme to upgrade and modernize existing buildings. Such new programme should explicitly address the issue of resource efficiency in buildings; it can be expected to boost jobs and growth throughout Europe.

The proposal is to establish a dynamic programme that – in a kick-off step – compares and draws upon ambitious national roadmaps on low/zero carbon energy buildings. Simultaneously, it shall harmonize measurement and certification processes throughout the EU. This process shall also lead to a harmonized measurement methodology for local and municipal action to combat greenhouse gases.

To facilitate this kick-off, a European network of local and regional focal points of expertise shall be established, whose task is to inform the various owners and users and qualify local craftsmen in their respective areas. Scaling up of these activities to a European network not only will disseminate knowledge via exchange and the development and implement of training modules. The European network can also synthesize feedback on administrative barriers and bring it to the 'better regulation' attempts of the EU.

Following a kick-off period, the programme shall fully integrate aspects of material intensity and resource efficiency in building codes and standards, and work with the European network to qualify local and regional focal points on these issues. Demonstration projects and an actively communicated evaluation will help to foster the ramp up of these activities. One driving forces for this task will result from future waste streams resulting from current insulation materials. Simultaneously, a European-wide databank on materials embedded in current buildings shall be established, in order to prepare re-use of construction materials and metals. This huge task will need to be coordinated with ongoing databank initiatives at Eurostat and EEA. Indeed, other health aspects (odours, toxicological aspects, electro-magnetic issues, etc.) will need to be integrated as well.

To ramp up activities, the programme shall enhance and support radical eco-innovation of existing buildings via e.g. decentralized energy production and new materials at a large scale in a third step. Possible lighthouses on "urban mining" (extracting materials from end-of-life buildings) shall be conducted and co-financed by this programme. It can be expected that the other proposals suggested here – especially taxing construction materials, setting up a trust fund for eco-entrepreneurship and the technology platform for resource-light industries – lead to new innovation that can be implemented via such a European programme. Of course, utilizing the existing EU funds is also an option for eligible regions. Proper incentive schemes may take advantage of innovative financing instruments (see paper written by Forseo in the annex, contracting, public purchasing and other means. Counterarguments – does it pass the subsidiarity test? Will the EU give support to free riders and hitchhikers? – can thus be balanced against the manyfold advantages of such a programme.

4.3.8. Eco-innovation and EU Foreign policy

The stimulation and increased development and market introduction of eco-innovation in the EU is not a task for the internal market alone. It offers opportunities and challenges for EU foreign policy. It offers opportunities because the deployment of eco-innovations in the EU reduces energy and material import costs and dependencies, and thus increases energy and material security. Furthermore, eco-innovative goods developed within Europe do have a significant export potential, and thus stimulate sustainable growth and jobs in Europe ("first mover advantage"), in addition to the induced growth and employment due to reduced energy and material costs. The world market for eco-technologies is estimated to become a $800 billion market worldwide by 2015 and a $ trillion market afterwards.[15] In that regard, one policy challenge might result from new mandatory product requirements via standards and sectoral agreements, which might hold off imports of less environmentally friendly products – and raise issues at the World Trade Organisation. In a similar vein, producers or developers from outside the EU might infringe property rights of European firms by copying eco-innovative products. It is proposed that the EU takes the following initiatives to support eco-innovation internationally:

- Support companies to source and purchase materials from raw material deposits and refining routes with least amount of resource extraction and emissions; in that regard, certification schemes of sustainable materials shall be developed (as it it the case in the G8 initiative on Coltan).
- To support high quality recycling in the world, especially in emerging economies, via bilateral and multilateral initiatives; the main tasks will be technology and know-how transfer on the recovery and recycling, rather than the obstruction of waste exports for recycling for short term raw material security.
- Negotiate standards and sectoral agreements on energy and resource efficiency for key products and its components in line with European standards.
- Take initiative for an international convention on sustainable resource management (see Bleischwitz and Bringezu, 2007).

[15] F.A.Z., 17.08.2007, Nr. 190 / Seite 14

5. A VISION FOR THE FUTURE

Without ecological stability
Sustainable economy is not possible

The bailout of the financial crisis must be paralelled
by the prevention of the ultimate ecological breakdown,
which has some of the same root causes.

In late fall of 2008 the German minister of finance noted: „When the financial market burns, the fire must be extinguished, even if it was deliberately set“. With unsurpassed speed a bank-survival package worth 500 billion euro was produced in Germany. Apparently, this is the presumed size of the expected accumulated losses of an important sector of the economy, due to the failures of its own leaders. A survival assurance worth close to twice the yearly federal budget in that country. A commitment worth almost 6100 euro for every German citizen. Similar packages have passed all Parliaments throughout Europe.

In 2008, sixty minutes of „googling“ would have sufficed to become aware of the fact that a persistent smoldering fire has increasingly harmed the life-sustaining services of nature since many years. A smoldering fire that on occasion bursts worldwide into open flames, for instance in respect especially of greenhouse gas emissions, the extinction of species, and the increased occurrences of floods and hurricanes [16].

The human economy must be constrained and enabled to function within the limits of the environment and its resources and in such a way that it works with the grain of, rather than against, natural laws and processes. This argues for a strong conception of sustainability, whereby the economy respects and adapts to ecological imperatives, rather than seeking to substitute manufactured for natural capital where the former fails to deliver the full range of functions and services of the latter [17].

Consideration of current material flows and their ecological implications, and taking account of expected population growth, has led to the conclusion that by 2050 the total global mobilization of natural resources for human use should not exceed 5-6 tons per person per year, while the emission of climate-changing greenhouse gases should be limited to 2 tons of CO2-equivalent per person per year.

These goals imply an enormous increase in the resource productivity of industrial economies: in Germany, for example, a Factor 10 improvement in resource productivity, at a rate of approximately 5% p.a. from now, would need to be achieved. Only by dematerializing their economies in this way will the industrial countries free up the necessary resources and ecological space to allow an economic growth in developing countries that does not exceed the natu-

[16] See, for instance, the Wiegandt Series „Courage for Sustainability“ Haus Printers, London, 2008/2009; and the IPCC (Intergovernmental Panel on Climate Change) Climate Report 2007; the UNDP (United Nations Development Programme) Report 2007 on Climate Change and Poverty; the UNEP (United Nations Environment Programme) Report 2007 „Global Environmental Outlook GEO-4“, and the EEA (European Environment Agency) Report 2007 „Europe’s Environment – the 4th Assessment“.

[17] See, for example, publications by R. U. Ayres, S. Bringezu, Lester Brown, W. Van Dieren, C. Fussler, P. Hawken, F. Hinterberger, C. Liedtke, A. Lovins, F. Schmidt-Bleek, R. Stern, E. U. von Weizsäcker, B. Meyer, R. Bleischwitz und R. Yamamoto.

ral limits of the global environment. Obviously, eco-innovation is one of the most important tool to reach such targets.

Rate and quality of eco-innovation is particulary urgent for capital goods and other goods with long life-times, such as infrastructures for transportation and buildings.

While some emphasis must first be placed on energy conserving measures of existing technology ("easy fruits"), the medium-term goal must be to minimize the use of carbon rich materials as source of energy altogether, particularly that of imported fossil energy carriers. The political implication of the import dependance - from Russia for example - should give a powerful incentive to the EU to develop at the greatest speed possible an economy that does no longer depend on strategic imports into the EU. For that reason, smart grids and ecologically-sound buildings and a whole shift to a bio-based economy merge to become a strong pillar for the future of the European Union.

Incremental resource-saving innovations related to existing technology are important but will not deliver the long-term targets proposed above. It must become standard in the EU to give strong preference for R&D funding of projects that are clearly in tune with the definition for eco-innovation given in this study. Radical eco-innovations are required that not only replace existing with completely new technologies, but which rethink and develop whole new systems to deliver the services that are the goals of economic activities with a small fraction of the natural resources. This very requirement applies for future energy supply systems. Those who pioneer these innovations must be assured that it is to them that the markets of the future, and associated profits, will belong.

Policies must therefore be urgently re-oriented towards material-saving technical progress. The whole direction of technical change in industrial societies, which has been focused on increasing labor productivity, ought to change towards promoting resource productivity. This implies a fundamental change in the economic incentives that drive technical progress, both to squeeze out the manifold inefficiencies in the use of resources by current technologies, and to kick-start the radical eco-innovation that is required.

Concerned economists [18] suggesting fundamental changes in the framework conditions of western economies have a preference for economic instruments – environmental taxes and tax reform, trading schemes and other measures that give explicit prices to the use of natural resources and the emission of pollutants – because of the way they work with the grain of markets and give transparent incentives for increased resource productivity without specifying particular technologies. However, because of market failures and political considerations, such instruments will often need to be complemented with other policy measures, such as information and coordination policies, voluntary agreements and regulation of outcomes, products and processes. In particular, policies complementary to economic instruments will be required to ensure that the required increases in resource productivity are achieved in ways that are fair and do not bear disproportionately on those who are relatively poor or otherwise disadvantaged.

A future basic European "Material Savings Law" can form the legal framework for an upswing of the proposals presented in this study, the core of which would shift present taxes and levies on labor to materials needed as inputs into the metabolism of the economy, including a

[18] The "Lindau Group", see www.worldresoursesforum.org, and watch for publications by mid 2009.

carbon tax, giving strong incentives to the production sector for minimizing the use of natural resources. This must be a law that regulates a host of areas in which resources are taken and used from nature (e.g. material, water, and land-use) along the whole value added chain for generating food, infrastructures, goods and services. A law that reflects expected problems for ex- and imports for the countries that have agreed to the legislation.

Many (especially economic) institutions will need to be reformed in order to take account of and pursue the new imperative of resource productivity: government departments, educational and research institutions, and statistical offices. However, there is a case for the creation of a major new public institution, comparable in importance to a central bank, that is independent of central government, that generates, validates and publishes relevant data and information, and state of the art developments and experiences, and that carries out policy analysis and gives policy support. If the amount of resource use is are as important as the volume of money circulated in the economy – there should be similar tools available to avoid an inflationary overuse of natural resources. Such public institution should also support educational and training measures and could administer an award scheme for outstanding ecological performance or developments that promote resource productivity.

In line with the challenge of climate change in regard to Developing Countries, the EU may well also take the initiative to establish a large EU "Resource Saving Co-operation Program" with developing and emerging countries that agree to the European goals for resource saving. 5-6 yearly tons per capita consumption of non-renewable resources world-wide by 2050 could serve as a common goal, as indicated above. This implies to limit the use of natural resources in developing and emerging countries – but not to reduce it immediately – and gives incentives to establish leadmarkets for eco-innovation in those countries.

After all, the way human societies treat and use the environment and its resources ultimately reflects their value-systems as expressed in their lifestyles and environmental behaviours. Social values change slowly, but such change can be promoted and supported by education. It is vital that, through education, human societies become much more aware than at present, both of the fundamental role of the environment and its resources in underpinning economic activity and generating human welfare more broadly, and of the extent of the threats to the environment that may prevent it playing that role to the necessary extent in the future.

The monitoring of progress towards greater resource efficiency, and the comparison of the ecological performance of countries, regions, systems, firms, products, services, processes and procedures, will require a range of appropriate indicators that are robust, informative, cost-efficient, practicable and internationally recognized. They must also take account of the full life-cycle impacts of their subject, and be available on a per capita basis, to link the impacts being indicated directly to population levels. Extensive further data generation, research and development will be required to make the necessary indicator framework fully operational.

Because of the time lags associated with technological innovation and diffusion, the large-scale dematerialization of economic activities will take several decades. Because of this, and because of the strains on natural systems that are already apparent, it is essential that measures, policies and processes to begin large-scale dematerialization at the necessary rate are developed and adopted without further delay. The sooner Europe takes action the better.

ANNEX 1

This Annex lists the detailed tables of worldwide distribution of reserves of different resources.

Table 6: Top ten oil reserve countries; end of 2006

Rank	Country	Oil reserves (kt) in 2006	Percent of world total 2006
1.	Saudi Arabia	39.373.399	21,87%
2.	Iran	20.486.010	11,38%
3.	Iraq	17.135.000	9,52%
4.	Kuwait	15.123.500	8,40%
5.	United Arab Emirates	14.572.200	8,09%
6.	Venezuela	11.921.788	6,62%
7.	Russian Federation	11.851.478	6,58%
8.	Libya	6.178.136	3,43%
9.	Kazakhstan	5.934.372	3,30%
10.	Nigeria	5.396.780	3,00%
	Top Ten	147.972.663	82,19%
	EU-27	2.295.887	1,28%

Source: BP, 2007

Table 7: Top ten natural gas reserve countries; end of 2006

Rank	Country	Natural Gas reserves (kt of oil equivalent) in 2006	Percent of world total 2006
1.	Russian Federation	42.885.720	26,26%
2.	Iran	25.317.000	15,50%
3.	Qatar	22.824.900	13,98%
4.	Saudi Arabia	6.365.700	3,90%
5.	United Arab Emirates	5.454.900	3,34%
6.	USA	5.332.500	3,27%
7.	Nigeria	4.689.000	2,87%
8.	Algeria	4.053.780	2,48%
9.	Venezuela	3.883.500	2,38%
10.	Iraq	2.853.000	1,75%
	Top 10	123.660.000	75,72%
	EU-27	5.538.369	3,39%

Source: BP, 2007

Table 8: Top ten coal reserve countries; end of 2006

Rank	Country	Coal reserves (kt) in 2006	Percent of world total 2006
1.	USA	246.643.000	27,13%
2.	Russia	157.010.000	17,27%
3.	China	114.500.000	12,60%
4.	India	92.445.000	10,17%
5.	Australia	78.500.000	8,64%
6.	South Africa	48.750.000	5,36%
7.	Ukraine	34.153.000	3,76%
8.	Kazakhstan	31.279.000	3,44%
9.	Poland	14.000.000	1,54%
10.	Brazil	10.113.000	1,11%
	Top 10	827.393.000	91,02%
	EU-27	71.880.000	7,91%

Source: BGR, 2006

Table 9: Top ten bauxite (aluminum) reserve countries; end of 2006

Rank	Country	Bauxite reserves (kt) in 2006	Percent of world total 2006
1.	Guinea	8.600.000	23,66%
2.	Australia	7.900.000	21,74%
3.	Brazil	2.500.000	6,88%
4.	Jamaica	2.500.000	6,88%
5.	China	2.300.000	6,33%
6.	India	1.400.000	3,85%
7.	Cameroon	1.100.000	3,03%
8.	Guyana	900.000	2,48%
9.	Indonesia	900.000	2,48%
10.	Greece	650.000	1,79%
	Top 10	28.750.000	79,10%
	EU-27	1.445.000	3,98%

Source: USGS, 2006

Table 10: World top ten copper reserve countries; end of 2006

Rank	Country	Copper reserves (kt) in 2006	Percent of world total 2006
1.	Chile	360.000	38,30%
2.	United States	70.000	7,45%
3.	China	63.000	6,70%
4.	Peru	60.000	6,38%
5.	Poland	48.000	5,11%
6.	Australia	43.000	4,57%
7.	Mexico	40.000	4,26%
8.	Indonesia	38.000	4,04%
9.	Zambia	35.000	3,72%
10.	Russia	30.000	3,19%
	Top 10	787.000	83,72%
	EU-27	48.000	5,11%

Source: USGS, 2006

Table 11: World top ten iron ore reserve countries, end of 2006

Rank	Country	Iron Ore reserves (kt) in 2007	Percent of world total 2007
1.	Brazil	41.000	22,78%
2.	Russia	31.000	17,22%
3.	Australia	25.000	13,89%
4.	Ukraine	20.000	11,11%
5.	China	15.000	8,33%
6.	Kazakhstan	7.400	4,11%
7.	India	6.200	3,44%
8.	Sweden	5.000	2,78%
9.	United States	4.600	2,56%
10.	Venezuela	3.600	2,00%
	Top 10	158.800	88,22%
	EU-27	5.000	2,78%

Source: USGS, 2008

Table 12: World top ten uranium reserve countries; end of 2006 (uranium RAR < 130 $/kg)

Rank	*Country*	*Uranium reserves (t) in 2006*	*Percent of world total 2006*
1.	Australia	725.000	21,72%
2.	Kazakhstan	378.100	11,33%
3.	United States	339.000	10,15%
4.	Canada	329.200	9,86%
5.	South Africa	283.400	8,49%
6.	Niger	243.100	7,28%
7.	Namibia	176.400	5,28%
8.	Russia	172.400	5,16%
9.	Brazil	157.400	4,71%
10.	Ukraine	135.000	4,04%
	Top-10	2.939.000	88,04%
	EU-27	49.800	1,49%

Source: NAE/IAEA, 2008

Table 13: Literature review concerning peak and anticipated depletion

Resource	Peak		End	
Oil				
• EIA (2004)	Scenario 1	2026	*2100*	
	Scenario 2	2037	*2120*	
	Scenario 3	2047	*2125*	
• BRG (2002)	2020		-	
• Meadows et al. (2006)	2000		-	
• ASPO (2006)	2006		-	
• Campbell (2003)	2010		-	
• Rempel (2000)	2025			
• Bundesanstalt für Geowissenschaften (2008)	-		45 Years	
• Hansen (2007)	2075		-	
• Energy Watch Group (2007)	2020		-	
Gas				
• ASPO (2006)	2010		-	
• Campbell (2003)	2015		-	
• Rempel (2000)	*2055*		-	
• Bundesanstalt für Geowissenschaften (2008)	-		65 Years	
• Hansen (2007)	*2075*			
• Schweizerische Energiestiftung (2008)	2025			
Coal				
• Bundesanstalt für Geowissenschaften (2008)	-		200 Years	
• Hansen (2007)	2100		-	
• Energy Watch Group (2008)	2025		-	
• World Coal Institue	-		155 Years	
Resource	**Peak**		**End**	
Other minerals				
• Bundesanstalt für Geowissenschaften (2008)			Lead	25 yrs
			Zinc	25 yrs
			Copper	35 yrs

		Uranium	40 yrs
• Cohen (2007)	Copper 2100	Indium Antimony Silver Hafnium Tantalum Uranium Platinum Zinc	10 yrs 15-20 yrs 15-20yrs 10yrs 20-30 yrs 30-40 yrs 15 yrs 20-30 yrs
• Lifton (2007)	Gallium around 2000 Rhodium reached peak		
• Bardi and Pagani (2007)	Mercury Tellurium Lead Cadmium Potash Phosphate rock Thallium Selenium Zirconium Rhenium Gallium	Copper Indium Silver Antimony	38-61 yrs 4-13 yrs 9-29 yrs 13-30 yrs

Sources available on demand at SERI (mail: stefan.giljum@seri.at).

REFERENCES

Acosta-Fernández, J. et al. (2007): Identifikation prioritärer Handlungsfelder für die Erhöhung der gesamtwirtschaftlichen Ressourcenproduktivität in Deutschland. Projektergebnisse zum Projekt im Auftrag des BMBF „Steigerung der Ressourcenproduktivität als Kernstrategie einer nachhaltigen Entwicklung“, Wuppertal Institut, Wuppertal, www.ressourcenproduktivitaet.de

Alcott, Blake (2005): Jevon's Paradox. Ecological Economics 54 (1): 9-21

Arthur D'Little / Wuppertal Institute / Frauenhofer ISI (2005): Studie zur Konzeption eines Programms für die Steigerung der Materialeffizienz in Mittelständischen Un-ternehmen, Abschlussbericht [Study for the Conception of a Program to Increase Material Efficiency in Small and Medium Sized Enterprises, final report for the Federal Ministry of Economics and Labour (BMWi)]; Wiesbaden / Wuppertal / Karlsruhe.

BGR (2005): Reserven, Ressourcen und Verfügbarkeit von Energierohstoffen 2005. Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover.

BGR (2006): Trends der Angebots- und Nachfragesituation bei mineralischen Rohstoffen. Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover.

BGS [British Geological Survey] (2008), 'Primary aggregates', in: European Mineral Statistics 2002-06, Keyworth, Nottingham, pp. 148-152.

Bleischwitz, R. (2003): Cognitive and Institutional Perspectives of Eco-Efficiency, in: Ecological Economics, 46: 453 – 467.

Bleischwitz, R. (2006): International Raw Materials Markets: Rising Prices and Growing Conflict Potential, in "Global Trends 2007", edited by Tobias Debiel et al. and by the Foundation for Development and Peace (SEF), pp. 65 – 78.

Bleischwitz, R. (Ed.) (2007): Corporate Governance of Sustainability: A Co-Evolutionary View on Resource Management. Edward Elgar Publisher.

Bleischwitz, R. / Bahn-Walkowiak (2007): Aggregates and construction markets in Europe – towards a sectoral action plan on sustainable resource management, in: 'Minerals and Energy' H 3-4, pp. 159–176.

Bleischwitz, R. / Bringezu, S. (2007): Global Resource Management – Conflict Potential and Characteristics of a Global Governance Regime, SEF Policy Paper No. 27, Stiftung Enwicklung und Frieden (Foundation for Development and Peace).

BMU (2009) : Umweltwirtschaftsbericht, Berlin.

Boverket (2005): Housing Statistics in the European Union 2004. National Board of Housing, Building and Planning, Sweden and the Ministry for Regional Development of the Czech Republic www.boverket.se

BP (2006): Review of world energy 2006. British Petrol, London.

BP (2007): Review of world energy 2007. British Petrol, London.

Brezet, H. and van Hemel, C. (1997): Ecodesign: a promising approach to sustainable production and consumption; United Nations Environment Programme, Industry and Environment

Bringezu, S., et al. (2007): Addressing multi-beneficial and cross-sectoral strategies for sustainability, Technical Report, http://www.forescene.net/Resources.htm

Carbon Trust (2008): Enhanced Capital Allowances. Available at: http://www.carbontrust.co.uk/energy/takingaction/eca.htm, 01 May 2008

Rosegrant, M.W., M.S. Paisner, S. Meijer, and J. Witcover. (2001): 2020 Global food outlook: Trends, alternatives, and choices. Food Policy Report 30, Washington, DC:

Cohen, D. (2007): Earth's natural wealth: an audit. New Scientist(2605).

COUNCIL DIRECTIVE 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity

CSCP, gtz, the Federal Ministry for Economic Cooperation and Development and the Wuppertal Institute for Climate, Environment and Energy (2006): Policies for Resource Efficiency, Towards Sustainable Consumption and Production, Wuppertal.

Davenport, E., Bruce, I. (2002): Innovation, Knowledge Management and the Use of Space: Questioning Assumptions About Non-traditional Office Work, in: Journal of Information Science, Vol. 28, Nr. 3, S. 225–230.

Department of Environment, Food and Rural Affairs [Defra] (2007), Recycling and waste: Aggregates Levy Sustainability Fund in England.

Department for Transport (2008), Site Specific Advice - Aggregate Levy Sustainability Fund (ALSF), http://www.dft.gov.uk/pgr/freight/alsf/sitespecificadviceaggregatel3174, 2008-11-04.

Destatis (Statistisches Bundesamt) (2005): Verwendung von Primärmaterial nach Produktionsbereichen und Materialarten 1995 - 2002. Statistisches Bundesamt, Wiesbaden.

Easterby-Smith, M., Araujo, L., Burgoyne J. (Eds) (1999): Organizational Learning and the Learning Organization. Developments in Theory and Practice, London; u.a.: Sage.

EEA (European Environment Agency) (2001): Indicator Fact Sheet Signals 2001 – Chapter Households. YIR01HH03 Household number and size. European Environment Agency (EEA), http://themes.eea.europa

EEA (2005): Household Consumption and the Environment. EEA Report No 11/2005.

EEA (2006): Urban sprawl in Europe – The ignored challenge. European Environment Agency (EEA), Office for Official Publications of the European Communities (OPOCE). EEA Report No 10/2006. http://reports.eea.europa.eu/eea_report_2006_10/en

EEA (2007a): Europe’s environment. The fourth assessment, Copenhagen, 2007

EEA (2007b) Transport and Environment: On the way to a new common transport policy, EEA Report No. 1/2007, EEA, Copenhagen

EEA (2008): Effectiveness of environmental taxes and charges for managing sand, gravel and rock extraction in selected EU countries, EEA report 2/2008, Copenhagen 2008.

EEA, CSCP, Ministry of Environment and Spatial Planning Slovenia (2008): Time for Action – Towards Sustainable Consumption and Production in Europe, EEA Technical Report 1/2008.

EIPRO-Study (2006): Environment Impact of Products Analysis of the life cycle environmental impacts related to the final consumption of the EU-25. Main report IPTS/ESTO project

Ernst and Young (2006): Eco-industry, its size, employment, perspectives and barriers to growth in an enlarged EU, Report commissioned by the European Commission, DG Environment, September 2006.

EU/UNEP (2005): Standstill or Move Clean. World Environment Day 5 June 2005

Europe Innova (2008): What is the right strategy for more innovation in Europe? Drivers and challenges for innovation performance at the sector level. Synthesis Report, Systematic Innovation Watch (SIW), prepared by Reinstaller, Andreas / Unterlass, Fabian; Vienna: Austrian Institute for Economic Research (WIFO).

European Commission (2000): Innovation in a knowledge-driven economy. COM(2000) 567 final, Brussels

European Commission (2003): Some key issues in Europe's competitiveness - towards an integrated approach. COM(2003) 704 final, Brussels

European Commission (2004): Stimulating Technologies for Sustainable Development: An Environment Technologies Action Plan for the European Union. COM(2004), 38 final, Brussels

European Commission (2005a): Annual Policy Strategy for 2006. COM(2005) 73 final, Brussels

European Commission (2005b): Integrated guidelines for growth and jobs (2005-2008). COM(2005) 141 final, Brussels

European Commission (2005c): A report on the functioning of public procurement markets in the EU: benefits from the application of EU directives and challenges for the future, 03/02/2004

European Commission (2007a): A renewable Energy Roadmap. MEMO/07/13, Brussels

European Commission (2007b): Observatory of European SMEs: Analytical report. Flash Eurobarometers 196, Brussels

European Commission (2007c): A lead market initiative for Europe. COM(2007), 860 final, Brussels

European Commission (2008a): communication from the commission to the european parliament, the council, the european economic and social committee and the committee of the regions on the sustainable consumption and production and sustainable industrial policy action plan, brussels 2008, SEC(2008) 2110; SEC(2008) 2111

European Commission, Energy Transport DG (2006e): Road Transport Policy: Open Roads Across Europe. Brussels

European Commission (2003b). Towards a thematic strategy for the sustainable use of natural resources. COM(2003) 572 final, DG Environment, Brussels.

EUROSTAT (2007): Measuring progress towards a more sustainable Europe, 2007 monitoring report of the EU sustainable development strategy, Luxembourg

Eurostat / European Commission (2007), Taxation trends in the European Union: Data for the EU Member States and Norway, Luxembourg.

Eurostat (2008), Environment: Environmental Accounts, Domestic material consumption, by material, http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,39140985&_dad=portal&_schema=PORTAL&screen=detailref&language=en&product=REF_TB_environment&root=REF_TB_environment/t_env/t_env_acc/tsdpc230 , 2009-01-26.

Foxon T., Pearson P. (2008): Overcoming barriers to innovation and diffusion of cleaner technologies: some features of a sustainable innovation policy regime, The Journal of Cleaner Production, 16S1 (2008) 148 – 169

Fundetec (2007): Comparison and Assessment of Funding Schemes for the Development of New Activities and Investments in Environmental Technologies. Fundetec Consortium

Fussler, C., James, P. (1996) Driving Eco-Innovation: A Breakthrough Discipline for Innovation and Sustainability

Gravgård Pedersen, O. (1999): Physical Input-Output Tables for Denmark. Products and materials 1990. Air emissions 1990-92. Statistics Denmark, Kopenhagen.

Greening, Greene, Difiglio (2000): Energy efficiency and consumption- the rebound effect – a survey, Energy Policy, Vol 28, Issues 6-7 June 2000, pp. 389-401

Hawken P., Lovins A., Lovins L.H. (1999): Natural Capital, Back Bay Books, New York

Herring H., Roy R. (2007 oder 2008 wie in Kap. 3.3.1.): Technological innovation, energy efficient design and the rebound effect, Technovation 27 (2007) 194–203

Hinterberger, F., Luks F., Schmidt-Bleek (1997): Material flows vs. 'natural capital'. What makes an economy sustainable?, Ecological Economics 23, 1 – 14

HM Revenue & Customs (2008), Aggregates Levy, http://customs.hmrc.gov.uk/channelsPortalWebApp/channelsPortalWebApp.portal?_nfpb=true&_pageLabel=pageExcise_InfoGuides&propertyType=document&id=HMCE_CL_001169, 2008-11-04.

Horbach, Jens (2005): Methodological aspects of an indicator system for sustainable innovation, in: Jens Horbach (ed.) Indicator systems for sustainable innovation, Physica, Heidelberg 2005

IDEA consult (2008): Evaluation of the European Technology Platforms (ETPs). Request for Services in the context of the DG BUDG Framework Service Contracts on Evaluation and Evaluation-related Services, Ref. nr.: BUDG06/PO/01/Lot 3, Brussels.

IEA. (2007a): Energy balances of non-OECD countries, 1971-2005. IEA, Paris,

IEA. (2007b): Energy balances of OECD countries, 1960-2005. IEA, Paris,

INSEE, Institut national de la statistique et des études économiques (2006): Household Consumption.

Irrek, Wolfgang, Jarczynski, Lutz (2007): Overall impact assessment of current energy efficiency policies and potential 'good practice' policies. Working paper within the framework of the AID-EE project. Final Version. Wuppertal Institute for Climate, Environment, Energy. Wuppertal

Jacob, Klaus et al. (2005): Lead Markets of Environmental Innovations; Heidelberg-New York: Physica

Jacobsson, S., Bergek, A. (2004): Transforming the energy sector: The evolution of technological systems in renewable energy technology; Industrial and Corporate Change, Vol. 13, Issue 5, pp. 815-849.

Jänicke (2008): Megatrend Umweltinnovation: Zur ökologischen Modernisierung von Wirtschaft und Staat; München: oekom

Kemp, René, Pearson, P. (2008): MEI project about Measuring Eco-Innovation, Final report, Maastricht. Available at: http://www.merit.unu.edu/MEI/papers/Final%20report%20MEI%20project%20DRAFT%20version%20March%2026%202008.pdf, 06 April 2008

Kendall, G. (2008): Plugged in: the end of the oil age, WWF.

Koskimäki, Pirjo-Liisa; Lechtenböhmer, Stefan (2008): Potential, current implementation, and initial ideas for reinforcing the EPBD. Presentation at the European Commission together with Wuppertal Institute at the Sustainable Energy Week, 1 February 2008, Brussels

Lane, C., Bachmann, R. (Ed) (2002): Trust within and between Organizations. Conceptual Issues and Empirical Applications, Oxford: Oxford University Press.

Mäenpää, I., Muukkonen, J. (2001): Physical input–output in Finland: methods, preliminary results and tasks ahead. Conference on Economic Growth, Material Flows and Environmental Pressure, Stockholm, Sweden.

Mäenpää, I. (2002): Physical input–output tables of Finland 1995 — solutions to some basic methodological problems. 14th International conference on input–output techniques, Montreal, Canada.

Mäenpää, I. (2008): Comparison of environmental multipliers of monetary and physical Leontief inverse. Presentation at the International Input-Output Meeting on Managing the Environment (IIOMME) in Seville, 9-11th of July, 2008.

McKillop, A. (2006): Peak Oil to Peak Gas is a short ride. Energy Bulletin.

Meadows, D., Randers, J., Meadows, D. (2006): Grenzen des Wachstums. Das 30-Jahre-Update. German translation and update of “The limits to growth. The 30-years update”. Hirzel. Stuttgart.

NEA/IAEA (2008): Redbook Uranium 2007. Resources, Production and Demand, Vienna.

NAMEA-Study (2006): Environmental Input-Output Analyses based on NAMEA data — A comparative European study on environmental pressures arising from consumption and production patterns. Moll, S.; Vrgoc, M.; Watson, D.; Femia, A.; Gravgård, Pedersen, O. Draft; European Topic Centre for Resource and Waste Management, European Environment Agency, Copenhagen

OECD (2008): OECD Environmental Outlook to 2030. Organisation for Economic Cooperation and Development, Paris.

Pehnt, Martin, Höpfner, Ulrich;, Merten, Frank (2007): Elektromobilität und erneuerbare Energien, Arbeitspapier Nr. 5 im Rahmen des Projekts “Energiebalance – Optimale Systemlösungen für Erneuerbare Energien und Energieeffizienz” im Auftrag des BMU, ifeu-Institut und Wuppertal Institut, Heidelberg und Wuppertal

Perez, J., Allen, P., Brown, M. (Winter 2003): Research Brief #1 Community Supported Agriculture on the Central Coast: The CSA Member Experience, The Center for Agroecology and Sustainable Food Systems (University of California, Santa Cruz)

Reid, Alasdair, Miedzinski, Michal (2008): SYSTEMATIC Innovation Panel on eco-innovation. Final report for sectoral innovation watch. www.europe-innova.org

Rennings, K. (2000): Redefining innovation — eco-innovation research and the contribution from ecological economics, in „Ecological economics" Volume 32, Issue 2, pp. 319-332

Rocholl, Martin, Giljum, Stefan, Schlegelmilch, Kai (2006): Factor X and the EU: How to make the EU the most resource and energy efficient economy in the world; Aachener Stiftung Kathy Beys, 2nd edition. Aachen

Sarasin, B. (2006): Buying into sustainability - Environmental and social challenges in Trading, Distribution and Retailing, http://www.sarasin.ch/internet/iech/en/institutional_clients_trade_2006_iech

Schepelmann, Philipp (2005): Die ökologische Wende der EU-Regionalpolitik: die regionale Resonanz von umweltpolitischen Indikatoren des Lissabon-Prozesses der Europäischen Union. - Hamburg : Kovac, 2005 - (Studien zur Umweltpolitik ; 8)

Shaheen, S., Sperling, D., Wagner, C (Summer 1998): Carsharing in Europe and North America: Past, Present and Future, Transportation Quarterly, vol. 52, No. 3 pp.35-52

Smith, A. et. al. (2005): The Validity of Food Miles as Indicator of Sustainable Development - Final Report produced for DEFRA

SP/HUMI (2005): Sustainable urban development and affordable housing in south eastern Europe. Summary Progress Report May-November 2005

UNECE (2006): Bulletin of Housing Statistics for Europe and North America 2006. http://www.unece.org/hlm/prgm/hsstat/Bulletin_06.htm

UNEP (2008a): Environment Ministers Meet to Accelerate Transition to a Low Carbon Society. Available at: http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=528&ArticleID=5745&l=en, 03 April 2008

UNEP (2008b): Cleaner Production - Related Concepts. Available at: http://www.unep.fr/pc//cp/understanding_cp/related_concepts.htm, 13 April 2008

UNEP (2008c): Breaking Down the Barriers to a Green Economy, 20.02.08. Available at: http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=528&ArticleID=5748&l=en, 16 April 2008

UNEP (2007): Global Environmental Outlook - 4. Progress Press Ltd, Malta. → ist das der UNEP Report 2007 aus Kap. 4.3.8.?

UN University (2007): Great Potential to Improve Collection, Recycling of Europe's Electronic Waste, http://www.vie.unu.edu/file/UNU_ZEF2007+pr+english.pdf?menu=27

USGS (2006): Minerals yearbook 2006. United States Geological Survey, Washington, D.C.

USGS (2008): Mineral Commodity Summaries. US Geological Survey, Washington D.C.

Vorley (2003): Food Inc. Corporate Concentration from farm to customer. UK Food Group. IIED, London http://www.ukfg.org.uk/docs/UKFG-Foodinc-Nov03.pdf

Wallbaum, H., Kaiser, C. (2006): Building materials and conversion factors. Internal working document, private communication

Wilke, Georg (2004): Konkurrenz belebt das Geschäft, Car-Sharing in Deutschland, Politische Ökologie, 91-92, 109-111

Wilson, Alex, Boehland, Jessica (2005): Small is Beautiful, Journal of Industrial Ecology. Vol 9, No 1-2

Wuppertal Institute (2008): Updated study on: How to achieve a domestic 30% GHG emission reduction target in the EU by 2020? Unpublished draft paper on behalf of WWF European Policy Office. Wuppertal

Wuppertal Institute for Climate,
Environment and Energy
P.O. BOX 100480
42004 Wuppertal
GERMANY
www.wupperinst.org

ISBN: 978-3-929944-77-8