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Resource use scenarios for Europe in 2020

Stefan Giljum, Mark Hammer, Friedrich Hinterberger

with contributions from
Arno Behrens, Rui Frazao, Andrzej Kassenberg, Samuel Niza,
Michael Rattinger, and Wojciech Stodulski

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Sustainable Europe Research Institute (SERI)
Garnisongasse 7/27, 1090 Vienna, Austria
Tel.: +43-1-9690728-0, Fax: +43-1-9690728-17
www.seri.at, office@seri.at

The authors

Stefan Giljum, Mark Hammer and Friedrich Hinterberger are researchers at the Sustainable Europe Research Institute (SERI) in Vienna.

Contact:
Stefan Giljum
Garnisongasse 7/27
1090 Wien, Austria
e-mail: stefan.giljum@seri.at

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Executive summary

This SERI study summarises the research undertaken in Work Package 1.4 of the MOSUS project (see www.mosus.net for details on the MOSUS project). It presents the scenario component "*Resource Use*" for the integrated scenarios, which will be compiled based on six scenario components focusing on different economic, social and environmental aspects of future European development.

In all documents of the European Union and the accession countries screened for the scenario component "resource use", high levels of resource use and high amounts of waste and emissions' release is addressed as one major obstacle for the realisation of an environmentally sustainable development in Europe. The sustainable management of natural resources, in order to keep anthropogenic environmental pressures within the limits of Earth's carrying capacity, is highlighted as one central objective for the implementation of a sustainability strategy within Europe. However, the issue of resource use and the need for its reduction is addressed rather in correlation to specific environmental problems, such as GHG emissions and climate change, energy use, and land use changes than a major environmental problem on the economy-wide level. This also becomes evident by analysing the recognition of resource use in existing scenario packages concerning future European development.

De-coupling (or de-linking) economic growth from the use of natural resources and environmental degradation is regarded as the core strategy to achieve sustainable levels of resource use. Raising the resource productivity of production and consumption activities should help producing the same or even more products with less resource input and less waste. Reducing the use of natural resources also follows the goal of preventing pollution at its source. However, there is still ongoing debate whether the de-coupling objective is understood as a relative de-coupling, i.e. that environmental impacts increase more slowly than the economy, or an absolute de-coupling, i.e. that environmental impacts decrease in absolute terms even in a growing economy.

Concerning Europe's responsibility in the global economy, it is explicitly stressed in several of the documents that Europe is consuming an over proportional share of worlds natural resources. Therefore, Europe should follow a development path, which fosters sustainability within Europe without causing increased environmental pressures in other parts of the world (in particular in so-called developing countries). From this statement originates the need to take into account adequately the implications stemming from international trade relations between Europe and the rest of the world (for example, through the comprehensive accounting of so-called hidden resource flows associated with imports and exports, which is one of the major goals of the MOSUS project). Although most instruments could only be applied within the EU it is pointed out that the EU could influence experiences in the rest of the world by ensuring the transfer of technology and best practices.

In the MOSUS project, three main scenarios are developed, each of them up to the year 2020. The ***baseline scenario*** projects further trends observed between 1980 and 2003, if no particular sustainability-oriented policy strategies and instruments are put into force. The ***weak sustainability scenario*** reflects sustainability policy goals and measures derived from strategic documents of the European Community, such as the 6th Environment Action

Programme and the Sustainable Development Strategy of the European Union. The ***strong sustainability scenario*** defines policy goals and instruments, which are more ambitious from the point of view of sustainable development compared to those included in the EU documents.

I. Baseline scenario

The baseline scenario project describes likely developments concerning the use of natural resources up to the year 2020, if *no policy measures* towards a sustainable resource management are put into force. For this it projects forward trends in resource use that could be observed since the 1980s (1990s for Eastern European countries), which are derived from existing studies in material flow accounting and analysis (MFA). If no material flow study was available – as it was the case for many countries and regions outside Europe – data and projections from other sources have been used. In the baseline scenario we only describe the trend in resource without looking at resource stocks scarcities, as in almost all documents on which this scenario is based resource scarcity is not seen as a problem until 2020, in particular for non-renewable resources.

Global Trends

Agriculture: According to most recent FAO outlooks, growth rates of aggregated global agricultural production are estimated at 1,6% p.a. between 1997/99 and 2015 and 1,3% p.a. between 2015 and 2030, which means a slight decline compared to growth rates in the last three decades (between 2,0% and 2,2% p.a.). Global production of cereals is expected to rise from 1.889 million tons in 1997/99 to 2.387 million tons in 2015 and 2.838 million tons in 2030.

Forestry: Global consumption of industrial roundwood is expected to move upwards in the next 30 years, to a production of 2,4 billion m^3 in 2030, of which about one third is expected to be provided by plantations. Most of this increase will be due to rising income and consumption of wood products in developing countries. According to the FAO, dramatic changes in fuelwood consumption are unlikely over the next 15 years. Access to alternative fuels (in particular, liquid fuels) will become easier, but the majority of current wood-using communities are likely to be still burning wood in 2015.

Fisheries: The management of wild catch fishery is expected to continue much as it is today, whereas aquaculture is expected to grow significantly (at a rate of 5-7% p.a.), providing the major share of increased fisheries production.

Fossil fuels: Global primary energy demand is projected to increase by 1.7% per year from 2000 to 2030. This growth is slower than the growth over the past three decades which (2.1% per year). Fossil fuels will meet 90% of this increase in demand.

Regional Trends

EU-15: The baseline scenario for aggregated EU-15 resource use assumes that trends in domestic resource extraction during the next twenty years will follow extraction trends observed since 1980. Consequently, domestic extraction of biomass will increase 8% until 2020; construction minerals extraction will increase nearly 5% the next twenty years; industrial minerals extraction will decrease 37% in the next two decades, fossil fuels extraction will follow the past 15 years trend of a decrease of 35%; unused domestic extraction will decrease by around 17%. In addition to these aggregated numbers, country-specific projections are given.

Eastern Europe: Total Direct Material Input (DMI) in aggregated accession countries increased by 13% between 1992 and 1997 and then decreased by 8% until 1999. Domestic extraction showed the same. Domestic extraction of fossil fuels declined by 17% between 1992 and 1999, domestic extraction of metals increased by 19%, and the one of biomass increased by 13%. Imports increased by 31%, imports of fossil fuels increased by 10%, imports of metals decreased by 11% with strong fluctuations in the first years, and imports of biomass increased by 82%. As the numbers considerably differ between countries, baseline assumptions are given on a country-specific level. It is important to mention that due to wide-ranging processes of economic restructuring in the 1990s (which will continue in the future with even high pace), it is in general difficult to predict future trends based on past observations concerning the use of natural resources in Eastern Europe.

North America: Country-specific trends are formulated for USA, Canada and Mexico which represent specific country models in MOSUS.

Central and South America: Concerning Latin American countries (except Mexico, see above), only Brazil, Argentina and Chile are modelled on a country-specific level. All other Latin American countries are grouped as “Rest of Latin America”. Total agriculture production in Latin America will increase by a growth factor of 2,1% p.a. between 1997/99 and 2015, and by 1,7% p.a. between 2015 and 2030. Latin Americas chare on world minerals and metal production increased for almost all products during the past 15 years and is assumed to further increase until 2020.

Africa: In the simulation model system applied in MOSUS, no African country is represented with a separate country model. Africa is integrated with only one aggregate (continental) model. Therefore, in the baseline scenario, only general trends for Africa are described, without going into details on the level of single countries. Production of oil and gas is expected to increase. Aggregated agricultural production in Africa is forecasted to grow by 2,8% p.a. in Sub-Saharan Africa and 2,1% p.a. in North Africa between 1997/99 and 2015 and by 2,7% p.a. and 1,9% p.a., respectively, between 2015 and 2030.

Asia: The following countries are represented by a country-specific model in MOSUS: Japan, Korea, China, Hong Kong, India, Malaysia, Philippines, Indonesia, Singapore, Thailand, and Taiwan. All other Asian countries are aggregated into "Rest of Asia", if not belonging to the group of OPEC countries. In South Asian countries, total agricultural production will increase by 2,5% p.a. from 1997/99 to 2015 and at 2,0% p.a. from 2015 up to 2030. For East Asia (excl. Japan), annual growth rates are predicted as 1,7% from 1997/99 to 2015 and 1,0% from 2015 to 2030. Production of fish in aquaculture will continue to grow in Asia.

Australia and Oceania: Although Australia and New Zealand are represented with a separate country model, baseline trends are only formulated for Australia, due to data restrictions.

The following table summarised the main components of the baseline scenario.

Table I: **Summary table baseline scenario**

Region	Resource / Indicator	Trend
World	Agriculture	+1,6 (1,3)% p.a. 1999-2015 (2025-2030)
	Forestry	Increasing in the next 30 years
	Fisheries	Increase in fisheries and aquaculture
	Fossil fuels	+1,7% p.a. until 2030
EU 15 (domestic extraction)	Biomass	+ 8% until 2020
	Construction minerals	+4,5% until 2020
	Industrial minerals	-37% until 2020
	Fossil fuels	-35% until 2020
	Unused domestic extraction	-17% until 2020
Eastern Europe (Domestic extraction)	DMI	increasing until mid-90s, now decreasing
	Fossil fuels	-17% between 1992 and 1999
	Metals	+ 19% between 1992 and 1999
	Biomass	+13% between 1992 and 1999

North America	Country-specific projections for USA, Canada and Mexico	
Latin America	Biomass	+2,1 (1,7)% p.a. 1999-2015 (2015-2030)
	Metals and minerals	Increasing share on world production until 2020
Africa	Metals	No total trend observed
	Fossil fuels	Increasing production of oil and gas until 2020
	Biomass	Increasing production until 2020
Asia	Agriculture	Growing production until 2020
	Fisheries	Growing production until 2020
	Fossil fuels	No total trend observed
	Metals and minerals	No total trend observed
Oceania	Country-specific projection for Australia	

II. Policy scenarios

Although the issue of unsustainable levels of resource use and waste generation is addressed as a major issue in all documents, quantitative **reduction targets** on the EU level have so far been formulated only for outputs (waste and emissions) of economic activities. However, the principal need to reduce natural resource inputs through de-coupling of economic growth from material extraction is generally highlighted as a crucial factor for achieving environmental sustainability in Europe. Therefore, reduction goals from the scientific literature are taken to specify requirements of resource use reduction, in particular for the strong sustainability scenario.

Almost all policy documents reviewed for this report highlight a number of **key economic sectors**, which are determining the levels of natural resource use. These sectors are either extracting sectors in the direct sense (such as agriculture, fisheries and forestry) or sectors, which are indirectly responsible for resource extraction (such as energy, industry and transport). The report contains a short description concerning the current situation in Europe and (if available) summarises existing outlooks and scenarios for future developments for the sectors of energy, industry and manufacturing, transportation, construction, agriculture, fishery and forestry and summarises the implications of likely developments in the various economic sectors for future primary resource extraction in Europe.

Concerning **general policy strategies**, increasing resource efficiency, dematerialisation and waste prevention are the main means advanced to reach the general goal of de-coupling economic growth from the use of renewable and non-renewable natural resources and the production of waste and emissions. In order to achieve this goal, resource saving and resource re-use are stressed as important elements, as well as resource substitution (e.g. using wind and solar instead of fossil fuels).

A large number of possible **policy instruments**, which could contribute to the objective of dematerialisation is mentioned in the screened documents, ranging from voluntary instruments (such as eco-audits and extended producer responsibility), via market-based instruments (such as taxes, subsidies and permits) to command and control instruments (such as regulations, restrictions and quotas). However, as none of these instruments is described in sufficient detail in the policy documents, a more extensive literature review of policy instruments for dematerialisation and sustainable resource use is included in this report. It is concluded that in order to reach sustainability and associated material flow reduction targets a single instrument operating in isolation will usually not be enough. Rather, the right mix of instruments covering a wide selection needs to be implemented, allowing for different problems to be combated by different solutions. As an example, a mix of instruments could consist of increased consumer information through labelling, selected raw material taxes, energy taxes, rewards for resource efficient behaviours, taxes on the consumption of specific materials, legal restrictions to the use of certain materials and feebate systems. The suitable mix of instruments should be the result of a political process taking into account ecological, as well as economic and social objectives.

Accession Countries with transition economies face specific problems with regard to the future use of natural resources and the implementation of dematerialisation policies. The first priority of Accession Countries may be economic growth to improve the standard of living, which will likely stimulate resource use (e.g. through expected rapid increase of the number of cars and other transport facilities). At the same time the access of these countries to environmentally sound technologies still is poor, which could result in a worsening of the overall situation in these countries. On the other hand, agriculture contributes a large share to GDP and is marked by relatively low average use of fertilisers and pesticides, and a high level of biodiversity in comparison to Western European countries. In addition, these countries are considered to have a high potential for renewable energy. The implications of enlargement could therefore enhance achieving the objective of decoupling, but could also be detrimental. Enlargement will enhance decoupling if Accession Countries are able to catch up economic growth by using most advanced environmental technologies. It will be detrimental if economic growth of the Accession Countries occurs through the use of resource-intensive technologies.

The scenarios formulated and simulated in MOSUS should consider international aspects of resource use and the role of international trade as one core issue. Recommendations concerning possible policy strategies and instruments elaborated in the course of the MOSUS project should fully integrate the demand of the EU that a transformation of EU production and consumption patterns towards dematerialisation must go along with positive impacts on transitions towards sustainability in all other world regions, in particular in so-called developing countries and must not lead to the externalisation of environmental problems (e.g. in terms of high material intensities of production processes) outside EU borders.

II. I. Weak sustainability scenario

As noted above, the *weak sustainability scenario* reflects policy goals and strategies formulated in key documents of the European Union, its member countries and accession countries. Key documents are the 6th Environmental Action Plan and the European Strategy for Sustainable Development as well as national sustainability strategies and national environmental policy plans. Key sectoral policy developments considered in the scenario are the reform of the Common Agriculture Policy, reforms of the energy and transport sectors, implementation of the Urban Thematic Strategy and implementation of the new Common Fishery Policy.

The following table summarises the key components of the weak sustainability scenario:

***Table II*: Summary table weak sustainability scenario**

Targets	Overall resource use	Continued de-coupling of economic growth from use of natural resources (materials and energy) Small reduction of overall resource use in absolute terms (absolute dematerialisation)
Assumed sectoral developments	Energy	Total energy use stays more or less constant on levels of 2003. Fossil fuels remain the dominating category of energy supply until the year 2020, as energy prices remain relatively low. Natural gas significantly increases its importance, in particular for electricity production. Trend of decreasing domestic extraction of fossil energy carriers continues. Growth in hydroelectricity and other renewable forms of generation is modest, primarily due to cost considerations. Significant improvement of the energy intensity ratio.
	Industry	Creation of markets for sustainable products in some areas of the manufacturing industry (e.g. high-tech industry, automobile industry). Continuing of the general trend of raising material and energy efficiency in the manufacturing sectors. No radical changes of the resource base for manufacturing

		purposes from non-renewables to renewables, due to continued low prices for fossil fuels.
	Transport	Stabilisation of passenger and freight transport (and respective levels of energy consumption) at the levels of the end 1990s. Increasing demand for mobility limits the positive impacts of policy measures on overall resource demand. Road freight will remain the most important means of transport to the detriment of rail and inland shipping.
	Agriculture	Full implementation of the CAP reform, in particular system of decoupling of grants. Lower cereal price support, leading to a significant reduction in the total area grown with cereals. Increased energy crop production. Increased voluntary set-aside (abandonment of land). Decrease of production volumes on the aggregated level.
	Fisheries	Implementation of the new Common Fishery Policy (CFP), promoting the sustainable management of fish stocks. Further decline of open-sea fish catch. Increasing aquaculture production.
Policy instruments on the macro level	Voluntary instruments	Implementation of a labelling system for life-cycle wide material inputs for all consumer products. Extension of eco-audit schemed to include dematerialisation aspects
	Market-based instruments	Reform of the subsidy system Ecological fiscal reform focusing on energy taxes
	Regulatory instruments	Limiting the use of natural resources with high potential of environmental burden Regulations forcing producers to use the best available technologies (in terms of resource efficiency). Full implementation of the concept of “Integrated Product Policy (IPP)”.
Sectoral policy strategies	Energy	Rebalance supply side policies in favour of demand side policies Introduction of higher energy taxes and other parafiscal levies,

		with the clear goal of a reduction of energy consumption. Active support for increased shares of renewable energy resources in total energy consumption.
	Industry	Stimulating demand for eco-efficient products Fiscal incentives, environmental regulation and reduction of market uncertainties to foster creation of key markets for sustainable products and services.
	Transport	Introduction of a framework for transport charges (“road pricing”) to ensure that prices for different modes of transport, reflect their costs to society. Harmonisation of fuel taxation for commercial users, in particular in road transport. Giving priority to infrastructure investment for public transport and for railways, inland waterways, short sea shipping and intermodal operations. Improve transport systems by addressing missing transport links, developing open markets and co-operation at EU level (e.g. railway liberalisation, air traffic systems).
	Construction	Funds and subsidies supporting new resource-extensive solutions and the development of new eco-efficient and renewable building materials. Public procurement considering requirements of eco-efficiency in construction. Taxes and other regulatory mechanisms at the EU, national and regional levels Urban planning instruments making sustainability standards a condition for construction permits.
	Agriculture	Full implementation of instruments of CAP reform, in particular concept of “decoupling” grants from production Linking grants to statutory environmental, food safety, animal health and welfare and occupational safety standards (cross-compliance).
Specifics for Accession Countries	Targets	Same basic resource use reduction targets as set for EU countries
	Developments	Energy sector: Energy consumption will slightly increase; energy intensity improvements higher than in Western European countries due to replacing of old technologies

		Transport sector: Increase of transport activities (compared to stabilisation in Western Europe) due to high demand caused by continued economic growth and restructuring
	Policy instruments	Same policy instruments as detailed for Western European countries

II. II. Strong sustainability scenario

The second policy scenario is called *strong sustainability scenario.* The main policy target is a considerable reduction of material and energy use in absolute terms, in accordance with the Factor 10 concept. Sectoral policies as well as policy instruments implemented on the macro level are assumed to be designed and implemented in a way that support a radical change of production and consumption patterns towards the general goal of absolute dematerialisation.

The following table summarises the key components of the strong sustainability scenario.

***Table III*: Summary table strong sustainability scenario**

Targets	Overall resource use	Strong de-coupling of economic growth from use of natural resources (materials and energy) Reduction of overall resource use in absolute terms (absolute dematerialisation) following “Factor 10” requirements, e.g. a 30-40% reduction in absolute terms until 2020.
Assumed sectoral developments	Energy	Major technological breakthroughs in the energy sectors with environmentally friendly energy forms, such as hydrogen and methanol, significantly gaining in market shares. Significant price increases for fossil fuel energy carries due to the implementation of high energy taxes. High growth in the contribution of hydroelectricity and other renewable forms of energy generation. Substantial reduction in fossil energy use. Significant absolute reduction in energy consumption in Western Europe.
	Industry	High material and energy efficiency gains due to high energy prices. Increased substitution of bio-resources for non-renewable raw materials in production chains.

		Significant reduction of raw material input due to new technologies, such as micro technologies.
	Transport	Absolute reduction of transport activities both concerning passenger and freight transport. Full reflection of costs of transportation activities to society through road pricing together with high taxation of fossil fuels. Significant increase in costs of passenger and freight transport, reducing private demand for car and air transport and increasing demand for alternative modes of freight transport. Shift in the overall structure of the transportation system towards public transport, railways and inland waterways.
	Agriculture	Full implementation of the CAP reform, in particular system of decoupling of grants (as in weak sustainability scenario). Strong support for organic agriculture, leading to an average EU share of 20% in total agricultural area.
Policy instruments on the macro level	Voluntary instruments	As in weak sustainability scenario, but additionally: Implementation of extended producer responsibility (EPR) to include producer’s responsibility, physical and/or financial, for a product also at the post-consumer stage of a product’s life cycle.
	Market-based instruments	Reform of the subsidy system as in weak sustainability scenario, but including introduction of new forms of subsidies dependent on the material intensity of an industry. Ecological fiscal reform focusing on energy taxes and introducing a material input tax (MIT) Alternatively to material input tax: introduction of a system of tradable material input permits.
	Regulatory instruments	In addition to weak sustainability scenario: Input regulations on production processes that completely prohibit the use of certain resources that are associated with a high environmental burden. Production quotas for highly material intensive products.
Sectoral policy strategies	Energy	Instruments as in weak sustainability scenario, but with more stringent means (e.g. higher energy taxes, etc.).
	Industry	Changes in the regulatory framework to support renewable and resource efficient raw materials

		Cost internalisation measures for non-renewable resources and fossil energy (in particular, taxes). Substantial support of research in new resource-saving technologies.
	Transport	Measure as in weak sustainability scenario, but with more stringent means Full reflection of costs of transportation activities to society through road pricing together with high taxation of fossil fuels. Strong public support for investments in infrastructure for public transport and for railways and inland waterways.
	Construction	Urban planning instruments make standards for resource extensive construction and waste minimisation a condition for construction permits. High taxes and other regulatory mechanisms at the EU, national and regional levels on resource and pollution intensive construction materials. Public procurement sets examples by considering high standards and latest technologies in its construction-related activities.
	Agriculture	In addition to weak scenario assumptions: Strong support for transformation towards organic agriculture, through: • Promotion and information campaigns • Ensuring traceability and organic food authenticity • Harmonisation of control procedures and accreditation • Funding of research in organic farming
Specifics for Accession Countries	Targets	Same basic resource use reduction target than for Western EU countries
	Developments	Energy sector: “Leapfrogging” towards high share of renewable energy Agricultural sector: Transformation towards sustainable, resource-extensive agriculture without passing through phase of highly industrial and resource intensive agricultural production
	Policy instruments	Fostering transfer of most advanced environmental technologies from Western EU to new members

Contents

1 Introduction

In all documents of the European Union and the accession countries screened for the scenario component “resource use” (see Annex), high levels of resource use and high amounts of waste and emissions’ release is addressed as one major obstacle for the realisation of an environmentally sustainable development in Europe. The sustainable management of natural resources, in order to keep anthropogenic environmental pressures within the limits of Earth’s carrying capacity, is highlighted as one central objective for the implementation of a sustainability strategy within Europe. However, the issue of resource use and the need for its reduction is addressed rather in correlation to specific environmental problems. Across all sustainability-oriented documents of the EU and the accession countries, clear priorities concerning main environmental issues can be observed: GHG emissions and climate change, energy use, land use changes and agriculture, biodiversity loss, and transport and environment. The high level of resource use is thus regarded as a sectoral or issue-specific problem rather than a major environmental problem on the economy-wide level.

De-coupling (or de-linking) economic growth from the use of natural resources and environmental degradation is regarded as the core strategy to achieve sustainable levels of resource use. Raising the resource productivity of production and consumption activities should help producing the same or even more products with less resource input and less waste. Reducing the use of natural resources also follows the goal of preventing pollution at its source. However, there is still ongoing debate whether the de-coupling objective is understood as a relative de-coupling, i.e. that environmental impacts increase more slowly than the economy, or an absolute de-coupling, i.e. that environmental impacts decrease in absolute terms even in a growing economy.

The proposal of the EU Commission for a *Thematic Strategy on the Sustainable Use of Natural Resources* (European Commission, 2002c) states hereto (p.15): “If nothing is done the use of natural resources grows with 1-2% per year (which is relative decoupling since the economy grows faster). Absolute decoupling (decreasing resource use in a growing economy) will not occur under the present circumstances ... Existing policies are dedicated to stimulate economic growth and do not create sufficient driving forces to save natural resources.” Furthermore, it is stressed that scarcity of non-renewable resources, such as fossil fuels and metals, is not a major concern, since proven reserves are not diminishing or even growing (as in the case of fossil fuels). On the other hand, renewable resources such as fish, forests, and space (including fertile soil) are threatened by scarcity and by pollution and overexploitation of sinks. The most severe and urging environmental problems thus rather stem from negative impacts caused by material outflows than from impacts linked to material extraction.

Concerning Europe’s responsibility in the global economy, it is explicitly stressed in several of the documents that Europe is consuming an over proportional share of worlds natural resources. Therefore, Europe should follow a development path, which fosters sustainability within Europe without causing increased environmental pressures in other parts of the world (in particular in so-called developing countries). From this statement originates the need to take into account adequately the implications stemming from international trade relations between Europe and the rest of the world (for example, through the comprehensive accounting of so-called hidden resource flows associated with imports and exports, which is one of the major goals of the MOSUS project). Although most instruments could only be applied within the EU it is pointed out that the EU could influence experiences in the rest of the world by ensuring the transfer of technology and best practices.

This report summarises the research undertaken in Work Package 1.4 of the MOSUS project. It presents the scenario component "*Resource Use*" for the integrated scenarios, which will be compiled in Deliverable 3 based on the six scenario components focusing on different economic, social and environmental aspects of future European development.

In the MOSUS project, three main scenarios are developed, each of them up to the year 2020. The ***baseline scenario*** projects further trends observed between 1980 and 2003, if no particular sustainability-oriented policy strategies and instruments are put into force. The ***weak sustainability scenario*** reflects sustainability policy goals and measures derived from strategic documents of the European Community, such as the 6th Environment Action Programme (European Commission, 2001f) and the Sustainable Development Strategy of the European Union (European Council, 2001). The ***strong sustainability scenario*** defines policy goals and instruments, which are more ambitious from the point of view of sustainable development compared to those included in the EU documents.

This report describes the three scenarios with regard to the use of natural resources, covering both renewable and non-renewable resources. In the simulation model applied in the MOSUS project, only a small number of ***economic sectors*** represented in the input-output model structure actually serve as primary material suppliers. These sectors are agriculture, forestry and fishery with regard to biotic resources and mining and quarrying (metal ores, industrial minerals and construction minerals) with regard to abiotic resources. However, primary resource extraction is to a large extent driven by development in (secondary) sectors, which refine, process, manufacture and trade natural resources as products. Therefore, these sectors (such as transport, industry, and energy supply) have to be considered in the formulation of the scenarios on resource use (see Chapter 5 below).

A large spectrum of ***policy instruments for dematerialisation and sustainable resource use*** exists, ranging from regulatory and planning instruments, via economic (market-based) instruments to voluntary instruments. In all screened sustainability-oriented documents, some of these instruments are mentioned. However, the documents do not provide sufficient detailed descriptions on design and implementation of these instruments. Therefore, in this report, a more extensive description of dematerialisation instruments is included based on existing literature in this field (see Chapter 6 below), which serves as the basis for the formulation of instruments in the weak and strong sustainability scenario.

The rest of this report is structured as follows. As a general introduction, Chapter 2 gives a summary of the representation of resource use in prominent scenario packages ("global scenarios") formulated for Europe. The baseline scenario on resource use is described in Chapter 3; it describes the main past trends of resource extraction in Europe as well as non-European countries and projects these trends further up to the year 2020. The presentation of the two policy scenarios (weak and strong sustainability scenario) starts with three introduction chapters, one summarising reduction targets for resource use as presented in the literature and in policy documents (Chapter 4), the second focusing on the most important economic sectors determining directly and indirectly the extraction of natural resources (Chapter 5) and the third giving an overview of policy instruments for dematerialisation and sustainable resource use (Chapter 6). Chapter 7 contains the detailed description of the weak sustainability scenario, which is based on policy goals and strategies formulated in key sustainability-oriented documents of the EU and accession countries and specified by information from other existing scenarios and scientific literature. The policy targets and instruments of the strong sustainability scenario are presented in Chapter 8. An Annex containing the summaries of the screened EU documents is appended.

2 Resource use in prominent existing scenario packages

In recent years, a substantial number of scenario packages and future outlooks have been published, focusing on environmental, economic and/or social issues of future European and global development (for example, European Commission, 1999a; IPTS, 2000, 2002, 2003). The most comprehensive scenario packages formulated for Europe were presented by the ICIS (1998; 2001) under the title of “Visions. The European scenarios” and by the European Commission (1999b) entitled “Scenarios Europe 2010”. In this chapter, a short summary shall be given concerning the representation of the issue of resource use in these comprehensive scenario packages.

2.1 VISIONS. The European scenarios

„VISIONS” was published by the International Centre for Integrative Studies in February 2001 (ICIS, 2001). The process of developing the scenarios began with a participatory workshop where European stakeholders were involved in a free-format process of creating storylines – the building blocks of scenarios. These storylines were further developed and expanded to yield three diverse, concise and multifaceted narrative story lines, entitled “Knowledge is King”, “Convulsive Change” and “Big is Beautiful?”. In each of these scenarios, there is a main driver: technology, the environment and the economy, respectively. The time horizon covered is 2000-2050, with a mid-term analysis of developments in 2020 (the time horizon for the three scenarios applied in MOSUS). Each scenario has a set of dominant sectors, actors and factors. The main sectors under review are energy, water, transport and infrastructure. The principal actors are governmental bodies, businesses, NGOs and scientists, whose roles and influence vary according to the premises of the scenarios. Factors under consideration are equity, employment, consumption behaviour and environmental degradation.

In the “**Knowledge is King**” scenario, the first decade of the millennium is characterized by a rapid growth of high technology and related sectors. The transition to a knowledge economy, lead by the Information & Communications Technology (ICT) and biotechnology sectors, accelerates. At the same time, the ongoing decline in the importance of ‘traditional’ manufacturing in Western Europe continues and accelerates, as many industries relocate their production units to the Central and Eastern European countries. Unemployment rises, particularly amongst older men and low-skilled workers. After the successful expansion of the EU to 25 member states by 2010, and to over 30 member states by 2020, the biggest environment-related challenge is the full implementation of the Kyoto

Protocol. A campaign for the use of the joint implementation clause of the Kyoto Protocol, headed by NGOs, business groups and some new member states, is successful. NGOs also successfully petition governments to increase expenditures in R&D, promote use of cleaner fuels and encourage energy saving, and a fifteen-year plan for renewable energy research is implemented. Transport and electricity generation are the principal sectors targeted for emissions and fuel use reduction. In electricity generation, the use of natural gas continues to increase, boosted by the liberalisation that reduces some of the subsidies for other fossil fuels and nuclear power. Targeted programs to boost the efficiency and reduce the costs of electricity production from carbon-free renewables are also increased.

In the scenario "**Convulsive Change**", the effects of climate change and the consequences of environmental degradation have serious implications for Europe and the world. In general, there is a rise in mean temperatures. While northern Europe is increasingly hit by heavy precipitation and high winds, which cause coastal and river flooding, mud slides, soil erosion and glacial melting, the southern part of the continent suffers from an alarming absence of rain, leading to long dry spells and even droughts. The overabundance of water in the north damages infrastructure and contaminates drinking water supplies, while the lack of water in the south poses severe threats to irrigated agriculture and tourism. The subject of climate change also looms large in the public eye, and the use of natural resources is very much the focus of consumers in the first decade of the millennium. This leads them to adopt changes in lifestyle in order to decrease consumption of natural resources, particularly in transport. On the international level, the EU pushes for the implementation of the Kyoto Protocol. As in scenario one, the EU targets transportation and electricity as the main sectors for emissions reduction, and aims to reduce overall energy demand. Transport policy legislation and specific regulations focus on two aspects, a shift in modes (from individual to collective) and a shift in fuels (from high carbon to low carbon). In electricity generation, renewable sources of electrical power, such as solar, wind and biomass, are to be promoted by imposing regulations on the minimum required amount of energy derived from renewables in the energy mix, as well as by stimulating research and scaling down financial support for the coal industry. The reduction of overall energy demand is achieved through macro-economic regulations, such as an EU-wide carbon tax, whose revenue is used to reduce other taxes and to support the investments in energy efficiency and clean technology. The concept of 'green' labelling is extended to energy products, with a subsequent reduction in the demand for energy-intensive products as demand increases for products that are produced from energy-efficient processes.

The driving force behind the scenario "**Big is Beautiful**" is the continued economic integration brought about by globalization. The 'merger principle' of globalization not only affects major industries and companies, but also deeply affects social, cultural and ecological patterns. By 2010, governments have left sectors such as health care, education, energy, water and transport to markets. The merger and privatisation processes lead to a massive rationalisation of most industries, resulting in a few clusters of large, integrated, trans-national companies, commonly referred to as 'Big Business'. The use of private automobiles for personal transport and air travel continue to grow, adding to already troublesome congestion on the roads and in the skies. The rise in demand for mobility and energy in general is reflected in the continuing rise of electricity generation from natural gas, although this is primarily due to economic and geopolitical reasons rather than a result of environmental considerations. Coal remains the dominant player, nuclear also remains a key provider of electricity and petroleum continues its dominance in the transport fuels market. The biggest losers are renewables, which see both public and private investment in their development slow as other fuels continue to provide much more rapid economic returns. There have been some slow improvements in many local environmental issues. Most of this is due to previous regulations and improvements in technology and the increased use of natural gas, and less due to any new regulatory efforts by national governments or the EU. These modest advances, however, cannot compensate for the fact that the Kyoto Protocol has not been implemented on a worldwide basis, which puts a halt to international efforts to address climate change. Similarly, the slight improvements in emissions in individual vehicles do not make up for the general rise in greenhouse gas production due to increased traffic.

2.2 Scenarios Europe 2010

Subtitled "Five possible futures for Europe", this study was compiled by the Forward Studies Unit of the European Commission from contributions by civil servants of the Commission and published as a working paper in July 1999 "with the objective of producing a set of coherent and thought-provoking images of the future of Europe" (p.11) until the year 2010 (European Commission, 1999b). The Scenarios Europe 2010 project was implemented in order to contribute to "a wide public debate on the future of Europe" (p. 13) as well as to foster a "future culture" inside the Commission. For this reason, it is both a "rigorous review of the factors that are bound to influence the future of Europe" (p.13) and an eminently readable, not overly complex set of qualitative scenarios written in a narrative style. Scenarios Europe 2010 consists of five separate scenarios: Triumphant Markets, The Hundred Flowers, Shared Responsibilities, Creative Societies, and Turbulent Neighbourhoods. Environmental issues are just one of many (economic, cultural, political, etc.) topics addressed in the scenarios and there no detailed description is given on environmental implications resulting from the scenarios' assumptions.

In the scenario "**Triumphant Markets**" the remarkable growth of worldwide trade and economic and technological development has left its mark on the world's ecosystem as the issue of environmental protection has taken a back seat. Climate conferences have failed on a regular basis as the overriding concern has been to keep economies flexible and competitive. "While ever greater numbers of people are acquiring the consumption habits of the developed countries, infrastructure and waste-processing systems are failing to keep pace" (p. 20), effectively reversing global progress towards sustainable development. Although the state of Europe's environment has actually been improving in relative terms, "the continent's stability is increasingly threatened by shortages of drinking water in North Africa, the dying Mediterranean and the many types of industrial and agricultural pollution further north" (p. 20).

In the scenario "**The Hundred Flowers**", environmental issues are not addressed.

The scenario "**Shared Responsibility**" assumes a reconciliation of Europe's ideals of solidarity and respect for the individual with technological innovation and the pursuit of economic efficiency, which resulted in substantial progress in areas such as social affairs and environmental protection. A system of voluntary contracts, which has been implemented throughout the economy, is widely used in agriculture and industry, with contracts being introduced to observe certain basic precepts, such as environmental protection, product quality and compliance with employment law.

In the scenario "**Creative Societies**", European Forums have been created, giving citizens an opportunity to express their concerns and contribute their points of view with regard to future European development. This fact ensured that social concern have remained high on the Union's agendas and given impulses for subsequent reforms. By 2006, every company in Europe was required to maintain "green accounts", and was obliged to present and environmental assessment at the end of every year. "The tax structure has been overhauled, and a full range of new taxes introduced on capital, international financial movements, pollution, energy, and environmental damage" (p. 42), which significantly contributed to the improvement of environmental quality in Europe.

The scenario "**Turbulent Neighbourhoods**" has seen a Europe in the midst of a sea of regional instability, and, occasionally, military conflict. "Today's problem [of political instability] is the cumulative result of a number of converging and long-standing historical trends. The first real signs of environmental damage were visible way back in the twentieth century; sooner or later shortages of natural resources such as drinking water, and political struggles for control of them, were bound to follow" (p. 48). The natural environment all around the Union's borders was slowly but irreversible deteriorating, with the over-exploitation of the Mediterranean coast to the south and massive industrial and agricultural pollution to the east. Only a few hundred kilometres from Europe, armed conflicts erupted, with one of the reasons given the control of natural resources, such as water.

2.3 Concluding remarks

In almost all scenarios within the two prominent scenario packages analysed in this chapter, the issue of resource use is directly or indirectly addressed. Depending on different assumptions on future European developments regarding economic, social and environmental policy, the overall state of the environment either improves or worsens in comparison to the 1990s. Improvements with regard to the issue of natural resource use are described as a consequence of (a) raising environmental awareness and changes in lifestyles, (b) of the implementation of new, resource-saving ("green") technologies in manufacturing and energy production and/or (c) changes in the macro-economic policy framework (e.g. through the implementation of new resource consumption-related taxes).

What can be observed as a general trend is the fact that environmental problems related to the high level of resource use in Europe are always analysed from a sectoral perspective. Consequently, strategies to reduce resource consumption are formulated for particular sectors, most prominently for the energy and electricity generation sector, the transport sector and the manufacturing sector. In none of the scenarios, an economy-wide reduction of resource use through an integrative and cross-sectoral policy of dematerialisation is mentioned.

PART I: Baseline scenario

3 Detailed description of the baseline scenario

The baseline scenario in Work Package 1.4 of the MOSUS project describes likely developments concerning the use of natural resources up to the year 2020, if *no policy measures* towards a sustainable resource management are put into force.

The baseline scenario projects forward trends in resource use that could be observed since the 1980s (1990s for Eastern European countries), which are derived from existing studies in material flow accounting and analysis (MFA). These derived trends are supplemented and cross-checked by projections and scenario analyses carried out by other organisations, such as the FAO for future agricultural production and forest use (FAO, 2003), or the USGS for future developments in the mining sectors (USGS, 2000). If no material flow analysis has been available – as it was the case for many countries and regions outside Europe – data and projections from other sources have been used.

The description of the baseline scenario starts with global baseline projections for the categories of agriculture, forestry, fisheries, as well as energy use. In the following sections, the baseline scenario is formulated separately for the EU-15, for non-EU countries from Western Europe, Eastern Europe as well as all other world regions.

In the baseline scenario we describe the trend in resource use without considering resource stocks scarcities as in almost all documents on which this scenario is based resource scarcity is not seen as a problem until 2020 – at least for non-renewable resources. A draft version of the European Commission for a thematic strategy on the sustainable use of natural resources states that for fossil fuels and metals scarcity is not a problem (European Commission, 2002c). Concerning fossil fuels the report states that the problem is not running out of fossil fuels but rather “running out of air” to store the amounts of CO_2 emissions. For metals the world reserves hold for 20 or more years using the production of 1999 as basis (see Table 1) which is assumed to be an appropriate time to develop new mining technologies or switch to substitutes. According to this report the development of metal prices also shows no indication of scarcity.

***Table 1*: Metal reserves (worldwide)**

	World production (1999) *million tonnes*	World reserves, m*illion tonnes*
Iron	535	71,000
Zinc	8	190
Lead	3	64
Copper	12	340
Nickel	1.1	49

Source: modified after European Commission, 2002c

However, for renewable resources scarcity seems to be a serious problem. Fresh water at the regional level, fish, forests and space (area) seem to become increasingly scarce (European Commission, 2002c).

3.1 Global trends and projections in resource extraction

3.1.1 Agriculture

Growth rates of aggregated global agricultural production are estimated at 1,6% p.a. between 1997/99 and 2015 and 1,3% p.a. between 2015 and 2030, which means a slight decline compared to growth rates in the last three decades (between 2,0% and 2,2% p.a.) (FAO, 2003). The major increases in production will come, as they did in the past, from increases in yield and more intensive use of land, although the potential for further growth of yields is now much more limited than it was in the historical period. However, the two propositions (that yield growth potential is less than in the past and that yield growth will continue to be the main factor of the production increases) are not necessarily contradictive, as future slower growth in production is expected to be needed than in the past.

As in many developing countries growth in population and food demand are expected to be higher than growth in domestic production, developing countries in general will be increasingly dependent on food imports (in particular, cereals, with the share of self-sufficiency in cereals for all developing countries decreasing from 91% in 1997/99 to 86% in 2030) from other world regions (mainly industrialised countries). Global production of cereals is expected to rise from 1.889 million tons in 1997/99 to 2.387 million tons in 2015 and 2.838 million tons in 2030.

As stated by the FAO (2003), world agricultural production is being increasingly driven by the shift of diets and food consumption patterns towards livestock products. In the developing countries, where almost all world population increases take place, consumption of meat has been growing at 5-6 percent p.a. and that of milk and dairy products at 3.4-3.8 percent p.a. in the last few decades. Aggregate agricultural output is being affected by these trends, not only through the growth of livestock production proper, but also through the linkages of livestock production to the crop sector which supplies the feeding stuffs (mainly cereals and oilseeds). Currently, 35% of world's cereal production is used for feeding purposes. Aggregated meat production is forecasted to grow by annual 1,9% between 1997/99 and 2015 and 1,5% p.a. between 2015 and 2030, which is a significant decline compared to growth rates in the last three decades (around 2,8% p.a.).

3.1.2 Forestry

In the 1990s, global forest areas showed an annual decline of 9,39 million hectares or 0,22% of global forest area to a total of 3,87 billion hectares in 2000. Nearly all forest losses occurred in the tropical area, while Europe was the only world region to increase its forested area by 0,08% annually (1990s average). 48% of global forests are available for wood supply, the rest of the forest areas are either protected, inaccessible or otherwise not useable in economic terms. The greater part of global wood harvest (55%) is used as fuelwood, in particular in developing countries, where wood often is the most important source of energy. The other part of wood harvest (45% or 1,5 billion m^3) is used as industrial roundwood. Increasing demand for forestry products mainly arise from growing populations, increasing affluence and related changes in consumption patterns (FAO, 2003).

Global consumption of industrial roundwood is expected to move upwards in the next 30 years, to a production of 2,4 billion m^3 in 2030, of which about one third is expected to be provided by plantations. Most of this increase will be due to rising income and consumption of wood products in developing countries.

According to the FAO, dramatic changes in fuelwood consumption are unlikely over the next 15 years. Access to alternative fuels (in particular, liquid fuels) will become easier, but the majority of current wood-using communities are likely to be still burning wood in 2015. The shift towards alternative fuels may accelerate beyond 2015, depending on developments of infrastructure and on improvements in the efficiency and cost-effectiveness of generating energy.

3.1.3 Fisheries

During the 1990s, the production of capture fisheries fluctuated between 80 and 85 million tonnes per year for the marine sector. Fish from the Pacific Ocean dominated world capture fisheries, accounting for almost two-thirds of total world supplies in 1999. During the same period, the production from fisheries in inland waters expanded, increasing from 6.4 million tonnes in 1990 to nearly 8.3 million tonnes in 1999. However, inland fishery catches are believed to be greatly underreported, as many inland fish are expected to be bartered or consumed locally without entering the market economy. Production from wild capture fisheries is approaching the limits for sustainable use for many species. Of total world fish stocks, 4% are underexploited, 21% moderately exploited, 47% fully exploited, 18% overexploited and 9% depleted (FAO, 2003).

Demand for fish consists of two main components: fish as food and fish for animal feeding. During the 1990s, global consumption of fish per capita increased from 13.4 kg per capita in 1990 to 16.3 kg per capita in 1999, to a large extent due to events in China, which emerged as the world's largest fish producer in this period. Between 28 and 33 million tons of fish were used for animal feeding during the 1990s.

The management of wild catch fishery is expected to continue much as it is today, whereas aquaculture is expected to grow significantly (at a rate of 5-7% p.a.), providing the major share of increased fisheries production. Estimates of total fish production in 2030 range between 150 and 160 million tons (FAO, 2003).

3.1.4 Energy

According to the International Energy Agency fossil fuels will continue to dominate global energy use (International Energy Agency, 2002). Global primary energy demand is projected to increase by 1.7% per year from 2000 to 2030. This growth is slower than the growth over the past three decades which was 2.1% per year. Fossil fuels will meet 90% of this increase in demand. Global oil demand will rise by 1.6% per year from 2000 to 2030. About three quarters of this increase will result from the transport sector. A shift is expected in all world regions from heavier oil products to light and middle distillate products like gasoline or diesel. Demand for natural gas will rise more strongly than for any other fossil fuel. Primary gas consumption will double between now and 2030 and the share of gas on world energy demand will increase from 23% to 28%. Two thirds of this increase will be due to new power stations. Coal consumption will also grow but more slowly than the one of oil and gas. China and India together will account for two thirds of the increase of coal demand. Coal will be mainly used for power generation. The role of nuclear power in energy production will decline and the role of renewable energy will grow. The report states that the world's energy resources will be adequate to meet the projected growth in energy demand.

More than 60% of the increase in primary energy demand will come from developing countries, mainly in Asia. These countries share of world demand will increase from 30% to 43%. The OECDs share will fall from 58% to 47%. The share of the former Soviet Union and the transition economies in Eastern Europe will fall slightly to 10%. The transport sector will show the fastest growth among all end-use sectors and is expected to overtake the industry as largest endues sector in 2020. Electricity will grow faster than any other end-use source of energy (2.4% between 2000 and 2030). Almost all the increase in energy production will occur in non-OECD countries compared to only 60% between 1971 and 2000. Most of the projected 60% increase in oil demand will be met by OPEC producers. Gas production will increase in any region except of Europe. Future coal extraction will be concentrated in South Africa, Australia, China, India, Indonesia, North America and Latin America. Energy trade will grow dramatically and will more than double until 2030.

No such prognoses could be found for **mining and quarrying**. Reports and trend studies from the United States Geological Service (USGS) are available only for single countries or world regions and will be discussed in the following below.

3.2 European Union

The European Statistical Office published the most recent data on material use in the European Union in 2002, covering the time span from 1980 to 2000 and presenting various indicators based on used domestic extraction as well as physical imports and exports (EUROSTAT, 2002). The most elaborated estimation of total material use (including unused domestic extraction and indirect flows associated to imports) for the European Union is presented in a study prepared by the Wuppertal Institute in Germany for the European Commission (Moll et al., 2003).

Although the analysis will be concentrated in the domestic (used) extraction a short overview on the most widely used indicators, Direct Material Input (DMI) and Total Material Requirement (TMR), will first be given.

3.2.1 Direct Material Input and Total Material Requirement

According to Moll et al (2003), in 2000 the EU-15 DMI amounted to about 16.8 tonnes per capita. About 40% of this value is due to construction minerals. Biomass and fossil fuels represent about 25% each and industrial minerals and metal ores represent only about 9%. Between 1980 and 2000 DMI almost didn't suffer any change, in aggregated values. It ranged from 6 billion to 6.3 billion tonnes meaning 16.95 to 16.76 tonnes per capita (EUROSTAT, 2002).

Nevertheless the DMI composition has changed over time - component categories developed differently during this period. The industrial minerals category significantly increased since 1993, construction minerals have constantly been slightly above the 1980 value since 1987, fossil fuels slightly decreased during the 1990ies and biomass showed a continuous steady increase with moderate growth rates. The origin of the materials also changed over time. The imported part of the DMI ranged from 12% during the 1980ies to 16% around 2000 – 3.1 to 3.8 tonnes per capita.

According to the last available data, the EU-15 TMR amounted 51,4 tonnes per capita in 1997. About 28% of this value refers to fossil fuels, 23% to metals and 18% to construction minerals (excavation and dredging included, accounting 6%). Biomass and erosion amounted 12% and 9% respectively. Non-renewable materials then form the major part of the TMR – almost 90%. The called “hidden” part of the TMR (materials not valued by the economy like mining overburden or imported goods’ ecological rucksacks) represents around 60% of the total – that is, about two thirds.

During the 1980-1997 period the metal category of the TMR evidenced the strongest increase, calculated to be 30%. Especially since 1993 this was due to a shift from domestic production (extraction) to the import of these materials. Construction minerals category increased about 17% during the same period. Due to what is identified as a change in energy-mix (Moll et al, 2003) fossil fuels steadily decreased from 1989 on, after an observed rising during the 1980ies.

In the end of the period the domestic part of the TMR was about two thirds of the total but the foreign part has significantly risen since the late 1980ies from around 30% to almost 40%.

In resume, DMI and TMR results for the EU-15 evidence the weight of non-renewable resources in the materials consumption of EU economic system (fossil fuels, construction minerals and metals, mainly) and the growing importance of imports.

3.2.2 Used domestic extraction

Between 1980 and 2000, total used domestic extraction of resources in the EU-15 remained more or less constant, varying slightly around the figure of 5 billion tonnes. In 2000, construction minerals accounted for around 53% of total domestic extraction, biomass for 29%, fossil fuels for 15%, and industrial minerals and ores for 3%. Fossil fuels extraction has two evident trends in two different periods – 1980 to 1985 and 1985 to 2000 – while the other flows evidence a single trend over all the period. While industrial minerals and fossil fuels (since 1985) domestic extraction evidenced a clear decrease, construction minerals and biomass evidenced a slight increase.

Table 2 resume the results of the development of the different categories during the period at stake.

***Table 2*: Change rates of the different categories of domestic extraction 1980-2000**

Category	**Biomass**	**Construction Minerals**	**Industrial Minerals**	**Fossil fuels**	
Period	(1980-2000)	(1980-2000)	(1980-2000)	Phase 1 (1980-1985)	Phase 2 (1985-2000)
total change in %	*8,19*	*4,40*	*-36,67*	*19,20*	*-35,25*
average annual change in %	0,41	0,22	-1,83	3,84	-2,35
range of annual change rate	-4,96 to 8,11	-4,36 to 6,95	-7,92 to 5,00	-3,98 to 17,09	-8,66 to 1,52

Source: EUROSTAT, 2002

3.2.3 Unused domestic extraction

Between 1980 and 1997 unused domestic extraction (UDE) in aggregated EU-15 decreased by 17%. The decrease was to a good part determined by reduced UDE from fossil fuel extraction, particularly from lignite mining in former Eastern Germany.

3.2.4 European Union baseline scenario

The baseline scenario for the overall EU-15 assumes that extraction trends during the next twenty years will follow extraction trends of the past twenty years. Then:

- Domestic extraction of Biomass will increase 8% until 2020;
- Construction Minerals extraction will increase near 4,5% the next twenty years;
- Industrial Minerals extraction will decrease 37% in the next two decades, and
- Fossil fuels extraction will follow the past 15 years trend of decrease of 35%.
- Unused domestic extraction will decrease by another 17%.

3.2.5 Country-specific data and projections

Table 3, obtained from EUROSTAT (2002) summarises the per capita domestic extraction of the four main categories of materials in the year 2000 and the change observed in this indicator for the period 1980-2000 for the 15 member countries of the EU.

Table 3: **Domestic used extraction per capita for 2000 and 1980-2000 difference**

	Total DE per capita [tonnes]	Biomass DE per capita [tonnes]	Construction minerals DE per capita [tonnes]	Industrial minerals, Metal ores DE per capita [tonnes]	Fossil fuels DE per capita [tonnes]	DE per capita change 1980-2000 [%]
EU-15	13.0	3.8	6.9	0.4	1.9	-6.0%
Austria	14.7	4.3	9.4	0.6	0.5	-8.7%
Belgium, Luxembourg	11.1	3.3	7.7	0.05	0.0	8.4%
Denmark	22.4	6.4	11.1	0.2	4.6	29.7%
Finland	31.9	12.9	16.6	1.2	1.2	-1.5%
France	13.0	6.3	6.3	0.2	0.1	-11.3%
Germany	15.0	3.3	8.6	0.3	2.8	-18.2%
Greece	13.1	3.1	3.2	0.8	6.0	15.0%
Ireland	18.5	9.3	6.6	1.0	1.6	3.3%
Italy	8.9	2.4	6.1	0.2	0.3	-8.1%
Netherlands	8.5	2.5	1.7	0.3	4.0	-28.8%
Portugal	10.8	3.6	7.0	0.2	0.0	17.6%
Spain	13.6	3.8	8.6	0.5	0.6	29.1%
Sweden	21.5	8.8	9.5	3.1	0.2	-3.9%
United Kingdom	11.4	2.0	4.5	0.4	4.5	-2.8%

Source: EUROSTAT, 2002

Grouping EU-15 countries by DE components magnitude it may be concluded that construction minerals extraction is clearly the most important component of DE in Austria, Belgium/Luxemburg, Denmark, Finland, Germany, Italy, Portugal and Spain. The second most important category in these countries is currently biomass extraction.

France, Ireland, Sweden, Netherlands, Greece and also Finland are countries where biomass extraction represents an exceptionally important fraction of the total DE. In Ireland it is indeed the most important category.

Fossil fuels extraction is the most important fraction of DE in Greece and the Netherlands. In UK it shares the weight with construction minerals and in Denmark it is becoming the second most important DE category.

Austria

Domestic extraction per capita decreased around 9% between 1980 and 2000. In 2000 its value was about 15 tonnes per capita being construction minerals about two thirds of it. On the other hand biomass represented almost one third of the total DE. Industrial minerals and fossil fuels are extracted in a much smaller scale than the previous ones.

The DE diminishing is essentially observed in the biomass category that decreased almost 1 tonne during the period at stake. Construction minerals considerably increase in the early 1990ies and decrease to the 1980ies levels during the last three years seeming to be stabilizing.

According to the current situation and the observed trends biomass and construction minerals will remain the most important categories of DE for Austria the next years.

Belgium/Luxembourg

Domestic extraction per capita of these two countries augmented about 8% achieving about 11 tonnes per capita in 2000. Construction minerals represent about 70% (7,7 tonnes) of that value followed by 27% of biomass (3,3 tonnes per capita).

This growth is essentially due to the increase in the construction minerals category especially after 1988 - even so since 1994 is observed a slight decrease. Biomass values seem to be stable over the years not experiencing great changes. However, according to trends this category as well as construction minerals will represent the major part of DE for the next years.

Denmark

This country registered the utmost increase in DE per capita during the assessed period. DE values rose 30% attaining 22 tonnes per capita in 2000, the second greatest value per capita of the EU-15 group. Half of this extraction is attributable to construction minerals and about one fourth (4.6 tonnes per capita) is due to fossil fuels.

In fact fossil fuels extraction is responsible for the DE rise during the assessed period since this category has been continuously rising in opposition to construction minerals and biomass that registered some stabilization or even a slight decrease.

Trends seem to demonstrate that during the next year's fossil fuels extraction per capita will surpass biomass extraction becoming the second most important category of DE after construction minerals.

Finland

Finland's DE shows a slight decrease (1.5%) during the period assessed being currently about 32 tonnes per capita. It has to be highlighted that this is the maximum per capita value of all the member countries. This fact is due to the greatest per capita values of construction minerals and biomass extraction. The first category achieved the record value of 23 tonnes per capita in 1990 but since then it has been decreasing. The extraordinary values associated to biomass extraction are due to the importance of the forest sector in the country (one of the main exporters of wood in Europe). Biomass extraction values have been continuously increasing since 1991.

Trends seem to evidence that construction minerals' extraction will tend to stabilize around the 15 tonnes per capita over the next years and biomass extraction will carry on growing.

France

Domestic extraction decreased about 11% during the last two decades of the past century accounting 13 tonnes per capita (precisely equal to the average value of the EU-15 countries) in 2000. This amount is basically divided in construction minerals and biomass with extraction values around 6.3 tonnes per capita each.

Numbers evidence the weight of the agriculture sector in the domestic extraction of the country. Consumption of the mentioned material categories seems to have stabilized during the last years of the analysis. It can then be advanced that these are going to remain the most important extraction flows during the next years.

Germany

In 2000 DE per capita in Germany was 15 tonnes per capita, 18% less than the value of 1980. About 60% of that value (8.6 tonnes per capita) comes from construction minerals extraction while the biomass and fossil fuels categories are currently extracted in a volume of around 3 tonnes per capita each. As widely mentioned in MFA works Germany reunification has had as a consequence an important decrease in fossil fuels domestic extraction followed by an increase in construction minerals extraction.

Trends seem to evidence that fossil fuels extraction will continue decreasing and construction minerals and biomass will be the most important extraction flows during the next years.

Greece

Domestic extraction in Greece increased 15% during the 1980-2000 period. In 2000 that value was 13 tonnes per capita and about half of it (6 tonnes per capita) is due to fossil fuels extraction - lignite extraction has a great expression in Greece. Biomass and construction minerals' values maintained relatively stable around 3 tonnes per capita each during all the period.

So, the most important extraction categories of Greece during the next years will be fossil fuels, biomass and construction minerals.

Ireland

In 2000 the DE of Ireland was 18.5 tonnes per capita. During the twenty years' period considered that indicator increased around 3%. Biomass extraction is about half (9 tonnes per capita) of the total extraction indicating the importance of agriculture in this country. This value maintained relatively stable during all the period. Construction minerals registered an increase from 1991 to 1996 and then stabilized around the 7 tonnes per capita.

During the next years biomass will remain the most important extraction category followed by construction minerals.

Italy

Italy's DE decreased about 8% between 1980 and 2000. In the end of this period it accounted 9 tonnes per capita. This decrease is essentially due to the construction minerals extraction decline mainly since 1985. Biomass extraction has always been stable around the 2.5 tonnes per capita. Since 1993 construction minerals' values seem to have stabilized also (around 6 tonnes per capita).

The most important extraction categories during the next years will as well be the both mentioned above.

Netherlands

Domestic extraction of this country registered the greatest decrease – 30% - of all the 15 member countries. This fact drove the country to the smallest per capita domestic extraction value, 8.5 tonnes. The decrease is essentially observed in the construction materials category since 1989 and the fossil fuels category since 1996. Biomass and fossil fuels represent presently the most important components of the total domestic extraction (2.5 and 4 tonnes per capita respectively) and this situation seems to maintain during the next years.

Portugal

Portugal's domestic extraction increased about 18% during the 1980-2000 period. The greatest responsible for this trend was the construction sector. Construction minerals extraction represents currently about 65% (7 tonnes per capita) of the total domestic extraction (10.8 tonnes per capita). Extraction of these materials evidenced a clear raise from 1987 on, the year after Portugal's adhesion to EEC. The second most important DE component, biomass extraction, shows a continuous but slight increase during the same period being its value of 3.6 tonnes per capita in 2000 (33% of the total DE).

Trends clearly evidence that the mentioned extraction categories will be the most important during the next years.

Spain

This country recorded the second major increase (29%) of DE per capita during the past two decades - which results in a 13.6 tonnes per capita DE in 2000. Like Portugal the most important categories are construction minerals and biomass (8.6 and 3.8 tonnes per capita respectively). The first category evidenced relatively stable values from 1985 to 1993 and since then it has been increasing continuously. Biomass values evidenced a much more stable development during all the twenty years' period – varying from 3.1 to 3.8 tonnes per capita. These are also going to remain the most important domestic extraction categories for the next years.

Sweden

DE decreased about 4% from 1980 to 2000. In the last year Sweden's DE per capita accounted 21.5 tonnes per capita, the third greatest value of the EU-15. The most important material extraction flows are construction minerals (9.5 tonnes per capita in 2000) and biomass (8.8 tonnes per capita in the same year). Nevertheless the first category evidences a decrease trend over the period seeming to be the motor of the overall decrease in domestic extraction during time. These categories represent 85% of the total extraction but what distinguishes this country from the others EU-15 is the greatest value of industrial minerals and metal ores extraction. It accounts 3.1 tonnes per capita, representing 14% of the total.

Trends show that biomass and construction minerals will be the most important for the next years but industrial minerals extraction will continue raising its importance.

United Kingdom

This is also a country where DE decreased during the evaluation period. The decrease was about 3% and DE accounted 11.4 tonnes per capita in 2000. Fossil fuels sector has a significant weight in UK domestic extraction: in 2000 the value was the same as the construction minerals' one (4.5 tonnes per capita). These two categories represent 80% of the total DE being the third major category biomass with a 2 tonnes per capita value in 2000.

During the next year's fossil fuels and construction minerals will remain the most important components of UK's DE followed by the biomass component.

3.3 Non-EU western European countries

If not indicated otherwise we assume – for the baseline scenario – that the shown trends will prolong within the period to be modelled within the project.

Turkey

DMI of Turkey increased by 27% between 1992 and 1999 (Moll et al., 2003). Total domestic extraction (DE) and domestic extraction of fossil fuels increased by almost the same amount whereas DE of minerals grew to the 2,4-fold and DE of biomass increased by 6%. Total imports increased by 50%, imports of fossil fuels by 57% whereas imports of minerals declined by 42% during the last 2 years. Imports of biomass doubled. The same trends are assumed to continue until 2020.

Norway

DMI of Norway increased by 32% between 1992 and 1999 (Moll et al., 2003). Total domestic extraction increased by the same amount, DE of fossil fuels increased by 46%, DE of minerals decreased by 6% and DE of biomass decreased by 9%. Imports increased by 47%, imports of fossil fuels by 39%, imports of minerals stayed more or less constant and imports of biomass doubled. The same trends are assumed to continue until 2020.

3.4 Eastern Europe

The Eastern European countries are strongly differentiated regarding their achievement in dematerialisation standards. The reasons of that are poorly recognized and researched because of a lack of interest by governments and administration. Only the approaching accession to the EU realised interest in this issues. The information presented below describes the state of dematerialisation processes in 10 Eastern European countries on the eve of accession to the EU.

Total Direct Material Input in accession countries increased by 13% between 1992 and 1997 and then fell decreased by 8% until 1999. Domestic extraction showed the same trend with a growth of 10% and a decrease of 5% respectively. Domestic extraction of fossil fuels declined by 17%, domestic extraction of metals increased by 19% between 1992 and 1999, and the one of biomass increased by 13%. Imports increased by 31%, imports of fossil fuels increased by 10%, imports of metals decreased by 11% with strong fluctuations in the first years, and imports of biomass increased by 82% (Moll et al., 2003).

It is important to mention that due to wide-ranging processes of economic restructuring in the 1990s (which will continue in the future with even high pace), it is in general difficult to predict future trends based on past observations concerning the use of natural resources in Eastern Europe.

Hungary

Main processes with regard to material use in Hungary in the 1990s are the following (Moll et al., 2003): From 1992 to 1999 total DMI increased by 14,5%. The input of all material categories showed an increase with the exception of minerals which decreased by 12,16%. Domestic extraction of fossil fuels and minerals decreased by 13% and 11,4% and increased for all other material categories. The total input of fossil fuels stayed more or less constant as the imports increased. Imports increased for all categories instead of minerals. Positive trends are observed in changing of role of fossil fuels and minerals in Hungarian DMI – they share in DMI decreased substantially. Resource productivity in Hungary increased slightly at approx. 5% what resulted from much higher increase in GDP in comparison to DMI. Unused domestic extraction in Hungary between 1993 and 1997 decreased in the first years an increased by 5% until 1997 (Hammer and Hubacek, 2002). From a general point of view the economic growth in Hungary in the years 1992 – 1999 was only slightly de-coupled from using and consuming of raw materials, fossil fuels and semi-manufactures.

Baseline assumptions: Trends for the future are not easy to predict as the integration into the European Union in 2004 will change the past trends. We assume that accession may stimulate material inputs through faster economic growth (although the efficiency in terms of GDP generated by material input might also increase). For the MOSUS baseline scenario we assume that the trend shown between 1992 and 1999 will prolong.

Czech Republic

Economic growth in the Czech Republic in the 1990s was quite strongly de-coupled from using and consuming materials. Total DMI decreased by 7,3% mainly due to the decrease in input of fossil fuels which decreased by 26,1%. Domestic extraction of fossil fuels decreased by 33,3%. All other inputs increased between 1992 and 1999. Domestic extraction decreased at about 15% in absolute and in per capita term as well. There was a big reduction of domestic material extraction in fossil fuels – the extraction in 1999 was approx. of one third of extraction in 1992. Positive trends are observed concerning the changing role of fossil fuels and minerals in Czech DMI – they share in DMI decreased strongly. Unused domestic extraction for the Czech Republic showed a decreasing trend between 1990 and 2000 (Scasny et al., 2003).

Baseline assumptions: The past trends make assumptions for the future quite difficult. DMI increased between 1992 and 1996 and then decreased again. The trend between 1996 and 1999 was decreasing and the effects of the accession to the European Union are not known. Another study on the Czech Republic (Scasny et al., 2003) showed a decrease of DMI between 1990 and 1994, a slight increase for 1994 to 1997, again a decrease until 1999 and another increase until 2000. We assume that accession to the EU might stimulate material input. This all leads us to the assumption that DMI in the Czech Republic might increase slightly but not up to the level of the early 1990s.

Slovak Republic

In the Slovak Republic, DMI decreased by 1,6% between 1993 and 1999. DMI for the main categories (fossil fuels, minerals and biomass) also decreased. Domestic extraction stayed more or less constant, increasing for fossil fuels and minerals and decreasing for biomass. Positive trends are observed in the structure of Slovak DMI – the share of fossil fuels, minerals and biomass in DMI is stabile over the nineties. DMI productivity in Slovak Republic increased strongly at approx. 35% what resulted from much higher increase in GDP at 32% whereas DMI decreased (Moll et al., 2003).

Baseline assumption: With the described trends and the assumption that EU accession might increase material inputs we assume that material inputs may slightly rise.

Poland

Poland is the biggest country of the region regarding territory, population and economic capacity. Thus dematerialization indices in Poland can strongly influence their average levels in the region. DMI increased by 10% between 1992 and 1993 but fell back to the level of 1992 in 1999 (Moll et al., 2003). Domestic extraction has decreased slightly at about 4%. The imports increased distinctly in absolute as well as in per capita terms at about 30%. Fossil fuels took the dominant position in domestic extraction, imports and DMI; share of fossil fuels in domestic extraction decreased however in imports substantially increased so that their share in DMI at the end of 1990s was reduced. The share of biomass in domestic extraction as well as in imports has visibly increased. Minerals and biomass belong still to the main group of goods creating domestic extraction and DMI however the share of minerals in imports substantially increased. The imports distinctly increased but mainly by remarkable increase in inflow of fossil fuels. The share of semi-manufactures and final goods in DMI was still relatively low but increased substantially. DMI productivity increased strongly between 1999 and 1992. Economic growth in Poland was de-coupled from using and consuming of materials. We assume that DMI will slightly decrease during the next years. Unused domestic extraction for energy carriers and metals decreased between 1992 and 1997 and increased for minerals (Mündl et al., 1999).

Bulgaria

Bulgaria is one of the Balkan countries with modest and slightly diminishing economic growth in the nineties. It is the main reason why domestic extraction of raw materials and natural resources was stabile and even decreased over that period. The Bulgarian economy was rather closed what suggests low level of imports in direct material flows. Direct material input grew by 13% between 1992 and 1995 and until 1999 fell back again to the level of 1992 (Moll et al., 2003). Imports are dominated by fossil fuels, and than by increasing inflow of semi-manufactures and final goods. Minerals dominated in domestic extraction, imports and direct material flows. Creating of GDP was heavily burdened by the use of material resources and increased over that period of time. It means that less of GDP was generated from 1 tonne of DMI used in production and consumption. Afore-mentioned data suggest that Bulgaria has great possibilities to economic growth without increasing in material resources. However, it depends from effectiveness of structural policy aiming at development of tourism and services. The assumption for the baseline scenario is that DMI will stay more or less constant or may slightly increase as economic growth continues.

Rumania

Between 1992 and 1997, Rumania's DMI stayed more or less constant but until 1999 it fell by 14% (Moll et al., 2003). Fossil fuels dominated in domestic extraction, imports and DMI however theirs share at the end of the nineties was much lower than at the beginning of the period of time. Biomass was dominant in domestic extraction and DMI so as it was the main group of goods which contributed to increase in DMI; but at the same time its share in the imports has substantially diminished. The share of minerals in DMI decreased substantially; it resulted from diminishing of share of minerals in domestic extraction as well as in imports. DMI productivity in Romania increased at approximately 20% what resulted from only slightly increase in GDP and dramatically decrease in using of materials. The Romanian economy in the nineties was in state of recession: the level of GDP per capita belonged to one of the lowest in the region. Thus reduction in direct material input to large extent could be attributed rather to recession than to restructuring of the economy. We assume that Rumania's DMI may stabilize at the present level or increase after economic restructuring leads to higher rates of economic growth.

Estonia

Estonia with its well developed economy and relatively high GDP per capita could be to some extent the example for other countries of the EEC. Estonia over the nineties heavily changed its production and consumption model by decreasing in using of fossil fuels and increasing in using of biomass and semi-manufactures and final goods.

Domestic extraction and DMI have increased in the last decade. DMI grew by 42% between 1992 and 1999 (Moll et al., 2003). Imports were an important factor of development of the economy and of consumption. Imports were dominated by fossil fuels and to some extent by increasing inflow of semi-manufactures and final goods. Biomass has contributed much to domestic extraction and direct material flows what suggests that Estonia re-build its traditional sectors of economy forestry and agriculture while importing more self-manufactures and final goods. The economic growth in Estonia over the nineties was only slightly de-coupled from using and consuming of raw materials, fossil fuels and semi-manufactures. We assume that with the accession to the EU material inputs may further increase. Therefore an increase with the same rate as in the nineties is assumed.

Latvia

The structure of the Latvian economy has not changed much during the 1990s. Between 1992 and 1999 DMI first decreased and the increased again so that in 1999 DMI was 10% higher than in 1992 (Moll et al., 2003). Domestic extraction and DMI increased during the time of transformation at about 10% - a little bit more the domestic extraction what suggests that the internal production and consumption were main driving forces in developing of the economy. Concerning domestic material extraction, the main role has been played by production and use of biomass. Contribution of fossil fuels to domestic extraction, imports and DMI was diminished over the period of nineties. DMI productivity in Latvia decreased slightly. We assume that DMI will follow the trend shown in the last years and will further increase.

Lithuania

Lithuania belongs to the group of countries which economies relatively much suffered in the nineties from systemic transformation. DMI increased by 15% between 1992 and 1998 and in 1999 fell back almost to level of 1992 (Moll et al., 2003). The growth was due mainly to the increase in imports. Domestic extraction dominated in DMI over the years 1992-1999, biomass contributed mainly to that category – its share in domestic extraction even increased at 1 percent point. Fossil fuels have been generally imported so that their share in imports in the end was higher than in the beginning of nineties. DMI productivity in Lithuania decreased slightly at approximately 5% what resulted from much higher increase in GDP in comparison to DMI. The economic growth in Lithuania in the years 1992 – 1999 was overburdened by an over-proportional use and consumption of materials and goods. For the baseline scenario we assume a growth in DMI as in the mid-1990s.

Slovenia

Slovenia belongs to small countries in the region which have achieved a relatively high level of economic development. High contribution of imports to DMI suggests that Slovenia just in the nineties was highly developed country with open and competitive economy. The imports were the driving force of economic development in Slovenia. DMI increased by 12% between 1992 and 1999 (Moll et al., 2003). Domestic extraction has decreased at 5%; at the same time the imports jumped in absolute as well as in per capita terms at over 92%. DMI productivity in Slovenia increased strongly and. It resulted from much higher increase in GDP than in DMI. Economic growth in Slovenia therefore was de-coupled from using and consuming of materials. Relatively positive dematerialization indices noticed in Slovenia can positively contribute to lowering of average dematerialization in the region. We assume that imports will increase further and domestic extraction declines, with the rate as it did in the 1990s.

3.5 Rest of the world

Information concerning countries outside Europe is split according continents. The coverage of these countries in the model applied in MOSUS is varying significantly. All OECD countries and some Asian countries are represented with an input-output model in GLODYM, whereas other countries are only integrated with a macro economic model. As only 55 countries are represented with a separate country model, all other countries form country groups containing the “rest of” South America, Asia, Africa and Oceania.

3.5.1 North America

In the simulation model applied in MOSUS, the USA, Canada and Mexico are all three represented by a specific country model.

USA

A study lead by the World Resources Institute (WRI) compiled material flow accounts for domestic extraction, imports and exports for the United States in the time span of 1975-1994 (Adriaanse et al., 1997). The most significant characteristic of the US economy is the high domestic supply with natural resources. Only 5% of total material flows are associated with imported products. Direct material input increased slightly from 20 tons in 1975 to 21 tons in 1994. The share of direct inputs as percentage of TMR increased slightly from 21% to 26% between 1975 and 1994. Therefore the share of unused domestic extraction and indirect flows associated to imports slightly decreased.

For the baseline scenario of the USA, the following assumptions are taken: a future slight decrease for the input of industrial minerals; an increase with regard to construction minerals; an increasing trend of extraction of metals due to increases in copper and gold production; a growth in fossil fuel extraction and in domestic agricultural production.

Canada

In 2000, Canada produced 8% of the world’s copper, 6% of silver, and 15% of nickel, as well as 21% of zinc, 3% of iron ore, 6% of gold, 5% of lead, 7% of primary aluminum, 6% of salt, and 3% of crude oil. Canada also was the world largest producer of uranium, the third largest of zinc and second largest of nickel. Statistics released by the Canadian government showed anticipated 2000 exploration spending at $348 million. This value was almost half of the reported exploration expenditure for the highest level of 1997 (Gurmendi et al., 2000). No trends, time series or future projections on Canadian metal and mineral production have been found.

Energy consumption per capita in Canada grew by 4% between 1992 and 1997 (World Resources Institute, 2003a). Agricultural production also grew: cereals production grew by 28,6% between 1992 and 2002, pulses production grew by 132.2% and roots and tubers production increased by 28.8%. Industrial round wood production increased from approximately 85 million m3 in 1961 to app. 180 in 2001 (World Resources Institute, 2003d). For the baseline scenario it is assumed that these trends will continue.

Mexico

In 2000, Mexico led the world production in silver and strontium and was the fourth largest producer of steel. Mexico is among the top producers of crude oil, natural gas and coal in Latin America (Gurmendi et al., 2000). In 2001 Mexico was the worlds leading producer of bismuth (30% of world's total), celestite (47%) and silver (15%). Mexico was in the following positions in world mineral and metal production: fluorspar (2nd with 15% of world's total production), cadmium 5th, barite, gypsum, lead (mine), molybdenum and zinc (mine) 6th, salt and graphite 7th, manganese ore (metal content) and sulphur 9th, copper (mine) 11th, cement 12th and gold an crude steel 17th. Mexico was the worlds 6th largest producer of crude petroleum, in the western hemisphere only the USA produced more petroleum (Torres, 2001b). Consumption of fossil fuels in Mexico increased from app. 40 million tons of oil equivalents to app. 120 between 1971 and 1999 (World Resources Institute, 2003b). No other trends or projections for metal and mineral production could have been found.
Between 1961 and 2001 fuel wood production increased from app. 24 to app. 37 million m3 and industrial round wood production from 3 to 6 million m3. Cereals production increased by 3.1.% between 1992 and 2002, pulses production by 113,1% and roots and tubers production by 27.5% (World Resources Institute, 2003e). For the baseline scenario we assume that these trends will continue until 2020.

3.5.2 Central and South America

Concerning Latin American countries (except Mexico, see above), only Brazil, Argentina and Chile are modelled on a country-specific level. All other Latin American countries are grouped as "Rest of Latin America".

According to the latest FAO projection (FAO, 2003), total agriculture production in Latin America will increase by a growth factor of 2,1% p.a. between 1997/99 and 2015, and by 1,7% p.a. between 2015 and 2030.

In 2000, Latin America (including Mexico) produced 43% of the world's copper, 41% of tin, 39% of silver, and 26% of bauxite; it also produced 24% of iron ore, 19% of zinc, 17% of nickel, 15% of gold, and 14% of lead. During the past 10 years, investments in prospecting, exploration, and development have taken various new discoveries of such minerals as bauxite, copper, iron ore, nickel, silver, and tin to the point of production. Expansions and new mines had come on-stream and increased Latin America's world position in the production of those minerals. Latin America's world share of output of silver, tin, nickel, and gold has increased, and conspicuous effort has been exerted to find and produce diamond, copper, and gold. The world share of Latin American production of crude oil decreased to 12% from 14% in 1999, and resultant derivatives of petroleum (products) increased to 8% from 7% in 1995. Natural gas production increased to 8% from 5% in 1995 after fluctuating unevenly since 1985. Output of crude oil reached new peaks in Brazil, Ecuador, and Venezuela. The top producers were, in order of importance, Venezuela, Brazil, Argentina, Colombia, Ecuador, and Trinidad and Tobago and represented 97.7% of the regional total. Venezuela, Argentina, Bolivia, Trinidad and Tobago, Brazil, and Colombia, in order of importance, also reached new peaks in the production of natural gas by volume. Coal output was lead by Columbia, Venezuela and Brazil. During the past 30 years, exploration in the central Andes of Argentina, Bolivia, Chile, and Peru has had notable success. From 1970 to 1999, 11 copper deposits, 17 precious-metal deposits, and 2 polymetallic deposits were developed in this region. Notable exploration and development activities in 2000 included exploration at the Veladero base-metals deposit in Argentina; the Magistral copper-molybdenum deposit, the Tambogrande polymetallic deposit, and development activities at Antamina in Peru; and the Pascua/Lama deposit on the border of Argentina and Chile (Gurmendi et al., 2000).

The following table shows the change in the role of Latin America in world mineral production during the last 15 years:

Table 4: **Role of Latin America in world mineral production (percentage of world output)**

Commodity	1985	2000
Copper	26	43
Tin	25	41
Silver	35	39
Bauxite	20	26
Iron Ore	17	24
Zinc	17	19
Nickel	6	17
Gold	10	15
Lead	15	14
Crude Oil	12	12
Aluminium	8	9
Cement	7	7
Steel	5	6
Coal	1	1
Petroleum products	7	8

Source: Gurmendi et al., 2000

Brazil:

Machado (Machado, 2001) compiled material flow accounts for the Brazilian economy for the years 1975-1995. DMI per capita rose from 10.4 tons in 1975 to 15.2 tons in 1995. Biomass extraction is the most important category in Brazilian's domestic extraction, followed by minerals and fossil fuels. Domestic extraction (DE) of fossil fuels stayed more or less constant, DE of minerals increased by 55% and DE of biomass increased by 25%. Total imports increased by 70% during this period. Imports of fossil fuels stayed more or less constant, imports of minerals increased by 66% and imports of good grew 4,4-fold. No imports of biomass are reported. All export categories also increased significantly.

Baseline scenario assumptions: We assume that the trends describe above will continue until 2020. Therefore domestic extraction of minerals and biomass would increase as well as imports of minerals and goods.

Chile

MFA accounts for domestic extraction, imports and exports were compiled for the period of 1973-2000 (Giljum, forthcoming). In particular due to the rapid expansion of copper mining activities, which are extremely material intensive due to the low concentration of copper in the primary extracted mineral, Chile's DMI rose considerably in the last 30 years. With around 40 tons per capita, Chile's DMI at present is one of the highest in the world. DMI of Chile increased to the 6,4-fold between 1973 and 2000. Domestic extraction increased for all categories except of fossil fuels where domestic extraction fell to 34%. Imports and exports also multiplied.

Baseline scenario assumptions: Metal mining will increase at the same pace as in the 1990s, also biomass production will increase due to higher export demand. Domestic extraction as well as imports and exports of almost all material categories will further increase until 2020.

Argentina

In 2001 Argentina was Latin America's third largest producer of aluminium and the third largest crude steel and the fourth largest producer of primary iron (pig iron and direct-reduced iron) in Latin America with 7.9% and 6.6%, respectively, of the regional production. Argentina was one of six Latin American producers of mine lead and zinc in 2001. Although Argentina produced less than 10% of lead in the region, only Mexico mined more lead in the area. Argentina also produced about 5% of the region's zinc mine output. It became the fourth largest producer of ammonia in the Latin America and Caribbean region with the completion of a new ammonia plant; the country's production more than doubled during the year and represented 10% of the region's output. Argentina was also the fourth largest producer of silver in Latin America and a significant producer of gold. Argentina was the third largest producer of of crude petroleum in Latin America and an important regional supplier of natural gas (Torres, 2001a). Energy consumption in Argentina increased from about 30 million tons of oil equivalent in 1971 to about 55 in 1999. Cereals production increased by 25.1% between 1992 and 2002, pulses production by 17,9% and roots and tubers production by 27.5% (World Resources Institute, 2003c). Between 1961 and 2001 industrial roundwood production increased from 2 to 6 million m3, fuel wood production decreased from 9,5 to 3,5 million m3 (World Resources Institute, 2003c). For the baseline scenario we assume that trends will continue until 2020.

3.5.3 Africa

In the simulation model system applied in MOSUS, no African country is represented with a separate country model. Africa is integrated with only one aggregate (continental) model.

Therefore, in the baseline scenario, only general trends for Africa are described, without going into details on the level of single countries.

No MFA studies for African countries were carried out so far. Information for the baseline scenario thus had to be taken from other sources, such as the minerals yearbook of the USGS (2000) and the “State of Food and Agriculture” by the FAO (2002).

The USGS report (USGS, 2000) states that Africa is richly endowed with mineral reserves and – as a continent – ranks first or second in terms of amounts of world resources with regard to important metals and minerals such as bauxite, chrome, cobalt, diamonds, gold, manganese, phosphate rock, platinum, titanium, and others. For many African countries, mineral and metal extraction and refining constitutes a significant part of their economic activities and is regarded as a key to future economic growth. Due to Africa’s severe poverty and the low development of production infrastructure, domestic markets for minerals and metals are hardly developed – most of the extracted resources are therefore exported to other world regions.

The following descriptions are all taken from the USGS report cited above.

Metals

In 2000, Africa contributed 11% of world’s **bauxite** production and 5% of world’s **aluminium** production, respectively. Aluminium production doubled from 605.000 tons in 1990 to 1.200.000 tons in 2000 and is expected to increase rapidly (last estimation given in the report are 2.000.000 tons in 2005). While Africa delivered one fourth of world **copper** production in the 1960s, this share fell to 4% (or 465.000 tons) in 2000. In 1990, production was 1.290.000 tons. Copper production is expected to increase from 2000 to 2005 to 710.000 tons. In 2000, Africa produced 604.000 kg of **gold**, which represented 24% of total world production. Total gold production stayed more or less constant since 1990 (678.000 tons) and is not expected to rise until 2007 (600.000 tons). Between 1990 and 2000, extraction of **iron** ore maintained its level at 49 million tons annually. Iron ore extraction (as well as steel production) is expected to increase slightly to 53 million tons in 2005. Extraction of **lead** increased from 160.000 tons in 1990 to 177.000 tons in 2000, but is expected to show a declining trend in the future (140.000 tons in 2005). With 2,74 million tons of extracted **manganese** ore in 2000, Africa represented 38% of world’s total production. With 3,63 million tons predicted for 2005, production will again surpass the levels of the 1990s (3,23 million tons in 1990). In 2000, Africa’s production of **nickel** was 79.000 tons, which marks an increase compared to 66.000 tons in 1990. Nickel extraction is expected to decrease to 68.000 tons in 2005. Concerning platinum-group metals, South Africa alone accounted for an estimated 74% of world’s production of platinum, 86% of rhodium and 32% of palladium. African **platinum** production was 87.800 tons in 1990 and increased to 115.000 tons in 2000. This trend is expected to continue through 2005 (140.000 tons). A similar trend could be observed for **palladium** (38.300 tons in 1990; 56.200 tons in 2000; estimated 67.000 tons in 2005). African **titanium** production almost doubled from 600.000 tons TiO_2 in 1990 to 1.120.000 tons TiO_2 in 2000. Extraction is forecasted to further increase to 1.600.000 tons in 2005. Between 1990 and 2000, African **zinc** production showed a steep increase, from 140.000 tons to 260.000 tons. Zinc extraction activities are expected to further expand significantly to 410.000 tons in 2005.

Industrial minerals

In 2000, Africa produced an estimated 71,5 million tons of **cement** (4% of world production). No forecast on future development of cement production is given. Africa's output of **diamonds** represents 50% of world production. Production increased from 48.800 carat to 61.700 carat in 2000 and is predicted to increase to 65.000 carat in 2005. **Graphite** extraction in 2000 amounted 27.000 tons with no projection for the future given. In 2000, Africa produced 19% of world's total **phosphate** rock extraction. No clear tendency for future development can be derived.

Fossil fuels

Africa's production of **coal** of 228,9 million tons represented about 5% of world production in 2000. No trend for the future is indicated. Production of **natural gas** more than doubled between 1990 and 2000, climbing from 66.900 million m^3 to 146.000 million m^3. This trend is expected to continue to around 200.000 million m^3 in 2005. A similar increase in production could be observed for **crude oil**, rising from 2,37 billion barrels in 1990 to 2,79 billion barrels in 2000. Due to a large number of new exploitation projects currently underway, production is forecasted to increase to 3,9 billion barrels a day in 2005.

Agriculture

Past trends: Total agricultural production in Sub-Saharan Africa grew by around 35% between 1987 and 2001 (FAO, 2002). All numbers are taken from this study, if not otherwise specified. **Total cereals** production (including rice in milled form) increased from 40,7 million tons in 1979/81 to 58,3 million tons in 1989/91 and 70,9 million tons in 1997/99. Production of **wheat** increased from 1,34 million tons in 1979/81 to 2,03 million tons in 1989/91 and to 2,52 million tons in 1997/99. A significant increase in the last 20 years also could be observed for **rice** production with 6,11 million tons in 1979/81, 9,75 million tons in 1989/91 and 11,66 million tons in 1997/99. Production of **maize** doubled in the last 30 years, from 13,86 million tons in 1979/81 to 26,02 million tons in 1997/99. Harvest of **barley** only showed a slight increase, from 12,15 million tons in 1979/81 to 15, 24 million tons in 1997/99.

Projections: **Aggregated agricultural production** in Africa is forecasted to grow by 2,8% p.a. in Sub-Saharan Africa and 2,1% p.a. in North Africa between 1997/99 and **2015** and by 2,7% p.a. and 1,9% p.a., respectively, between 2015 and **2030**. **Total cereal production** is estimated to increase from 97 million tons in 1997/99 to 114 million tons in 2015 and 168 million tons in 2030 at an average growth rate of 2,7% p.a.

3.5.4 Asia

With regard to Asia, the following countries are represented by a country-specific model in MOSUS: Japan, Korea, China, Hong Kong, India, Malaysia, Philippines, Indonesia, Singapore, Thailand, and Taiwan. All other Asian countries are aggregated into "Rest of Asia", if not belonging to the group of OPEC countries.

Agricultural projections for total production according to the FAO (2003) are as following. In South Asian countries, total production will increase by 2,5% p.a. from 1997/99 to 2015 and at 2,0% p.a. from 2015 up to 2030. For East Asia (excl. Japan), annual growth rates are predicted as 1,7% from 1997/99 to 2015 and 1,0% from 2015 to 2030.

Production of fish in aquaculture will continue to grow in Asia and provide important segments to fish markets in Asia.

Japan

In the first WRI study (Adriaanse et al., 1997), Japanese material flow accounts were compiled for the years 1975-1994, comprising domestic material extraction (used and unused) as well as imports and hidden flows associated with them. Japan is to a large extent depending on material inputs from outside, with about 30% of DMI and 50% of TMR being associated with imported resources and products, in particular fossil fuels, metal ores and agricultural and forestry products. Unused domestic extraction in Japan showed a decrease from 1000 million tons in 1975 to 850 in 1984 and increased again up to 1200 in 1994. The baseline scenario assumes increasing import dependence and a reduction of domestic materials up to 2020.

China

A preliminary material input analysis of China was presented by Chen and Qiao (2001), covering the years from 1990 to 1996. Both direct material input (DMI) and total material requirement (TMR) significantly increased within these 7 years. Hidden material flows, in particular related to excavation activities for infrastructure building and to the extraction of fossil fuels (especially coal), as well as to soil erosion in agriculture, contributed the largest shares to TMR. Physical imports of non-renewable materials more than tripled within the 7 years. Chinas energy demand will grow between 2000 and 2003. China and India together will account for two thirds of the increase of coal demand between 200 and 2003. Coal will be mainly used for power generation (International Energy Agency, 2002). Baseline scenario assumptions for fossil fuel extraction and extraction of other non-renewable resources state a continued rapid increase.

Projections for agricultural production: In 1997/99, China already had a level of food consumption nearly equal to the one of industrial countries (3040 kcal/person/day). Increase in consumption will therefore be moderate at 0,3% p.a. up to 2030. Together with the slowed down growth rates in population (0,5% p.a. up to 2030, compared to 1,5% p.a. in the last three decades), this fact will significantly reduce pressures on growth in per capita food consumption in the next decades. This deceleration foreseen for China will also show positive impacts on the global situation (FAO, 2003). During the 1990s, China emerged as the world's largest producer of fish.

Due to data restriction, no country-specific projections are given for the other country-models within the model system applied in MOSUS (India, Russia, Korea, Indonesia, Malaysia, Philippines, Singapore, Thailand and Taiwan).

3.5.5 Oceania

For Oceania, a country-specific projection is only provided for Australia.

Australia

Poldy and Foran (1999) compiled material input data for the Australian economy for the time span of 1946-1991. Due to the significant expansion of primary sectors activities (in particular, mining of fossil fuels, minerals and metals), values of DMI and TMR per capita in the 1990s lay significantly above the values for other industrialized countries. Biomass extraction, however, showed a much slower growth.

Baseline scenario assumptions: Fossil fuel extraction and extraction of other non-renewable resources will continue to increase rapidly, biomass extraction will increase as well, but at a slower pace.

3.6 Summary of the baseline scenario

The following table summarised the main components of the baseline scenario.

Table 5: **Summary table baseline scenario**

Region	Resource	Trend
World	Agriculture	+1,6 (1,3)% p.a. 1999-2015 (2025-2030)
	Forestry	Increasing in the next 30 years
	Fisheries	Increase in fisheries and aquaculture
	Fossil fuels	+1,7% p.a. until 2030
EU 15 (domestic extraction)	Biomass	+ 8% until 2020
	Construction minerals	+4,5% until 2020
	Industrial minerals	-37% until 2020
	Fossil fuels	-35% until 2020
	Unused domestic extraction	-17% until 2020

Eastern Europe (Domestic extraction)	DMI	increasing until mid-90s, now decreasing
	Fossil fuels	-17% between 1992 and 1999
	Metals	+ 19% between 1992 and 1999
	Biomass	+13% between 1992 and 1999
North America	Country-specific projections for USA, Canada and Mexico	
Latin America	Biomass	+2,1 (1,7)% p.a. 1999-2015 (2015-2030)
	Metals and minerals	Increasing share on world production until 2020
Africa	Metals	No total trend observed
	Fossil fuels	Increasing production of oil and gas until 2020
	Biomass	Increasing production until 2020
Asia	Agriculture	Growing production until 2020
	Fisheries	Growing production until 2020
	Fossil fuels	No total trend observed
	Metals and minerals	No total trend observed
Oceania	Country-specific projection for Australia	

PART II: Policy scenarios

As mentioned in the introduction chapter, two policy scenarios are formulated in the MOSUS project: a *weak sustainability scenario* reflecting policy goals and strategies formulated in key documents of the European Union, its member countries and accession countries. The second scenario is called *strong sustainability scenario* and contains more ambitious sustainability goals and more restrictive policy instruments. All screened documents (see the Annex for summaries of the most important ones) do address the issue of natural resource use. However, they do in most cases not provide sufficient information with regard to reduction targets, the most important economic sectors, and the design of policy instruments for a sustainable use of natural resources.

Before going into detailed description of the two policy scenarios, the following three chapters will therefore present short reviews concerning the issues of reduction targets for resource use, key economic sectors and policy instruments based on information both from scientific literature and official policy documents.

4 Reduction targets for resource use

4.1 In the scientific literature

In the 1990s a number of approaches have been developed, which demand a reduction of the environmental impact of economic activities through a significant decrease in resource use, in order to realise environmental sustainability. This discussion is often referred to as the "Factor X debate" (Reijnders, 1998), with X ranging between 4 and 50. The factor X is qualitatively similar to the concepts of "dematerialisation," "eco-efficiency," and "increased natural resource productivity," but includes quantitative reduction goals.

The most influential Factor X concepts have been introduced by von Weizsäcker et al. (1995), Schmidt-Bleek (1994) and the Factor 10 Club (1995) under the notion of Factor 4 and Factor 10. These concepts are built on two explicit assumptions: that today humankind is at or already beyond earth's carrying capacity and that the equity principle of intra- and intergenerational justice should be applied (Spangenberg et al., 1998). According to these concepts, total global resource use has to be reduced by 50% in absolute terms until 2050, in order to achieve environmental sustainability. Given the uneven distribution of resource use today, this translates into a need to reduce the physical resource consumption of industrialised countries drastically, in this case by a factor of ten or 90% compared to today's level, in order to provide necessary environmental space for future increase in resource consumption in developing countries. If this goal is to be reached in a 50 years time-span (needed to allow the technical, social and economic dynamics to adapt and adjust without major conflicts), it is equivalent to an annual increase in resource productivity of 4.5% and can be considered a pragmatic, feasible and necessary policy target for industrialised countries.

In the literature, only very few examples exist, which give a detailed description of reduction targets for specific materials or product groups. One of these studies is "Sustainable Europe" (Spangenberg, 1995), which was performed by the Wuppertal Institute in Germany for

Friends of the Earth Europe. As it is assumed that reduction of material flow will not be implemented easily and quickly due to time-lags and path-dependent barriers in the process of structural change, reduction goals are formulated to be achieved between 2030 and 2050. Until 2010, about 25% of this reduction should be reached. Reference year for production and consumption numbers is 1990. Quantified reduction targets are listed for a selected number of key abiotic raw materials and chemical products: cement, pig iron, aluminium, chlorine, copper, lead, N fertiliser, P_2O_5-fertiliser and K_2O-fertiliser (Table 1). In general, it is assumed that a reduction by a factor 5 to 10 in Europe is necessary, in order to reduce the magnitude of resource use to the available global ecological capacity.

Table 6: **Reduction targets for selected abiotic raw materials and chemical products**

Material (primary based)	recorded use	EU12 use in 1990 (kg/capita)	Desirable proportion of reduction until 2030/2050 (from 1990 levels)	Desirable proportion of reduction until 2010 (from 1990 levels)
Cement	production	536	85%	21%
Pig Iron	production for steel making	273	87%	22%
Aluminium	apparent consumption.	12	90%	22%
Chlorine	production	23	86%	21%
Copper	apparent consumption.	6.4	88%	22%
Lead	apparent consumption.	2.3	83%	22%
N-fertiliser	apparent consumption.	29	81%	20%
P_2O_5-fertiliser	apparent consumption.	13	80%	20%
K_2O-fertiliser	apparent consumption.	14	92%	20%

Source: Spangenberg, 1995

Concerning energy use and energy-related emission targets, the “Sustainable Europe” study gives the following numbers.

Table 7: **Reduction targets for energy use and energy-related emissions**

	1990	2010	2030	2050
CO_2 emissions (t/cap/yr)	7.3	5.4	2.3	1.7
Reduction required (%)	0	26	68	77
Primary Energy Use (EJ/yr)	71.2	56.5	42	± 35

Primary Energy Use (GJ/yr/cap)	123	98	73	
Reduction (%)	0	20	41	± 50
Fossil Fuel Use (GJ/yr/cap)	100	78	37	25

Source: Spangenberg, 1995

The reception of policymakers to the factor X debate has varied greatly. In the United States the debate has essentially remained restricted to nongovernmental environmental organisations, and has not become part of mainstream thinking in the environmental policy community (Reijnders, 1998). In a number of European countries, especially in Austria, Germany, Denmark, Sweden and the Netherlands, the concept of the factor X has entered environmental policy debates (see also below).

4.2 In policy documents

Although the issue of unsustainable levels of resource use and waste generation is addressed as a major issue in all documents, quantitative reduction targets on the EU level have so far been formulated only for outputs (waste and emissions) of economic activities. However, the principal need to reduce natural resource inputs through de-coupling of economic growth from material extraction is generally highlighted as a crucial factor for achieving environmental sustainability in Europe.

As stated in the Commission's proposal for the EU sustainability strategy, the EU intends to meet its Kyoto commitment (reduce CO_2 emissions by 8% during the period 2008-2012 in comparison with the 1990 level). Thereafter, the EU should aim to reduce atmospheric greenhouse gas emissions by an average of 1% per year over 1990 levels up to 2020, resulting in a 20-40% reduction of greenhouse gas emissions over 1990 by 2020.

The *6th Environmental Action Program* (European Commission, 2001f) lists quantified goals for waste production, which should be reduced by 20% by 2010 compared to 2000.

The European Sustainability Strategy (European Council, 2001) reaffirms the effort to meet the indicative target for the contribution of electricity produced from renewable energy sources to gross electricity consumption by 2010 of 22% at Community level as set out in the Directive on Renewable Energy. In the Green Paper on energy security the European Commission (2000) states that in 2010 12% of total EU energy supply should be provided by renewable energy sources (in comparison to 6% in 2000).

The most comprehensive listing of reduction targets for natural resource use is provided by the background document of the European Commission for establishing a “Thematic strategy for the sustainable use of natural resources” (European Commission, 2002c).

***Table 8*: Objectives and targets for sustainable resource use**

Resources	Policy objectives	Tentative targets
1) Renewable, non-extinguishable resources (sun, wind, air, oceans)	• Promote use • Limit environmental impacts and use of space	X % of electricity production by renewable energy in 2010 Built up of a hydrogen economy in 20 years time
2) Renewable, extinguishable resources (biological resources, including fish, biomass, fresh water)	• Protect quality • Conservation • Sustainable use • Benefits sharing	• Organic agriculture Stabilisation and restoration of forests, marine fish stocks, fresh water
3) Non-renewable, non-extinguishable resources (metals, minerals)	• Limit overall environmental impacts of mining according to life-cycle approach	• X % reduction of energy use in mining and steel making X % reduction in environmental pressures
4) Non-renewable, extinguishable resources (fossil fuels)	• Limit environmental impacts of fossil fuel use	• Reduction of CO2 emissions 40-60 % (till 2030) • NOx, SO2, VOC: 80% • Fine particles: 90%
5) Space (land, seas, air)	• Optimise use of space with regard to maximise environmental protection	• Limit built-up of land (urbanisation) • Promote multifunctional use of space

Source: European Commission, 2002c

Several “National Strategies for Sustainable Development” mention more concrete targets for resource use reductions. The German Strategy (Deutsche Bundesregierung, 2002) states that the crucial basis for reduction of absolute consumption is the increasingly efficient use of energy and other raw materials. By 2020, Germany should aim for an approximate doubling of energy- and raw materials productivity in relation to the beginning of the 1990s. In the long term, the improvements in energy and raw materials productivity should be guided by the "Factor 4" vision (doubling welfare, halving environmental impact), implicating an absolute reduction of resource consumption by 50%. The Danish National Strategy (Danish Government, 2002) also states that the main goal is to increase resource efficiency during the course of one generation. As a long-term target to achieve sustainable development and sustainable production and consumption patters, resource consumption should be limited to about 25% of the current level, which would represent absolute dematerialisation.

4.3 Resource use indicators

In the evaluated policy documents it is generally agreed that appropriate indicators play a crucial role in measuring the present situation and monitoring future trends in terms of progress or set-backs towards the goal of decoupling. The current list of environmental indicators within the EU set of structural indicators consists of the following five thematic areas: climate change, transport, public health, natural resources and energy.

The group of indicators devoted to the issue of "managing natural resources more responsibly" comprises four indicators, which focus on specific environmental problems: waste generation, extinction of fish stocks, water use, and biodiversity. They do not include comprehensive economy-wide indicators.

In several documents on the national level, the indicators of "resource productivity" and "energy productivity" are regarded as the most relevant indicators for measuring resource use (see, for, example, Deutsche Bundesregierung, 2002). These efficiency indicators are suited to reflect trends in resource use in relation to economic growth, thus providing information on relative de-coupling. However, these indicators do not tell anything on absolute levels of resource use, which – from the perspective of environmental sustainability – is the more important category of measurement.

In the literature on material flow accounting and analysis (MFA), a large number of indicators have been proposed to measure absolute levels of resource use (see, for example, Adriaanse et al. 1997, Matthews et al. 2000). These indicators can be grouped into (a) input, (b) output and (c) consumption indicators and have been developed in international co-operations in the course of the last 5-10 years.

In the MOSUS project, material input and material consumption indicators will be of particular importance. Main input indicators include so-called "Direct material input (DMI)", which comprises all materials, which have economic values and are directly used in production and consumption activities. DMI equals the sum of domestic extraction plus direct imports. The model used in MOSUS will also allow calculating so-called "Total material requirement (TMR)" of countries and Europe as a whole. TMR includes - in addition to DMI - the unused domestic extraction of materials (e.g. overburden from mining) and the indirect (used and unused) flows associated to the imports of an economy.

In parallel to the two input indicators, material consumption indicators comprise "Direct material consumption (DMC)" measuring the total quantity of materials used within an economic system, excluding indirect flows and "Total material consumption (TMC)" including, in addition to DMC, also the indirect flows associated to imports and exports. TMC equals TMR minus exports and their indirect flows.

5 Key economic sectors

Almost all policy documents reviewed for this report (see Annex) highlight a number of key economic sectors, which are determining the levels of natural resource use. Main sectors frequently mentioned in the policy documents with significant implications for resource use are: energy, transportation, industry, construction, agriculture, fisheries and forestry.

These sectors are either extracting sectors in the direct sense (such as agriculture, fisheries and forestry) or sectors, which are indirectly responsible for resource extraction (such as energy, industry and transport). Each of the following subchapters focuses on one economic sector and contains a short description of the current situation in Europe and (if available) summarises existing outlooks and scenarios for future developments. The last subchapter summarises the implications of likely developments in the various economic sectors for future primary resource extraction in Europe.

5.1 Energy

5.1.1 Developments in the 1990s

Total energy consumption in Western Europe increased by 8% between 1992 and 1999, to around 1.500 million tons equivalent. In the same time period, consumption fell by 3,5% in Central and Eastern European countries (CEEC) to around 350 million tons equivalent. The major share of energy in Western Europe is provided by oil, followed by natural gas, nuclear energy and coal. In Central and Eastern Europe, coal still is the most important source (but with a clear declining trend), followed by oil and natural gas. The contribution of renewable energy to total energy consumption (electricity production) in 1999 was around 7% (22%) in Western Europe and 8% (19%) in CEEC. Between 1992 and 1999, final energy intensity (measured in tons of oil equivalents per million US $) decreased 6% in Western Europe to around 100 and 20% to around 400 in CEEC (EEA, 2003).

5.1.2 Projections for Europe until 2020

Projections of future developments in the energy sector are generally characterized by a very long planning horizon as energy technologies diffusion time may range from 10-20 years all the way to 100 years. Furthermore, energy policy must often adopt a very long horizon in order for its effectiveness and economic efficiency to be optimized (European Commission, 2001c). An illustration of projections to 2020 as necessary for the scenarios constructed in MOSUS is incomplete and may not represent an accurate factual basis for policy decisions, if these are taken solely on the basis of short-term developments in the years to come. An analysis of the energy sector must implicitly adopt a long-term perspective, bearing in mind that the costs of shifting the economy towards sustainability might have to be borne long before the actual benefits become apparent. Significantly, “[t]he choice of the world’s future energy systems may be wide open now. It will be a lot narrower by 2020, and certain development opportunities that are forgone now might not be achievable later” (UNDP, 2002, p. 365).

“The EU energy system remains dominated by fossil fuels over the next 25 years and their share rises marginally from its level of just under 80% in 1995. Nearly two thirds of overall energy requirements in the EU will be imported by 2020” (European Commission, 2001c, p.13) and this trend is set to continue in the long term. Reasons for increases in imported energy and energy carriers are “the decrease in the protection of indigenous coal, the reduced dependence on nuclear power and the rapid growth in gas consumption” (ibid.,

p. 20). While it is generally assumed that the price of imported gas and oil will rise over time, consumer prices will remain steady or even decrease, mainly due to technological progress and liberalization of energy markets. Europe already has an energy cost disadvantage vis-a-vis other countries, industrialized and developing. Together with the generally less stringent environmental regulations outside Europe, this will lead to a more rapid relocation of energy intensive industries away from the EU with adverse impacts on growth and employment. Within Europe, “gas is by far the fastest growing primary fuel” (ibid., p. 13). Assuming baseline projections, i.e. the EU energy sector policies currently implemented will also be carried out in future, and there are no major technological breakthroughs, novel energy forms, such as hydrogen and methanol, do not make significant inroads, primarily due to cost considerations. As the importance of natural gas grows, the use of traditional coal and oil plants declines very rapidly. These declines in capacity are more than made up from the dramatic increase in gas turbine combine cycle plants and small gas turbines. By 2020, these will make up 45% of total installed capacity. The EU is set to decommission a number of older power generation plants, many of them nuclear, after 2015, and is projected to build 594 GW of new plants over the 1995-2020 period in order to cover its growing needs and replace the decommissioned plants. “A key uncertainty for the period beyond 2020 is the means by which the large number of decommissioned nuclear plants will be replaced. More than 110 GW of nuclear capacity will be retired between 2015 and 2030. Whether this capacity is replaced by nuclear plants or by plants using fossil fuels will make a significant difference to both the emissions and energy outlook of the EU” (ibid., p. 15). Growth in hydroelectricity and other renewable forms of generation is projected to be modest but at more than 50 GW of new capacity, the increase in these capacities will make a significant contribution. The additions mostly concern wind power. Significant growth in electricity generation by clean coal plants and biomass generation is also expected to occur over the next 20 years, in particular towards the end of the projection period at 2020.

In spite of the long-term decline of solid fuel production in Europe, energy supply will increase somewhat due to the increased contribution of gas, oil, and renewable energy sources. Under baseline technology assumptions, the amount of energy supplied by indigenous solid and liquid fuels, natural gas, and nuclear sources is set to fall from a total of just over 700 Mtoe (millions of tons of oil equivalent) in 2000 to 509 Mtoe by 2020, while the share of renewable energy is predicted to rise from 79 Mtoe to 100 Mtoe in the same time period. While hydro will only experience little growth over the projection period, the rise in ‘other’ renewables (e.g. solar and wind energy) will be particularly marked. There is an overall reduction in the primary energy supply in the EU-15 states from 782 Mtoe in 2000 to 609 Mtoe in 2020. In relative terms, only nuclear energy and renewables will gain percentage shares, with the former making up 33% of fuel production by 2020, an increase of 5% over 1995 levels, while the latter will grow from 10% to 16% in the same time span. In 2020, natural gas will constitute 23% of EU fuel production, while liquid and solid fuels make up 16% and 12%, respectively (ibid., p. 45).

“For the 1995-2020 period as a whole, EU energy demand growth averages 0.7% pa” (ibid., p. 45). Baseline projections estimate a significant improvement of the energy intensity ratio, which is expected to average around 1.5% pa throughout the projection period. This decoupling is attributed to the growth of the services sector at the expense of the more material-intensive primary sector and to technological innovation. Energy demand is projected to grow from a total of 1454 Mtoe in 2000 to 1612 Mtoe in 2020, the bulk of which, 663 Mtoe, will remain liquid fuels. All forms of energy, except for nuclear, will register increases in demand, with renewables experiencing an annual growth rate of 1.3% from 1995 to 2020. Primary energy demand per capita will rise from 3.7 toe to 4.2 toe during this time period. Demand for natural gas will rise by a yearly 1.8% between 1995 and 2020. The rise in demand for oil and gas, coupled with the decline in EU domestic production, will lead to a considerable increase in import dependency. By 2020, 90% of the oil and more than two-thirds of the gas consumed in Europe will be imported. The demand for coal also drops less sharply than the decrease of local production, due in part to the reduction in government subsidies, implying that higher imports of solid fuels will be necessary.

It is generally agreed that there will be a relative abundance of primary energy resources until 2020. "[N]o supply constraints are likely to be felt, at least in the period to 2020. For these assumptions on primary energy prices, it is necessary to adopt an optimistic view on future discoveries of new oil and gas fields and on further advances in extraction technologies." (ibid., p. 26) The future price of oil, a vital energy source for Europe but one it is not able to influence easily, is difficult to estimate, but a slight rise is expected to 2020. This implies a moderate increase in gas prices, too. Need for more gas infrastructure as demand rises will increase transportation and therefore final costs after 2010. Coal prices are expected to remain stable throughout the projection period. Very large increases in global oil and gas production are expected until 2020 to match increases in demand. Western Europe's demand for gas will have nearly doubled between now and 2020. "[G]iven the consensus view of relatively low energy prices throughout the projection period as well as the concerns on nuclear power, fossil fuel energy is likely to maintain its competitiveness. New renewable forms of energy are likely to be badly affected by a period of sustained low energy prices" (ibid., p. 28).

For the accession countries in Eastern and Central Europe (i.e. the Czech Republic, Hungary, Poland, Slovenia. Estonia, Latvia and Lithuania), "primary energy consumption is expected to grow by 1.1% pa in the 1995-2010 period and by slightly more (1.4%) between 2010 and 2020. The implied energy intensity improvement is expected to reach an annual rate of more than 2.9% pa in 1995-2020 [...]. This is due to the economic recovery after 1993, the industrial restructuring, the opening up to competition and the 'rationalisation' of the energy system initialised by the advent of economic reforms, as well as the accelerated substitution of solid fuels with natural gas" (ibid., p. 30). In 2020, the final energy consumption of CEE countries is estimated to be: Residential and tertiary sector almost 50%, industry 30%, and transport 22%, compared to the EU 15's 41%, 26% and 32%. Electricity use in the CEE countries is projected to rise by 3% yearly until 2020. District heat and nuclear power will generally remain stable. Renewable energy forms are expected to gain some market share but remain below 5% of total electricity generation in 2020.

5.1.3 EU energy policy strategies

The EU Commission's Green Paper on energy security (European Commission, 2000, p. 3) states that "the European Union's long-term strategy for energy supply security must be geared to ensuring, for the well-being of its citizens and the proper functioning of the economy, the uninterrupted physical availability of energy products on the market, at a price which is affordable for all consumers (private and industrial), while respecting environmental concerns and looking towards sustainable development, as enshrined in Articles 2 and 6 of the Treaty on European Union."

The energy options that the European Union holds in the next 20 years are conditioned by the world context, by the enlargement to perhaps 30 Member States with different energy structures, but above all by the new reference framework for the energy market, namely the liberalisation of the energy sectors and growing environmental concerns, in particular with regard to the issue of global warming and climate change.

A long-term energy strategy for the European Union must take into consideration the following major points:

- Energy policy should rebalance supply side policies in favour of demand side policies.
- In order to trigger a real change in consumption behaviour and to reduce environmental pressures posed by the energy sector, energy taxes and other parafiscal levies are advocated, with the clear goal of a reduction of energy consumption.
- Profitable energies, such as oil, gas and nuclear energy could finance the development of new and renewable energy sources, which should increase their share within the next decades to 12% of total energy supply and 22% of total electricity production. Financial measures, such as taxes and subsidies must be implemented to achieve these ambitious goals.

5.2 Industry and manufacturing

5.2.1 Trends in the 1990s

Industry remains a dominant sector in the European economy, generating around 30% of GDP in Western Europe and 35% in Central and Eastern European Countries (CEEC) at the end of the 1990s. Since 1993, total industrial value added has been growing by 10% in Western Europe and by 30% in CEEC (EEA, 2003).

Industrial energy use (including mining and electricity production) increased in Western European countries at around 1% per year, while in CEEC a small increase in energy use was observed between 1993 and 1996, with a steep declining trend afterwards. In Europe as a whole, energy efficiency improved over the 1990s, in particular in CEEC (30%). However, industry in CEEC still is about three times more energy intensive than industry in Western Europe. Most of the environment-related industrial indicators (emissions, water and energy use) showed a positive development in the last years, resulting in a general relative de-coupling between these environmental categories and industrial output (EEA, 2003).

5.2.2 Policy aspects

The crucial future challenge for environmental policy measures in industrial sectors is to improve the cost-effectiveness of environmental regulation in a way that guarantees increased environmental quality, while maintaining Europe's competitiveness on the world markets. As the EEA (2003) states, most relatively inexpensive measures have already been taken in Western Europe and this many firms face a steep increase in marginal costs for further pollution abatement measures. However, such high costs may provide opportunities for eco-efficient production technologies to gain in competitiveness.

An important obstacle to the implementation of tighter environmental standards is the fear to loose ground in international competitiveness, in particular in polluting industrial sectors and many environmental plans include special arrangements for pollution-intensive sectors. The exceptions undermine the application of the polluter-pays principle and lead to a sub-optimal pollution control, as abatement measures are not directed towards the sectors, where they could have the most significant impacts.

Voluntary instruments, such as environmental management systems and environmental reporting (see also section on instruments below) play an important role in industrial environmental policy.

For the EU accession countries, the full implementation of EU law (in particular the environmental regulations) will be very costly, in particular for manufacturing and energy production industries.

5.2.3 Projections for Europe

In a recent scenario study carried out by the Institute for Prospective Technological Studies (IPTS, 2003), several scenario on the future of manufacturing in Europe were formulated and evaluated with regard to their possible impact on sustainability. The study shows that future manufacturing industry in Europe will be shaped by a variety of factors, including globalisation, new technologies, market demand, fiscal measures and regulations as well as overall societal change. The study emphasises that many of these driving forces are possibly being shaped by European policy efforts, thus providing the possibility to reconcile manufacturing trends with goals stated in the European Strategy for Sustainable Development (European Council, 2001).

Conclusions of the IPTS study hold that transformation of the manufacturing sectors towards sustainable development is less a question of technological opportunities alone than a question of the implementation of adequate policy strategies and future market developments. The realisation of sustainable manufacturing will only be possible, if lead markets of sustainable product and services will be created. Without new market and policy incentives, manufactures will likely continue concentrating on short-term economic performance improvements, rather than pursuing long-term oriented sustainability objectives. European policies could foster the creation of new markets for sustainable products and services through stimulating demand, fiscal incentives, environmental regulation and by reducing market uncertainties.

Concerning the future developments concerning resource efficiency and new materials, the study states (IPTS, 2003, p. 40): "Whilst raising resource efficiency is clearly in the interest of the manufacturing industry and progress is likely to materialise in all scenarios, the transition towards renewable materials and energy resources will be far more challenging. Improvements in industrial resource efficiency are even likely if energy and resource prices remain on low levels over the next fifteen to twenty years. Plenty of efficiency improvement measures do not require new energy or material sources: modelling and simulation, micro-production technology and improved process technology will help industry to reap the benefits of new technology. In contrast, raising the use of renewables is likely to depend on high energy prices. The transition towards renewables will also require strong public commitment, especially to finance infrastructure, and is likely to continue far beyond the 2020 time horizon. In the medium term, bio-resources are more likely to substitute non-renewables in existing production chains rather than building the starting point for radically new manufacturing processes. Increasing the use of bio-resources significantly will require significant research resources, supportive regulatory frameworks, and investments in infrastructure."

5.3 Transport

5.3.1 Trends in the 1990s

In Western Europe, both passenger and freight transport have more than doubled since the 1970s. In both the EU-15 and CEE countries, energy demand in the transportation sector was the fastest growing segment of final energy demand in the 1990s, primarily due to increase in road and air transport (European Commission, 2001c). Total European Union freight transport increased by 33% over 1991-1999 and passenger transport by 19% in the same time period. "Important factors behind the increase in passenger transport b road over the past 20 years in the EU are years in the EU are growing car ownership (increasing affordability), transport prices (in a number of countries private car use has become relatively cheaper than rail and bus use), infrastructure investments that prioritise roads (better flexibility), and the worsening quality of public transport and rail. Urban sprawl has enhanced this trend (EEA, 2003, p. 72).

In central and eastern Europe (CEE), there was a sharp decline in transport volumes after 1989 following economic recession. Freight transport is currently back at the level of the mid-1970s and still well below that in the 1980s. In CEE freight volumes have been on the rise again since the mid-1990s, following economic recovery. Passenger transport in CEE countries are currently back at 1990 levels and rising rapidly.

Road has been increasingly dominant as the main transport mode in Western Europe in the last decades. The stabilisation of its share in passenger transport in the EU in the 1990s at around 80% is mainly due to strong growth in air transport. For freight transport, road is also dominant with a 74% share. The share of road in inland freight transport is still growing (from 68% in 1991), while that of the alternative modes (rail, inland waterways) continues to decline. While rail and public transport dominated the transport system in the CEE countries in the early 1990s, road is gaining rapidly at the expense of rail. The market share of rail in CEE is however still much higher than in Western Europe (EEA, 2003).

5.3.2 Projections for Europe

Transportation accounts for almost a third of EU final energy consumption, a trend which will continue until 2020 and beyond (European Commission, 2001c). When compared to industry, and the residential and tertiary sectors, it is also the fastest growing sector in absolute terms. This increase in consumption is due to three developments: the increased number of passenger kilometres, a tendency to use bigger cars, and a shift to car and air travelling (EEA, 1999). By 2020, final energy demand in the transportation sector is projected to reach a total of 360 Mtoe, up from 276 Mtoe in 1995. The percentage share of transportation in the overall final energy demand will remain around 32%. Transportation is almost exclusively fuelled by oil: “Not only does transportation need a great deal of oil, it needs very little energy except oil. Fuels derived from petroleum (crude oil) now account for more than 96% of all the energy used in transportation” (WBCSD, 2001, p. 2-14).

Passenger transportation is projected to increase at a rate of 1.4% pa (European Commission, 2001c). Most of this will be through the use of private car on roads. “Road transport accounts for more than 89% of total passenger travel and its share is expected to fall by a very small account. Both public road transportation as well as rail are in a long term decline [...]” (ibid., p. 54). The average European will travel 17,545 km yearly by 2020, a considerable rise from the 1995 average of 12,287 km. The energy intensity of travel, however, will not rise nearly as much, as “energy demand in road transports is projected to grow by only 0.7% pa, which is significantly below the corresponding travel activity” (ibid., p. 54). Furthermore, these projections do not reflect further improvements brought about by the 1998 emissions reduction agreement between the European Commission and auto manufacturers, so energy intensity might actually be even lower.

Periods of growth in freight transportation are usually a reflection of GDP growth, but current projections show a possible reversal of this long-established trend. Energy demand for goods transportation in 2020 will be 241 Mtoe per GDP tkm/000 (thousand ton-kilometers), down from 280 Mtoe in 1995, an average drop of 0.6% pa. “The main reason for this is the rapid growth in the service sector and the high value added manufacturing activity in the EU economy. These sectors are less freight intensive than the more traditional basic manufacturing and extraction activities” (European Commission, 2001c, p. 55). It is expected that road freight will remain the most important means of transport throughout the time period under investigation, to the detriment of rail and inland shipping, which “in spite of policy programmes to support these modes (e.g. the Trans-European Network policy), [...] continue to [lose] ground to road transport” (EEA, 1999, p.24).

5.3.3 Transport policy in the (enlarged) EU

The EU White Paper on European transport policy in 2010 (European Commission, 2001b) states that the European transport systems and the common transport policy urgently need to be reformed in order to meet objectives of sustainable development in both economic, social and environmental terms. The White Paper states that current socio-economic transformations towards a so-called information society have not slowed down the demand to travel, but rather the contrary. Unless major actions are taken, freight transport alone will increase by 50% until 2010 over its 1998 level in the enlarged EU. The same growth is expected for CO_2 emissions from transport activities. Major drivers of growth in transport are economic growth in general and the enlargement of the EU in particular, which will lead to an explosion of traffic in particular in the frontier regions.

The major policy objectives to be addressed in the next years are

(1) decoupling transport growth significantly from growth in Gross Domestic Product in order to reduce congestion and other negative side-effects of transport and

(2) bringing about a shift in transport use from road to rail, water and public passenger transport so that the share of road transport in 2010 is no greater than in 1998.

The White Paper favours an integrative reform strategy, which links a large number of policy instruments and measures. These include:

- Introducing a framework for transport charges to ensure that by 2005, prices for different modes of transport, including air, reflect their costs to society.
- Implementing a framework ensuring through the use of intelligent transport systems the interoperability of payment systems for road transport; promote further technological progress enabling the introduction of road pricing.
- Harmonisation of fuel taxation for commercial users, in particular in road transport.
- Give priority to infrastructure investment for public transport and for railways, inland waterways, short sea shipping and intermodal operations.
- Improve transport systems by addressing missing transport links, developing open markets and co-operation at EU level (e.g. railway liberalisation, air traffic systems).
- Fostering intermodality through technical harmonisation and interoperability, in particular for transport chains with containers.
- Building the trans-European network, with focus on removing bottle-necks in the railway network and in the road network in frontier regions to accession countries.
- Promote teleworking by accelerating investments in next generation communications infrastructure and services.

Transport-related policy documents in the accession countries in general provide similar policy suggestion to cope with future problems in the transport sector. For example, the Second National Environment Plan for Poland (see Annex for details) recommends for the transportation sector the following approaches:

- influencing reduction of demand for transportation (by means of spatial management, behavioural patterns reducing the transportation needs within the national economy),
- wide-spread introduction of „cleaner" fuels (including bio-fuels) and „cleaner" vehicles (less air polluting and less-noisy ones), as well as non-engine vehicles (e.g. bicycles in individual, personal transport),
- improvement in operational and economic parameters of vehicles;
- rationalisation of haulage,
- introduction of railway transit to limit automotive transit transport,
- development of public transport in cities
- construction of ring roads around cities; introduction of pro-environmental tariff system.

5.4 Construction

Future developments in the construction sector will have wide-ranging implications for primary extraction of construction materials. As the Danish National Strategy for Sustainable Development (Danish Government, 2002) states, resource consumption in the **construction sector** is vital to society's total resource consumption. Construction and operation of buildings are reported to account for half of Denmark's energy consumption, while consumption of construction materials constitutes the major part of raw materials consumption. In addition, construction generates large amounts of waste.

The EU Commission currently develops an *Urban Thematic Strategy*, in which sustainable construction methods and techniques are one of the key issues (European Commission, 2003c). One of the central objectives of the strategy is to integrate sustainability principles into the practice of design, construction, maintenance and management of buildings. The use of more sustainable construction materials could have a considerable positive impact on the environment. Sustainable construction could also have direct cost reduction implications for the end user as well as positive consequences for the health of the inhabitants. However, more sustainable construction has an extra value, which markets currently in general are not willing to pay for. Thus, policy intervention is needed in order to redirect the construction sector towards increasing resource and energy productivity. This interim report states that both top-down policy measures as well as bottom-up market initiatives are to be considered.

Suggested policy instruments include:

- Standards for sustainable construction to be fulfilled by all publicly funded construction projects
- Funds and subsidies to support new resource-extensive solutions and the development of new eco-efficient and renewable building materials
- Public procurement should set an example in terms of more sustainable construction
- Taxes and other regulatory mechanisms at the EU, national and regional levels should help motivate actors in the construction industry to achieve these goals
- Urban planning instruments should make sustainability standards a condition for construction permits.

Market-oriented measures include:

- Campaigning for relevant environmental information on energy consumption in buildings, toxic emissions of materials' and ventilation systems' impact on indoor air quality and on waste separation and disposal.
- Campaigning for recycling systems and decentralised energy production and waste collection.

With the implementation of the Urban Thematic Strategy it is expected that EU construction policies will make notable process towards the integration of sustainability principles in construction activities.

5.5 Agriculture, fisheries and food industry

In its most recent report the European Environment Agency (EEA, 2003) states that European agriculture is extremely diverse, ranging from large, highly intensive and specialised commercial farms to subsistence farming using mainly traditional practices.

Consequently impacts on the environment vary in scale and intensity and may be positive or negative. The most important policy objective throughout Europe since WW II was to increase food production and agricultural output grew significantly in the last decades. Supported by public investment, this resulted in mechanisation combined with the abandonment of traditional practices, reliance on non-renewable inputs such as inorganic fertilisers and pesticides, the cultivation of marginal land and improvements in production efficiency.

The common agricultural policy (CAP) has been one of the important drivers of farm intensification and specialisation in the EU. Market pressures and technological development have also contributed to these trends. Intensive farming has had significant impacts on the environment. Public concerns related to production methods and some reorientation of the common agricultural policy have created new opportunities, for example through labelling and agri-environment schemes, for farmers to reduce pressures on the environment.

The report also states that the Central and Eastern European (CEE) countries with its still low input and extensive agriculture have the opportunity for a long-term transformation towards sustainable agricultural development, if EU measures do not force farmers to make intensification and increase in output their priority objective.

5.5.1 CAP reform and its implications on production

In June 2003, the Council of Agriculture Ministers of the European Union (EU) reached agreement on a fundamental reform of the common agricultural policy (CAP). In line with the overall objectives of Agenda 2000, this reform will be introduced from 2004 and 2005, completing that reform process in some areas and establishing a more stable policy framework for European agriculture.

The promotion of more market-oriented and sustainable agriculture constitutes one of the objectives of the CAP reform, as stated in the midterm review (MTR) of the CAP (European Commission, 2003a). It is achieved through the introduction of the concept of decoupling which, with the granting of a single income payment per farm replacing all existing (or newly introduced) direct payments -with the exception of some premia in some specific sectors- can be expected to have a significant impact on producers' behaviour, as the latter would increasingly base their production decisions on market signals (i.e. profitability expectations). At the same time, these new decoupled payments are linked to the respect of statutory environmental, food safety, animal health and welfare and occupational safety standards (cross-compliance). These decoupled payments may be expected to generate significant adjustments in the production structure of the agricultural sector, although factors such as social and economic inertia, the maintenance of some crops for agronomic purposes, the participation in various schemes (e.g. agri-environmental programmes), and the eligibility to Less Favoured Area payments, may mitigate the pace and magnitude of these adjustments. Changes could take place in the production mix, in the production intensity and in farm structure, and could lead to abandonment of agricultural activities.

The main quantitative results from the different impact analyses on the medium-term developments of agricultural markets and income for EU-15 can be summarised as follows (European Commission, 2003a):

- A **reduction in total cereal production** as cereal area would be constrained by the land allocated to energy crops, the rise in voluntary set-aside and the changes in the support level in this sector. Rye and durum wheat would be the cereals most affected. Part of the negative impact on total cereal supply of the reduction in cereal area would be compensated by higher projected growth in cereal yields. Total cereal consumption would in turn exhibit slower growth in the face of lower availability, sustained prices and a projected reduction in feed demand from the animal sector (linked to the expected fall in beef production which would only be partially compensated by the slight increase in white meat production). These developments would also affect the level of net EU cereal exports, which would display a significant fall. Total cereal stocks would drop significantly, with public stocks of cereals becoming non-existent.
- As far as **land allocation** is concerned, food oilseed area is generally projected to fall, whereas energy crops would develop on around 0.7-0.9 mio ha previously mainly allocated to cereals. Silage area would be reduced against Agenda 2000 levels in the face of the decline in beef production, greater incentives to shift towards more extensive animal production methods and competition from other fodder crops area. Finally, voluntary set-aside (abandonment of production) would rise by 0.4 to 0.7 mio ha as some land is foreseen to be taken out of production owing to low profitability.
- The implementation of the decoupling scheme would have a significant impact on the animal sector, notably in the **beef and sheep sector** as it would favour the **extensification of production systems**. Combined with a small increase in feed prices, it would entail a decline in beef production, estimated at between 3 % and 8 % by 2009. Sheep output would also fall by between 3 % and 6 % over the medium-term. Lower beef and sheep supply would trigger a rise in EU producer prices of some 6-8 % and 8-12 % respectively by 2009 and would result in a fall in domestic consumption of some 1-3 % and 3 % respectively. Net EU beef exports would show a significant decline.
- Over the medium term, the increase in prices and the fall in consumption expected in the beef and sheep sectors would **favour pig and poultry consumption**. This demand side effect would outweigh the negative impact of higher feed cereal prices on the competitiveness of the latter two sectors, which would display a small expansion in production and consumption.
- The MTR proposals would display a rather **favourable, though limited impact on the income of the agricultural sector** as compared to the baseline: all the impact studies show that the reduction in the level of agricultural production and the implementation of dynamic modulation would be broadly compensated by the resulting price rises (and the increase in the level of aids in the arable crops and rice sectors). Given that most of the savings from modulation (more than 3 bio EUR by 2009) can be assumed to return to the agricultural sector through the second pillar measures, the overall income of the agricultural sector should rise. However, diverging trends across the various commodity sectors and regions may be expected, with most favourable developments projected in the animal sector (notably the beef and pork sectors, which should display strong price increases).

The MTR proposals are also expected to generate a significant and sustainable **improvement in the medium-term perspectives of the agricultural sector of the EU-25**. Decoupling in the EU-25 would produce similar trends to those in the EU-15, as producers' decisions would be driven by market considerations rather than by the maximisation of direct payments. The balance of the rye and beef markets in the EU 25 would significantly improve. The MTR proposals would enable the significant rise in agricultural income projected in the new Member States after enlargement to be secured.

5.5.2 Detailed projections for agricultural production

Arable crop sector

The new policy environment with lower cereal price support, the development of energy crops and the granting of greater flexibility in producers' decisions is projected to lead to the following developments:

- A reduction in the total area grown with cereals: the decline would range from 2 % to 9 %. It appears that the rye and durum wheat sectors would exhibit the strongest falls in line with the overall reduction in the level of support in these two sectors;
- For oilseeds, results are mixed. Four of the six studies show a fall in oilseeds area of between 3 % and 9 %, but two analyses foresee a slight increase in oilseed area;
- Energy crops would develop on an area estimated to range between 0.7 and 0.9 mio ha previously allocated to arable crops (to a large extent cereals);
- Silage area is expected to decline by some 5 to 7 % in line with the projected decline in beef production, greater incentives to shift towards more extensive animal production methods and competition from other fodder crops area;
- Voluntary set-aside (i.e. abandonment of land) would increase in all studies. However, this rise in voluntary set-aside would remain limited to approximately 0.4 mio to 0.7 mio ha.

The development of energy crops and the rise in voluntary set-aside would result in a fall in total cereal production which would range in most studies at between 1% and 4 % by 2009/10 (i.e. between 1 and 9 mio t) as yields would increase on account of the decrease in low-yielding, marginal land and higher price perspectives, and would thus partially compensate the decline in area harvested.

Rye and durum wheat are found to display the strongest fall in production levels. However, even if all studies agree on the direction of change, they exhibit wide differences regarding the magnitude of the MTR impact on these sectors. Less pronounced developments projected for high-yielding cereals, such as soft wheat and maize, would somewhat mitigate the overall decline in cereal production.

In spite of a modest recovery on world commodity markets, lower availability and sustained domestic prices would affect the level of EU exports, which would display a significant decline over the medium term. EU cereal imports would also slightly increase owing to the reduction in the EU's border protection linked to the cut in support price.

Meat

The implementation of the decoupling scheme is foreseen to have a significant impact on parts of the livestock sector. Combined with a small increase in feed prices, decoupling would lead to a decline in beef and sheep production, as it would favour the extensification of production systems. After a short-run increase resulting from the herd size reduction effect, beef output would decline progressively to stand some 3 % to 8 % below baseline levels by 2009.

The suckler cow sector would appear to be the most affected (with a projected fall in herd size of more than 10 %) as it would display the highest rate of output not covering variable costs in the beef sector (with the premium playing a major role in determining producer's behaviour). Similar trends are foreseen for the sheep sector, where output would drop by between 3 % and 6 %.

Over the medium term, the increase in beef prices and the fall in beef consumption would favour pig and poultry consumption. This demand side effect would outweigh the negative impact of higher feed cereal prices on the competitiveness of the two sectors, which would display a small expansion in production and consumption.

The MTR proposals are projected to display only a marginal impact on the dairy sector over the medium term, with a very small impact feeding through from developments on the sheep and goat sector and cereal feed prices. Dairy cow numbers would remain essentially unchanged, as the quota would continue to drive milk production and the size of the dairy cow herd in the EU.

5.5.3 Projected impacts of the CAP reform on EU-25

From a sector perspective, the CAP is foreseen to improve the situation of agriculture in the new Member States as compared to a situation without membership and under the continuation of domestic policies. The CAP in combination with the Single Market should provide stable and, on average, higher prices than the domestic policies of these countries could sustain and secure in terms of WTO and government spending.

The new Member States would add about 38 mio. ha of utilised agricultural area to the 130 mio. ha of the current Member States. However, the resulting increase in the agricultural production of the EU-25 would remain relatively moderate due to the lower intensity of production in the new Member States. The EU-25 would produce in 2009 about 28 % more cereals with 45 % more cereal area, 24 % more oilseeds with 32 % more oilseed area (excluding non-food production), 10 % more beef, 17 % more pork, and 27 % more poultry than the EU-15. At the same time, domestic use of cereals would increase by 27 %, of oilseeds by 6 %, of beef by 9 %, of pork by 23 %, and of poultry by 12%.

The implementation of the Agenda 2000 policy in the new Member States would lead to an increase in cereal production from 57.6 mio t in 2002 to 64.1 mio t in 2009, demonstrating the rather moderate impact of the CAP on cereal production in the new Member States. Total EU-25 production would stand at some 293 mio t. Accession and the effects of the Single Market would entail a redirection of trade according to the relative competitiveness of the Member States. One of the prime shifts in trade concerns cereals, pork, and poultry. Latest data would suggest that the new Member States have improved their competitiveness in poultry production thanks mainly to foreign direct investments into production and processing. Upon enlargement an increasing part of poultry production – up to 0.9 mio t – would be directed to the current Member States as it would benefit from a comparative advantage. By contrast, a large part of pork production in the new Member States would have a comparative disadvantage with respect to quality, i.e. lean meat content, and feed costs. Here the projections suggest that the current Member States would trade between 0.7 mio t and 0.9 mio t of pork to the new Member States.

Generally, only a few sectors – such as the rye and beef sectors – would continue to display structural imbalance after the implementation of Agenda 2000 in the new Member States. The annual marketable surplus in rye would increase from 2.6 mio t in the EU-15 to 3.6 mio t for the EU-25, making intervention storage an even more important marketing instrument. Beef prices would also remain under pressure, with these being around 100 EUR/t lower in the EU-25 than in the EU-15.

5.5.4 Organic farming

The 6th Environmental Action Programme as well as the European Strategy for Sustainable Development both emphasise the importance of organic farming and its positive contribution to the integration of sustainability principles in the agricultural sector. Although organic farming represented only 3% of total EU agricultural area, it was characterised by considerable growth rates in many in the last few years and has developed into one of the most dynamic agricultural sectors in the EU. The organic farm sector grew by about 25% a year between 1993 and 1998 and since 1998 it is estimated to have grown around 30% a year. In some member states, however, it recently seemed to have reached a plateau.

The recently published document preparing the implementation of an action plan for organic food and farming (European Commission, 2002a) holds that in some member states, such as Sweden and Germany, goals for organic farming have been set at 20% of total agricultural land. Policy instruments, which could support the expansion of organic farming activities and the development of broader organic markets in the future include:

- Ensuring that the CAP supports the development of organic farming
- Promotion and information campaigns
- Targeting organic farming to environmentally sensible areas
- Encouraging the exchange of technical information between farmers
- Ensuring traceability and organic food authenticity
- Harmonisation of control procedures and accreditation
- Funding of research in organic farming

5.5.5 Fisheries and aquaculture industry

Due to persistent chronic overexploitation of fish stocks in the last decades, many fish species are today outside safe biological limits, and some are in critical state. The situation is particularly serious for fish stocks such as cod, hake and whiting. If current trends continue, many stocks will soon collapse (EEA, 2003). The situation is better for pelagic stocks (such as herring, mackerel, and sardine) and species which support industrial fisheries (Norway pout, sandeels), which have generally not deteriorated over the last twenty years.

Government subsidies were one main driving force for the continued expansion of fish fleets all over Europe, resulting in a significant overinvestment and overcapacities. Another factor results from the fact that annual catch limits were often set in excess of those proposed by the Commission on the basis of scientific advice, and from fleet management plans short of those required (European Commission, 2001e).

While open-sea fish catch generally is declining, aquaculture production has increased dramatically, in particular marine aquaculture in Western Europe. This development played a significant role in the improvement of the socio-economic situation of coastal communities.

The new Common Fishery Policy (CFP) of the EU entered into force in January 2003, aiming at greater integration of environmental concerns and application of the “precautionary principle” to fisheries and aquaculture management (European Commission, 2002b). The new policy aims at promoting the sustainable management of fish stocks in the EU and internationally, while securing the long-term viability of the EU fishing industry and protecting marine ecosystems.

Specific policy action include, among others (see European Commission, 2001e):

- **Strengthening and improving conservation policies** through implementation of multi-annual and ecosystem-oriented management, adoption of stronger technical measures to protect juveniles and to reduce discards including pilot projects for measures not applied until now such as discard bans and development of a system to track progress of the CFP towards sustainable development and the performance of the management schemes and policies against stated objectives.
- **Promoting the environmental dimension of the CFP** through full implementation of the relevant environmental instruments, Action Plans and Strategies for the protection of the Biodiversity and the integration of environmental protection requirements into the CFP and the launch of a debate on the eco-labelling of fisheries products.
- **Reform of the fleet policy** in line with multi-annual objectives, taking into account technological progress and ensuring that public aid does not contribute to an increase in fishing effort. The new system should ensure transparency and simplicity with tighter control and enforcement by Member States and stronger sanctions for non-compliance.

5.6 Forestry

As the European Environment Agency in its recent report (EEA, 2003) observes, forest cover around 38% of Europe’s land area with an increasing trend. Forests constitute an important natural resource for Europe, providing renewable fibre and timber resources, and other non-wood goods and services, such as a major reserve for Europe’s biodiversity and an important carbon sink along with socio-economic services such as recreation.

Forest management in many parts of Europe during the past two centuries has often favoured single-species plantations. Currently, there is a general trend, especially in western and central Europe, to increase the share of mixed forests by converting monocultural stands. Natural regeneration is becoming a more common forest management practice and often increases the amount of mixed forests. However, only about 17 % of the forests are considered mixed for all Europe (13 % for the EU) (EEA, 2003).

The EU is the biggest trader and second biggest consumer of forest products in the world. However, within this context, the EU is a net importer of raw materials, mainly roundwood, mostly from Eastern Europe and former Soviet-Union states, and woodpulps from N. and S. America and other regions having high growth rates and low costs in timber growing. Within certain sectors where there is a particularly high level of domestic supply and for some, the EU is a prominent exporter, especially for the more highly value-added products.

In 1998, the European Commission developed a "Forestry Strategy for the European Union" (European Commission, 1998a). The overall objective of the EU forestry strategy is to strengthen sustainable forest development and management as stated in the "Forest Principles" adopted by the United Nations Conference on Environment and Development (Rio 1992) and as defined in the resolution adopted at the pan-European Ministerial Conferences on Protection of Forests.

5.7 Implications of sectoral developments for primary material extraction

5.7.1 Fossil fuels

According to existing baseline scenarios for the energy sector, the EU energy system will remain dominated by fossil fuels over the next 25 years and their share will rise marginally from its level of just under 80% in 1995. The transport sector is the sector with the fastest growing demand for energy, and this trend will continue until 2020. Both passenger and freight transport are forecasted to increase in existing baseline scenarios, which will have direct implications for demand for fossil fuels, in particular for oil, as the transport sector will remain almost exclusively dependent on this combustible.

However, domestic extraction of fossil energy carriers has been decreasing significantly since 1985 (see also the baseline scenario in this report) and this trend is assumed to continue. It is expected that by 2020, 90% of the oil and more than two-thirds of the gas consumed in Europe will be imported. So even if the use of fossil fuels is not significantly decreasing until 2020, domestic extraction will continue to fall, as increased demand will be mostly satisfied through higher imports.

5.7.2 Industrial minerals and ores

In the manufacturing sectors, the past trends of increasing material and energy efficiency will continue in the future. However, a radical change towards the broad realisation of markets for sustainable products and services will be less a question of technological opportunities alone than a question of the implementation of adequate policy strategies and future market developments.

New technologies, like micro production, new process technologies and innovative high-tech materials, could significantly reduce the amount of primary resources needed for industrial production in the future. However, the transition towards renewable materials and energy resources, which is likely to continue far beyond 2020, will be far more challenging and require strong public commitment, especially to finance new infrastructure, fund research and restructure regulatory frameworks.

5.7.3 Agricultural products

The promotion of more market-oriented and sustainable agriculture constitutes one of the main objectives of the reform of the Common Agricultural Policy (CAP). In particular the implementation of the concept of decoupling could have strong implications for total production levels, as in the future a single income payment per farm will be granted, replacing all former payments, which were in most cases related to production volumes. Changes could take place in the production mix, in the production intensity and in farm structure, and could lead to abandonment of agricultural activities.

The new policy environment will result in lower support for cereal prices, faster development of energy crops and the granting of greater flexibility in producers' decisions. This is expected to result in a significant reduction of total area grown with cereals and respective production volumes. Rye and durum wheat are expected to display the strongest fall in production levels. However, increase in production of soft wheat and maize, could to some extent mitigate the overall decline in cereal production. Part of former cereal production land will likely be used for planting energy crops, which production is assumed to increase in the future. Voluntary set-aside (abandonment of land) is expected, which would further decrease overall production of agricultural products.

5.7.4 Fisheries

The new Common Fishery Policy (CFP) of the EU, which entered into force in January 2003, formulates as its central goals the greater integration of environmental concerns and application of the "precautionary principle" to fisheries and aquaculture management, aiming at promoting the sustainable management of fish stocks in the EU and internationally.

As many marine fish stocks today are threatened by overexploitation, the implementation of the new CFP is expected to decrease open sea marine extraction of fishery resources. In contrast, production from aquaculture, in particular marine aquaculture is likely to increase in the next decades, following trends since the mid-1980s.

6 Policy strategies and instruments

6.1 General strategies

Resource efficiency, dematerialisation and waste prevention are the main means advanced to reach the general goal of de-coupling economic growth from the use of renewable and non-renewable natural resources and the production of waste and emissions. In order to achieve this goal, resource saving and resource re-use are stressed as important elements, as well as resource substitution (e.g. using wind and solar instead of fossil fuels).

Some of the screened policy documents explain that incremental technological progress is not sufficient to achieve the decoupling objective. Instead, leapfrogging technologies, system innovations, including institutional changes, are required.

The relative low price of resources, in particular of (fossil) energy, is identified as being a strong driver for resource use. Therefore, the prices of resources may need to be changed to better reflect the environmental impact of their extraction, use and disposal/recovery.

A strategic approach for dematerialisation and decoupling includes improving the implementation of existing legislation, encouraging the market to work for the environment, setting incentives for companies and fostering the distribution of information.

Integration of resource use concerns and goals into other policy areas could be one of the most efficient strategies. This approach has already been implemented within the so-called Cardiff environmental integration process, which was introduced to discriminate positively environmental policies in relation to the far more developed economic and social ones in order to facilitate and speed up the sustainability process (European Commission, 1998b). The Cardiff process needs to be revived and carried forward in order to complete the process started with the prominent placement of the integration principle as Art 6 in the EU treaty and to use its full potential for agreed dematerialisation goals.

Integrated Product Policy (IPP) is regarded as another key approach to reduce the environmental impacts of products along their life cycle, from the raw materials extraction to the waste management stage. Promotion of environmental quality of goods and services is understood as using market forces to the largest possible extent, and thus the instruments probably most effective are those that help to "get the prices right", in particular through the correction of market failures ("external costs") according to the polluter pays principle (European Commission, 2001d).

A large number of possible instruments, which would contribute to the objective of dematerialisation is listed in the screened documents. Policy instruments that are frequently listed in the documents comprise:

- Stimulating research and technology development for resource efficiency in products and processes;
- Improvement in planning processes with regard to environmental impact assessment,
- Implementation of best practice programs;
- Promotion of use of alternative raw materials and alternative and renewable energy sources;
- Shift of tax burden from labour to the use of natural resources (for example, through the implementation of an environmental fiscal reform including energy taxes and taxation of extensive agriculture);
- Other economic instruments such as tradable permits or material input certificates to favour resource efficiency;
- Removal of subsidies that encourage overuse of resources, in particular in the agricultural, fisheries, transport and energy sectors;

- Pledge systems (pledges for recycling packages, car tires, car bodies, accumulators, batteries, motor oil, etc.);
- Integration of resource efficiency goals into other programs like IPP, eco-labelling, green procurement, and environmental reporting;
- Fostering of voluntary environmental agreements between industries.

However, in the screened policy documents, none of these instruments is described in sufficient detail. For the scenarios formulated in the MOSUS project, a more extensive description of policy instruments for dematerialisation and sustainable resource use is necessary. This chapter will therefore give a literature review, covering voluntary instruments, market-based instruments and command and control instruments. Finally, the issue of the right mix of policy instruments is discussed. This chapter will serve as the information base for the formulation of the policy instruments in the weak and strong sustainability scenario (see Chapter 7 and 8).

6.2 Voluntary instruments

Of all possible policy instruments, those that support voluntary changes towards a more sustainable resource use cause the least interference with individual freedom. Four different areas of policy intervention have been pointed out by Hinterberger et al. (1996). First, the need for an institutionalised concept needs to be acknowledged and the concept appropriately communicated to the public in order to create consensus on the goal of environmental policy. Second, all relevant actors need sufficient information on how to behave in accordance with the above concept, i.e. on how to translate it from theory into practice. The third area deals with another aspect of information: environmental information and management systems in general and the eco-audit specifically, as promoted by the European Union, need to be developed into integrated resource management systems with the aim of reducing the material intensity of all goods and services. The fourth main area of intervention mentioned is education.

The pre-requisite for policy measures focussing on voluntary actions is a clear concept of dematerialisation (e.g. Factor 10, Schmidt-Bleek, 1994), providing ecological guard-rails for long term economic development (Schütz and Welfens, 2000). Such a concept lays out common rules for decision making understandable and relevant for all, creating and facilitating certain behavioural options when well communicated to the public. However, it cannot be dictated by public authorities but should be allowed to evolve in societal processes resulting in institutional change. Policy measures can therefore only try to influence such a process. This can be done through the media by supporting the publication of new insights or views, by initiating study commissions where scientists and politicians come together for public discussions, by initiating research projects with the results published and made freely available etc. (Hinterberger et al., 1996), to name but a few examples. The result of such 'thought-provoking impulses' is a publicly held debate on dematerialisation leading to a slow institutional change in society associated with a change of preferences, thus leading the economic units to cut environmental use voluntarily by means of sustainable production and consumption patterns.

The successful implementation of voluntary approaches requires a set of pre-requisites, which have been outlined by Croci and Pesari (1999): the definition of clear and attainable objectives; the recognition of reciprocal advantages for the parties; the threat of retaliation by public authorities in the case of non-compliance; and trust between the parties. However, even when these conditions are met, a number of disadvantages or problems can still arise. Objections against voluntary approaches include the possibility of competition restricting agreements between firms of an industry due to internal agreements on which individual firms can achieve the commitments made in the most cost-effective way (Wicke, 1993). Another one is concerned with the consequences in cases where the objectives of the agreements have not been met. The danger of environmental problems to become 'eternalised' in such cases seems especially relevant due to the time-horizon of voluntary agreements being very long in some cases, and retaliatory environmental measures by public authorities taking time to be implemented (Ibid.).

One of the main problems in realising the implementation of this concept lies in the **prisoners' dilemma** situation. This situation arises due to the fact that environmental resources are public goods, which implicates that "there is an incentive built into the system for each individual to use environmental goods and services while at the same time it is rational for them to avoid the costs of obtaining or preserving them. Moreover, the behaviour of a single individual is completely irrelevant as far as the overall environmental result is concerned. So the environmentally favourable results of changing individual behaviour are at best uncertain, while the costs of changing behaviour are quite sure. Environmental policy aiming at voluntary actions needs to take this into account and should try to bridge the awareness-action gap by means of information and communication stressing the negative effects of that form of individual rational decision making for society as a whole. On the other hand, due to the co-evolution of formal and informal institutions, new laws and regulations can only endure when compatible with informal institutions. With the adoption of the concept of dematerialisation by society, i.e. its informal institutionalisation, the basis for the implementation of new norms is thus laid (Hinterberger et al., 1996).

Advantages, on the other hand, include the fact that industries or individual companies can choose their own strategies to comply with the contracts. Thus, the most cost-effective way can be selected. Also, voluntary approaches reduce the need for costly and tedious law-making procedures and the disputes and resistance associated with it. One of the most striking advantages of voluntary approaches, however, is their flexibility. They can be implemented on products as well as on production processes and product chains; on the local, regional, national or EU-level; differentiated according to the size of a company; as integrated frameworks or as plans by stages subject to regular control; but also in combination with subsidies, incentives for innovation or other additional provisions (Ibid.).

6.2.1 Raising information and awareness

One imperative for sustainable development is sufficient **environment related information** on the macro as well as on the micro level. More and better information is needed about the threats posed by an ever increasing scale of the socio-economic metabolism. In fact, "unless firms and consumers are well informed, they may take actions that are not in their own interests. Unless decisions are based on good information, markets will not work well. But in a modern, complex, free market economy, firms and consumers are unlikely to be well informed about the consequences of all their decisions" (Begg et al., 1994, p.52). This also applies to policy makers, who need environmental data for successful planning and decision making. Without such information, their decisions will be "little better than best guesses and are likely to be wrong" (UNEP, 2002). However, "high quality, comprehensive and timely information on the environment remains a scarce resource" (ibid.). Reasons for this include the difficulty to obtain the right data, and the problem of finding indicators that "capture and reflect the complexity of the environment and human vulnerability to environmental change" (ibid.).

Even though it needs to be accepted, that the consequences of certain environmental damages cannot be known, such tools can help to place decisions on a solid basis with more calculable outcomes. However, they do not solve the problem for consumers and producers to make the economic and environmentally right decision within a certain policy framework. For consumers to behave in an environmentally friendly way requires them to know about the environmental impact of the production, use and disposal of a good or service. Such information would serve as an environmental criterion for buying or not buying a product. In cases of high **environmental awareness**, this would put pressure on producers of products with high environmental impacts to rethink their strategy. Unfortunately private markets tend not to produce such information because producers have little incentive to do so. Even though many products are branded as 'ecological' or 'biological' and marked with labels that 'prove' their environmental friendliness, there is no indication of the total material or energy use over their whole life cycle. Instead of focussing on details, an integrated, comparable and easily understandable labelling system should be introduced. As a start, this could focus on the material intensity of a product 'from cradle to grave' using the material intensity analysis (MAIA) methodology, for example, which not only includes used and unused abiotic and biotic raw materials associated with the product life cycle, but also earth and water movements as well as the chemical conversion of air (Schmidt-Bleek et al., 1998). The problem of imported goods and services that have not been evaluated for their material use can be solved temporarily by using average values or approximations until the relevant environmental management and accounting systems have been installed there (Hinterberger et al., 1996).

6.2.2 Eco-Audits

Another possibility for publishing environmentally relevant information is the **eco-audit**, also known as **EMAS** (Environmental Management and Auditing Scheme) Regulation, "allowing voluntary participation by companies in the industrial sector in a Community eco-management and audit scheme" (European Commission, 1993). It builds on the possibility for companies in the industrial sector to voluntarily exceed the legal provisions in force and hence to make further improvements in their own internal environmental protection arrangements. Companies signing up for the scheme will become objectively judged by independent internal or external experts by means of an environmental audit. One of the drawbacks of the eco audit is the fact that it aims at production sites and leaves out the products themselves (Hinterberger et al., 1996). This implies that companies whose production sites fulfil all relevant EU regulations but whose products are environmentally hazardous or very material intensive can still be awarded the certificates associated with the EMAS Regulation. On the other hand, it is also possible for companies to adopt dematerialisation as their corporate environmental goal for specific production sites. Such a goal cannot be reached solely by changing production processes. The corporate environmental policy should also focus on the selection of preliminary products according to their material and energy efficiency and on decreasing the material intensity of the products, e.g. by increasing their usability. In general, the environmental goal should be the reduction of the material intensity per service unit (MIPS) (Schmidt-Bleek, 1992). The quantity of such a voluntary achievement will depend on the possibilities of different regions, industries, production sites, products etc., but could be positively influenced by a well communicated guiding concept of dematerialisation.

6.2.3 Extended producer responsibility (EPR)

One rather new aspect to internalise external environmental costs is referred to as **extended producer responsibility (EPR)**. It is defined as "an environmental policy approach in which a producer's responsibility, physical and/or financial, for a product is extended to the post-consumer stage of a product's life cycle. There are two related features of EPR policy: (1) the shifting of responsibility (physically and/or economically; fully or partially) upstream to the producer and away from municipalities, and (2) to provide incentives to producers to incorporate environmental considerations in the design of their products" (OECD, 2001, p. 18). This approach bears recognition to the fact that producers have "a considerable ability to reduce the life-cycle impacts of their products" (EPA, 1998). However, numerous other actors along the product chain could also be involved on order to achieve better resource use and pollution prevention. This view is represented by the notion of extended product responsibility. It calls for "lasting and substantial environmental improvements in product systems" (Ibid.) with the "combined expertise, ingenuity, cooperation and commitment" (Ibid.) of suppliers, designers, manufacturers, distributors, retailers, customers, recyclers, remanufacturers, and disposers. For example, consumers play a critical role in selecting products that are characterised by low material intensity. However, this approach also highlights the producers' "unique position - through their capability to affect product design, material choices, manufacturing processes, and product delivery - to reduce the lifecycle environmental impacts of their products" (EPA, 1998). In other words, both approaches described above are bearing recognition to the polluter-pays principle, i.e. by internalising social costs "within the product chain responsible for generating the externality" (OECD, 2001, p. 21).

Both concepts (eco-audit and EPR) stand in contrast to the common practice where producers not only sell the right to dispose of the product but also the obligation to manage its environmental burden with the sale of a good or service. They usually include strategies like corporate or industry-wide stewardship programs, 'servicing' and leasing programmes, life-cycle design and management, partnerships for recycling and waste management, and take-back or buy-back programmes. Even though they are usually implemented by means of legal mechanisms, there are many incentives for producers to comply by committing themselves voluntarily to EPR, i.e. to commit themselves "to improve their environmental performance beyond legal requirements" (OECD, 1999b). The motivations for such voluntary measures “can include economic drivers to recover high-value items, public relations gestures, means to avoid government intervention, or means to secure greater market share” (OECD, 2001, p. 33) resulting in “reduced resource and energy consumption, reduced operational costs, and increased credibility with shareholders and the public” (Ibid.). Also, costumer satisfaction and loyalty to the company increase with ‘greener’ products (EPA, 1998). Industry-based initiatives are increasingly being adopted especially in the fields of product stewardship and take-back. Other widely used voluntary strategies are leasing and ‘servicing’. The latter refers to firms evolving into service providers, selling “their costumers function rather than physical input” (OECD, 2001, p. 45). This creates incentives for producers to increase the economic life-time and to simplify maintenance of their products, thus allowing for new strategies to minimise resource consumption while maximising resource productivity.

Another strategy consistent with EPR is for firms to voluntarily **increase the length of warranty** for their products. With increased acceptance of the concept of dematerialisation, a competition about lengths of warranties could emerge, providing an effective sign for consumers indicating the product’s expected lifetime (Hinterberger et al., 1996).

6.3 Market-based instruments

With the development of environmental policy over the past decades, an increasing emphasis has been placed on the design of policy instruments that allow for the internalisation of external environmental costs. Policy makers thus “face the challenge of identifying policies and strategies that make it in everyone’s economic interest to utilise environmentally sound products and services” (Huber et al., 1998, p.7). Unlike the traditional instruments of environmental policy such as regulations, market-based systems of incentives and disincentives allow policy makers to achieve environmental objectives in the most cost-effective way. A definition of economic instruments is given by the OECD, describing them as “instruments that affect costs and benefits of alternative actions open to economic agents, with the effect of influencing behaviour in a way which is intended to be favourable to the environment” (AIM, 1997, p.7). Generally identified with taxes, subsidies, tradable permits, user charges etc., they deal with incentives, flexibility, and understanding people’s behaviour and self-interest.

The principal objective of economic instruments is the reduction of externalities (i.e. environmental degradation costs and resource depletion costs arising due to market, institutional, and policy distortions), resulting in the incorporation of social costs into individual cost-benefit calculations, hence leading to higher cost consciousness and a higher rate of innovation. However, as opposed to regulatory measures, market-oriented instruments, by making use of the price mechanism, “allow polluters and resource users to find their own best mix of controls or responses and therefore result in lower private costs than other approaches” (Huber et al., 1998, p.17).

As such, economic instruments are very important in bringing about an ecologically oriented structural change. This is also reflected in their increased role in policy design resulting not only in a broader application amongst OECD countries, but also in a greater variety of instruments applied within the context of economic instruments (OECD, 1999b). The role of the World Commission on Environment and Development (WCED) in 1987 and the United Nations Conference on Environment and Development (UNCED) in 1992 in this development is widely recognised. However, while accepting the importance of economic instruments to protect the environment, the WCED Report (1987) still considered regulations to be more desirable and efficient (WCED, 1987). This view was somewhat changed with the adoption of Agenda 21 at the end of the UNCED in 1992. Agenda 21 acknowledges that regulations alone will not be able to solve all environmental problems. The need for market-oriented approaches to be implemented in addition to regulatory measures is stressed in the document, calling for international co-operation in the use of these instruments (Agenda 21, 1993).

In its Sixth EAP, the European Community underlined the need to provide for cost internalisation and the importance of market forces for environmental improvements. The effectiveness of the latter “in both cost and environmental terms” (European Commission, 2001f, p.15) has been noted, providing incentives for firms to “research and invest in more environmentally-friendly or less resource intensive technologies” (Ibid.). This makes market based instruments especially suited for long-run environmental problems.

6.3.1 Reform of the subsidy system

Reforming or abolishing subsides has been ranking very high on the European political agenda for over a decade. The need for such measures is undisputed, however, the discussion focuses on where and how to restructure the system. With regards to improving the environment in general and the implementation of dematerialisation in particular, financial incentives for environmentally beneficial activities need to be promoted, while subsidies for unsustainable and environmentally problematic actions need to be abolished.

Subsidies in an environmental context are defined as “all forms of explicit financial assistance to polluters or users of natural resources, e.g. grants, soft loans, tax breaks, accelerated depreciation, etc. for environmental protection” (OECD, 1999a, p.9). As such, subsidies are a useful means to reduce market imperfections and to promote environmentally friendly technologies. On the other hand, in the form of ‘perverse subsidies’ they can exert “adverse effects on both the economy and the environment in the long run” (Myers and J., 1998, p.8). A thorough assessment of their effectiveness is thus vital for the achievement of environmental objectives.

The primary aim of policies dealing with subsidies should be to reduce those maintaining economic structures. Concerning sustainability, this would apply to all those that prove ecologically harmful. Generally, all subsidies should be of a temporary nature, being reviewed at regular intervals (Hans-Böckler-Stiftung, 2000).

All forms of subsidies have some impact on resource use, whether intended or not (Hinterberger et al., 1996). Those with apparent negative consequences include energy subsidies favouring unsustainable and environmentally problematic energy sources such as coal and nuclear energy, while penalising environmentally friendly sources such as biomass and other renewables. For example, “coal subsidies slowed down the shift to cleaner sources of energy production such as gas or wind farms because using coal remains artificially cheaper” (Gervais, 2002, p.41). Tax concessions for logging, settlement, and ranching can have an accelerating effect on deforestation, species loss, as well as soil and water degradation. Also, pesticide subsidies advancing their excessive use can lead to human health problems as well as water pollution and an increase in the pesticide resistance of affected species, while subsidies for water resource development and water use can result in the overuse of water for industrial and other purposes (Schmidt-Bleek, 2001).

The abolition of such subsidies has long been demanded, their existence repeatedly justified by reasons such as lower costs of production abroad, protecting domestic employment, securing domestic supply, etc. (Hinterberger et al., 1996). It is questionable whether these arguments are sufficient in view of the costs incurred by 'perverse subsidies' alone. As noted by Myers and Kent, they increase government expenditures resulting in higher taxes or larger budget deficits, diverting "government funds from better options for fiscal support" (Myers and J., 1998, p.8). They also distort economies by undermining investment decisions and reducing "the pressure for businesses to become more efficient" (Ibid.), fostering "many other forms of environmental degradation, which apart from their intrinsic harm, act as a further drag on economies" (ibid. p. 13).

All these reasons give evidence of their economic and environmental violation against sustainability and of them counter-acting against the objective of dematerialising the economic metabolism by more efficient resource use. The reduction of 'perverse subsidies' is thus of primary importance, leading to a 'double dividend' in the form of an acceleration of sustainable development and an increase of government funds "available to give a new push to sustainable development (e.g. by investing in research and development or in public transport).

Alongside the abolition of 'perverse subsidies', the introduction of new forms of subsidies dependent on the material intensity of an industry is suggested. Industries with low material input levels or industries striving for a reduction of material input levels would thus be eligible for subsidies, whereas industries with high material inputs would not. This would create new financial incentives to reduce resource use. The MAIA-Method for measuring the material intensity of products 'from cradle to grave', could serve as a general criterion for restructuring the subsidy system in such a direction (Hinterberger et al., 1996).

6.3.2 Ecological fiscal reform

Apart from restructuring the subsidies system, an ambitious environmental fiscal reform policy must include taxes that support resource efficiency. As defined by OECD (1999) taxes in an environmental context refer to "any compulsory, unrequited payment to general government levied on tax bases deemed to be of particular environmental relevance" (OECD, 1999a, p.56). The EU definition, in comparison, states that one likely feature for a levy to be considered as environmental would be that the taxable base of the levy has a clear negative effect on the environment. However, a levy could also be regarded as environmental if it has a less clear, but nevertheless discernable positive environmental effect.

The need for ecological taxes arises due to external costs not being accounted for by market prices. Their aim is to internalise those externalities by equating private and social costs of using nature for production, making "prices work for environment". The EU has been committed to correct prices for energy consumption since the 2001 European Council in Gothenburg. Furthermore, the sixth EAP calls for the "promotion of sustainable production and consumption patterns", particularly through "promoting and encouraging fiscal measures such as environmentally related taxes and incentives" (European Commission, 2001f, p.5). Environmental taxes have thus been recognised as powerful tools to integrate environmental objectives into the economy, providing for a variety of benefits such as "economic incentives to reduce pollution and resource use" (Gervais, 2002, p. 42), "revenues that can be used for fiscal reforms" (Ibid.) and the stimulation of investment in the environment.

In particular relevant for the MOSUS project are energy (or CO_2-emissions) and material input to be selected as tax bases, representing estimations of the potential for environmental harmfulness of the goods and services under consideration. Even though previous suggestions highlighted the importance of energy taxes as the prime tool for 'greening' the tax system, it is now recognised that the concentration on fossil fuels alone will be not sufficient to considerably reduce the total material requirement of an economy. Hence the need for a complementary tax in the form of a *material input tax* (MIT).

One of the early concepts for an ecological tax reform, advanced by von Weizsäcker et al. (1992), proposes a shift of the tax burden from labour to environmental load in general and energy sources in particular. Considering the overuse of natural resources and the underuse of human resources (i.e. high unemployment rates) in the EU, and the fact that 85% of taxation in the EU falls on human endeavour, such a shift "may contribute to increased employment alongside environmental improvements" (Gervais, 2002). This is commonly referred to as a 'double dividend'. Furthermore, an increase in energy prices would support a structural shift away from capital intensive, environmentally harmful industries to labour intensive industries with a lower environmental impact (Wicke, 1993).

The MIT, on the other hand, refers to a tax that uses material input as its tax base, placing a certain amount of money on each ton of total material requirement. Taxing the extraction of natural resources (except water and air) needed to produce domestic goods and services as well was imported ones leads to the internalisation of external costs associated with it and thus to higher input costs. As a consequence thereof, production will be faced with increased incentives to reduce material input (Hans-Böckler-Stiftung, 2000). This will be done in the most efficient way as long as the costs of reducing material input are lower than the additional costs imposed by the MIT.

Additionally, since some of these increased costs will be shifted to the consumers, MIT acts as a tool for differentiating between resource intensive and less resource intensive products. The associated price signal will have a positive effect on consumer choice for goods and services with a lower total material requirement, ceteris paribus.

The same applies for energy taxes in relation to energy intensive industries/products. One of the main differences between MIT and energy taxes, however, arises due to the fact that there are much less energy sources than matters to be considered as material inputs. Hence, energy taxes are believed to be easier to administer. The introduction of energy taxes would then have to be accompanied by considerations on how to reduce other material flows. For example, when applied to energy sources, this would allow for a differentiation between material intensive and less material intensive ways to produce one kilowatt hour of electricity (Hinterberger et al., 1996).

Unfortunately, not a lot of progress has been made by the EU to broaden the application of energy taxes recently, let alone MIT. The Directive on minimum rates for energy taxation finalised on 20 March 2003 by the Council of Economic and Finance Ministers has been heavily criticised by the European Environmental Bureau (EEB) as "drastically watered" (EEB, 2003) compared to the original proposal put forward by the Commission nearly six years ago. "The Directive lays down an energy taxation framework including natural gas, electricity and coal for the coming 10 years. However, the Council has drastically watered the original proposal of the Commission, in particular the minimum rates, and has added a huge list of rebate and exemption possibilities. As a result, with regards to mineral oils, the directive will do no more than merely correct the EU minimum rates agreed in 1992 for inflation, whilst very minimal rates are introduced for new products. Moreover, the text does not plan a review of the rates before 2012" (EEB, 2003). It is argued, that the directive will have very little impact on the price of energy in the EU, not contributing enough to foster sustainable development over the long-run.

6.3.3 Certificate trading systems

Another important form of economic environmental policy instruments is generally referred to as certificates. The aim of permits, rights or quotas is to create marketable rights for the use of environmental goods and services that would otherwise not be marketable. Public authorities can create markets for environmental 'bads' by limiting environmental harm of production (e.g. resource use, emissions, etc.) to some agreed quantity and by then distributing that limit to tradeable certificates. Producers of such environmental 'bads' would be required to own or purchase a quantity of certificates corresponding to their environmental use.

Certificates are thus "based on the principle that any increase in emissions or in the use of natural resources must be offset by a decrease of an equivalent, or sometimes greater, quantity" (OECD, 1999a). Even though they have so far mainly been implemented to reduce emissions, certificates have also been proposed in the form of material input (MI) certificates for limiting resource consumption. In such a system, MI-certificates would "constitute a permission to displace a certain quantity of primary material (following MAIA – in tons of MI)" (Hinterberger and Meyer-Stamer, 1997, p.14).

The design of that system could be established with reference to the two broad types of tradeable permit systems currently in operation for reducing emissions: one based on reduction credits, and the other based on ex ante allocations ('cap-and-trade'). The former approach "takes a 'business as usual' scenario as the starting point, and compares this baseline with actual performance" (OECD, 1999a, p.8). Producers consuming fewer resources than anticipated by the baseline scenario would earn MI-credits which they could either use themselves for additional material input in the future or they could sell them to other producers with higher resource consumption than accepted by the baseline. Of course, credits will only be bought when their price is lower than the required costs to reduce resource consumption. Since the price of the credits is solely determined by market supply and demand, credits will be most efficiently allocated to producers with the highest MI reduction costs.

The 'cap-and-trade' approach "sets an overall emission/use limit (i.e. the 'cap') and requires all emitters to acquire a share in this total before they can emit [/use]" (OECD, 1999a, p.8). The resource use limit would be introduced according to the macroeconomic reduction goal (e.g. a factor of X) and translated into permits that could either be allocated free-of-charge by the public authorities or auctioned. Firms whishing to move primary material will then be required to “return a corresponding amount of certificates to the issuing authority in exchange” (Hinterberger and Meyer-Stamer, 1997, p.14). However, in order to achieve a reduction in material input by a factor of ten within the next 50 years, the quantity of certificates would need to be reduced by about 5% each year (Hinterberger et al., 1996). The price increase associated with such a reduction in supply of certificates will result in further increased incentives to reduce material input, either by using less primary materials, more recycled materials or by switching to new product designs that require diminished resource flows (Ibid.).

Certificates belong the group of – what Huppes and Simonis (2000) refer to as – market volume instruments. They focus on the allocation of a permitted quantity of resource use/emission while leaving its price up to the market. The price for the environmental ‘bads’ under consideration will thus be the result their supply and demand, i.e. where the marginal costs of reduction equals the marginal benefit of reduction. On the other hand, financial instruments (e.g. subsidies, taxes, etc.) influence prices directly, leaving it up for the market to decide on the quantity of environmental ‘bads’ to be consumed at a given price. Again, at the right tax level marginal costs of reducing material input equal the benefits of that reduction.

Whereas the latter are largely used on local, regional and national levels, market volume instruments play an increasing role in international environmental policy, especially climate policy. Of particular relevance are the four ‘Kyoto Mechanisms’ laid out in the Kyoto Protocol of 1997 for countries to achieve their targets for emission of greenhouse gases. Even though they act upon the output of the economic system, they can also serve as an impetus for the discussion on MI-certificates. The Kyoto Mechanisms consist of (see Michaelowa, 2001):

- ‘bubbles’, where “a group of countries defines a joint target which is the sum of the original country targets and then redistributes the target among its members”;
- ‘Joint Implementation’, where “a country invests in emission reduction or sequestration projects in other countries with emission targets and thus earns ‘emission reduction units’”;
- the ‘Clean Development Mechanism’, a very elaborate instrument which allows for a country to earn ‘certified emission reductions’ “created through projects in countries without targets”; and
- ‘International Emissions Trading’, allowing for counties with emission targets to transfer ‘assigned amount units’ between each other.

The bubble concept has been propagated to help existing firms/countries to achieve environmental targets in the most cost-effective way. They allow for producers to reduce the use of environmental goods in excess of the baseline reduction requirement in areas where the reduction is most cost-effective. The resulting surplus in reduction requirements can be balanced against higher environmental impacts of sources with reduction potentials that are more difficult and expensive to realise. Bubble policies thus allow for a greater flexibility in complying with market volume interventions leading to considerable cost savings (Wicke, 1993).

Reducing costs is also the aim of international trading schemes. Integrated Emissions Trading, as proposed in the Kyoto Protocol has been found to reduce costs by 30% to 90% in economic models (OECD and IEA, 2001). The saving potential of an international MI-certificates trading scheme remain open, however, it increases with the difference in marginal costs of reduction among market players. An argument against such a system is the possibility of unacceptably high local resource which could arise by allowing some sources to exceed their targets (Ibid.).

It remains open as to how far these instruments can be integrated into a MI-certificates trading scheme, however, a cooperation among countries of the international community seems sensible in view of the increasing interaction of national economic systems.

6.3.4 Public procurement

An often neglected instrument to reduce the domestic material requirement is public procurement. According to Gervais (2002), public purchases of services, works and goods within the EU account to over € 1,000 billion annually or about 14% of EU's GDP. Such figures "confirm the importance of public procurement, in terms of impact on the Single Market and competition, as well as opening of markets for European suppliers" (European Commission, 2003b). They also emphasise the leading role such a large sector can play to "boost innovation and development and [to] encourage the offer/demand for environmentally friendly products and services" (Gervais, 2002: 45). This also applies for eco-efficient products with low material input per service unit. However, EU public procurement legislation guaranteeing fair access for suppliers sets limits on governments for attaching environmental conditions to their purchasing contracts. Furthermore, even within the limited scope to benefit the environment, "any such criteria, at this stage, must provide benefits to the contracting authority rather than to the wider community" (Ibid.). This also applies for environmental externalities, which by definition are born by society as a whole. These costs could only be taken into account in specific cases, "for instance where external costs are due to the execution of the contract and at the same time are born directly by the purchaser of the product or service in question" (European Commission, 2001a, p.22).

On the other hand, by stipulating precise green requirements in the contract specification, authorities "could take into account the 'environmental soundness' of products or services, for example, the consumption of natural resources, by 'translating' this environmental objective into specific, product-related and economically measurable criteria by requiring a rate of energy consumption" (European Commission, 2001a. p.21). For the assessment of the most economically advantageous tender, the life-time costs of a product to be born by the contracting authority may be considered. Running costs and cost effectiveness as possible award criteria "might include direct running costs (energy, water and other resources used during the lifetime of the product); spending to save (for example, investing in higher levels of insulation to save energy and thus money in the future); as well as the costs of maintenance or recycling of the product" (European Commission, 2001a, p.21). To promote the case of dematerialisation in public procurement, the legal framework allowing for governments to favour eco-efficient products and services where possible, should be utilised to its full potential.

6.4 Command and control instruments

Belonging to the group of budget neutral measures, regulatory instruments are often chosen over economic ones “where there is little flexibility allowable on the timing or nature of the outcome required” (DEFRA, 2002, p.2). This would apply primarily to “situations where high environmental risk and irreversibilities of environmental impacts call for rapid preventive action” (Bartelmus et al., 2000, p. 37). Often referred to as ‘command-and-control measures’, they are most commonly implemented in the form of standards and quotas, with the most stringent kind of the latter being prohibitions or bans.

According to Wicke (1993), regulatory instruments can be applied on three different areas: emissions, the production process and production itself. Product-related policies can be added as a fourth element. Even though they are very important for emissions control, the latter three are of special relevance for the purpose of this report.

Input regulations on the production process can oblige producers to select only a limited number of natural resources for their activities. As such, they may prohibit the use of certain resources that are associated with a high environmental burden. They may, however, also focus on quantities to be limited or reduced, rather than on qualities to be forbidden. This has been the case in “fleet efficiency regulations or licences for mining (relative input limitations) and logging or ground water extraction permits (usually absolute input limitations)” (Spangenberg et al., 1999).

Regulations may also lay down technologies to be used and how they should be used in the production process. The preference of resource efficient technologies can serve as an important factor for reducing material input. As an example, producers may be obliged – where possible – to supply industrial waste heat to district heating networks, thus reducing the pressure on primary materials (Wicke, 1993).

Additionally, regulations can impose production quotas on economic agents, which can go as far as prohibiting production at all. Again, such policies are mainly used with regard to emissions, but may also be useful for highly material intensive products.

Regarding product related policies, extended product/producer responsibility has been mentioned before. Other than shown in the section about voluntary instruments, it can also be implemented by means of regulatory approaches. In the EU, the growing interest in integrated product policy (IPP) (European Commission, 2001d) marks an important new stage in the development of environmental policies, focussing on all phases of a product’s life-cycle, as well as on the different actors involved in it. It is associated with a shift in policy style, from “an external approach (i.e. from outside the industry) to an internal approach (i.e. from within the industry) and should be much more efficient as it will tackle the problem […] at its origin” (Gervais, 2002: 32). As noted by Geiser (2001), it will act upon firms “to forgo conventional identities as independent entities and come to view themselves as participants in a chain of value-adding and subtracting suppliers and costumers”. Targeted at dematerialisation, product related policies can thus serve as an important new approach to reduce the use of primary resources.

Regulations like bans, emissions standards, etc. are best implemented in cases "where regulation has to be binding and enforceable throughout a country and its population according to the same standards, in particular for health concerns and ecotoxicity" (Spangenberg et al., 1999). They may, however, be replaced by voluntary agreements (agree-and-control approaches) even though "the hope for significantly reduced transaction cost in this case seems exaggerated" (Ibid.).

It has been made clear before, that the limits defined by the dematerialisation objective constitute the general 'guard-rails' of sustainability and thus of the material flow targets. However, "within these limits as little restrictions as possible should be imposed on human self-determination and the innovation potential of firms in the market economy" (Spangenberg et al., 1999). The dematerialisation approach satisfies the latter requirements by shifting the emphasis "from specific activities and regulations (without, however, underestimating their value for specific protection measures) to general objectives" (Ibid.). Even though still widely implemented for output related environmental protection, regulatory instruments are losing importance due to a lack of flexibility and little incentives to reduce environmental use to a level lower than imposed by public authorities. Furthermore, they do not take into account individual cost situations, leading to an economically inefficient attainment of environmental targets at costs higher than minimal social costs.

The need to adjust the regulatory framework for dematerialisation is evident. This also applies to supplementing and/or replacing existing output related regulations "by the development of input policies […] in order to reduce the total throughput of our economies" (Spangenberg et al., 1999).

6.5 The need for a policy mix

Many instruments suited to bring about a dematerialisation of Europe's economies have been presented in this chapter. The range has covered voluntary instruments, with little government intervention; economic instruments aimed at increasing incentives to reduce material flows; and regulatory measures marked by high levels of government intervention.

In order to reach sustainability and associated material flow targets a single instrument operating in isolation will usually not be enough. Rather, a package of instruments covering a wide selection needs to be implemented, allowing for different problems to be combated by different solutions. This requires diverse types of instruments to work alongside: newly introduced instruments like certificates together with traditional ones like subsidies, with some of them having an effect in the long run, others in the short run. It also is likely required for such a policy-mix to change over time. A package of instruments could, for example, "require as a minimum specific changes in behaviour; encourage greater changes in behaviour in the short run; incentivise even greater changes in behaviour in the long run; and facilitate those changes, at least in the short run" (DEFRA, 2002: 4).

Regulatory instruments are best suited to keep the environmental impacts of resource use within the general 'guard-rails' of sustainability in the short and long term by targeting on the reduction of environmental risks and irreversibilities of environmental impacts associated with specific substances. For the unspecific reduction of material flows, as promoted by the concept of dematerialisation, a policy mix emphasising economic instruments such as material input taxes is often suggested (Hans-Böckler-Stiftung, 2000). They are designed to promote a shift away from material intensive activities, providing for long term incentives for reducing the use of primary materials. This shift may also be facilitated though the availability of funds generated by taxes (cp. DEFRA, 2002).

Also in some of the documents (e.g. European Commission, 2002c) it is stated that a set of instruments is needed in order to move in the direction of decoupling and to overcome barriers. As an example, a mix of instruments consisting of selected raw material taxes, rewards for resource efficient behaviours, taxes on the consumption of specific materials, legal restrictions to the use of certain materials and feebate systems (tax the bads and subsidise the goods), is given.

A precondition for the implementation of any policy-mix is the knowledge about material intensities of economic activities. Hence, environmental information plays a crucial role in the process of selecting appropriate instruments. The determination of the ecological relevance of economic activities enables prices to fully reflect social costs (e.g. by means of taxes or certificates). However, relying on prices to reflect social costs may not be sufficient in many cases, which highlights the importance of supporting voluntary behavioural changes (Hinterberger et al., 1996). A suitable mix of instruments should be the result of a political process taking into account ecological, as well as economic and social objectives.

6.6 The challenge for Accession Countries

The EU Commissions' suggestion for a „Thematic Strategy for the Sustainable Use of Natural Resources“ (European Commission, 2002c) gives special attention to problems related to future resource management in accession countries with transition economies.

The document states that first priority of Accession Countries may be economic growth to improve the standard of living, which stimulates resource use (e.g. through expected rapid increase of the number of cars and other transport facilities). At the same time the access of these countries to environmentally sound technologies is poor, which could result in a worsening of the overall situation in these countries. A number of Accession Countries suffer from low economic growth, high unemployment and even poverty in some regions particularly in the post-industrial and rural areas. Also some traditional branches of industry, such as coal mining, steel industry, chemical industry, and the energy sector create hindrances for quicker and deeper dematerialisation processes because of their extremely high capacity to produce waste and harmful emissions to the environment. However, speeding up restructuring processes could in some countries create clearly negative social and employment effects.

On the other hand, agriculture contributes a large share to GDP and is marked by relatively low average use of fertilisers and pesticides, and a high level of biodiversity in comparison to Western European countries. In addition, these countries are considered to have a high potential for renewable energy.

The implications of enlargement can enhance achieving the objective of decoupling, but they could also be detrimental. Enlargement will enhance decoupling if Accession Countries are able to catch up economic growth by using most advanced environmental technologies. It will be detrimental if economic growth of the Accession Countries occurs through the use of resource-intensive technologies.

Therefore, the Accession Countries may be able to play an important role in system changes and applying environmentally benign technologies, since in many cases existing infrastructures are no obstacle for the introduction of new technologies (whereas in countries of Western Europe this is often the case). In order to enable Accession Countries to create prosperity, while the environmental pressure decreases, the Community as a whole should develop ways and means to make use of different regional conditions and apply a flexible approach for achieving certain objectives. This may refer to time schedules, technology transfer mechanisms, joint implementation, etc.

It should be noted that the dematerialisation processes in and capacities of individual countries in the Central and Eastern European (CEE) region to implement them are very different depending on a large number of factors: the level of economic growth, social balance, stabilisation of macroeconomic strategies and policies, public awareness, value of environmental investments, extension and effectiveness of the public sector, extension of private sector activities (particularly direct foreign investments and its engagement in transferring of know-how and new technologies to recipient EE countries), level of openness of CEE economies to international markets, entrepreneurship friendly internal legislation and institutional framework, investors particularly SME friendly banking and capital market network, and transparency in public procurement procedures.

The Eastern European should decide to implement the same general dematerialisation targets for the year 2020 as the EU-15 countries. This step is needed not only because the majority of those countries will become member countries of the EU in May 2004, but simply because direction on economising of natural resources and decreasing of material flows in production and consumption will be a major condition for continued economic growth and social welfare in this century.

However, the same target for 2020 does not mean the same way and timing of concerning the implementation of dematerialisation processes. There are countries in the CEE region which could be to some extent serve as examples for other countries concerning the dissemination and implementation of dematerialisation processes. Countries such as Slovenia or Estonia already take benefits from close co-operation with their Western neighbour countries. Also profitable from both an economic as well as from a social point of view are regional co-operations of Germany or Austria with their neighbour countries Hungary, Czech Republic, Slovak Republic, and Poland.

Taking these considerations into account it might be suggested that the only effective way of achieving EU dematerialisation targets by 2020 in the Accession Countries is to:

- Implement sustainable development at all levels of public governance and entrepreneur management in the EE countries.
- Continue the restructuring of the economy to gain multi-sectoral effects of saving of natural resources.
- Strengthen the proliferation of technological, financial, organisational and institutional innovation between the EU-15 and Accession countries as well as among Accession countries.
- Elaborate strategies and policies of dematerialisation specific for individual EE countries addressing their structural and employment problems (timing of specific undertakings binding them with macro-economic, environmental and sectoral strategic policies).

- Implementing the same packages of regulatory and economic instruments useful for dematerialization effects as in the EU-15 countries.
- Extending regional and multi-countries co-operation between institution, enterprises, investors and people.
- Encourage capital market and banking institution in EE countries to active support of dematerialisation investments.

6.7 The role of international trade

In the European Strategy for Sustainable Development, the European Council states that production and consumption activities within the EU borders have impacts on other parts of the world and increase the pressure on the environment (particularly in so-called developing countries). Thus the links between trade and environment have to be taken into account in order to guarantee that the goal of achieving sustainability within Europe fosters sustainability on a global scale at the same time. This becomes particularly relevant, as the externalisation of environmental burden through international trade might be an effective strategy for industrialised countries to maintain high environmental quality within their own borders, while externalising the negative ecological consequences of their production and consumption processes to other parts of the world (Muradian and Martinez-Alier, 2001; Rothman, 1998).

An evaluation of the economic activities of one country or world region within the context of the urgently due transformation of societies towards sustainability on the global level, can therefore only be carried out by extending the domestic physical accounts and including so-called indirect resource requirements (or “ecological rucksacks” associated to imports and exports (Bringezu et al., 1998). The declining material use per unit GDP in countries of the western hemisphere (“relative dematerialisation”) (Adriaanse et al., 1997; EUROSTAT, 2002) does not automatically lead to lower overall consumption of material-intensive goods, but results to some extent from higher imports of these products from “developing” countries (Giljum and Eisenmenger, 2004; Muradian and Martinez-Alier, 2001).

The scenarios formulated and simulated in MOSUS should consider international aspects of resource use as one core issue. Time series of European use of natural resources (including indirect resource flows associated with imports) should reveal, whether or not a tendency towards the re-location of resource intensive production towards the global South can be observed. It should be analysed, whether the process of relative dematerialization, which can be observed in Western Europe, is going along with a dematerialisation of imported products or whether Europe’s dematerialisation is connected to a “re-materialisation” in other world regions. Recommendations concerning possible policy strategies and instruments elaborated in the course of the MOSUS project should fully integrate the demand of the EU that a transformation of EU production and consumption patterns towards dematerialisation must go along with positive impacts on transitions towards sustainability in all other world regions, in particular in so-called developing countries.

7 Weak sustainability scenario

7.1 Targets for resource use reduction

Although the principal need to reduce natural resource inputs through de-coupling of economic growth from material extraction is generally highlighted as a crucial factor for achieving environmental sustainability in Europe, quantitative reduction targets on the EU level have in most documents been formulated only for outputs of economic activities (in particular GHG emissions and solid wastes, see above). Only energy policy papers include quantitative goals for the increase of renewable energy sources in total energy supply, which would as a consequence decrease the use of fossil energy carriers.

In its proposal for a “Thematic Strategy for the Sustainable Use of Natural Resources”, the European Commission (2002c) specifies key areas for resource use reduction (see also Table 8 above). Concerning renewable, extinguishable resources (agricultural products, fish, and forestry products) the strategy demands a promotion of organic agriculture and a stabilisation and restoration of forests and marine fish stocks. Although no quantitative goals are mentioned, this would imply reductions of agricultural output, of timber harvest as well as for marine fish catch. Concerning mining of minerals and ores, the strategy calls for a reduction of negative environmental impacts according to the life-cycle approach and an X% reduction of environmental pressures. However X% is not specified in the document. With regard to fossil energy carriers, a reduction of CO_2 emissions by 40-60% until 2030 is demanded. Although not explicitly mentioned, this would translate into a substantial reduction with regard to fossil fuel use. The achievement of a reduction target for fossil energy carriers of this magnitude requires major policy actions and a radical change in supply and demand structures of the energy sector. We therefore assume this reduction goal to be part of the strong sustainability scenario rather than the weak sustainability scenario (see below).

Concerning overall resource use, the weak sustainability scenario sets the target of a faster de-coupling (or de-linking) of economic growth from natural resource use as compared to the trends of the baseline scenario. Aggregated indicators like Direct Material Input (DMI) and Total Material Requirement (TMR) should decrease slightly in absolute terms, reflecting a high relative and a small absolute dematerialisation.

7.2 Key sectoral developments and sectoral policy strategies

7.2.1 Energy

In the weak sustainability scenario, fossil fuels will remain the dominating category of energy supply until the year 2020. Natural gas will significantly increase its importance, in particular for electricity production, whereas coal and oil plants will be increasingly shut down. Most of this increased demand for natural gas will be met by higher imports, whereas the trend of decreasing domestic extraction of fossil energy carriers will continue. The EU energy sector policies currently implemented will also be carried out in future, and there will be no major technological breakthroughs, as novel energy forms, such as hydrogen and methanol will not make significant inroads, primarily due to cost considerations. Growth in hydroelectricity and other renewable forms of generation is projected to be modest, as fossil energy prices will remain relatively low. However, growth in electricity generation by biomass generation is expected to occur in particular towards the end of the projection period at 2020. The energy sector will show a significant improvement of the energy intensity ratio. This relative decoupling is attributed to the growth of the services sectors at the expense of the more material-intensive primary sector and to technological innovation. Total energy use is assumed to stay more or less constant on levels of 2003.

In the Accession Countries in Eastern and Central Europe, demand for energy and electricity will increase, but energy intensity improvement is expected to be higher than in Western Europe, due to industrial restructuring, the opening up to competition and the 'rationalisation' of the energy system initialised by the advent of economic reforms, as well as the accelerated substitution of solid fuels with natural gas. Renewable energy forms are expected to gain some market share but remain below the levels for Western Europe.

Energy policy in Europe is expected to rebalance supply side policies in favour of demand side policies and trigger a real change in consumption behaviour in order to reduce environmental pressures posed by the energy sector. Main policy instruments will include energy taxes and other parafiscal levies, with the clear goal of a reduction of energy consumption and active support for increased shares of renewable energy resources in total energy consumption.

7.2.2 Industry and manufacturing

In the weak sustainability scenario, the implementation of new policy and market incentives to support a transformation of the manufacturing sectors towards sustainable development is assumed, which will lead to the creation of markets for sustainable products in some areas of the manufacturing industry (e.g. high-tech industry, automobile industry). This process will be supported through stimulating demand, fiscal incentives, environmental regulation and by reducing market uncertainties.

The general trend of raising material and energy efficiency in the manufacturing sector is assumed to continue. However, no radical changes are to be expected concerning the general transformation of the resource base for manufacturing purposes from non-renewables to renewables, which is to a good extent caused by continued low prices for fossil fuels.

7.2.3 Transport

Considering the trends in transport development described above, the major transport policy objectives to be addressed in the weak sustainability scenario are

(1) decoupling transport growth significantly from growth in Gross Domestic Product in order to reduce congestion and other negative side-effects of transport and

(2) bringing about a shift in transport use from road to rail, water and public passenger transport.

In the weak sustainability scenario it is assumed that a number of policy measures and instruments are put into force, which are mentioned in the EU White Paper on future transport policy (European Commission, 2001b). The most important instruments are:

- Introducing a framework for transport charges (“road pricing”) to ensure that prices for different modes of transport, including air, reflect their costs to society.
- Harmonisation of fuel taxation for commercial users, in particular in road transport.
- Give priority to infrastructure investment for public transport and for railways, inland waterways, short sea shipping and intermodal operations.
- Improve transport systems by addressing missing transport links, developing open markets and co-operation at EU level (e.g. railway liberalisation, air traffic systems).
- Building the trans-European network, with focus on removing bottle-necks in the railway network and in the road network in frontier regions to accession countries.

Given the direction of past trends, it is assumed that the implementation of these policy instruments will lead to a stabilisation of passenger and freight transport (and respective levels of energy consumption) at the levels of the end 1990s, but will not achieve an absolute reduction of transport activities. Policy measures, such as taxes on fossil fuels and road pricing will increase costs for private and commercial transport, but increasing demand for mobility will limit the positive impacts of these measures on overall resource demand. Road freight will remain the most important means of transport throughout the time period under investigation, to the detriment of rail and inland shipping, which in spite of policy programmes to support these modes (e.g. the Trans-European Network policy), continue to loose ground to road transport.

7.2.4 Construction

In the weak sustainability scenario it is assumed that the currently developed *Urban Thematic Strategy* will be implemented and related policy instruments will be put in force, which will move activities in the construction sector towards a more sustainable direction.
Policy instruments assumed to be in force in the weak sustainability scenario are:

- Funds and subsidies supporting new resource-extensive solutions and the development of new eco-efficient and renewable building materials
- Public procurement considering requirements of eco-efficiency in construction
- Taxes and other regulatory mechanisms at the EU, national and regional levels helping motivate actors in the construction industry to achieve these goals
- Urban planning instruments making sustainability standards a condition for construction permits.

7.2.5 Agriculture

The recently agreed reform of the common agricultural policy (CAP) is expected to have a significant impact on producers’ behaviour, as the latter would increasingly base their production decisions on market signals (i.e. profitability expectations). The decoupled payments are expected to generate significant adjustments in the production structure of the agricultural sector, affecting the production mix, the production intensity and the farm structure, and could lead to abandonment of agricultural activities.

From a sector perspective, the CAP is foreseen to improve the situation of agriculture in the new Member States as compared to a situation without membership and under the continuation of domestic policies. The CAP in combination with the Single Market should provide stable and, on average, higher prices than the domestic policies of these countries could sustain.

For the weak sustainability scenario, assumptions follow existing projections concerning the impact of the CAP reform on restructuring processes in the agricultural sector. In the arable sector, the new policy environment will lower cereal price support, which will lead to a significant reduction in the total area grown with cereals. Part of the land previously attributed to cereal production will be used for increased energy crop production. Voluntary set-aside (abandonment of land) will likely increase, but will effect only a minor share of total arable land in the EU. On the aggregated level, production volumes in crop production are expected to decrease. Introduction of the decoupling system will lead to a decline in beef and sheep production, as it would favour the extensification of production systems. The increase in beef prices and the fall in beef consumption will favour the pig and poultry sectors, which will display a small expansion in production and consumption.

7.2.6 Fisheries

For the weak sustainability scenario we assume that the policy measures intended to be implemented in the new Common Fishery Policy (CFP) of the EU have entered into force. The new CFP is expected to promote the sustainable management of fish stocks in the EU and internationally, while securing the long-term viability of the EU fishing industry and protecting marine ecosystems.

Specific policy action will include the implementation of multi-annual and ecosystem-oriented management, adoption of stronger technical measures to protect juveniles and the development of a system to track progress of the CFP towards sustainable development and the performance of the management schemes and policies against stated objectives. Furthermore, fleet policy will be reformed, ensuring that public aid does not contribute to an increase in fishing effort.

The implementation of these measures will lead to a further decline of open-sea fish catch. At the same time, aquaculture production is assumed to continue to increase.

7.3 Policy instruments on the macro level

7.3.1 Voluntary instruments

In the weak sustainability scenario, we assume the implementation of two voluntary instruments. First, the implementation of a labelling system for life-cycle wide material inputs for all consumer products. Second, the adaptation of eco-audit schemes, such as EMAS (Environmental Management and Auditing Scheme) to include demand for eco-efficiency and dematerialisation in the evaluation of the environmental performance of enterprises. An extension of eco-audits should be carried out in order to also include products and not only production sites. The corporate environmental policy is assumed to on the one hand focus on the selection of intermediary products according to their material and energy efficiency and on the other hand on decreasing the material intensity of the products, e.g. by increasing their usability.

7.3.2 Market-based instruments

Reform of the subsidy system

The implementation of a subsidy system reform in the weak sustainability scenario is expected to provide financial incentives for resource saving activities, while abolishing subsidies for unsustainable and environmentally problematic actions. The reduction of 'perverse subsidies' will be of primary importance, leading to a 'double dividend' in the form of an acceleration of sustainable development and an increase of government funds available for sustainability-oriented investments. The following economic sectors will be the most important to be addressed by this reform and the following negative developments are expected to be reduced:

(a) Energy: Past trends favoured unsustainable and environmentally problematic energy sources such as coal and nuclear energy, while penalising environmentally friendly sources such as biomass and other renewables.

(b) Transport: Subsidies in the past were either directly granted or indirectly through low prices for energy not reflecting actual environmental and social costs of transport. The removal of transport subsidies is supposed to have significant impacts on international trade patterns, as long-distance transport becomes increasingly costly.

(c) Agriculture: Subsidies often fostered overproduction and high use of pesticides and fertilizers. With the reform of the CAP (see above), subsidies will be reduced and decisions of producers are expected to become more based on market signals.

(d) Forestry: Tax concessions for logging, settlement and ranching have in some cases shown negative effects in terms of deforestation, species loss as well as soil and water degradation.

(e) Water: Subsidies for water resource development and water use can result in the overuse of water for industrial and other purposes.

Ecological fiscal reform

The main objective of an ecological fiscal reform is to internalise external costs not being accounted for by market prices, in order to make prices better work for an improvement of the environmental situation. Examples in EU documents, demanding a fiscal reform are the 6^{th} Environmental Action Plan, which calls for the promotion of sustainable production and consumption patterns, particularly through promoting and encouraging fiscal measures such as environmentally related taxes and incentives as well as the correction of prices for energy consumption through energy-related taxes demanded by the 2001 European Council in Gothenburg.

In the weak sustainability scenario, this reform is assumed to provide economic incentives to reduce pollution and resource use and generate revenues that can be used for fiscal reforms (e.g. lowering indirect labour costs) and the stimulation of investment in the environment.

For the weak sustainability scenario we assume the implementation of higher energy taxes for coal, oil, natural gas and electricity consumption than planned in the "Directive on minimum rates for energy taxation", which by many institutions, such as the European

Environmental Bureau (EEB, 2003) is heavily criticised as having to little expected impact on energy prices and thus creating not enough incentive for substantial changes of the energy system towards sustainable development.

A further reaching ecological fiscal reform (including taxes on material inputs) is assumed to be part of the strong sustainability scenario (see below).

Public procurement

First regulations and standards for public procurement to purchase eco-efficient products and services are assumed to be in place in the weak sustainability scenario.

7.3.3 Command and control instruments

The following regulatory instruments are assumed to be implemented in the weak sustainability scenario:

- Regulations limiting the use of natural resources with high potential of environmental burden
- Regulations forcing producers to use the best available technologies (in terms of resource efficiency).
- Full implementation of the concept of “Integrated Product Policy (IPP)”, specifically targeted at the reduction of primary resource inputs for manufacturing processes.

7.4 Summary of the weak sustainability scenario

The following table summarises the key components of the weak sustainability scenario:

***Table 9*: Summary table weak sustainability scenario**

Targets	Overall resource use	Continued de-coupling of economic growth from use of natural resources (materials and energy) Small reduction of overall resource use in absolute terms (absolute dematerialisation)
Assumed sectoral developments	Energy	Total energy use stays more or less constant on levels of 2003. Fossil fuels remain the dominating category of energy supply until the year 2020, as energy prices remain relatively low. Natural gas significantly increases its importance, in particular for electricity production. Trend of decreasing domestic extraction of fossil energy carriers continues. Growth in hydroelectricity and other renewable forms of generation is modest, primarily due to cost considerations.

		Significant improvement of the energy intensity ratio.
	Industry	Creation of markets for sustainable products in some areas of the manufacturing industry (e.g. high-tech industry, automobile industry). Continuing of the general trend of raising material and energy efficiency in the manufacturing sectors. No radical changes of the resource base for manufacturing purposes from non-renewables to renewables, due to continued low prices for fossil fuels.
	Transport	Stabilisation of passenger and freight transport (and respective levels of energy consumption) at the levels of the end 1990s. Increasing demand for mobility limits the positive impacts of policy measures on overall resource demand. Road freight will remain the most important means of transport to the detriment of rail and inland shipping.
	Agriculture	Full implementation of the CAP reform, in particular system of decoupling of grants. Lower cereal price support, leading to a significant reduction in the total area grown with cereals. Increased energy crop production. Increased voluntary set-aside (abandonment of land). Decrease of production volumes on the aggregated level.
	Fisheries	Implementation of the new Common Fishery Policy (CFP), promoting the sustainable management of fish stocks. Further decline of open-sea fish catch. Increasing aquaculture production.
	Voluntary instruments	Implementation of a labelling system for life-cycle wide material inputs for all consumer products. Extension of eco-audit schemed to include dematerialisation aspects

Policy instruments on the macro level	Market-based instruments	Reform of the subsidy system Ecological fiscal reform focusing on energy taxes
	Regulatory instruments	Limiting the use of natural resources with high potential of environmental burden Regulations forcing producers to use the best available technologies (in terms of resource efficiency). Full implementation of the concept of "Integrated Product Policy (IPP)".
Sectoral policy strategies	Energy	Rebalance supply side policies in favour of demand side policies Introduction of higher energy taxes and other parafiscal levies, with the clear goal of a reduction of energy consumption. Active support for increased shares of renewable energy resources in total energy consumption.
	Industry	Stimulating demand for eco-efficient products Fiscal incentives, environmental regulation and reduction of market uncertainties to foster creation of key markets for sustainable products and services.
	Transport	Introduction of a framework for transport charges ("road pricing") to ensure that prices for different modes of transport, reflect their costs to society. Harmonisation of fuel taxation for commercial users, in particular in road transport. Giving priority to infrastructure investment for public transport and for railways, inland waterways, short sea shipping and intermodal operations. Improve transport systems by addressing missing transport links, developing open markets and co-operation at EU level (e.g. railway liberalisation, air traffic systems).
	Construction	Funds and subsidies supporting new resource-extensive solutions and the development of new eco-efficient and renewable building materials. Public procurement considering requirements of eco-efficiency in construction. Taxes and other regulatory mechanisms at the EU, national and regional levels Urban planning instruments making sustainability standards a

		condition for construction permits.
	Agriculture	Full implementation of instruments of CAP reform, in particular concept of “decoupling” grants from production Linking grants to statutory environmental, food safety, animal health and welfare and occupational safety standards (cross-compliance).
Specifics for Accession Countries	Targets	Same basic resource use reduction targets as set for EU countries
	Developments	Energy sector: Energy consumption will slightly increase; energy intensity improvements higher than in Western European countries due to replacing of old technologies Transport sector: Increase of transport activities (compared to stabilisation in Western Europe) due to high demand caused by continued economic growth and restructuring
	Policy instruments	Same policy instruments as detailed for Western European countries

8 Strong sustainability scenario

8.1 Targets for resource use reduction

The general reference for the setting of reduction targets in the strong sustainability scenario is the Factor 10 concept (Factor 10 Club, 1995; Schmidt-Bleek, 1994), which demands a general reduction of anthropogenic material extraction by a Factor of 2 worldwide and a Factor of around 10 for industrialised countries up to the year 2050 (over the 1990 levels). Calculated on an annual basis, this transforms into the goal of increasing resource productivity by around 4.5% p.a.

Considering that the scenarios in MOSUS are formulated up to the year 2020, this would imply a general reduction goal of around 30-40% in absolute terms compared to the year 2003.

This reduction goal should in particular be implemented for the use of non-renewable resources, above all fossil fuel energy carriers, in order to reduce GHG emissions.

8.2 Key sectoral developments and sectoral policy strategies

8.2.1 Energy

In the strong sustainability scenario we assume that major technological breakthroughs will occur in the energy sectors and novel and environmentally friendly energy forms, such as hydrogen and methanol, will significantly gain in market shares. Significant price increases for fossil fuel energy carries will be observed due to the implementation of high energy taxes, which will support these trends. There will be a high growth in the contribution of hydroelectricity and other renewable forms of energy generation, which will make a significant contribution to total energy supply. The additions will mostly concern wind and solar power. A significant growth in electricity generation by biomass generation will be observed. These structural changes in the energy sector will result in a substantial reduction in fossil energy use. Domestic extraction of fossil energy carriers will significantly decrease and also import dependency will be reduced. Energy intensity ratios will improve even more rapidly than in the weak sustainability scenario. All these developments will cause a significant absolute reduction in energy consumption in both Western and Eastern Europe.

8.2.2 Industry and manufacturing

In the strong sustainability scenario, higher prices for fossil fuels will lead to high material and energy efficiency gains and support an increased substitution of bio-resources for non-renewable raw materials in production chains. New technologies, such as micro technologies, new process technologies and new high-tech materials will significantly reduce the amount of raw materials needed for manufacturing purposes.

Policy will actively support this process through changes in the regulatory framework, cost internalisation measures for non-renewable resources and fossil energy and support of research in new resource-saving technologies. All these developments will support a process of absolute dematerialisation of the European economy.

8.2.3 Transport

Concerning transport policies in the strong sustainability scenario, a similar set of measures and instruments as described in the weak sustainability scenario is assumed to be implemented, but with more stringent meaning. Thereby, the goal of an absolute reduction of transport activities both concerning passenger and freight transport will be achieved.

Road pricing together with high taxation of fossil fuels will fully reflect costs of transportation activities to society and will significantly increase costs of both passenger and freight transport. This will reduce private demand for car and air transport and increase demand for alternative modes of freight transport. Together with a strong public support for investments in infrastructure for public transport and for railways and inland waterways, a shift in the overall structure of the transportation system will be achieved. Furthermore, it is assumed that the rapid growth in the service sectors and the high value added manufacturing activity in the EU economy contributes to the overall reduction of transport activities, as these sectors are less freight intensive than the more traditional basic manufacturing and extraction activities.

8.2.4 Construction

In the strong sustainability scenario, similar instruments as mentioned in the weak sustainability scenario are assumed to be in force, but having a stronger focus on the goal of absolute dematerialisation in the construction sector:

- Urban planning instruments making standards for resource extensive construction and waste minimisation a condition for construction permits.
- High taxes and other regulatory mechanisms at the EU, national and regional levels on resource and pollution intensive construction materials.
- Funds and subsidies supporting new resource-extensive solutions and the development of new eco-efficient and renewable building materials
- Public procurement setting examples by considering high standards and latest technologies in its construction-related activities.

8.2.5 Agriculture

In the strong sustainability scenario, the major policy objective (in addition to the measures considered in the weak sustainability scenario) in the agricultural sector is assumed to be the transformation towards organic agriculture. Concerted efforts are assumed to be undertaken, including the European Commission, Member States, consumers, farmers and industry to significantly expand organic agriculture in total agricultural area of the EU. It is assumed that on the EU level, a minimum goal of 20% organic agriculture is introduced. In some member states, where organic agriculture already had a significant market share at the end of the 1990s, an even larger share is supposed to be held by the organic farming sector. Main policy measures to support this transformation will include:

- Promotion and information campaigns.
- Ensuring traceability and organic food authenticity.
- Harmonisation of control procedures and accreditation.
- Funding of research in organic farming.

For Eastern European countries, this development will imply that today's relatively energy and material-extensive production forms will be maintained, transforming the agricultural sector towards sustainability without going through the phase of highly industrial agriculture with high material and energy inputs.

8.3 Policy instruments on the macro level

8.3.1 Voluntary instruments

The following two voluntary instruments are assumed to be in force in the strong sustainability scenario:

- Implementation of a labelling system for life-cycle wide material inputs for all consumer products
- Implementation of extended producer responsibility (EPR) to include producer's responsibility, physical and/or financial, for a product also at the post-consumer stage of a product's life cycle. Lasting and substantial environmental improvements in product systems, including suppliers, designers, manufacturers, distributors, retailers, customers, recyclers, remanufacturers, and disposers.

8.3.2 Market-based instruments

Subsidies

Alongside the abolition of ‘perverse subsidies’ formulated for the weak sustainability scenario, the introduction of new forms of subsidies dependent on the material intensity of an industry is suggested for the strong sustainability scenario. Industries with low material input levels or industries striving for a reduction of material input levels would thus be eligible for subsidies, whereas industries with high material inputs would not. This will create new financial incentives to reduce resource use.

Ecological fiscal reform

In the strong sustainability scenario, the ecological fiscal reform is assumed to consist of both an increase in energy taxes and the introduction of a complementary material input tax (MIT), placing a certain amount of money on each ton of total material requirement. The taxation of the extraction of natural resources (except water and air) needed to produce domestic goods and services as well was imported ones will lead to the internalisation of external costs associated with it and thus to higher input costs. As a consequence thereof, production will be faced with increased incentives to reduce material input. This will be done in the most efficient way as long as the costs of reducing material input are lower than the additional costs imposed by the MIT. Additionally, since some of these increased costs will be shifted to the consumers, the MIT will act as a tool for differentiating between resource intensive and less resource intensive products. The associated price signal will have a positive effect on consumer choice for goods and services with a lower total material requirement.

Trading system for material input permits

As an alternative to the introduction of a material input tax (MIT), a system of tradable material input permits according to the ‘cap-and-trade’ approach could be introduced, which would set an overall limit for material extraction and would require all actors to acquire a share in this total before they can use material inputs. The resource use limit would be introduced according to the macroeconomic reduction goal (e.g. a factor of X) and translated into permits that could either be allocated free-of-charge by the public authorities or auctioned. Firms whishing to move primary material will then be required to return a corresponding amount of certificates to the issuing authority in exchange. In order to achieve a reduction in material input by a factor of ten within the next 50 years, the quantity of certificates would need to be reduced by about 5% each year. The price increase associated with such a reduction in supply of certificates will result in further increased incentives to reduce material input, either by using less primary materials, more recycled materials or by switching to new product designs that require diminished resource flows.

Public procurement

Strong regulations for public procurement are assumed to be implemented by public authorities, which enforce purchasing exclusively resource-efficient products and services.

8.3.3 Command and control instruments

In the strong sustainability scenario, the following regulatory measures are assumed to be in place:

- Input regulations on production processes that completely prohibit the use of certain resources that are associated with a high environmental burden.
- Production quotas for highly material intensive products.

8.4 Summary of the strong sustainability scenario

The following table summarises the key components of the strong sustainability scenario.

Table 10: **Summary table strong sustainability scenario**

Targets	Overall resource use	Strong de-coupling of economic growth from use of natural resources (materials and energy) Reduction of overall resource use in absolute terms (absolute dematerialisation) following "Factor 10" requirements, e.g. a 30-40% reduction in absolute terms until 2020.
Assumed sectoral developments	Energy	Major technological breakthroughs in the energy sectors with environmentally friendly energy forms, such as hydrogen and methanol, significantly gaining in market shares. Significant price increases for fossil fuel energy carries due to the implementation of high energy taxes. High growth in the contribution of hydroelectricity and other renewable forms of energy generation. Substantial reduction in fossil energy use. Significant absolute reduction in energy consumption in Western Europe.
	Industry	High material and energy efficiency gains due to high energy prices. Increased substitution of bio-resources for non-renewable raw materials in production chains. Significant reduction of raw material input due to new

		technologies, such as micro technologies.
	Transport	Absolute reduction of transport activities both concerning passenger and freight transport. Full reflection of costs of transportation activities to society through road pricing together with high taxation of fossil fuels. Significant increase in costs of passenger and freight transport, reducing private demand for car and air transport and increasing demand for alternative modes of freight transport. Shift in the overall structure of the transportation system towards public transport, railways and inland waterways.
	Agriculture	Full implementation of the CAP reform, in particular system of decoupling of grants (as in weak sustainability scenario). Strong support for organic agriculture, leading to an average EU share of 20% in total agricultural area.
Policy instruments on the macro level	Voluntary instruments	As in weak sustainability scenario, but additionally: Implementation of extended producer responsibility (EPR) to include producer's responsibility, physical and/or financial, for a product also at the post-consumer stage of a product's life cycle.
	Market-based instruments	Reform of the subsidy system as in weak sustainability scenario, but including introduction of new forms of subsidies dependent on the material intensity of an industry. Ecological fiscal reform focusing on energy taxes and introducing a material input tax (MIT) Alternatively to material input tax: introduction of a system of tradable material input permits.
	Regulatory instruments	In addition to weak sustainability scenario: Input regulations on production processes that completely prohibit the use of certain resources that are associated with a high environmental burden. Production quotas for highly material intensive products.
Sectoral policy strategies	Energy	Instruments as in weak sustainability scenario, but with more stringent means (e.g. higher energy taxes, etc.).
	Industry	Changes in the regulatory framework to support renewable and resource efficient raw materials Cost internalisation measures for non-renewable resources

		and fossil energy (in particular, taxes). Substantial support of research in new resource-saving technologies.
	Transport	Measure as in weak sustainability scenario, but with more stringent means Full reflection of costs of transportation activities to society through road pricing together with high taxation of fossil fuels. Strong public support for investments in infrastructure for public transport and for railways and inland waterways.
	Construction	Urban planning instruments make standards for resource extensive construction and waste minimisation a condition for construction permits. High taxes and other regulatory mechanisms at the EU, national and regional levels on resource and pollution intensive construction materials. Public procurement sets examples by considering high standards and latest technologies in its construction-related activities.
	Agriculture	In addition to weak scenario assumptions: Strong support for transformation towards organic agriculture, through: • Promotion and information campaigns • Ensuring traceability and organic food authenticity • Harmonisation of control procedures and accreditation • Funding of research in organic farming
Specifics for Accession Countries	Targets	Same basic resource use reduction target than for Western EU countries
	Developments	Energy sector: “Leapfrogging” towards high share of renewable energy Agricultural sector: Transformation towards sustainable, resource-extensive agriculture without passing through phase of highly industrial and resource intensive agricultural production
	Policy instruments	Fostering transfer of most advanced environmental technologies from Western EU to new members

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Annex: Summary of screened policy documents

A. Documents of the European Union

European Sustainability Strategy „A Sustainable Europe for a Better World: A European Union Strategy for Sustainable Development" (Commission's proposal to the Gothenburg European Council)
COM (2001) 264 final, 2001

From the mentioned main threats to sustainable development, the following deal with the area of resource use (p.4). It is stated that the loss of **bio-diversity** in Europe has accelerated dramatically in recent decades. **Fish stocks** in European waters are near collapse. **Waste** volumes have persistently grown faster than GDP. **Soil loss** and declining fertility are eroding the viability of agricultural land.

The chapter "Limit **climate change** and increase the use of clean energy" states the following headline objectives:

- The EU will meet its Kyoto commitment. However, Kyoto is but a first step. Thereafter, the EU should aim to reduce atmospheric greenhouse gas emissions by an average of 1% per year over 1990 levels up to 2020.
- The Union will insist that the other major industrialised countries comply with their Kyoto targets. This is an indispensable step in ensuring the broader international effort needed to limit global warming and adapt to its effects.

These objectives shall be achieved by the following measures at EU level:

- Adoption of energy products tax directive by 2002. Within two years of this, the Commission will propose more ambitious environmental targets for energy taxation aiming at the full internalisation of external costs, as well as indexation of minimum levels of excise duties to at least the inflation rate.
- Phase out subsidies to fossil fuel production and consumption by 2010. Where necessary, flanking measures to help develop alternative sources of employment should be put in place. Analyse whether there is a need to create a stockpile of coal reserves, and whether or not we should maintain a minimum level of subsidised production for security of supply reasons. Commission proposal in 2001 for adoption by Council before the expiry of the ECSC Treaty in July 2002. Take account of the specific situation of some candidate countries in the accession treaties.
- Greenhouse gas emission reduction measures based on the outcome of the European Climate Change Programme. Specifically, the Commission will propose by end-2001 a proposal for the creation of a European CO_2 tradable permits system by 2005.
- Alternative fuels, including bio fuels, should account for at least 7% of fuel consumption of cars and trucks by 2010, and at least 20% by 2020. The Commission will make a proposal in 2001 for adoption in 2002. Clear action to reduce energy demand, through, for example, tighter minimum standards and labelling requirements for buildings and appliances to improve energy efficiency should be made.
- More support to the research, development and dissemination of technology on:
  – clean and renewable energy resources
  – safer nuclear energy, namely the management of nuclear waste." (pp.10)

In the chapter "Manage **natural resources** more responsibly" the following headline objectives are pointed out:

- Break the links between economic growth, the use of resources and the generation of waste.
- Protect and restore habitats and natural systems and halt the loss of biodiversity by 2010.
- Improve fisheries management to reverse the decline in stocks and ensure sustainable fisheries and healthy marine ecosystems, both in the EU and globally.

These objectives shall be achieved by the following measures at EU level:
- Develop an Integrated Product Policy in co-operation with business to reduce resource use and the environmental impacts of waste.
- EU legislation on strict environmental liability in place by 2003.
- The Commission will establish a system of biodiversity indicators by 2003.
- The Commission will propose a system of resource productivity measurement to be operational by 2003.
- In the mid-term review of the Common Agricultural Policy, improve the agri-environmental measures so that they provide a transparent system of direct payments for environmental services.
- In the 2002 review of the Common Fisheries Policy, remove counter-productive subsidies which encourage over-fishing, and reduce the size and activity of EU fishing fleets to a level compatible with worldwide sustainability, while addressing the consequent social problems." (p.12)

Presidency Conclusions Göteborg European Council,
15 and 16 June 2001
http://eu2001.se/static/eng/eusummit/conclusions_htm.asp

Under chapter II "A Strategy for Sustainable Development" the presidency conclusions invite the industry to take part in the development and wider use of environmentally friendly technologies in sectors such as energy and transport. It stresses the importance of decoupling economic growth from resource use.

In the chapter "a new approach to policy making" it is states that "getting the prices right" is important to reflect the true costs of activities to the society. The presidency asks the council to take due account of energy, transport and environment in the 6th Framework Programme for Research and Development.

The conclusions define four **priority areas**: climate change, transport, public health and natural resources.

In the area **climate change** the conclusions state the following:

The conclusions state that the conference of the parties in mid-July in Bonn must be a success. The Community and the Member States are determined to meet their own commitments under the Kyoto Protocol. The Commission will prepare a proposal for ratification before the end of 2001 making it possible for the Union and its Member States to fulfil their commitment to rapidly ratify the Kyoto Protocol. The European Union will work to ensure the widest possible participation of industrialised countries in an effort to ensure the entry into force of the Protocol by 2002. To enhance the Union's efforts in this area, the European Council:

- reaffirms its commitment to delivering on Kyoto targets and the realisation by 2005 of demonstrable progress in achieving these commitments. Recognising that the Kyoto Protocol is only a first step, it endorses the objectives set out in the 6th Environmental Action Programme;

- furthermore reaffirms its determination to meet the indicative target for the contribution of electricity produced from renewable energy sources to gross electricity consumption by 2010 of 22 percent at Community level as set out in the Directive on Renewable Energy;

- invites the European Investment Bank to promote the Sustainable Development Strategy and to cooperate with the Commission in implementing the EU policy on climate change.

On the management of **natural resources** it states:

The relationship between economic growth, consumption of natural resources and the generation of waste must change. Strong economic performance must go hand in hand with sustainable use of natural resources and levels of waste, maintaining biodiversity, preserving ecosystems and avoiding desertification. To meet these challenges, the European Council agrees:

- that the Common Agricultural Policy and its future development should, among its objectives, contribute to achieving sustainable development by increasing its emphasis on encouraging healthy, high quality products, environmentally sustainable production methods, including organic production, renewable raw materials and the protection of biodiversity;

- that the review of the Common Fisheries Policy in 2002 should, based on a broad political debate, address the overall fishing pressure by adapting the EU fishing effort to the level of available resources, taking into account the social impact and the need to avoid over-fishing;

- that the EU Integrated Product Policy aimed at reducing resource use and the environmental impact of waste should be implemented in cooperation with business;

- halting biodiversity decline with the aim to reach this objective by 2010 as set out in the 6th Environmental Action Programme.

Integrating environment into Community policies is seen as an important objective: The Council is invited to finalise and further develop sector strategies for integrating environment into all relevant Community policy areas with a view to implementing them as soon as possible and present the results of this work before the Spring European Council in 2002. Relevant objectives set out in the forthcoming 6th Environmental Action Programme and the Sustainable Development Strategy should be taken into account.

Green Paper on Integrated Product Policy
COM (2001) 68 final, 2001

Integrated Product Policy (IPP) is an approach that seeks to reduce the environmental impacts of products along their life cycle, from the raw materials extraction to the waste management stage.

Considering that the rising consumption of products is also at the origin of most of the pollution and depletion of resources caused by our society, the Green Paper defends that products of the future shall, among others, use fewer resources, proposing a strategy to strengthen and refocus product-related environmental policies to promote the development of a market for greener products. Its central element is the question how the development of greener products and their uptake by consumers can be achieved most efficiently, presenting a mix of instruments which can contribute to do so.

Promotion of environmental quality of goods and services is understood as using market forces to the large possible extent, and thus the instruments probably most effective are those that help to "get the prices right". In line with this, the Green Paper considers that the environmental performance of products can best be optimised once all prices reflect the true environmental costs of products during their life-cycle, the most powerful instrument considered to be the correction of the market failures ("external costs") according to the polluter pays principle. The investigation of the "external costs" should assist in identifying the main stages of the products life cycle where these costs occur and in conceiving measures to better take them into account in the price of new products.

It is considered to be important that stakeholders have and use information on the life-cycle environmental impacts of the products about which they are deciding, especially:

- Manufacturers should know the environmental profile of the materials and components there are incorporating in their products;
- Designers should examine life-cycle impacts of their choices and have easy access to existing life-cycle data and methodologies to do so.

One form of information considered to be particularly effective in promoting life cycle thinking among companies is ecodesign guidelines. In terms of resource use, we could emphasize the following ones:

- Optimisation of the service provided by the product;
- Conservation of resources.

Design concepts to achieve these goals include:

- Design for cleaner production (source reduction leading to reduced materials amounts);
- Design for the use of renewable materials (leading to a decreased use of non renewable materials);
- Design for reuse and recycling (reduced material complexity, use of recyclable and recycled materials, closed loop re-manufacturing schemes)
- Design for simplicity (should lead to lower material amounts and easier disassembly).

Other incentive that could be relevant for resource use is the idea, considered as highly desirable, that in the near future the concept of "environmental soundness" must be associated systematically with products meeting a European standard, along the current concepts of "fitness for use" and "safety for the user".

The conclusions of the conference "The IPP Green Paper: Launching the Stakeholder Debate" (European Commission, Brussels, 8-9th March, 2001) state that "the relationship between IPP and the resource thematic strategy as announced in the 6th Environment Action Programme needs to be better developed and communicated, especially with respect to targets."

Initially, a White Paper on IPP was expected in 2003. But instead, the European Commission decided to publish an IPP Communication (announced to the next 27th May, 2003), where a set of instruments to be used and a group of the most important product categories to be addressed will be defined. Also, the document is expected to set a path and follow up in order to define targets in the near future, the ultimate goal being to contribute to the future EU Directive on Resource Use, to be developed in the next 4-5 years.

Conclusions from the Barcelona Summit and environment-related structural indicators

SN 100/1/02 REV 1, March 2002

In the final document of the European Council held in Barcelona 15 - 16 March 2002, the European Council lists a number of key issues to be addressed in the implementation of a sustainable development strategy. One of these issues is the “conservation and sustainable management of natural and environmental resources”. Promoting sustainable consumption and production patterns through the use of more efficient and environmentally friendly technologies would help decoupling economic growth from the use of natural resources and environmental degradation. The development of appropriate indicators to monitor a sustainable management of natural resources is demanded. However, there are no quantitative reduction targets listed in the document.

The environment-related headline indicators selected for the 2003 spring review are the following:

- **Combating Climate Change**
  Greenhouse Gases Emissions (6 Gases); Distance to Target, sectoral breakdown and related to GDP (= carbon intensity of the economy)
  Share of renewables in electricity consumption
- **Ensuring sustainable transport**
  Volume of transport related to GDP (Passengers km, freight in tonne km)
  Modal split of transport (passenger’s km, freight in tonne km)
- **Addressing threats to public health**
  Urban population exposure to air pollution (PM10, Ozone, SO2 and NOX)
  Residues of pesticides in fruit, vegetables and cereals
- **Managing natural resources more responsibly**
  Municipal waste collected and landfilled and incinerated in kg/inhabitant and related to GDP
  Sustainability of fishing for selected species in EU Marine Waters (fish stocks in European marine waters)
  Water use by sector
  Protected areas (for biodiversity)
- **General economic background**
  Energy intensity of the economy (energy consumption/GDP)

In the chapter “managing natural resources more responsibly”, no comprehensive resource use indicator is part of the set.

In the “open list” of environment-related headline indicators, several are related to the issue of resource use, such as intensity of economy-wide material use and resource productivity by type of resource.

Environment 2010: Our future, our choice: The 6th Environmental Action Program

Decision 1600/2002/EC, 22 July 2002

The 6th Action Program gives primary importance to the idea of decoupling environmental problems and economic growth. With more eco-efficient business "the same or more products would be produced with less input and less waste". The over-use of renewable and non-renewable resources is one of the important problems identified. In terms of objectives, the 6th Program wishes "to ensure that the consumption of resources does not exceed the carrying capacity of the environment". Resource efficiency, dematerialisation and waste prevention are the main means advanced to reach this goal. Indirect consumption of resources is acknowledged with the awareness that we have an international responsibility: "we consume a major, some would say unfair, share of the planets renewable and non-renewable resources". The 6th Program also recognises that the use of many renewable resources is above the replenishment rate. The link between the current rate of use of non-renewable resources and impacts is fully recognised.

The Program calls for the development of a thematic strategy (see next summary) to establish a consistent analytical framework and to identify and implement specific policy measures to reduce the consumption of specific resources. This strategic approach includes improving the implementation of existing legislation, integration of the mentioned concerns in other policies, encouraging the market to work for the environment, incentives for companies and development of information.

In the area of resource use this strategy would include:

- Research and technology development for resource efficiency in products and processes;
- Best practice programs;
- Shift of tax burden from labour to the use of natural resources and other economic instruments such as tradable permits to favour resource efficiency;
- Removal of subsidies that encourage overuse of resources;
- Integration of resource efficiency goals into other programs like IPP, eco-labelling, green procurement, and environmental reporting.

A call is made towards all public and private levels, pointing out the benefits of improving European resource efficiency for the European competitiveness and innovation.

Monitoring is important to measure present situation and trends and the progress made. Geographical distribution, causes behind problems and the socio-economic trends need to be taken into account. The 6th Program has quantified goals in the area of outputs: for instance the reduction of 20-40% of greenhouse gas emissions over 1990 by 2020 and the reduction of waste quantities by 20% by 2010 compared to 2000. On the input side, although the general objectives in terms of sustainable resource use are clearly stated, quantified targets are still missing. Monitoring the progress made in the area of resources use follows the goal of preventing pollution at source.

Thematic Strategy on the Sustainable Use of Natural Resources

http://europa.eu.int/comm/environment/natres/

The sustainable use of natural resources is one of 6 thematic priorities in the 6th Environmental Action Plan. A web page has been set up at the EU-server, providing

background documents and studies commissioned by the EU on the issue of resource use. The background document states:
„Resources are the backbone of every economy. In using resources and transforming them capital stocks are built up which add to the wealth of present and future generations. On the other hand, the dimensions of current resource use are such that the chances of future generations and the developing countries to have access to their fair share of scarce resources is endangered. Moreover, the consequences of our resource use in terms of impacts on the environment may induce serious damages going beyond the carrying capacity of the environment. These effects risk to be aggravated once the developing world has taken up growth and resource use similar to the industrialised countries."

The following characterisation of the current situation and likely trends can be listed:

(1) The use of resources will increase between 2002 and 2020, despite the trend that the energy and material intensity of the economy decreases.
(2) Scarcity of resources, such as fossil fuels and metals, is not a major concern, since proven reserves are not diminishing or even growing (fossil fuels). On the other hand, resources such as fish, forests, and space (including fertile soil) are threatened by scarcity and by pollution and overexploitation of sinks.
(3) In order to achieve decoupling of economic growth and environmental impact, the eco-efficiency of currently used resources must be improved drastically. In order to achieve this resource saving and resource re-use are important elements, as well as modified resource use (e.g. using fossil fuels to produce a clean energy carrier such as hydrogen) and resource substitution (e.g. using wind and solar instead of fossil fuels).
(4) Incremental technological progress in not sufficient to achieve the decoupling objective. Leapfrogging technologies, system innovations, including institutional changes, are required.
(5) The relative low price of (fossil) energy seems to be a strong driver for resource use. Therefore, creating incentives for saving resources and sinks may be a priority.

A stakeholder workshop within the thematic strategy was held in Brussels on 10th April, 2002. Several important points were discussed:

- It was suggested that resource use in itself is not the problem but rather the environmental impacts of resource use, an exception being the overuse of some environmental resources such as fish, fresh water, timber, etc.
- It was highlighted that it is not yet clear whether the thematic strategy would understand this de-coupling objective as a relative de-coupling, i.e. that environmental impacts increase more slowly than the economy, or an absolute de-coupling, i.e. that environmental impacts decrease even in a growing economy.
- The necessary trade-off between some resources and land-use was explained to be the reason for considering space (in terms of land) to be a key resource.
- The main challenge was explained as being the need to determine the appropriate framework to achieve the de-coupling objective. This would need data gathering and the determination of appropriate indicators. In addition steps would need to be taken to create the necessary conditions to encourage considerable advances in innovation. Finally, the prices of resources may need to be changed to better reflect the environmental impact of their extraction, use and disposal/recovery.
- Concerning European responsibility for global environmental issues, the Commission representatives stated that there was no intention to propose to take Europe down a path, which the rest of the world would not follow. However, it was stressed that by making Europe a world leader in new technologies it would be possible to achieve major environmental benefits whilst ensuring European industry remains competitive

on a global market. Although most instruments could only be applied within the EU it was suggested that the EU could influence experiences in the rest of the world by ensuring the transfer of technology and best practices.

- With regard to global assessment, the need to ensure that hidden material flows, including from imports and exports, are included in data analysis, was particularly highlighted. Without including such flows it was suggested that the wrong conclusions regarding the sustainability of the EU might be drawn.
- It was generally accepted that if a target is to be set an appropriate indicator also has to be defined. The work on indicators could be built on the basis of existing work carried out by the OECD, the European Environment Agency, and Eurostat.

B. National documents

B1. EU countries

Note: Summaries of national documents of member countries of the European Union are only given for countries, which explicitly address the issue of resource use.

<u>Germany</u>

National Strategy for Sustainable Development (2002)

The German National Sustainability Strategy is one of the most explicit in addressing the issue of resource use and the demand for its reduction. Under the headline of “Conservation of resources: Making prudent and efficient use of scarce resources”, the Strategy states (p. 93):

“The Earth's stocks of raw materials are limited. Raw materials that we consume today are no longer available for future generations. Prudent and efficient use of scarce resources is therefore a key to sustainable development. Energy consumption is a central focus in this respect. Above all, the model of sustainable development challenges the industrialized countries to scale down their consumption of scarce and finite energy-producing raw materials as well as other resources. Germany can attest to two positive achievements in this respect: in the 1990s, its primary energy consumption fell in absolute and per capita terms by around 5%.
A crucial basis for reduction of absolute consumption is the increasingly efficient use of energy and other raw materials. This is expressed in the key indicators "energy productivity" and "resource productivity". Just as labour productivity measures economic output per hour worked, so energy productivity expresses the economic output achieved by using a particular quantity of energy. In past years it has been possible to raise this continuously. Raw material productivity has also shown positive development. Important progress has been achieved through the avoidance of waste and greater use of closed-loop management of raw materials.
This improvement in efficiency is something that should continue. By 2020, we should aim for an approximate doubling of energy- and raw materials productivity in relation to 1990 and 1994 respectively. This means that with the same quantity of energy, we will be able to produce around double the amount of output in the year 2020 as we did in 1990. In the long term, the improvements in energy and raw materials productivity should be guided by the "Factor 4" vision.”

The German Sustainability Strategy therefore is one of the few documents, which explicitly addresses the Factor 4 debate and gives quantitative targets for de-coupling of resource use from economic growth.

Sweden

Sweden's National Strategy for Sustainable Development (2002)

Sweden's Strategy states that the overall objective of environmental policy is to hand over a society to the next generation in which the major environmental problems have been solved. This means that environmental impacts must be reduced to sustainable levels. Sustainable use of natural resources is considered the most important element of preserving biological diversity.

Sustainable forestry, agriculture and fisheries are considered the main areas to focus policy measures, but other sectors such as energy, tourism and infrastructure are also assumed to be important.

Three strategies are formulated as guidelines for efforts to achieve the environmental quality objectives (p. 20f):

1. "more efficient use of energy and transport – in order to reduce emissions from the energy and transport sectors;
2. non-toxic and resource-efficient cycles, including an integrated product policy – in order to create energy- and material efficient cycles and reduce diffuse emissions of pollutants; and
3. efficient management of land, water and the built environment – with a view to increased concern for biological diversity, the cultural environment and human health, efficient management of land and water, environmentally sound spatial planning and a sustainable urban structure."

Denmark

National Strategy for Sustainable Development (2002)

The Danish Strategy dedicates a whole chapter to the issue of „Resources and resource efficiency". As basic principles, the Danish Strategy states that consumption must be increasingly based on renewable resources and recyclable materials, but without exceeding their limit for regeneration. The use of non-renewable resources should take into account total volumes and possibilities of replacing those resources by other materials.

The main goal of the sustainability strategy is to increase resource efficiency during the course of one generation. As a long-term target to achieve sustainable development and sustainable production and consumption patters, resource consumption should be limited to about 25% of the current level, which would represent an absolute dematerialisation by a factor of 4.

It is stated that Denmark has already made significant progress towards a more sustainable use of natural resources, for example through specific initiatives in the energy sector, which lead to the situation, in which energy consumption stayed fairly constant during the 1990s despite permanent economic growth. In addition, water consumption has dropped

considerably over the last decade. However, more drastic steps are assumed to be necessary in order to ensure sustainable use of natural resources.
Resource consumption in the construction sector is considered vital to society's total resource consumption. Construction and operation of buildings are reported to account for half of Denmark's energy consumption, while consumption of construction materials constitutes the major part of raw materials consumption. In addition, construction generates large amounts of waste. However, 90% of construction waste is recycled, which is a long-standing tradition in Denmark (in 2000, recycling amounted to 65% of total waste amounts).

B2. Accession countries

Slovenia

National Environmental Action Plan (NEAP) (1999)

The NEAP is intended as a document to direct environmental policy towards priority goals and formulate objectives and action plans, in accordance with Slovenia's capacities and foreign support. The fundamental objectives of the NEAP are to guarantee a better living environment in Slovenia and to establish the environment as a limiting, but stimulating factor of development.

The NEAP identifies the following three main areas for action on the national level: aquatic environment, waste management and the conservation of biodiversity. In addition, the NEAP also covers air, soil and forest protection, noise, radiation and risk management. The use of natural resources is not regarded as one of the main problem areas.

Five sectors, which have or are likely to have the greatest impact on the environment, are discussed separately in the NEAP. These sectors are: industry and mining, the energy sector, agriculture and forestry, transport and tourism.

Concerning activities of industry and mining, the basic goal of the NEAP is to lay down framework conditions in accordance with the principles of sustainable development, which should facilitate economic and social development without consequences for the environment. Key issues for industry and mining are:
1. Sustainable use of natural resources,
2. Prevention of pollution through better management and control,
3. Prevention of waste generation and/or safe disposal of waste,
4. Enforcement of the sustainable conduct of companies.

Technological modernisation for the reduction of environmental burden and for the wise use of natural resources is seen as a crucial factor in future economic development. "Slovenia is about to replace many of its obsolete technologies. This is an important opportunity to apply environmental protection concepts, if the replacement is carried out in an environment-friendly manner and by consistently observing the principle of prevention. The modernisation and optimisation of technological processes are important for their positive economic effects, owing to the introduction of the more rational use of raw materials and energy" (p.25).

Economic instruments are regarded as the main mechanism to reach a transformation of production and consumption structures: "Economic instruments ensure the inclusion of environmental costs in the business costs of economic entities. The system of economic incentives has to be designed in such a way that it encourages manufacturers and consumers to use resources in a more environmentally successful manner. The application of economic instruments represents a source of revenue, which can be rationally used to cover the costs of environmental protection” (p.92).

<u>Poland</u>

Second National Environmental Policy (SecNEP) (2001)
Executive Program for the Second Environmental Policy (ExecProg) (2002)
The National Environmental Policy for the years 2003 – 2006 (NEP 2003) (2002)

The three documents contain provisions that are in line with the general concept of dematerialization and promoting policy of increasing resources productivity in products processing and consumption. The SecNEP is oriented to some extent towards a dematerialization strategy and policy, that means on increasing resources efficiency, energy saving, and reducing of waste-generation, particularly reducing packaging materials, waste collection for recycling, deposit-refund systems, but at the same time it hardly remarks other important areas of dematerialization such as: reducing transportation radius, regional distribution, products sharing, longevity or reparability of products. The SecNEP regards the increasing role of market forces and competition as a strategy for higher costs consciousness and a higher rate of innovation. It recommends using to the extent possible market instruments useful for dematerialization goals: voluntary agreements, environmental fiscal reform, energy taxes, and material input certificates. However none of these instruments have been implemented into practice up to the end of 2002.

The SecNEP claims that the scale of reduction of energy consumption (fuels, heating, technological processes) is unsatisfactory, and thereby a mechanism is needed that will better provide for reflection of environmental costs in energy prices first of all through imposing of product charges on fuels and energy carriers. Changing of the energy carrier structure toward using of energy from renewable sources is extremely important as an environmental policy goal.

The introductory chapter of the NEP2003 “Goals and attainments of systemic importance” includes comprehensive information about possible measures for market stimulation for environmental activities. Among many approaches enumerated in this section, it was few regarding directly to dematerialization of the economy and consumption. Two provisions are particularly remarkable (NEP2003; pages 4-5).

- the working group in the Ministry of Environment will be established for preparing assumption for Environmental Tax Reform which should be presented to the public in 2004 and could be implemented in Poland from 2005;
- the market support for discretional saving initiatives in using material resources (first of all natural and water resources, energy and fuels) will be created;
- the government will promote specific solutions for environmental farming, green energy production, thermo-renovation measures, and agglomeration public transport,
- the government will support implementing the pilot project of tradable permits mechanism for emissions of SO_2 by large emitters in energy and industry sectors in 2004,
- the government will support implementing the working mechanisms of tradable permits for emissions of SO_2, CO_2 and NO_x by other polluters in energy, industry and municipal infrastructure sectors successively from 2005 to 2009.

Those undertakings are made to get substantial results in dematerialization of production and consumption in Poland (NEP2003; pages 5).

Regarding the sustainable use of raw materials, processing materials, water and energy, the NEP2003 recommends four activities important for dematerialization processes in Poland (NEP2003; page 31):

- introducing into system of public statistics the indices characterizing water, material, and energy intensity in production sector,
- introducing of obligatory assessment of life-cycle of selected products running into market,
- creating a data base regarding the BAT approach for industry and services sectors, issuing recommendations for using of resources, energy and water in processing industry,
- introducing of recycling system of specific category of motor vehicles backed from exploitation.

The SecNEP as well as ExecProg and NEP2003 are to high extent declarative documents as regards the activities important for dematerialization processes in Poland. Since 1999 there was not much progress in putting the dematerialization concept into practice as a comprehensive system of activities. The ExecProg contains a number of specific undertakings aiming at the goals of the SecNEP. For each of activities the ExecProg specifies the responsible entity and the time in which the activity should be performed. Much of the important activities are to be implemented in the future: years 2004 – 2010, what is not beneficial to the implementing of dematerialization approach in Poland. The majority of dematerialization strategy goals, priorities and instruments are likely to be implemented not earlier than in 2005. The same conclusion is valid to implementing statistical mechanism allowing collecting data useful for objective and regularly assessing of progress in dematerialization of Polish economy and consumption. It is confirmed by analyzing of NEP2003 which is the newest of government documents describing Polish environmental strategy and policy goals for the years 2003-2010. However the NEP2003 in most distinctly way presents Polish dematerialization policy, implementation activities and instruments under circumstances resulting from accession to the EU in 2004.

Estonia

Estonian National Development Plan for Implementation of the EU Structural Fonds – Single Programming Document 2003-2006.

http://www.fin.ee/index.php?id=5119

On the **primary sector** this paper states that "efficient and sustainable forest management is hampered by the fragmentation of private forests, as well as by the lack of forestry-related skills and knowledge on the part of the forest owners. Fishing fleets need to be cut down if fish stocks are to be preserved". Further a "protection of valuable landscapes is impossible without stronger support for local economy".

On the **industry sector** the document lines out that 91% of the electricity in 2001 were produced by oil shale. "Development alternatives for electrical power generation would rely on the modernization of combustion technologies, a combined generation of electricity and heat and a more extensive utilization of renewable sources of energy".

The chapter on **natural environment and environmental infrastructures** shows a comparison on certain issues with the European Union. "In comparison to several central EU countries, biodiversity has survived relatively well in Estonia. Different types of protected

habitats amount to more than 10% of the territory of the country. The consumption of water in households (per inhabitant) is three times smaller than in the EU. The main problems involved in potable water are the lack of natural good-quality drinking water and the fact that in some areas pollution and out-dated water supply systems exist. While in Estonia the amount of untreated wastewater (2.6%) is smaller than the average indicator in the EU (19%), the quality of the cleaning process is insufficient in some cases.
In comparison with the EU average, the amounts of CO2 and SO2, emitted into the atmosphere in Estonia, are respectively two and six times that of the respective amounts in EU. The main sources of air pollution via SO2 and PM are energy production, heat production and the oil shale chemistry enterprises in Ida-Virumaa. The energy sector is the source of 91.8% of the total amount of CO2 emitted. A major share of waste generation (90%) is also attributable to oil shale mining, the oil shale chemical industry and oil shale energetics. Municipal waste makes up 3% in the total amount of waste. Where the collection of waste has been transferred to private hands over the last decade, the respective systems have developed fast. The renovation of municipal waste management systems has started and a national scheme for the collection of hazardous waste has been set in motion. So far, three landfills that meet EU requirements have been opened."

Past pollution is considered a major problem. Concerning the **future** "more attention should be paid to the prevention of problems in addition to the liquidation of immediate damage to the environment and investment into environmental technologies". Two important points mentioned in the document are the implementation of an existing programme for the elimination of air pollution and combining the generation of heat and electricity as well as utilising renewable resources of energy which should be implemented on "a larger scale".

National Environmental Strategy

http://www.agenda21.ee/english/index.html

In the introduction the strategy states that the last fifty years led to underdeveloped machinery and technology and an irrational use of natural resources. Sustainable use of natural resources is seen as of "utmost importance".
Main **priority environmental problems** identified by the strategy are: air pollution; past pollution; decrease in water quantity and quality of groundwater resources; irrational use, pollution and eutrophication of surface water bodies; decrease in reproduction and deterioration of the quality of fish stock; waste disposal; biological and landscape diversity and insufficient correspondence of built environment to environmental and health principles.
The following issues are seen as **main causes** for environmental problems: out-of-date technologies consuming large volumes of raw material and generating large quantities of waste; low level of public awareness; underdeveloped environmental-technical infrastructure and insufficiency of financial resources and management instruments.

In the field of **clean technologies** the following tasks are listed for the year 2010
- to introduce the best available technology and best environmental practices into production and everyday life;
- to consider environmental implications of the product in the product price throughout its life-cycle.

To reduce the negative effects of the **energy sector** the following targets are formulated:
Tasks by the year 2005
- to elaborate development trends in electricity production, taking into account environmental requirements;
- to introduce economic instruments that raise the efficiency of energy use;

- to reduce dust and ash emissions by 25% from 1995 levels;
- to terminate the use of high-sulphur fuel oil (sulphur content exceeding 2%).

Tasks by the year 2010
- to reduce emissions of pollutants in electricity production to a level harmonized with the European Union.

The primary **principles** that should be followed in the use of natural resources and environmental protection are:
- using best available technology which ensures sustainable use of natural resources, reduces the burden upon the environment and does not entail excessive costs on further development of the Estonian economy
- applying best available environmental practices

The following **measures** should be applied:
- technology-oriented measures which substantially change the structure of the production and consumption process and are the closest to the principles of sustainable development;
- volume-orientated measures which bring about a decrease in the use of raw materials, water and energy, thus reducing the overall volume of waste;
- measures that reduce the emission of pollutants (treatment facilities, recycling systems, etc.).

For the **sustainable use of natural resources** internationally accepted environmental principles and best practises in particular those accepted by the European Union should be integrated into environmental legislation and implementation. Foreign investment should be attracted for projects which ensure better use of natural resources as well as environmental improvement. Both the private and public sector should be modernised introducing environmentally sound technologies.

The main principles of using **economic instruments** are as follows:
- all the environmental protection costs incurred throughout the life cycle (production, distribution, use, final disposal) of the product, environmental damage and the value of natural resources used should be included in the price of the product;
- the revenue collected from the taxation of natural resources and environmental pollution will be used for solving environmental problems;
- common rules proceeding from environmental requirements of free market principles are valid for different polluters and users of natural resources.

Economic instruments should include:
- financial support from the state;
- pollution charges the stimulative effect of which will be improved and exemptions not corresponding to free market requirements withdrawn;
- charges for the use of natural resources;
- differentiation of taxes for the purpose of environmental protection;
- local taxes;
- pledge system (pledges for recycling packages, car tires, car bodies, accumulators, batteries, motor oil, etc.);
- environmental insurance (insurance for pollution risk).

Slovak Republic

Initial governmental undertaking pushing the Slovak Republic on the road to sustainable development is connected with implementation of AGENDA 21 into every day practice. In its resolution No. 655/1997 the government has appointed all ministers and heads of central administration bodies for applying and evaluating the SD indicators in the Slovak Republic. In 1999 the Council of Sustainable Development has been established which in turn had important role in preparation and adoption in 2001 the National Sustainable Development Strategy of the Slovak Republic. Preparation of this document has been proceeded by the elaboration of such documents as:

- The Strategy, Principles and Priorities of State Environmental Policy, which was approved firstly by the government and than later by the Council of the Sustainable Development in 1999;
- The National Environmental Action Programme, approved by the government in 1996,
- The II National Environmental Action Programme, approved by the government in 1999.

The National Sustainable Development Strategy has been ultimately approved by the Slovak Parliament in 2002.

All these documents have substantially contributed to developing and implementing of sustainable development in the Slovak Republic. The concept of sustainable development has been successively applied in dozens of cities, towns, villages and companies throughout the country. Many environmental programmes have been implemented with support of international and bilateral funds e.g.: the Programme of Village Restoring, the Renewable Energy Resources Programme, Aalborg Charter of SD Towns, the National Healthy Town Network, Brundland Town Programme. Many of Slovak companies have engaged into implementation of environmental management by adopting the ISO 14 000 standards.

In the preparation of the National Sustainable Development Strategy about 200 of specialists and independent experts representing all mayor groups of Slovak society: academics, central administration, self-governments, employers, NGOs etc have taken part. Thus this document expressed to large extent priorities and goals of the Slovak society. In the document basic orientation of the Slovak Republic to future development regarding the long-term and comprehensive pursuing the principle of sustainable development has been formulated.

The individual state administration bodies have initiated the elaboration of documents which are based on the sustainable development principle used to various sectors of the economy and horizontal areas e.g.:

- The Slovak Republik Mineral Raw Materials Policy, 1995
- Updated Energetic Concept for the Slovak Republic to 2005, 1997
- The Concept of Employment Policy to 2002, 1999, etc.

After approval of the Programme Declaration on Sustainable Development by the Slovak government in 1998, many cross-sectoral documents have been elaborated and approved, e.g.:

- The Concept of Decentralization and Modernization of Public Administration, 2000
- The Energy Policy of the Slovak Republic, 2000
- The Slovakia Territorial Development Concept 2001, 2001
- The National Regional Development Plan, 2001
- The National Programme for Acquis Communautaire, 2001.

Particularly most important for the nearest future of the Slovak Republic socio-economic development are the last two programmes because they are focusing on the policies and activities supporting sustainable development implementation in the period directly before the accession of the country to the European Union.

Generally afore mentioned documents do not regard directly the issues of using of material resources in production and consumption in the Slovak Republic apart from Mineral Raw Materials Policy (however, this document is only of historical importance). From this point of view the energy policy documents regards the issue of dematerialization and can support implementation of the concept into practice.

The majority of documents do not contain any strategies and policies directly requiring diminishing of material flows in the economy and consumption and how they could be implemented. However the problem of dematerialization in the economy is being seen and to some extent remarked.

Czech Republic

The State Environmental Policy, Ministry of The Environment of the Czech Republic, 1999:

The State Environmental Policy (SEP) is a strategic and binding document for the preparation of detailed programmes for individual environmental media and for tackling individual environmental issues. It sets out objectives for the integration of environmental concerns into sectoral policies e.g. energy, raw materials, transport, agriculture, etc. The SEP contains an analysis of the current state of the environment, which makes possible to set out the main directions and priorities of environmental policy in the years 1999-2005. Thus it is document which harmonises specific priorities of the Czech Republic with the requirements related to the accession of the country to the European Union in May 2004.

However, the SEP to some extent adopts or reflects the dematrialization concept as it is understood and adressed in relevant documents in the EU countries. As urgent structural problems in environmental protection the SEP quoted „inadequate restructuring of industry, high energy and raw material intensity in relation to gross domestic product". Among the internal and global aspects of environmental responsibilities of the Czech government the production, disposal and re-use of wastes were quoted. The problem to solve is highly specific waste production, a low proportion of selected and reutilized wastes and dominant role of landfilling in waste management. In chapter VI „Sectoral policy measures and objectives” crucial for the SEP usefulness as a base for undertaking adequate decision by users of the environment were included some provisions directly regarding dematerialization issue:

The SEP noted some positive tendencies in the extraction of mineral resources and energy using. The document enumerates several environmental requirements for raw material, energy, industry, waste management, transport, agriculture, forest management, and tourism policies which can support dematerialization processes in economu and consumption in Czech Republic. Additionally the SEP proposes the system of policy instruments (legal, economic, voluntary) as well as institutional changes and educational and training development supportive to the increasing of public awareness. Among other propositions effective to the implementing of SD the SEP contains land use planning and research and development activities. In many of those segments of SD undertakings proposing in the SEP it can be found recommendation for adequate dematerialization policy implementation.

Draft National Strategy for Sustainable Development, 2002

The Draft National Strategy for SD (NSSD) in the Czech Republic (2002) has not been adopted by the Czech government yet. However, it is a document which reflects progress in documental framework of implementing the dematerialization principle into practice in the Czech Republic. It contains extensive chapter II.3. „Prudent use of natural services, resources and sinks” in which the problems of renewable and non-renewable resources, exploitation and state of natural resources and lowering of exploatation of non-renewable resources as well as changing of patterns of consumption are discussed in context of responsibility of the government for long-term economic prosperity and prevention of negative impacts on the environment. The NSSD states the goals for waste management, material and energy intensity, role of using of renewable resources in balancing of total material exploitation, usage of water, undertakings against emission to the air and water pollution, wastes, energy and industry policies, etc. In the NSSD the problems of shaping of adequte criteria for the environmental and economic efficiency as well as increasing of production of goods with higher added value have been remarked. The point 67 of the NSSD states that „The greater use of material inputs also leads to higher flow of material within the economy” ... The processing of a greater volume of flow leads to a greater overall costs of production, thus to inefficiency of bussines”. In chapter III „Challenges” the NSSD discuss general idea that decoupling of the economic performance and the environmental impact is prerequisite of following the SD principle. There are included some recommendation about policies that are needed to achieve SD and dematerialization goals in the economy and consumption.

The long-term aim, in agreement with the sustainable development of society, is to ensure people's needs in the areas of energy supply and natural resource usage (renewable and non-renewable) with the aid of technology, techniques and systems close to natural processes, which are almost exclusively based on solar energy and the reuse of materials.
In the next 10-15 years, the following measures should be implemented to support the achievement of above stated goals:

1. Application of energy saving technology and the use of renewable energy sources in all areas of economic activity, through a combination of education and economic instruments (taxes on energy and materials and purposeful subsidies)
2. Internalisation of costs through payment systems for all emissions
3. Fostering use of secondary resources (recycled wastes)
4. Support of science, research and development of technologies for achieving greater energy savings and a more effective use of renewable energy sources.