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"Resource policies in the context of sustainable development: Current trends and challenges ahead"

By

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This ESDN Quarterly Report (QR) is intended as a first stocktaking of major international and national initiatives related to natural resource policies and management and in particular, resource efficiency, for the forthcoming ESDN Conference 2011 which takes place in Szentendre, Hungary in late June 2011.

It would seem that although numerous scientific disciplines achieved a certain understanding of complex interrelations between ecological and socioeconomic systems, a lack of a systemic perspective has been the main cause for the policy for decades failing to ensure sustainable outcomes of natural resource management. In particular in a situation when resource efficiency is regarded as a strategy out of the dilemma of achieving continuous economic growth while decreasing resource use and environmental degradation, an integrated perspective between social, economic and environmental dimensions should be held in the centre of attention. This report therefore aims to frame the discussion on sustainable natural resource management by outlining various recent concepts, approaches and paradigms as well as their implementation at the international and national levels.

The report is divided into four chapters. The first chapter includes a reflection on the various paradigms related to natural resource use in the political and scientific debates. It also introduces resource efficiency and related concepts to be found in individual initiatives presented in the second and third chapters (such as eco-efficiency, circular economy, life-cycle approach, dematerialisation and decoupling) and outlines why is resource efficiency back on the political agenda. The second chapter outlines application of these various concepts in the major international initiatives, in particular in the OECD work on sustainable materials management, the UNEP International Panel on Sustainable Resource Management and the EU activities on resource efficiency (the *Thematic Strategy on the Sustainable Use of Natural Resources* and the Europe 2020 flagship initiative *A Resource-Efficient Europe*). The third chapter highlights some of the recent developments on the Member-State level, focusing on best practice strategies, action plans and policy tools used to boost efficiency improvement in Austria, Finland, Germany and the Netherlands. In the fourth chapter, the report sketches some issues and future challenges related to resource efficiency policies and their measurement which can serve as a basis for further discussion in the forthcoming ESDN Conference.

Content

1 The scientific and political debates on resource management

This section of the QR provides first a historicising overview of the main paradigms in resource management (i.e. environmental conservation, nature preservation and the integrated approach to natural resource management) both in science, policy and politics. Then it goes on to describe the concept of resource efficiency, its background and related concepts and indicators (dematerialisation, life-cycle approach, eco-efficiency, ecological rucksack, circular economy). At the end of the section some of the problematic issues of resource efficiency are sketched.

1.1 Natural resource management paradigms

Modern debate on natural resources and the sustainability of their management began in the late 18th /early 19th century. As described in the ESDN Quarterly Report from June 2010, it were the significant advances made in science during this time (in biology, geography, demography, agriculture, social welfare and public health in particular) which made possible that "*the idea of a measurable and manageable population comes into existence, but so also does the notion of the environment as the sum of the physical resources on which the population depends*" (Rutherford 1999:39). The ideal of societal steering as **management based upon scientific understanding of the population and the environment** was formed. "Modern thinking about the environment is characterized by the belief that nature can be managed or governed through the application of the scientific principles of ecology" (Rutherford 1999:37).

The primary paradigm of natural resource management was rooted in this context. Natural resources are supposed to be used for human benefit (i.e. this paradigm is utilitarian) and nature outside of the sphere of human influence does not possess any intrinsic value (i.e. this paradigm is anthropocentric). The goal is to identify and pursue such patterns of resource use which "maximize the production of specified components in the system (set of particular products or outcomes) by controlling certain others" (Walker & Salt 2006:5–6) in a long-term perspective (i.e. maximise sustainable yield[1]). This paradigm came to be known particularly in the North American environmentalism as ***environmental conservation*** and towards the end of the 19th century it was promoted by thinkers such as Gifford Pinchot (and the debate still continues, primarily in the developing countries). Forestry (Jones 1991) and land use were among the primary areas where this modernist approach guided by the instrumental problem-solving and expert-technocratic ideal of optimization and efficiency (Lyotard 1984; Turnhout 2010:35) came to be 'deployed'.

The countermovement to the conservation movement was represented by thinkers such as Aldo Leopold, Henry Thoreau or John Muir (and the Sierra Club he established). They pushed for ***wilderness preservation***, a more radical alternative to environmental conservation, defending the position that nature has a value of its own – the closer a natural object is to a pristine state (i.e. untouched by humans), the higher its value (meaning the preservation movement is bio-/ecocentric). Being spiritually oriented, for the preservation movement the highest benefit humans can acquire from nature lies in witnessing its majesty and connecting with it on a 'deep' level. It accuses the modernist ecology of serving the needs of conservationism and being too 'shallow' in terms of interfering with nature to subjugate it to human ends and not recognising its true worth. Although the preservation movement achieved some notable successes in the form of regulatory designation

[1] The sustainable yield of natural capital is the ecological yield that can be extracted without reducing the base of the capital itself, i.e. the surplus generated with maintaining nature's services at the same or increasing level over time.

of certain areas as natural parks with protection status, the conservation movement has proven to be more compatible with the capitalist economic and societal transformations.[2]

Even despite the political success of the conservation movement and the optimistic rhetoric up until late 1960s,[3] the conservation movement did not have a lot of success in halting the decline of natural resources (Thadaku 2005). As interpreted by numerous scholars, among the main reasons for its failure was the lack of recognition of and a coordinated approach to the interrelations between social, cultural, economic and political problems. Even though the modernist management "resulted in enormous advance in resource productivity and human welfare" (Walker & Salt 2006:6), it **does not seem to be able to deal with the emerging secondary and so-called 'wicked' problems**[4]. It is now being recognised that the world does not behave in an incremental and linear cause-and-effect fashion, but is in a constant process of change. Environment–society interactions are characterized by complexity, indeterminacy, irreversibility and non-linearity, with systems "usually configured and reconfigured by extreme events, not average conditions" (ibid.). Pursuing the goal of efficiency might undermine system's resilience, i.e. its ability to absorb and adapt to internal and external disturbances, and therefore threaten long-term sustainability. The third main paradigm, originating in the 1980s, therefore addresses exactly these systemic issues (Folke et al. 2005; Allison & Hobbs 2006).

The third paradigm, the ***integrated approach to natural resource management*** (INRM), stands for "a process which promotes the coordinated development and management of resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems". By considering the linkages between natural systems and socioeconomic systems resource management should have environmental, economic and social benefits in mind (Rahaman & Varis 2005): multiple aspects of natural resource use (sustainable yield, biophysical carrying capacity, resilience), economic aspects such as meeting production goals of producers and other direct users (security of supply, reduction of dependency on a particular resource, low costs or prices, efficient utilisation, innovation, job creation), as well as social aspects (e.g. empowerment for the community, poverty alleviation, social inclusion, equity and fairness, welfare of future generations; Lowell et al. 2002, Holling & Meffe 2002, Williams et al. 1998, Mbaiwa 2004). INRM is increasingly adopting systems thinking concepts and tools (such as systems modelling,

[2] With the birth of capitalism "[f]or the first time, nature becomes purely an object for humankind, purely a matter of utility; ceases to be recognized as power in itself; and the theoretical discovery of its autonomous laws appears merely as a ruse so as to subjugate it under human needs, whether as an object of consumption or as a means of production" (Marx 1973:409-410).

[3] In the 1960s, one of the most famous and influential books in economics on resources and the human prospect *Scarcity and Growth* (Barnett & Morse 1963) predicated that scarcity of resources might not ever halt economic growth. However, during early 1970s concerns of the conservation movement were brought to the fore of the political agenda, which was manifested in the various conferences such as the first UN Conference on Human Environment in Stockholm 1972 or in establishment of environmental ministries and legislation across Western nations. With the publication of *Limits to Growth* (Meadows 1972) and the oil shocks of 1973 and 1974, even among economists the awareness that the environment capacity to absorb and neutralize the unprecedented waste streams of humanity was limited arose (Simpson et al. 2004) – the *Scarcity and Growth Reconsidered* (Smith 1979) documented the rise of new scarcities such as environmental quality, global climate and biological diversity.

[4] Examples of 'wicked' problems (as opposed to 'tame', relatively easily soluble problems) are problems related to e.g. climate change, genetically modified organisms, obesity, international terrorism, global financial crisis or nuclear energy. They have been described as persistent and insoluble, symptomatic of deeper problems, reactive (i.e. 'fighting back' against the attempts to resolve them), trapped within contradictory certitudes, lacking a clear set of alternative solutions and containing redistributive implications for entrenched interests, among others (Rayner 2006; see also Rittel & Weber 1973, Funtowicz & Ravetz 1993, Giampetro & Mayumi 2006). Similarly, Loorbach's (2008) 'persistent problems' are characterized by large complexity and structural uncertainty (i.e. unpredictability, nonlinearity, irreversibility) as well as a large number of actors involved, each often having a different perception of the problem and therefore with no general agreement on solutions. Funtowicz and Ravetz (n.d.) speak of situations when "facts are uncertain, values in dispute, stakes high and decisions urgent". These problems mostly cannot be reduced to "the real world [being] imperfectly understood and that more information will remedy that" (Weick 1995).

adaptive management and resilience thinking) in order to capture the complex dynamics across social, ecological and economic systems, e.g. to understand the extent to which a system can absorb natural and human perturbations and continue regenerating without slowly degrading or even unexpectedly flipping into undesirable states (Folke et al. 2005, Holling 1973, Holling 2001, Berkes et al. 2003). This systems approach replaces the view that resources can be treated as discrete entities in isolation from the ecosystem and social systems (Olssen et al. 2004).

The INRM is clearly in line with the sustainable development concept[5] and became the "favoured approach" of environmental policy in the 1990s (Allison & Hobbs 2006), originally applied in land use and water management. "Sustainable development and management of global and regional resources is not an ecological problem, nor an economic one, nor a social one (...) [i]t is a combination of all three" (Holling 2000). Addressing only the social dimension of resource management without an understanding of the resource and eco-system dynamics will not be sufficient to guide society towards sustainable outcomes (Folke et al. 2005). Similarly, focusing only on the ecological side as a basis for decision making may lead to too narrow conclusions (Folke et al. 2005) and also miss a number of environmental problems. Sustainable resource management goes beyond the ecological (i.e. "regulation and control"), economic (i.e. "get the prices right") and social (i.e. "empowerment and stakeholder ownership") thinking. Through an integrated approach the trade offs and synergies between the dimensions can better be addressed in decision making (Bleischwitz 2009; Holling 2000).

1.2 The concept of resource efficiency

In the 1980s a reform-oriented school of economics and environmental studies named ***ecological modernisation*** gained increasing attention among scholars and policymakers (Huber 1982, Simmonis 1989, Mol et al. 2009). Work on ecological modernisation grew out of the belief that the decoupling of economic growth from environmental destruction may become "an emerging feature of certain advanced industrial economies" (Baker 2006; see also the discussion on the 'environmental Kuznets curve'). Technological innovation was supposed to achieve '**dematerialisation of economic growth**'[6] – e.g. an increase in resource efficiency by a factor of 4 could result in the doubling of GDP with only half of the original resource input (von Weizsäcker et al. 1995; see also Schmidt-Bleek 1998). Concepts of resource efficiency, dematerialisation or decoupling used currently in the political debate originate in this school.

The concept of ***resource efficiency*** is itself rooted in the paradigm of neoclassical economics (efficient utilization of resources, economic scarcity of resources measured in prices or costs, resources which are scarce might be substituted with technological alternatives; Folke et al. 2005,

[5] Compare the following definition of sustainable development as a "pattern of social and economic transformations, which optimizes the economic, societal and environmental benefits available in the present, without jeopardizing the likely potential for similar benefits in the future" (Goodland & Ledec 1987) with the earlier definition of INRM.

[6] In economics 'dematerialisation' refers to the absolute or relative reduction in the quantity of materials used as input in an economy in relation to GDP (von Weizsäcker et al. 1995). Dematerialisation is essentially the reduction of throughput of materials in human societies. It can be measured in relation to geographical economic units (nations, regions, cities) but also to industrial sectors, households or products. **Absolute** (or strong) **dematerialisation** or decoupling is achieved when the total amount of material inputs in a society is decreasing. **Relative** (or weak) **dematerialisation** or decoupling is achieved when the amount of material input still grows, but at a slower pace than output (i.e. GDP). In addition to resource efficiency, dematerialisation strategies also include material substitution (exchanging heavy materials with light materials), use of products by more than one person and re-use and recycling of materials (using materials for multiple functions). In recent years, the concept of **double decoupling** is gaining prominence (EEA 2010), consisting of decoupling resource use from economic growth (fewer resources used per unit of GDP) and decoupling resource use from the environmental impacts it causes (lower impacts per unit of quantity).

Olssen et al. 2004), however, it has no commonly agreed definition (OECD 2008a).[7] The focus is typically either on maximising economic output with a given resource input (increasing resource productivity), or on minimising resource input with a given economic output (decreasing resource intensity); or sometimes both (as the Factor 4 example mentioned in the previous paragraph). UNEP promotes the normative goal of minimisation of natural capital depletion and pollution associated with resource use (Cropper 2008).

Several related concepts and indicators are in use. **Eco-efficiency**, a concept first coined by the World Business Council for Sustainable Development in its 1992 publication *Changing Course*, is defined as delivery of "competitively priced goods and services that satisfy human needs and bring quality of life while progressively reducing environmental impacts of goods and resource intensity throughout the entire life cycle to a level at least in line with the Earth's estimated carrying capacity". It is a slightly broader concept than resource efficiency as it covers all environmental implications of production (i.e. not only of resource use). OECD frequently utilises also the indicator of **resource productivity** (analogically to labour or capital productivity), an indicator reflecting the output generated or value added per unit of resources used (OECD 2010a). **Ecological rucksack** is an indicator measuring the hidden material costs of a product expressed as tons of any material which is extracted, processed, transported or deposited during production of the given product and its transport to the point of sale.

The concept of '**circular economy**', currently being successfully implemented in China, is based on the acknowledgement that the economy is embedded in a planetary bio-geophysical system and depends on both in terms for securing the necessary raw materials and absorbing or processing waste (i.e. sources and sinks; Ayres & Simonis 1994). It embeds cleaner production and industrial ecology in a broader system encompassing industrial firms, networks or chains of firms, eco-industrial parks, and regional infrastructure to support resource optimization (IISD 2006). A sustainable economy is characterized, among others, by a much reduced use of renewable and non-renewable inputs and closed-loop reuse and recycling of material outputs, thus drastically reducing or eliminating waste. At the *company level*, managers seek much higher efficiency through the 3Rs (reduce, reuse, recycle). The *industrial parks/clusters or chain of industries level* aims to achieve full resource circulation in the local production system through reuse and recycling of resources. At the *regional level*, the aim is to integrate different production and consumption systems in the whole region so the resources circulate among industries and urban systems, requiring development of municipal or regional by-product collection, storage, processing, and distribution systems. Combined efforts at all three levels create a strong economic impetus for investment into new ventures and job creation.

In a globalized world, where economies are strongly interlinked through trade flows, resources can be extracted in one country, processed in another and used in production in a third and then finally shipped for disposal to another. Therefore, resource use becomes a global concern, affecting countries in diverse ways – and particularly undeveloped countries. Resource efficiency has been promoted by pointing to the following **beneficial effects**: From an economic perspective resource

[7] Please note, however, that this broad definition can be operationalised in various ways (OECD 2010a). The **physical or technical efficiency** refers the amount of resource input required to produce a unit of output, both expressed in physical terms (e.g. iron ore inputs for crude steel production or raw material inputs for the production of a computer, a car, batteries). The focus is on maximising the output with a given set of inputs and a given technology or on minimising the inputs for a given output. The **economic efficiency** refers to the monetary value of outputs relative to the monetary value of inputs. The focus is on minimising resource input costs. The **economic-physical efficiency** refers to the monetary value added of outputs per mass unit of resource inputs used, used for the aim to decouple value added (i.e. GDP) and resource consumption. Resource efficiency can be applied at three stages: **input** (extraction and processing), **the economy** (material transformation and accumulation), and **output** (emissions, waste). Environmental policies and strategies have mostly focused on pollution and waste management on the production side; gradually there is a shift towards a '**life-cycle approach**' covering all three stages (Mont & Bleischwitz 2007, OECD 2009).

efficiency enables to sustain economic growth, achieve an increase in competitiveness, stimulate innovation and contribute to security of supplies and reduction of dependencies on resources (Bleischwitz 2009). From an environmental perspective it reduces environmental impacts of resource use (both in terms of sources and sinks) and contributes to wellbeing through a healthy environment. From a social perspective job creation through creation of new markets and industries as well as improvement of distributional effects on resources on undeveloped countries can be expected (Kristof et al. 2006).

There are, however, several contested issues. Firstly, ecological economists suggests that in order to sustainably manage resource use and emissions, **information on** their **limits is needed**, in particular on the risks arising from critical thresholds and ecological feedback systems. Market prices do not reflect the absolute scarcity of resources[8] and that even if in theory all market failures were addressed, a competitive equilibrium still would not deliver a sustainable allocation of resources across generations (Folke et al. 2005).

Secondly, as mentioned above, resource management driven by conservation interests often **ignores the need for systemic, adaptive designs** (e.g. featuring institutional flexibility; Holling 2000). Those driven by economic interests often act as if the uncertainty of nature could be replaced by human engineering and management controls. Those driven by social interests act as if community development and empowerment of individuals could not encounter limits to the imagination and initiative of local groups. Therefore a common cause behind failures of investment in sustainable resource management is the lack of the systemic and integrated approach in policy solutions (Holling 2000).

Thirdly, when analyzing impacts of resource efficiency rebound effects should be taken into account. Through behavioural changes or other systemic responses, rebound effects have the potential to compensate (or even overcompensate) for the potential resource savings made possible by resource efficiency (Schettkat 2009). A **direct rebound effect** occurs when higher efficiency lowers consumption costs, leading to higher consumption of a good. An **indirect rebound effect** occurs when lower consumption costs increase real income, triggering an increase in consumption. Although the existence of the effect is uncontroversial, analysis of rebound effects is challenging due to the high complexity (from simple demand reactions to price and income variations) and determining the size and importance of the effect in real word situations is therefore highly difficult (EEA 2010).

Global environmental and social impacts of resource use are difficult to measure. It is particularly difficult to measure long-term impacts as well as take into account substitution effects. Therefore, as an example, it is not entirely clear whether resource efficiency will make our economies or ecosystems more resilient or how trade with underdeveloped countries will be affected if developed countries become more resource efficient.

1.3 Why is resource management back on the political agenda

Now, around 40 years after the original debate on limits to growth and resource scarcity, these issues are back on the political agenda of international, European and national authorities. At the political level there is a an increasing recognition that economies are fundamentally dependent on

[8] The solution preferred by neoclassical economics lies in calculating the monetary value of externalities of ecosystem resources and services that are currently unpriced. Such values can then be incorporated into decision-making by e.g. including them in cost-benefit analyses, using them to design economic policy instruments (taxes and subsidies or cap-and-trade schemes) or integrating them into 'green' national accounts. Extensive progress has been achieved over the last decades, even though numerous practical, methodological and political obstacles still exist.

the capacity of the environment to support and generate preconditions for human and societal development. In light of skyrocketing commodity prices economies can no longer ignore resource scarcities. The inefficient resource use at a time of growing demand is leading to increasing environmental pressure and substantial costs, as highlighted in some reports such as the Stern review on climate change (2007) and also to an increasing resource scarcity that will face Europe and other parts of the world over the next years and decades (Bleischwitz et al, 2009). There is also a broad acknowledgement that until now environmental policy, despite current technological improvement and certain environmental policy instruments, has been only scratching on the surface of finding solutions and providing frameworks for absolute decoupling of resource usage from economic growth (Jackson 2009).

Box 1: Facts on resource consumption and usage in Europe (Bleischwitz et al. 2009)

World reserves on fossil fuels and metals are unevenly distributed cross the world.

Global extraction of natural resources is steadily increasing. In 2020, a total resource extraction of around 80 billion's tones (200% of the 1980 value) will be necessary to sustain worldwide economic growth. For various commodities the peak of extraction has already been reached or is about to be reached (oil, natural gas, various metals). The rapidly increasing demand for resources has led to an unprecedented boost in resource prices.

European economy is increasingly dependent on resource imports from other world regions. EU is the world region that outsources the biggest part of resource extraction required to produce goods for final demands, thus exceeding self-sufficiency of resource use.

A European consumes per year around on average three times the amount of resources of a citizen of the emerging countries while producing twice as such.

2 Overview of international policies and initiatives

This chapter provides a stock taking on international initiatives on resource efficiency and sustainable resource management. It provides an overview of the background and orientation of initiatives of the OECD, UNEP and the EU in particular.

2.1 The work of OECD on sustainable materials management

The Organisation for Economic Co-operation and Development (OECD) has, since the early 1980s, promoted international and national policies aimed at preventing and reducing waste generation and managing the residues in an environmentally sound manner. It has worked on resource productivity and waste management issues for the last 20 years, and since 2001 there has been a shift from waste minimization ('end-of-life perspective') to a more integrated approach and management of materials in a sustainable manner through the whole life-cycle from extraction and processing through use and to the disposal of the product as it has become evident that waste minimisation policies which address only end-of-life products and materials are not effective in reducing increasing amounts of waste and material consumption associated with economic activity.

The OECD Environmental Strategy for the 1st Decade of the 21st Century, adopted by Environment Ministers in May 2001, clearly outlined the need for governments to look for integrated

management solutions which link resource use and prevention of waste into a coherent policy approach. Against this background, in 2004 the OECD Environment Directorate initiated a new initiative on sustainable materials management (SMM), followed up by the OECD *Council recommendations on material flows and resource productivity* (OECD 2004, OECD 2008b). The OECD has called the countries in a cost-effective manner to introduce actions for an integrated approach using life-cycle thinking on materials and by improving resource productivity of resources. After a long debate on taking stock on SMM and sharing experiences with governments, at the 2010 Global Forum on Environment (GFENV) focusing on sustainable materials management the OECD proposed concrete steps and measures to put SMM into practice or to extend it to new areas. The aim of the 2010 and 2011 OECD work on SMM is to put into practical measures what has been set as target in the OECD council recommendation in 2008, focusing on (OECD 2011):

(1) sustainable materials management
(2) environmentally sound management of waste
(3) trans-boundary movements of waste, waste prevention and minimisation
(4) radioactive waste management.

The OECD working definition of SMM was developed in the first OECD workshop on SMM (held 2005 in Seoul, Korea): *"Sustainable Materials Management is an approach to promote sustainable materials use, integrating actions targeted at reducing negative environmental impacts and preserving natural capital throughout the life-cycle of materials, taking into account economic efficiency and social equity*" (OECD 2007).[9] SMM recognises that different materials have different attributes and life cycles with implications on their resource-efficient transformation, production, use and recycling (see also Fig. 1 below).[10] SMM, having resource productivity, economic efficiency and social equity at its core, elevates the focus of governments, industry and consumers from individual material, product or process attributes to an entire system of material flows and associated life-cycle impacts.

[9] The OECD Glossary of Statistical Terms defines **natural resources** as follows: "Natural resources are natural assets (raw materials) occurring in nature that can be used for economic production or consumption", subdivided into mineral and energy resources, soil resources, water resources and biological resources (OECD 2010b). **Materials** are not defined in the OECD glossary, but they can be thought of as intermediary products of the various stages of the process of transformation of natural resources into final products which meet economic and social needs (OECD 2010a; see also Fig. 1). According to the glossary, a material can be an *unprocessed raw material* (e.g. primary zinc; also resins, metals, chemicals...), *processed material* (a zinc sheet), *final product* (zinc rain gutters) and *waste* (building and construction waste).

[10] For example, metals can be infinitely recycled, while fuels cannot since they lose some of their features if they are often recycled. Consequently, sustainable management of fuels needs to focus on impacts of production and minimisation of emissions during the use phase, whereas sustainable management of metals would need to focus on production and optimizing recovery of the material from the economy (OECD 2010b).

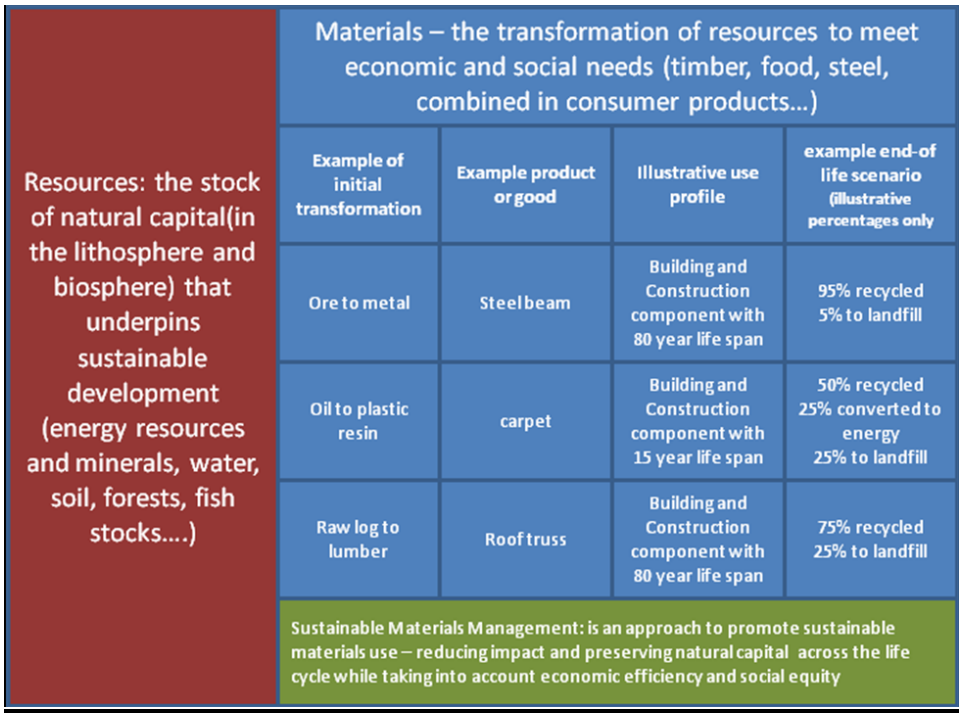

Figure 1: The relationships between resources, materials and SMM (OECD 2010b:7).

2.1.1 Policy implications of SMM

To highlight the shift from individual material, product or process attributes to the entire system of material flows and associated life-cycle impacts and help governmental authorities policy development for SMM, a **conceptual framework for a systemic view on material flows** has been developed by the OECD Environment Directorate on the basis of a broad literature review (see Fig. 2). The framework shows resource flows between three sets of systems – ecological, industrial and societal.[11] Applying an SMM approach would, for example, focus actions on not only developing infrastructure to ensure efficient recycling and recovery of materials (typical waste-reduction-focused policies), but also actions that would improve the sustainability of the transformation of the resource into a material (e.g. reducing carbon intensity of energy inputs) and optimise the design of the product to ensure best use of materials and optimal use and end-of-life profile (OECD 2010b).

[11] **Ecological/natural systems** represent the biosphere and the source of natural capital from which renewable and non-renewable materials are derived. **Industrial systems** utilise ecosystem services and derive materials from natural capital. **Societal systems** consume the products, services, and energy supplied by industrial systems and generate waste that is either recycled back into industrial systems or deposited into the biosphere (OECD 2010a).

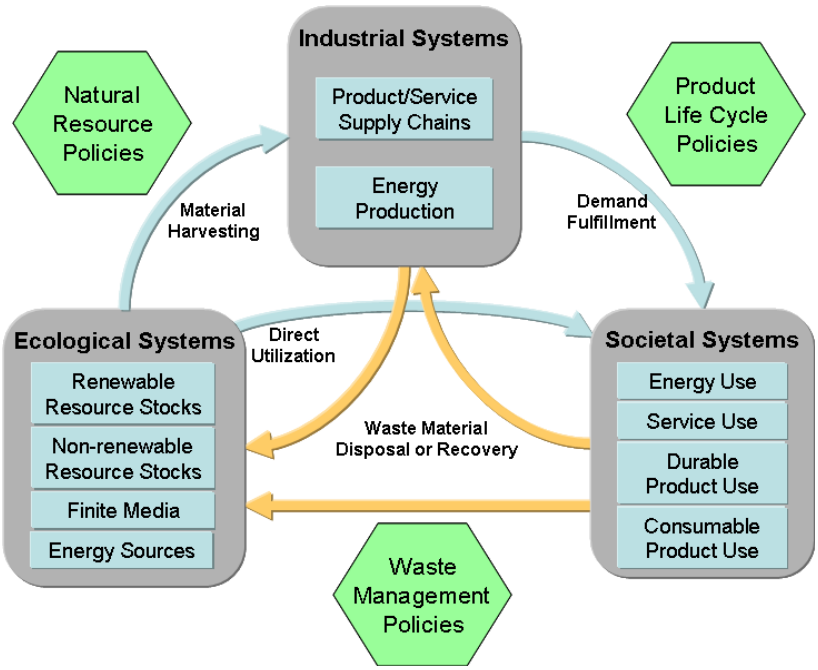

Figure 2: OECD's systemic view on material flows (OECD 2010a:21).

Based on the results of the 2010 Global Forum and in order to provide guidance for the development and implementation of SMM policies at the national level, the OECD Environment Directorate also elaborated a set of policy principles ('framework conditions'), policy instruments and targets. The OECD work on SMM, however, does not provide guidance for national authorities on resource polices, but focuses more on waste management and life-cycle policy targets and instruments with indirect impact on resource base; direct actions to ensure sustainability of the resource base do not fall within the scope of SMM (OECD 2010b:25).

The **four SSM policy principles** set by the OECD policy report are: (1) preserve natural capital; (2) design and manage materials, products and processes for safety and sustainability from a life-cycle perspective; (3) use the full suite of policy instruments to stimulate and reinforce sustainable economic, environmental and social outcomes; and (4) engage all parts of society to take active, ethically-based responsibility for achieving sustainable outcomes (OECD 2010a).

2.1.2 Horizontal linkages to other, related OECD programs

OECD attempts to strengthen coordination between its SMM approach and other programs within the OECD, such as the ***Green Growth Strategy***[12] (which should incorporate SMM outcomes over 2010-2011[13]), the program on material flows and resource productivity[14], the project on eco-innovation and sustainable manufacturing and outside the OECD the UNEP Resource Panel and EU

[12] The Green Growth Strategy aims to identify policies that would promote both economic efficiency and environmental integrity, while ensuring social equity. The Strategy guides government intervention across broader green growth policy areas, covering fiscal, innovation, trade, labour and social policies, as well as key sectors such as energy, transport, agriculture and fisheries. The initiative also focuses on four environmental areas: 1) climate change, 2) biodiversity and quality of eco-systems, 3) use of natural resources, and 4) materials management (OECD 2010c).

[13] For details see the following URL: http://www.unep.fr/scp/lifecycle/documents/Presentations/Sustainable%20Materials%20Management%20%28Henrik%20Harjula%29.pdf.

[14] The OECD program on material flows and resource productivity includes the establishment of a common knowledge base to enable sound fact-based Material Flow Analysis (MFA) and to inform related policy discussions, such as SMM.

initiatives on resource efficiency. OECD also aims to submit SSM outcomes to the Environment Ministerial Meeting in 2011. Moreover, these outcomes will, together with the work of the UNEP Resource Panel, provide a basis for a 2011 report to G8 Ministers on the implementation of the Kobe 3R Action Plan on initiatives to reduce, reuse and recycle materials and in 2013 to the OECD Council on the Implementation of Recommendations on Resource Productivity (OECD, 2008b).

OECD aims to "optimis[e] collaboration and minimis[e] overlap" as already analysed in an OECD study (OECD 2010a). Almost all of the initiatives have a focus on: (1) reducing the impacts of manufacturing; (2) reducing the impacts of consumption; and (3) enhancing recycling and the recovery of valuable materials. Other areas of overlap include enhancing resource efficiency and productivity in materials production, reducing greenhouse gas emissions during distribution of materials/products and optimising materials recovery and reuse (OECD 2010a:11). The study suggests that while the Green Growth Strategy and the UNEP framework for action on sustainable consumption and production provide comprehensive approaches that are intended to guide OECD government actions, to minimise overlap the SMM and resource productivity activities/initiatives should be more focused to support specific aspects of these framework programs (ibid.).

2.2 The UNEP International Panel on Sustainable Resource Management

In 2007 UNEP established the ***International Panel on Sustainable Resource Management***, understanding that decoupling economic growth from environmental degradation is a top political priority for many international and national authorities and the scientific debate has not yet reached global consensus on a number of issues. It was established to provide independent scientific assessments of policy relevance on the sustainable use of natural resources and in particular their environmental impacts over the full life-cycle. The Resource Panel should offer reform goals and roadmaps rooted in a solid holistic understanding of resource management and identify interlinkages and gaps in knowledge across the various initiatives on sustainable resource management and resource productivity.

The UNEP initiative builds upon the efforts of the 2002 World Summit on Sustainable Development, addressing sustainable resource management in light of the targets towards poverty eradication and sustainable consumption. The Resource Panel works to decouple economic growth from resource use and resource use from environmental degradation (double decoupling), and in particular to develop a better understanding of the ways to increase resource-efficient economic growth by taking into consideration the satisfaction of human needs within the carrying capacity of the Earth. It applies an integrated and life-cycle-based approach (including the 'circular economy') by considering multiple dimensions of resource efficiency, including economic, environmental and social perspectives. UNEP is aware that not only resource efficiency but also resource sufficiency is necessary for guaranteeing in the long-term the ultimate goal of sustainable consumption and production (SCP; Cropper 2008). Resource efficiency was welcomed as one of the six cross-cutting priorities of UNEP's medium-term 2010-2013 strategy.

In line with the recommendations from the Steering Committee in meetings in 2007-2008, the Resource Panel commenced work on two cross-cutting issues (decoupling and prioritisation) and on two sectoral cross-cutting themes where scientific assessments have already been published (resource efficiency in bio-fuels and in metal recycling). For more details on the hierarchical structuring of Resource Panel's work see Fig. 3.

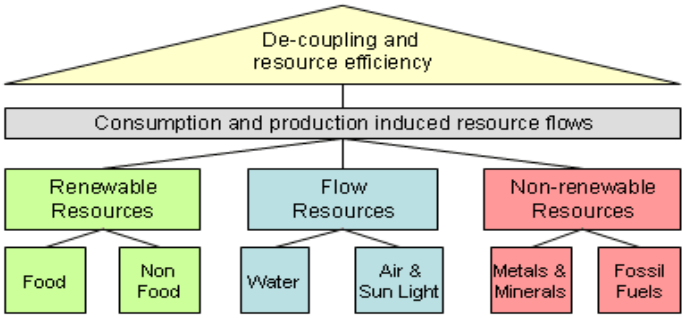

Figure 3: The UNEP Resource Panel work approach.

2.2.1 Horizontal linkages to other, related UNEP initiatives

The Marrakech Process on SCP[15] and the Resource Panel are regarded as the two main UNEP initiatives on resource efficiency[16], not only for building scientific knowledge but also for supporting governments in the implementation of policies towards SCP. While the aim of the Resource panel is to demonstrate and scientifically assess how to decouple growth from environmental degradation, the Marrakech Process supports countries in the development of national and regional SCP strategies, promotes sustainable public procurement and demonstrates the potential benefits of SCP and resource efficiency for poverty reduction in developing countries. Activities on resource efficiency are also closely linked to the work on 'green economy' as they promote a change to the current drivers of environmental degradation. The Green Economy Initiative complements the work of the Resource Panel by assessing and illustrating the economic potential of green investments.

As the UN Commission on Sustainable Development (UNCSD) will review the theme of SCP and the 10YFP during 2010-11, UNEP is in the process of developing a new organisation-wide strategy to enhance resource efficiency. The strategy will support actions which combine the development and implementation of government policies and with private sector activities in order to increase resource efficiency and reduce pollution over product life cycles and along supply chains and to increase investment in efficient, clean and safe industrial production methods through public policies and private sector actions (Cropper 2008).

2.3 European Union's initiatives on resource efficiency

Over the past 30 years resource use has been a theme in the European environmental policy discussions – and the third Environmental Action Plan (1982-1986) has pointed out the potential of environmental policy to enhance competitiveness of the EU`s economy (Baker 2006). Resource scarcity, however, has been lacking political attention at the European level for decades (EC 2005). For example In the fifth EAP (1993-2000) the emphasis was put on changing growth through higher material efficiency, without taking in consideration scarcity issues. As environmental policies have focused mostly on the visible problems of waste and pollutions, they were not successful in changing and reversing production patterns which led to increasing trends in consumption of resources (EC 2005). Therefore, the 6th EAP (2002-2012) aimed to set the priority on resource and waste management from a life-cycle perspective in order to strengthen environmental policies for de-coupling economic growth from resource use. Against this background, in 2005 the European

[15] The Marrakech Process is a global multi-stakeholder process to promote implementation of sustainable consumption and production (SCP) and to develop an international framework to support regional and national initiatives on SCP called the 10-Year Framework of Programmes (10YFP).

[16] The resource efficiency strategies are also further linked to the Life-Cycle initiative and the Global Compact and Global Reporting initiatives.

Commission proposed a Thematic Strategy on the Sustainable Use of Natural Resources to guide Member States towards more sustainable patterns of resource use.

Due to recent developments in commodity markets, especially a major surge in global raw material demand between 2002 and 2008, the issues of resource scarcity and security of raw materials supply as well as resource efficiency have moved at the fore of the European political agenda again (DG Env interview 28 Feb 2011). In the framework of the Europe 2020 Strategy the European Commission launched two important initiatives: (1) the ***new strategy on raw materials*** (basing on the earlier 2008 initiative on raw materials) which addresses security issues and improvement in supply of raw materials; and (2) the flagship initiative ***A Resource-Efficient Europe*** in support of a shift towards a resource-efficient and low-carbon.

2.3.1 The EU's *Thematic Strategy on the Sustainable Use of Natural Resources*

The EU resource strategy has the objective to reduce negative environmental impacts generated by the use of natural resources[17] while ensuring economic growth (EC 2005:5). In more detail, it aims to achieve decoupling by an increase in resource efficiency ensuring that: (1) the consumption of natural resources, both renewable and non-renewable, stays below the threshold of overexploitation; (2) the environmental impacts stabilise or decrease; and (3) economic growth increases (see Fig. 4).

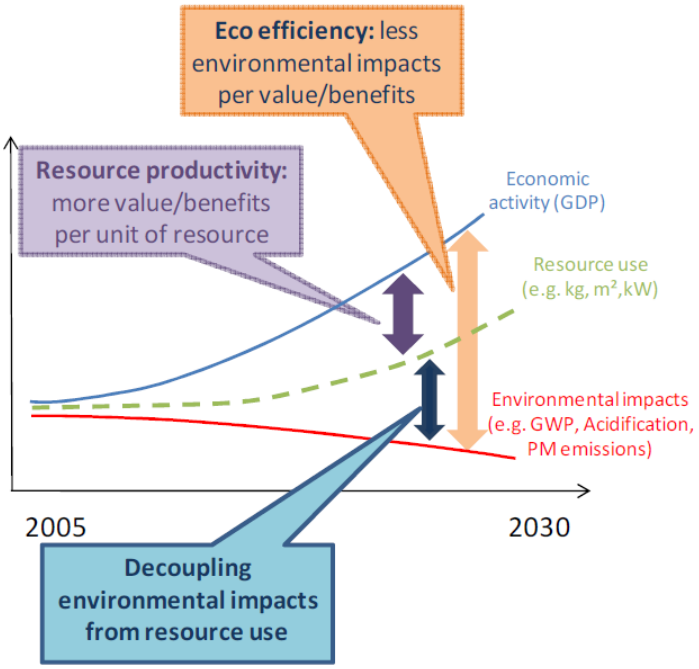

Figure 4: The EU resource strategy (BIS 2010:20).

Four areas of action to guide implementation at the EU level and Member State levels are specified:

- improvement of understanding and knowledge of European resource use, its negative environmental impacts and significance in the EU and globally

[17] Natural resources are defined as natural assets deliberately extracted or modified by humans activity for their utility to create economic value, divided between three categories: raw materials (metals, minerals, fossils and biomass), environmental media (air, water and soil; flow resources such as wind, geothermal, tidal and solar energy) and space or land (EC 2005:3).

- development of tools to monitor and report progress in the EU, Member States and economic sectors
- fostering of the application of strategic approaches and processes both in economic sectors and in the Member States and encouraging them to develop related plans and programmes
- raising awareness among stakeholders and citizens of the significant negative environmental impacts of resource use.

The resource strategy also offers an analytical framework to foster accountability for environmental impacts of resource use in public policies, identifying impacts throughout the whole life cycle and including global and cumulative impacts. The EC considers this necessary to design policy measures which can be most effective for reducing environmental impacts.

The implementation of the 2005 resource strategy was conducted through action plans and strategies at the national level. A 2010 evaluation of implementation (BIS 2010), conducted in preparation of the not yet announced review of the strategy, shows that, despite improvements in resource productivity in the EU and the achieved relative decoupling of material use in some areas, absolute decoupling has not been achieved. The integration promoted by the strategy had a positive, but only a partial and uneven influence at the national level, which was probably caused by insufficient understanding of its key concepts (such as 'resources'), lack of operational tools (e.g. for measuring environmental impacts linked to resource use), and lack of specific targets with quantitative goals. Nonetheless, some promising national-level examples have been noted (see chapter 3 of this report). Among significant successes of the strategy are also the establishment of a Data Centre for Natural Resources, the development of indicators of resource use, progress in cross-sectoral policy integration, gradual implementation of the life-cycle approach and a boost in the awareness of environmental impacts of resource use and life-cycle thinking at the national and European level. The evaluation recommends improvement in particular in more precise formulations, raising awareness, establishment of a basket of indicators, fostering the development of resource initiatives at the level of Members States and fostering policy integration.

2.3.2 The flagship initiative *A Resource-Efficient Europe*

The European Commission has brought the theme of resource efficiency also into the Europe 2020 Strategy, where it found its place as one of the flagship initiatives under the goal of 'sustainable growth', titled ***A Resource-Efficient Europe***. It will help build a strategic and integrated approach for ensuring concrete policy actions on resource efficiency and achieving a shift towards a resource-efficient and low-carbon economy in the perspective of medium-term objectives for 2020 and pave the way towards longer-term goals for 2050. In particular, it should: (1) boost economic performance while reducing resource use; (2) identify and create new opportunities for economic growth and greater innovation and boost the EU's competitiveness; (3) ensure security of supply of essential resources; (4) fight against climate change and limit the environmental impacts of resource use (EC 2011b:4). Recently the EC has launched a **consultation process** collecting the views of businesses, other stakeholders and the public on policy options for the ***roadmap to a resource-efficient Europe*** in preparation. The roadmap will set out a vision for the structural and technological change needed up to 2050, with objectives to be reached by 2020 and suggestions about how they could be met.

The flagship initiative cuts across sectors and includes broad policy areas such as climate change, energy, transport, industry, raw materials, agriculture, fisheries, biodiversity and regional development. For delivering a coordinated action complex modelling will be required – however, existing models have a sectoral focus and they insufficiently capture and estimate the full impact of resource use on ecosystems, enterprises, the economy, and society. The flagship initiative therefore also aims to build up a knowledge base and develop a more comprehensive analytical framework.

In comparison to the resource strategy, the flagship initiative enlarges the focus to include resource management and security of supply of essential resources and strives to better interlink demand-side (getting prices right, providing information to consumers) and supply-side (identifying critical raw materials, ensuring sustainable supply) policies addressing resource use. The flagship initiative also seems to tackle some of the mentioned shortcomings of the resource strategy, such as better policy integration across numerous sectors and policy areas, aiming for a more comprehensive analytical framework capturing impacts of resource use on ecosystems, enterprises, economy and society as a whole, enlarging the focus from resource demand to also resource supply issues (e.g. critical resources), including global concerns and issues of resource security as well as setting more quantifiable targets.

Moreover, the flagship initiative indentifies the need for the EU to intensify international cooperation for several reasons. International cooperation on resource use would contribute to achieving EU's objectives of sustainable development and poverty reduction in resource-reliant developing countries. Also, through encouraging the shift to clean technologies it would help reduce the fast growing demand for global resources. Trade policies should therefore be better integrated with development policies (policy coherence) to address supply of resources through e.g. exchanges in skills, technology and best practice. The EU is interested in working with other international organizations such as the OECD and UNEP (EC 2011a). In particular the Rio+20 international conference on sustainable development in 2012 with its focus on green economy and environmental governance will provide a good opportunity for the EU to coordinate its resource efficiency measures with global partners.

In the medium term, the topic of resource efficiency will, among others, be linked to:

- the EC's *Energy 2020: A Strategy for Competitive, Sustainable and Secure Energy* and the *Energy Infrastructure Priorities for 2020 and Beyond: A Blueprint for an Integrated European Energy Network*
- the communication on raw materials which will identify critical raw materials and define measures to help supply of raw materials to the EU from domestic and global markets
- the *Energy Efficiency Plan 2011* which aims to achieve energy savings of 20 % across all sectors and will be followed by a directive on energy efficiency in the 3rd quarter of 2011
- the 2020 EU biodiversity strategy in preparation.

In the long-term, following initiatives will help deliver the flagship initiative:

- the *Roadmap for Moving to a Competitive Low-Carbon Economy in 2050* sets the goal of reducing gas emissions by 80 to 95 % by 2050 while improving the EU's energy security and promoting sustainable growth and jobs
- the *White Paper on the future of transport* will present a vision for a low-carbon, resource-efficient, secure and competitive transport system by 2050, removing internal market obstacles for transport and promoting clean technologies
- the *Energy Roadmap 2050* (to be published autumn 2011; public consultation has finished recently) will explore the possible paths towards a low-carbon resource-efficient energy system.

The flagship initiative has also linkages to earlier strategic efforts such as the EU action plan on sustainable consumption and production (2008), the Eco-innovation Platform and the Environmental Technologies Action Plan (ETAP), the Integrated Product Policy (2003). The aim of the flagship initiative also serves the main objective of the EU SDS which explicitly mentions the need to move towards a resource efficient economy in order to enable the EU to achieve continuous improvement of quality of life both of current and future generations (Council of the EU 2006). Moreover, this

initiative is also linked to other flagship initiatives of the Europe 2020 Strategy, such as the innovation union, youth on the move, the European platform against poverty and others.

3 National initiatives[18]

The described international initiatives have also resonated on the national level (and are, to a significant extent, also influenced by developments on the national level). One of the main ambitions of the EU Resource Strategy is to foster implementation of national resource policies and measures ("each EU Member State [shall] develop national measures and programmes on the sustainable use of natural resources to achieve the strategy's objectives"). A number of Member States responded to the Resource Strategy with the development of actions plans, strategies, plans, roadmaps and market-based instruments (BIS 2010). In this respect, the Member States are classifiable into two broad groups:

1) Member States which have adopted a **proactive approach** to the key concepts of the resource strategy and manage accordingly at least specific natural resources (Finland, Austria, Germany, France and Netherlands) on which the third chapter of this report will focus as cases of best practice (BIS 2010:61)
2) Member States who seem to be in a **lag phase** – such as Slovakia, Poland, and Portugal, which all seem to have not yet developed a coherent approach to better understand and govern resource use.

3.1 Austria

The Austrian ***Resource Efficiency Action Plan (REAP)***, currently under development, aims to achieve an absolute decoupling of economic growth from resource consumption. The action plan considers the potential for efficiency gains, reduction of environmental impacts and of primary resource consumption over the whole life cycle in a systemic way while focusing on key use-related issues and complementing existing initiatives by targeted measures. It is considered an important tool for achieving the targets of the Austrian SD Strategy, but also achieves synergies with other eco-innovation initiatives such as the Austrian energy strategy, the public procurement action plan, the masterplan green jobs. The Resource Efficiency Action Plan will be finished ~ middle of 2011.

Next to the absolute decoupling goal, the task of the action plan is also to coordinate stakeholders already involved and to give existing initiatives a common direction and guidance for becoming mutually supportive by identifying gaps and contradictions between them and indentifying measures to address these gaps. The Ministry of Environment, which is mainly responsible for the coordination of this process, organised between 2009 and 2010 a number of workshops and a "round table resource efficiency" in order to involve as many stakeholders as possible from the various ministries as well as academia and business and to collect opinions on the priorities of the action plan.

Lessons learned from the preparatory process include:

- There are already existing national-level initiatives addressing some aspects and life cycle stages of resource use. The preparation of an action plan should therefore start with acquiring knowledge on the existing initiatives and the synergies and to develop a network of stakeholders. Especially the involvement of business / industry is a necessary pre-condition.

[18] Information on the national approaches to resource efficiency policies and actions across the four countries was mainly provided by Christopher Manstein, Federal Ministry of Land, Forestry, Agriculture and Water Management, Austria; Sauli Rouhinen, Ministry of the Environment, Secretary General, Finland's National Commission on Sustainable Development, Finland; Reinhard Kaiser, Federal Ministry of Environment. Germany; Frank Vollenbroek, Ministry of Housing, Spatial Planning and the Environment, Netherlands.

- It is necessary to identify the most important areas of resource use and to provide a good data fundament for the action plan. That's why Austria has worked out parallel to REAP an resource report which has collect the necessary data as a fundament for the action plan[19].
- As main fields of action the following have been identified: "resource efficient production"; "recycling and use of secondary materials"; "resource efficiency in public procurement" and "resource efficiency and awareness rising".

3.2 Finland

The 2009 ***A Natural Resource Strategy for Finland: Using Natural Resources Intelligently*** was the first of its kind in Europe in addressing all natural resources within a single strategic framework (BIS 2010). Resource use is understood by the strategy as a source of well-being and a basis for economic activities which also safeguard the environment, i.e. in a wider perspective extending across all sectors of society. The strategy promotes four key long-term (2030) strategic goals: (1) Finland should become a bio-economy generating high added value; (2) Finland utilises and recycles materials effectively; (3) regional resources generate both national added value and local well-being; and (4) Finland takes initiatives and leads the way on natural resource issues. Key topics are bio-economy including the enhancement of controls over the material cycle, product-centred resource efficiency and interaction between rural areas and growth centres. The strategy is expected to have wide impact on various areas linked to natural resources such as climate energy policies, biodiversity or reshaping of Finland's forest sector (SITRA 2009).

The preparatory process has been a non-governmental effort coordinated by SITRA (the Finnish Innovation Public Fund) under the supervision of the Finnish Parliament. In a dynamic process it included a wide range of individuals and organisations representing the society, politicians, administrators, business representatives, researchers, organisations and the media who gave their opinions on targets and measures of the strategy. The preparation utilised innovative approaches where **goal setting, implementation, evaluation and development work are all seen as parts of a single continuous process** (SITRA 2009:4). The implementation follows a work plan with an iterative process of strategic goal setting, implementation of specific measures and periodic reviews of the overall progress. To translate the principles conveyed by the strategy into concrete steps a number of development projects is being implemented (e.g. projects to develop expertise in reserves and characteristics of various types of bio-materials, establishment of bio-refineries processing organic materials to produce energy and new raw materials, development of calculation methods and measures to express the use of natural resources and material flows).

Work on the strategy has led to the development of the bio-economy strategy and the mineral strategy (both adopted in 2010), as well as the publication of a government report on natural resources (submitted to the parliament for adoption in 2010). The report works with the vision of making Finland until 2050 "a responsible forerunner in the intelligent natural resource economy" (MEEF 2011:51) and follows the strategic guidelines of the resource strategy when formulating areas of change and outlining the challenges ahead. The report will be integrated in the 2011-2014 government program and is expected to play an important role in shaping resource policies.

3.3 Germany

As a response to the EU Resource Strategy the German Federal Ministry of Environment initiated various research projects in various fields related to resource efficiency. One of the most important, involving 31 research institutes and lasting from 2007 to 2010, was on material and resource

[19] Austrian Ministry of Environment and Austrian Ministry of Economy: Resource use in Austria – Report 2011; forthcoming (June 2011).

efficiency, with its analysis of policy instruments also useful for policy makers. In 2007 the Ministry also invited various stakeholders from industry, economy, society and academia to participate in a network on resource-efficiency, an experiment in finding new forms of governance with the aim not only to foster closer collaboration and innovation, but also to share information on ongoing initiatives in efficiency improvement. The Ministry of Environment was also asked by the Ministry of Economy to develop an updated **governmental strategy on resource efficiency** to be adopted late 2011/early 2012. First drafts of the strategy are already published and open for comments from various stakeholders. The implementation of the strategy shall be horizontally coordinated between the Ministry of Environment and other relevant ministries, but involvement is expected also from the Parliamentary Committee for Inquiry into Growth, Prosperity and the Quality of Life.

The strategy aims to strengthen the target of doubling raw material by promoting a quadrupling of resource efficiency in the medium term by 2020 (i.e. the factor 4 approach, closely linked to the national SD strategy, which sets similar goals for productivity improvements). This initiative is **one of the rare attempts to set quantitative targets regarding overall resource use in EU** (BIS 2010:68). The draft of the strategy contains a description of the challenges, indicators for resource efficiency, outline of 20 actions addressing resource efficiency from the perspective of (i) resource policies, (ii) production and consumption, and (iii) circular flow economy, and analyses of mass flows.

3.4 The Netherlands

The Netherlands was one of the first countries to set decoupling of environmental degradation from economic growth as the overarching objective (the third National Environmental Action Plan 1998). Means of breaking the link between economic growth and environmental pressure included environmentally-friendly goods and services, efficient land use and internalising environmental costs in prices. In the beginning of the first decade of the 21th century it became clear that an integrated approach to resource use was needed: Dutch consumption is often part of a chain involving the production of raw materials and their transport from other countries, processing taking place in the Netherlands, and the use and disposal of products taking place in the Netherlands or exported. The **fourth National Environmental Policy Plan** (2001) therefore argued that in order to make the whole chain sustainable and to avoid shifting of the problem to other regions or future generations, a transition of the entire international system of production and consumption would be needed. It formulated a goal for 2030 of "a safe and healthy life within an attractive living environment surrounded by dynamic nature areas, without damaging biodiversity or exhausting natural resources" and launched programmes for the energy system (including mobility), biodiversity and food/agriculture.

Recently, the Netherlands has strongly advocated the development and implementation of **sustainability criteria for bio-fuels**, which should prevent that CO2 is reduced at the expense of social costs (e.g. raising food prices) and degradation of ecosystems. The Netherlands Standardisation Institute, with the support of market parties, the government and NGOs, has developed certain **standards to ensure the sustainable production of biomass for energy along the whole chain** and help companies and consumers to adopt more sustainable consumption patterns. This voluntary instrument sets out specific criteria based on the minimums requirements for a sustainable bio-mass production and use. A certification expected to be enforced in 2011 will ensure the compliance of applicants with those criteria.

Related is also the **Dutch Sustainable Trade Initiative** (IDH), which has a mission to accelerate and up-scale sustainability within mainstream commodity markets, in particular focusing on mainstreaming social and ecological sustainability of commodity supplies from emerging markets to the Netherlands and Western Europe. IDH is working on the Millennium Development Goals for

poverty reduction, sustainable environment, and an open trading and financial system (MDGs 1, 7 and 8). It is forging coalitions between government agencies, companies, trade unions and social organisations and sector by sector transforming the market to make sustainable production and trade the norm (currently implementing programmes on cocoa, tropical timber, tea, natural stone, soy, tourism, cotton, aquaculture, electronics and spices).

4 Current and future challenges at the European level

Recent policy initiatives show a conceptual progress in bridging product and waste strategies and integrating policies related to individual life-cycle stages of resource use. All the numerous and recently adopted concepts, tools and policy initiatives (e.g. eco-efficiency, industrial ecology, life-cycle management, integrated product policy, extended producer responsibility, circular economy, Sustainable Materials Management, low-carbon economy or the 3R of 'reduce, reuse, recycle') have a similar ultimate objective of decoupling economic growth and development from resource use and its related environmental impacts – and to do so in ways that enhance well-being for the current and future generations. Nevertheless, they also share a number of challenges:

- As there are currently so many international and national-level initiatives on resource efficiency, there is a **need to strengthen collaboration and coordination** to maximise synergies and minimise repetitions and overlaps.
- Despite conceptual progress, the **EU-wide knowledge base on resource use, material criticality and environmental impacts is not yet sufficient**. Lack of knowledge on environmental impacts is also hindering the development of more specific targets and measures on the national level as well as establishing links between resource use, related environmental impacts and economic sectors.
- A paradigm (see the first chapter of this report) often **implicitly frames and shapes the development and implementation of policy**. The definition of resource use (as e.g. tied to material aspects, to environmental impacts or to societal or individual well-being) can ultimately influence sustainability-relevant outcomes. Judging an environmental impact is also a value judgement, embedded in a certain paradigm.
- Implementation could be improved by providing **more concrete actions and measures** in the EU roadmap to guide Member States and to **integrate the different sets of measures** implemented by major policy initiatives at the EU level within a singular coherent framework. At the national and local level it is important to **identify improvement opportunities** that achieve simultaneous economic and environmental benefits.
- There is a need to support statistical agencies in **setting up resource-efficiency monitoring systems** by co-operatively improving the knowledge base as well as improving material flow, resource use and environmental impact indicators. Linked to this issue is also the challenge of **problematic setting of quantified targets**.

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