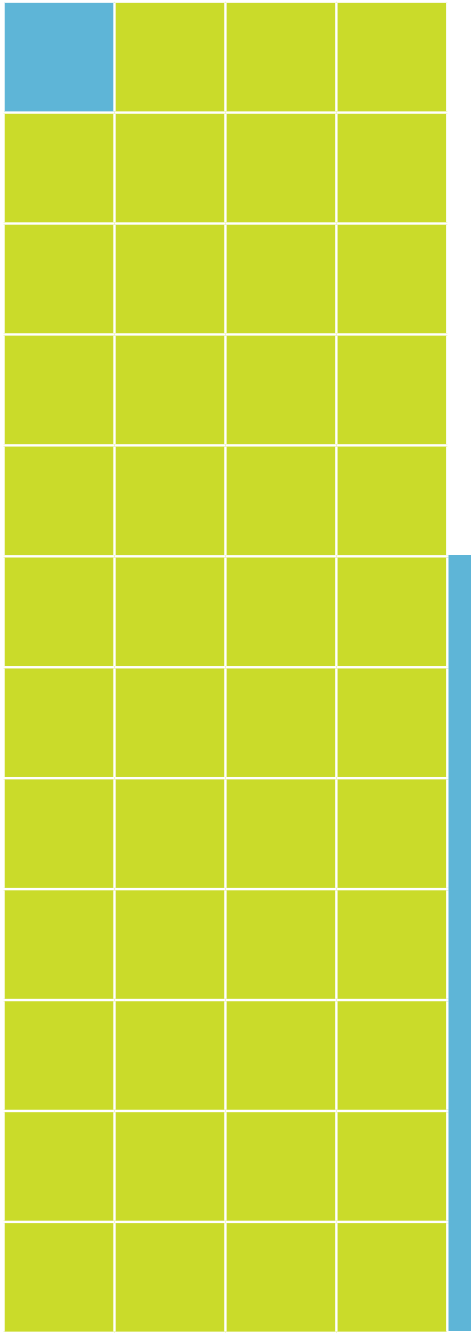
Miljø- og Planlægningsudvalget 2009-10
MPU alm. del Bilag 676
Offentligt



Sustainable Materials Management for Europe,

from efficiency to effectiveness.

Sustenuto

KATHOLIEKE UNIVERSITEIT LEUVEN

Wuppertal Institute
for Climate, Environment
and Energy

This background study on Sustainable Materials Management has been commissioned by the Flemish government, by the Department of Environment, Nature and Energy (LNE) and the Public Waste Agency of Flanders (OVAM).

This report serves as basis for the background paper for the informal Environmental Council on the 12th and 13th of July 2010, as part of the Belgian Presidency of the EU during the second semester of 2010.

The study is executed by a partnership of three expert organisations:

- ***Sustenuto:*** *independent Belgian strategic consultancy & research firm on Sustainable Development, CSR, cross-sector partnerships and Cradle to Cradle.*
  Author and lay-out: Ans Rossy. Contact: ans.rossy@sustenuto.be

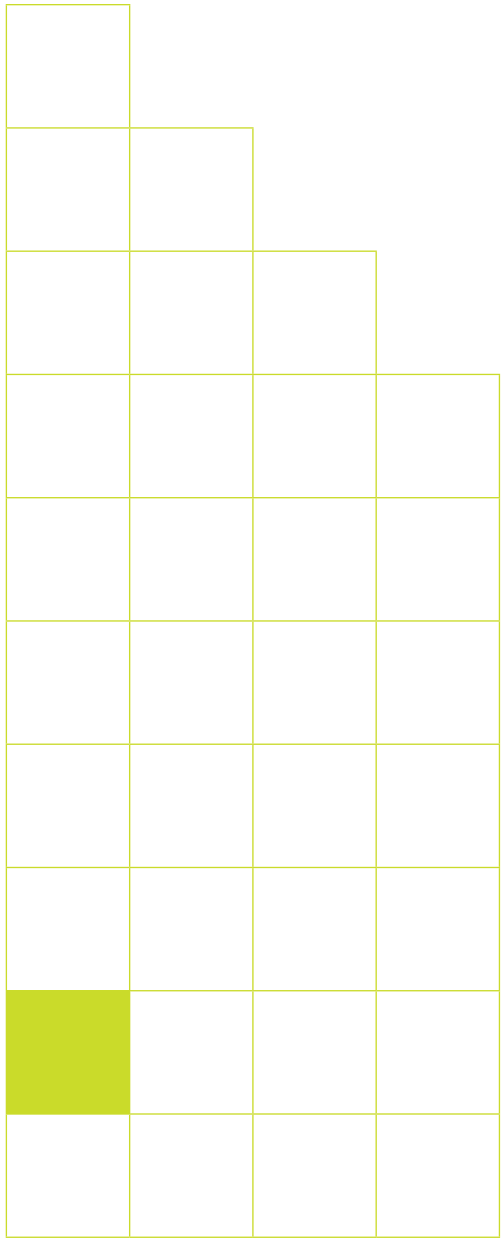
- ***Catholic University of Leuven (KULeuven)****, Department of Metallurgy and Materials Engineering, Leuven Research & Development including its Material Research Centre (MRC).*
  Authors: Dr. Peter Tom Jones and Dr. Daneel Geysen. Contact: peter.jones@mtm.kuleuven.be

- ***Wuppertal Institute for Climate, Environment and Energy:*** *application-oriented sustainability research, addressing the major challenges related to sustainable development, such as climate change or resource shortages.*
  Author: Katrin Bienge. Contact: katrin.bienge@wupperinst.org

Manuscript completed: Brussels, 31 March 2010

Table of Content

Executive summary



Objective

The objective of this report is to provide a clear and easily understandable background study on what sustainable materials management (hereafter SMM) is about, what the main evolutions are, and why SMM is relevant. The report provides examples of a great variety of cases and illustrates the challenges for further policy development on SMM at EU level.

The study serves as a basis for debate for the informal Environmental Council on July 12 and 13, as part of the Belgian EU Presidency during the second semester of 2010. It is not intended to give an exhaustive outline of the whole spectrum of SMM and related concepts, nor of the different existing policies at all political levels.

1. What is SMM?

The term SMM is one of several existing terminologies used for an approach to promote sustainable material use. Knowledge on sustainable development (SD) at large and the (complex) relationship with how we use, through production and consumption, materials, natural resources (including energy, water and land) have strongly evolved in recent decades. The terminology originates from the UN World summits on SD and is used at EU, UN and OECD level. The most common terms used are: Integrated Product Policy (IPP), Sustainable use and management of natural resources, Sustainable Consumption and Production (SCP), and Sustainable Materials Management (SMM). The study uses the OECD definition on SMM as a basis as it provides the broadest vision of these four concepts. This SMM definition must be seen from its most integrated point of view, also encompassing the issues of land use, absolute decoupling of economic growth and natural resource use, while addressing changes in human lifestyles.

The concept of material use has evolved over the past decades, due to increased knowledge on and understanding of the complexity of ecosystems and the strong interconnectedness of global environmental, societal and economic aspects. The evolutions in material use can be roughly divided in three main shifts, which have parallels with the different levels of organisational learning. These shifts indicate an evolution towards more integrated approaches of material use, bearing in mind that scientific knowledge, real business practices and actual governmental interventions do not necessarily emerge at the same time in these evolutions.

1. Reaction – single loop learning ('knowing what'): mainly end-of-pipe reactions on pollution and damage; waste management and eco-efficiency are central to business activities. The focus is mainly on the improvement and efficiency of production processes (clean technology).
2. Redesigning – double loop learning ('knowing how'): a shift towards rethinking and redesigning products, addressing challenges in the supply chain with involvement of other stakeholders, and taking on the responsibility for products. Eco-effectiveness, closing the loop and LCA are central to the business activities, whereby new product-service concepts emerge.
3. Reframing – triple loop learning ('knowing why'): this shift – we are only at the beginning of this process – implies a systemic change towards cyclical and fully integrated ways of addressing material use, towards sustainable materials management.

The further evolution of Sustainable Materials Management in the 21st century then also means:

- Responsible, fair and just extraction and use of raw materials and natural resources, including responsible land and water use, safeguarding soil quality and biodiversity;
- Establishment of absolute decoupling of material & resource use (including production of waste and emissions) and economic growth ('beyond GDP', from growth to wealth);
- Behavioural changes in the production and consumption patterns.

2. Why is SMM relevant?

In order to understand the real challenges for sustainable materials management we need to understand the bigger picture. Our human

ecological footprint overshoots earth's carrying capacity. In simple terms: we act as if we have more than one planet to live on. We use more resources and produce higher levels of greenhouse gases, toxics and non-degradable waste than this planet has the capacity and the time to, respectively, regenerate or assimilate. Nevertheless, respecting these ecological limits (sources and sink capacity) is the non-negotiable basis for our social and economic development. SMM is part of other challenges as well, e.g. the crises related to climate change, the energy system, land use, loss of biodiversity, social equity, etc. and has to be understood in the larger framework of sustainable development visions and strategies for the future.

To picture the monumental changes since the 1960's this study describes the evolutions in the major domains of human life (based on the division used by the EU SCORE! network - Sustainable Consumption Research Exchanges), for both the production and consumption side: food, living, and mobility.
The changed consumption and production patterns in the described domains show that biotic and abiotic materials in whatever form or size are part of every aspect of our lives. The amount and the way we use materials and products is influenced by a mixture of factors, e.g.: increased demand (population growth, changed ideas on comfort, convenience and health), rapid technological advancements, changed life-styles, increased income and mobility, and differences in consumption patterns between women and men.
Research shows, furthermore, that the EU is the world region that outsources the biggest part of resource extraction required to produce goods for final demand (private and public consumption), thus exceeding a potential self-sufficiency of natural resource use (ITRE, 2009). As materials demand is expected to grow four-fold in the next two decades, dematerialisation, resource productivity, and a shift from efficiency thinking to effectiveness and sufficiency is urgently needed.

3. Case examples of SMM

To provide a clear framework for the variety and levels of SMM initiatives the authors developed the 'SMM Maturity Model'. This model is based on the SMM concepts and evolutions as described in chapter 1 and 2 and combines three types of evolutions (with respect to economic, business and organisational/learning practices), while showing the level of 'integratedness' of SMM. The model has an 'open end' evolving into a 'world 2.0' where SMM reaches a fully integrated level. The 40 presented cases come from business, government and other societal actors worldwide. They are clustered in 12 themes (the position in the SMM Maturity Model is indicated per theme). The described cases within each cluster illustrate the enormous variety of existing SMM initiatives and their innovative potential. The cluster themes are:

1. Waste collection, treatment and recycling
2. Reuse and repair
3. Collection and linear upgrading/recycling/reuse/recovery of (inorganic) residues
4. Eco-design
5. Product Service Systems
6. Cradle to Cradle
7. Choice Editing
8. Biomaterials and natural ecosystems
9. Transition Towns
10. Knowledge Networks for Transitions
11. IT in SMM
12. Closed loop industry systems for (inorganic) residues

Furthermore, some specific policy measures from six countries are described to show the potential for further support and encouragement of SMM by national/regional governments through pro-active policy development.

4. Future policy directions for SMM

Striving to SMM is a matter for all actors in society, be it business, government, consumers, academia, civil society or others. Moving towards SMM cannot solely be achieved by being more efficient in existing production processes, or by minimising waste. To reach a 'reasonable' co-existence of the economy and the surrounding ecosystem(s) the use of natural resources by industrialised countries would need to be reduced by approximately 90% compared to its present level (Factor 10). This can only be achieved by real breakthrough system-level innovations; thus moving from eco-efficiency to eco-effectiveness and further to conservation; to eco-sufficiency. It is about transformation and changes in the systems of provision and our behaviour. Such changes are unlikely to occur by normal market processes, or at national levels alone. There is a strong need for a comprehensive policy mix and actions at EU level that further supports the necessary shift towards higher levels of SMM maturity.

An effective change strategy towards SMM requires integration of several aspects, such as: responsible extraction, use and re-use, healthy and safe technology development, fair distribution of resources and materials, smarter ways of consumption, and product-service effectiveness. This means that a solid SMM EU policy can further reinforce the current focus and targets in the EU policies on (renewable) energy use, CO2 emission reductions, and green innovation. Further integration of SMM as defined in this report then enhances the other European goals and SMM should therefore also be part of the new EU 2020 Strategy.
This creates challenges for a comprehensive policy mix and integrated policy approaches that contribute to the creation of a sustainable and resource-light world. This demands an

effective mix of strategies for change, taking into consideration the different drivers for human behaviour.

Therefore, the following main policy directions on SMM and EU level are suggested:

1. Policy integration:

- Further policy integration of the main existing EU frameworks linked to resource management and SCP;
- In parallel, a review of several existing strategies on the presence of SMM aspects, e.g. the new EU 2020 Strategy and the Eco-Design Directive;
- Establish strong European institutions, through for instance a cross-directorate European 'Green Cabinet';
- Develop a vision for sustainable future markets, set demanding and binding SMM targets;

2. Measuring and indicators:

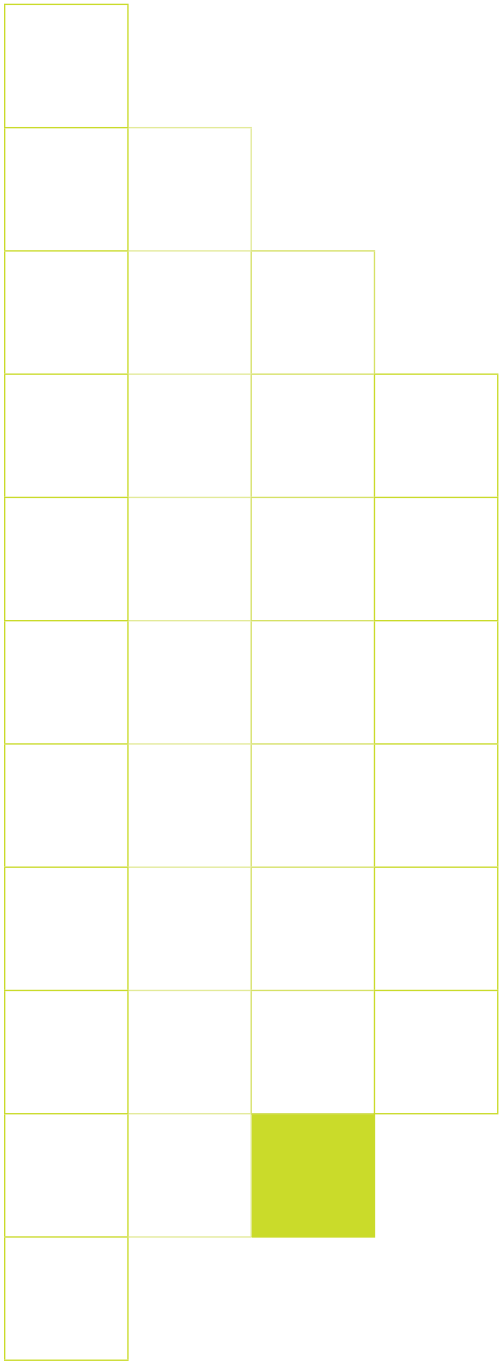
- Implement a comprehensive and robust resource use indicator set in the EU and member states;
- Establish one Data Centre where data on resource intensity can be internationally harmonised, validated and periodically updated;
- Develop strong and mandatory mechanisms for data generation of resource intensity at sector and company level;
- Support the establishment of national SMM agencies;
- Reinforce policy assessments and integrate indicators on SMM in the existing Sustainable Impact Assessment (SIA) at EU level;
- Design and start capacity building campaigns for sector and company level.

3. Research & Development:

- integrate SMM in future EU R&D programmes: EIT and EC FP7/FP8 calls, EU structural Funds, and specific SME programmes;
- The complexity of SMM issues require novel research and educational approaches that focus more explicitly on inter- and transdisciplinary networks and settings. Reserving substantially more means for multi-domain, integrative projects and networks is needed as a large part of the current EU funding is still reserved for the traditional single-domain projects.
- At global level: establish knowledge transfer to developing countries on how to develop their capacity to sustainable materials management, adequate measuring and monitoring, impact assessments, etc.

4. World 2.0 Transition:

- Further explore existing initiatives and debates at EU level on 'beyond GDP' and 'redefining prosperity';
- More research on developing financially stable and prosperous alternative macro-economics models is also urgently required, with the goal of transitionising the economy towards a World 2.0 and achieving the Factor 10 goal.
- Set up of a multi-stakeholder SMM Transition Platform at EU level, developing ideas to address the necessary transitions, systems changes, reframing, and actions needed for sustainable materials management (cf. the Flemish Transition Process Plan C, which focuses on SMM).
- Address the shortage of funding and investments at the stage of pre-commercialisation by developing an EU Trust Fund for 'Eco-innovation', which includes SMM.



Chapter 1 - What is Sustainable Materials Management?

Sustainable materials management (hereafter SMM) is not a stand-alone concept. It is part of the bigger picture of sustainable development and it is one of several existing terminologies used for an approach to promote sustainable material use. It is therefore relevant to further clarify this concept and define the framework. In this chapter we will address the:

1. different existing terms and concepts related to SMM and investigate the possible differences and similarities,
2. evolutions in material use that have taken place so far and the possible future directions.

1.1 Clarifying terminology; do we talk about the same?

Within the international arena of, for instance, the UN, EU and the OECD, different terminology is used for material use, often depending on the specific focus for policy development. There is a variety of reasons why different terminologies exist.

One of the main reasons is that ideas and knowledge about sustainable development at large and the (complex) relationship with how we use materials, substances, natural resources, including energy, water and land, have strongly evolved over the past decades.
The most common terms used are:

a. Integrated Product Policy (IPP)
b. Sustainable use and management of natural resources
c. Sustainable Consumptions and Production (SCP)
d. Sustainable materials management (SMM)

Several aspects can be part of all these concepts and are often intertwined, such as: (c)lean production, life cycle assessment and approach, resource efficiency and productivity, waste reduction, 3R's (reduce, reuse, recycle), eco-design, eco-innovation, industrial ecology, sustainable products & services, sustainable supply chain, etc.

The UN and the EU tend to use more often the first three concepts, originating from the UN World Summits on Sustainable Development (WSSD) in Rio (1992) and Johannesburg (2002), and the OECD uses more the term SMM.

a. Integrated Product Policy

In a report for the EC (Ernst & Young, 2000), that investigates the foundation for a European IPP, three main principles for national IPP policies are distinguished, namely: integration (integrating the control of impacts at given stages of the product chain), market based approach and life-cycle thinking. All products cause environmental degradation in some way, whether from their manufacturing, use or disposal.
IPP seeks to minimise these by looking at all phases of a products' life-cycle and taking action where it is most effective. The life-cycle of a product is often long and complicated. It covers all the areas from the extraction of natural resources, through their design, manufacture, assembly, marketing, distribution, sale and use to reuse and repair, reconditioning, remanufacturing, recycling and cascading use of materials.

At the same time it also involves many different actors such as designers, industry, marketing people, retailers, disposal contractors, recyclers, and consumers. IPP attempts to stimulate each part of these individual phases to improve their environmental performance.

Main focus in IPP is on 'greener' products in view of the life-cycle, throughout the product chain. The focus in IPP is aiming at an overall decrease of material flows, prevention of ecological impacts to soil, water, air, etc..

b. Sustainable use and management of natural resources

The basis for this concept is to ensure that the consumption of resources and their associated impacts do not exceed the carrying capacity of the planet and decoupling economic growth from resource use. The 6th Environmental Action Programme (EAP) called for the preparation of a 'thematic strategy on the sustainable use and management of resources'.
The strategy, which also has to be seen in

context with and contributes to the reviewed EU Sustainable Development Strategy, focuses on the natural resource use for products and materials.

Resource use has been an issue in European environment policy discussions over the past 30 years. A major concern in the 1970s, following the first oil crises, was natural resource scarcity and limits to growth (EC, 2005).

Rapidly growing demand, ecological damage and scarcity have put responsible natural resource management at the core of the SMM debate. This reality forces us to a significant reduction of negative environmental impacts, but also re-addresses the concepts of waste to the point that we cannot afford to 'waste' valuable materials anymore and a decoupling of economic growth and resource use is needed.

The attention paid to resource use is increasing at international level. In particular, the OECD has set the goal of decoupling environmental pressures from economic growth and has also published a joint agency paper (with World Bank, DFID, e.a.) on environmental fiscal reform and how that can contribute to more sustainable use of natural resources (OECD, 2001).

c. Sustainable consumption and production

In this concept IPP is part of a wider sustainable development perspective on SMM including the consumption patterns in the sense that, in order to render markets and economies more sustainable, production and consumption patterns are optimised. At the UN WSSD in Johannesburg (2002) all countries committed themselves to changing unsustainable patterns of consumption and production.

In the WSSD Plan of Action the so called Marrakech Process [1] was set up; a global process to support the elaboration of a 10-Year Framework of Programs (10YFP) on sustainable consumption and production.

The main objective of the 10YFP is to be a global framework for action on SCP that countries can endorse and commit to in order to accelerate the shift towards sustainable consumption and production patterns, thus promoting social and economic development within the carrying capacity of ecosystems by de-linking economic growth from environmental degradation.

The perspective of sustainable lifestyles at large is also part of the framework.
The EC Action Plan on this matter contains a dynamic framework to improve the energy and environmental performance of products and foster their uptake by consumers.

This includes setting ambitious standards, ensuring that products are improved using a systematic approach to incentives and (public) procurement, and reinforcing information to consumers through a more coherent and simplified labelling framework.

The challenge is to create a virtuous circle: improving the overall environmental performance of products throughout their life-cycle, promoting and stimulating the demand of better products and production technologies and helping consumers to make better choices through a more coherent and simplified labelling (EC, 2005).

d. Sustainable materials management

The OECD working definition of SMM was developed in 2005, and states:
"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".

Following **explanatory notes** are given with this working definition:

- **"Materials"** include all those extracted or derived from natural resources, which may be either inorganic or organic substances, at all points throughout their life-cycles;
- **"Life-cycle of materials"** includes all activities related to materials such as extraction, transportation, production, consumption, material, product reuse, recovery and disposal;
- An **economically efficient** outcome is achieved when net benefits to society as a whole are maximized;
- A variety of policy tools can support SMM, such as economic, regulatory and information instruments and partnerships;
- SMM may take place at different levels, including firm/sector and different government levels;
- SMM may cover different geographical areas and time horizons.

e. Approach of background for the study: What do we talk about?

It is clear that despite different wordings the differences between the above concepts are not always that significant and there is often overlap. The above described concepts of material use do not yet reflect the full and broad perspective, including water and land use, justice and fairness, societal behavioural paradigms.
The distinction exists mainly in the scope of the concepts, ranging from narrower to wider, up to a more integrated view:

- A strictly environmental and technological focus on the product and/or industrial process itself,
- The whole (linear) supply and product chain, upstream and downstream, including

1 HTTP://ESA.UN.ORG/MARRAKECHPROCESS/

natural resource use and consumers use,

- To a larger societal perspective, including consumption mechanisms, the connection between materials as (continuous) resource for each other, up to closed-loop product and service cycles,
- To the (relative) decoupling of economic growth and natural resource use (scarcity) and change of human lifestyles (behavioural and societal factors), considering overall sustainable development goals (including e.g. the relationship between material use and energy, land use and food production, global versus regional aspects, biodiversity and climate impacts, equity and justice (e.g. equal access to and use of the available natural resources), etc.

The SMM concept in this study takes the OECD SMM definition as a basis and starting point. However, it also takes the wider and more integrated perspective of material use into consideration. The concepts of SMM are still evolving, as we will see in the next paragraph.

1.2 Main evolutions in material use

Key factor in the evolution on the concept of material use is our enhanced knowledge on the complexity and interdependency of the planet's ecosystem. Particularly, the cause-effect linear thinking proved inadequate to understand the complexity and delicate balance between the multiple aspects of the ecosystem, from climate change and biodiversity, to deforestation, resource use, emissions, population growth and human lifestyles.

It is only since the last two decades or so that we start to better understand the effects of human activity on the system at large.

In 1990 the Intergovernmental Panel on Climate Change (IPCC), established by the UNEP and the World Meteorological Organization (WMO), issued its first assessment report (FAR), providing the world with a clear scientific view on the actual state of climate change and its potential environmental and socio-economic consequences.

These evolutions also affected our thinking on material use. We can witness a shift from a company's focus on the product and process towards a focus on the supply chain and a more sector wide approach, involving close cooperation with a variety of external stakeholders. The evolutions described below indicate the main changes at international level in three phases stretched over certain time periods.

These time periods are variable as both scientific evolutions, the range of market applications, and policy interventions often do not converge. Furthermore, the speed of innovation and adaptation may vary for individual countries.

Three main phases in the development of material use can be distinguished.
In the beginning material use was strongly focussing on reacting. Thereafter it changed towards redesigning. Considering the enormous challenges we face in the 21st century on resource scarcity, climate change, food insecurity, etc. the need for reframing becomes more apparent.

Albert Einstein already said: "The significant problems we face cannot be solved at the same level of thinking we were at when we created them".

This shift in depth and width of the understanding of material use and its relationship to a wider context and the related actions taken can be compared to the different levels in organisational learning (developed by Chris Argyris).

Organisational learning, according to Argyris, involves the detection and correction of error. Following comparison can be made:

1. **Reaction - single loop learning:** focus on factual knowledge - 'knowing what' and the actions involve mainly technical repair and a routine is in place (follows existing procedures and mechanisms).
2. **Redesigning - double loop learning:** focus on procedural knowledge - 'knowing how' and the actions involve improvements of processes, structures and practices, which demands reflection and creativity, as dilemmas emerge.
3. **Reframing - triple loop learning:** focus on meta-knowledge - 'knowing why' and the actions involve questioning the basic common framework. The problems then are reframed leading to the implementation of new approaches. This type of learning also refers to the capacity of action learning of a group (either in an organisation or multi-dimensional and across sectors), which is vital for the so called transition processes. Reframing implies the transition to new models or frameworks to construct our societies.

While describing below the evolutions in material use and management we have to bear in mind that the advancements of scientific knowledge, technology development and business models, and governmental actions do not always occur simultaneously.

The latter is often somewhat behind, which does not mean that it cannot influence the pace, direction and scale of developments, as we shall see in the following chapters.

1.2.1 Reaction: from end-of-pipe to eco-efficiency and supply chain

In the 1970's and 1980's the focus in industry and on material use was mainly dominated by end-of-pipe thinking. Strong economic growth,

expansion of multinationals, liberalisation and deregulation of the international markets also brought environmental damage. Waste production and pollution formed the first concrete negative signs of business activities.

The first response of business (and society) to environmental disasters and scandals was re-active, cleaning up after the damage had been done. The reaction of business was rather defensive and its main concern was to repair the damage and its image and clean up the waste, which in the early stages sometimes only meant: take it out of sight.

This then shifted in the 1980's to pollution and waste prevention, in parallel with EU and national government initiatives on environmental legislation.

Business started to realise that they also had a responsibility towards the environment and society and now attention focussed more on cleaner technology and industrial processes. In this period the eco-efficiency thinking, 'do more with less', becomes more central to business operations.

Eco-efficiency means that we produce the same amount of useful output with less input from resources and (fossil) energy. By the early 1990's the application in the company of various management systems and standards (ISO, EFQM, EMAS, SA 8000, etc.) becomes more and more prevalent, whereby multinational companies often take the lead.

The shifts in the perception and concepts of SMM do not stand alone. Since the 1990's a shift, in parallel with the evolutions on Corporate Social Responsibility (CSR) in business, has taken place.

This goes from a more internal focus towards an external focus, involving a wider range of external stakeholders and with considerations of the effects along the supply chain, both upstream and downstream (SERV, 2007). At the world summit in Rio de Janeiro in 1992, governments agreed to "encourage a shift to more sustainable patterns of production and consumption" (Agenda 21, 4.17).

Although, still mainly seen from a linear perspective. Companies now start to take on, but it is certainly not yet mainstream, wider responsibilities for the societal effects of their core business activities.

This is among others noticeable by the growth of a large number of product labels and international multi-sector initiatives in the mid nineties of last century, e.g. Fair Wear Foundation, Kimberly process (diamond sector), and more recent the WWF Round Tables on Soy & Palm Oil, which address the economic, environmental and social issues at stake in the whole supply chain.
Companies are asked to take responsibility for their products and services throughout the value chain and concepts as product stewardship emerge.

1.2.2 Re-designing: eco-effectiveness and closing the loop

In the past decade our understanding of the impacts of human activity on climate change, food security, depletion of natural resources and on many other sustainable societal challenges, has changed which also implies a shift in thinking on material use. Ten years later, the United Nations Commission on Sustainable

Development noted that little had changed with regard to non-sustainable patterns of production and consumption, and that the threat to the natural basis of life continued to exist ("Implementing Agenda 21", report from January 2002). In response, it was formally agreed in Johannesburg to accelerate the transition to sustainable manufacturing and consumption processes (Plan of Implementation, § 13) by means of ten-year plans.

Meanwhile, consumers and the wider public are better informed and become more demanding on the quality of products. People want to know from companies (and governments and civil society actors) where products come from, how they are made, under what circumstances, and what is in them.

This also demands a wider perspective on material use, including resource extraction from elsewhere, the global movements of products, the relationship to our consumption patterns and our (Western) concepts of comfort, cleanliness and convenience (Shove, 2003). With our increased understanding of the complexity, interdependency and the societal impacts, material use is no longer limited to industry processes and product efficiency.

Reduction of material and resource use in the whole production chain of a product becomes generally accepted, as is the reduction and smarter design of packaging at various levels, including for transportation. Reduction, reuse and recycling and eco-effectiveness become the buzz words. No longer just 'do more with less', but 'do it right from the beginning'.

This means designing products from a life cycle approach, where responsible extraction and material use are as much a concern as what can be done with products after the end-of-use stage. In the Cradle to Cradle concept this means how to keep materials in closed cycles, either biological or technical.
Here the concept of waste as such changes, after use materials still maintain value and can be reused of remanufactured in biodegradable

or new industrial products, without constantly extracting new resources from the earth.

This implies a shift towards products-services concepts; from owing (end-user) to using (leasing, renting) concepts. Producers then remain the owner of the product, and if a machine breaks down, he needs to repair or replace it. This contributes to the reduction of environmental pressures.

1.2.3 Re-framing: towards new horizons of integrated approaches

At the beginning of the 21st Century, we notice a shift in the developments of the concepts from more linear and simple to cyclical and complex. Trends and developments are on its way where material use, product development, and production & consumption patterns are considered in a system that has effect on society at large, here and elsewhere, today and tomorrow.

This means addressing the current shift of burden at three levels:

a. between generations (for our children and grand children),
b. between geographical regions (here and elsewhere on this planet),
c. the whole supply chain (and between different sectors).

We then enter the phase of reframing. This implies a fully integrated approach with a systems perspective or in other words, sustainable materials management. SMM is then interlinked with diverse aspects that affect the eco-systems and societal wellbeing.

The interdependency of resource use and scarcities between energy, land use, water and natural resources has become clear and, as we will see in chapter 2, the urgencies to act increase. This also implies that SMM will have to be looked at from a closed-loop, cyclical and systems perspective and that geological, physical, economical, social, institutional and geopolitical implications have to be addressed (Ministries VROM & Foreign Affairs, 2009).
It demands an integrated approach and a new framework for business.

1.2.4 Future Challenges

The existing materials management concepts, at this point in time, do not yet fully address for instance how raw materials and natural resources can be extracted in a responsible, fair and just way, how this is related to land use, the maintenance of soil quality and biodiversity, how absolute decoupling of material & resource use, production of waste and emissions, and economic growth (GDP) can be established, and what this means for the relationship between production and consumption patterns and the way we use products and materials. Furthermore, the current focus on (energy) efficiency, which often leads to rebound effects, can create adverse effects and undo the initial gains.

This also addresses cultural, value and behavioural questions; what do we really need for a decent living standard?
The main problems with materials and resource use are twofold:

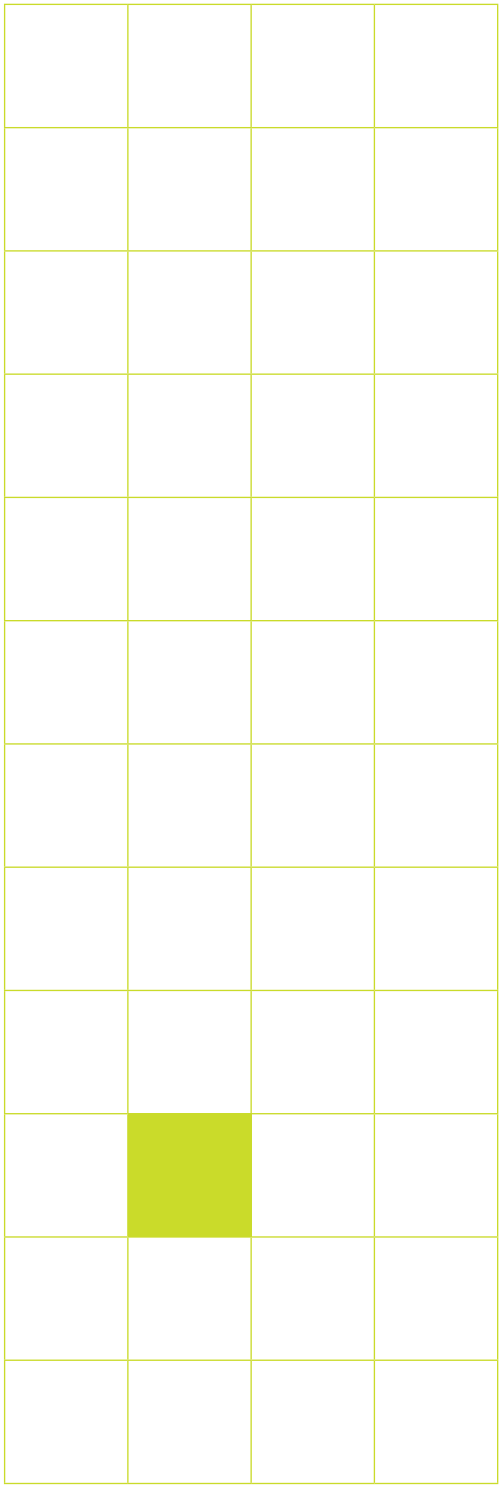
1. The environmental impact generated by the current patterns of resource use. For example, the availability (which is not limitless) of fossil fuels and the consequently extensive use to generate energy and to produce products creates severe air pollution and global warming.
   This also applies to non-renewable resources, such as metals and minerals, although their availability is not for all under threat, they do cause environmental problems and pressures.
2. In the case of renewable resources, scarcity in itself is an environmental problem, as the extinction of species means loss of biodiversity and land use means loss of habitats and diversity, and often also loss of soil quality, which then leads to a variety of other problems, such as floods or poor nutritious value of food crops. Scarcity is only partially solved by price mechanisms.

Despite considerable efforts in the EU in the last 20 years to improve material efficiency and the fact that overall consumption per inhabitant has remained virtually unchanged in the EU at around 16 tonnes per year, while economy has grown by 50% over that period, this has not been sufficient to reverse fundamentally unsustainable trends either in Europe of globally.
In order to reverse these unsustainable trends, containing environmental degradation and preserving the essential services that natural resources provide, environmental policy needs to move beyond emission and waste control (EC, COM 2005, page 4,5).

In order to reduce the overall environmental and societal impact of materials the future challenges for SMM are multiple:

- to design products ‘right’ from scratch;
- to use renewable resources and energy to extract, make, use, separate, and remanufacture them;
- to re-use materials as long as appropriate and avoid depletion;
- to develop concepts that shift from (one) end-user and ownership towards more effective use by leasing and renting (new types of services);
- by creating closed loops between material use and land use, while integrating and mixing functions of living, working, mobility, food supply, etc.;
- creating buildings and infrastructures that produce energy, clean water, etc.;
- waste in its current concept will become history.

The future framework for SMM lies in our ability to combine design, nature and technology with the environment (ecological and social), changing the mindset, optimising production and consumption patterns towards ‘resource-light’ patterns, and creating effective and collaborative economies, based on integrated (bio) systems. This cannot be realised by business, research, civil society actors or consumers alone.
Governments and public authorities can play an important role in stimulating and setting frameworks for SMM, and as such can contribute to a greener and more equitable economy.



Chapter 2 - Why is SMM relevant? The bigger picture.

Can we see the bigger picture and do we really understand the signs around us? Our human ecological footprint overshoots earth's carrying capacity (see table 2.2). In simple terms, we act as if we have more than one planet to live on. We use more resources and produce more damaging greenhouse gasses, toxics and non degradable waste than this planet has the capacity and the time to maintain a healthy eco-system, which is the sole provider of our and other species' living conditions.

SMM is therefore part of other challenges as well, e.g. climate change, energy, land use, resources, biodiversity, etc. and has to be understood in a larger framework and as part of sustainable development visions an way we live, what we consider necessary, useful or pleasurable, and the way we construct our societies anywhere on this planet. These manmade processes and (economic) activities create pressures on the ecosystem and on the potential for human development.

In this chapter we will see what has changed in a lifetime, what urgencies we face, and what the future challenges for SMM are.

2.1 What has changed in a life time?

In only a few decades our lives have changed dramatically. The impacts on many levels are not only significant but also occur in an accelerated way. We picture these changes over the time span of a human life of about 80 years (a life expectancy not yet a reality everywhere! see table 2.2), from around the 1960's, 70's until around 2040.

The changes and impacts that took place and the challenges we are facing for a sustainable development involve all areas of life and are indeed very complex. For the sake of clarity we will picture the overall urgencies by three main domains of human life (based on the EU project SCORE!- Sustainable Consumption Research Exchanges[2]): **food, living (housing), mobility**. Table 2.1 gives an overview of the environmental impacts of four consumption domains (recreation will not be addressed here) for the EU-25 with some country examples.

Table 2.1: Environmental impact (full life cycle) of consumption domains (based on Tukker e.a., 2008)
Source: Jones, P. T., De Meyere, V. (2009)

Domain	% of expenses in EU-25	Ecological footprint	Energy	CO2(eq)	CO2	CO2(eq)
		Cardiff	Denmark	Netherlands	Norway	EU-25
Food	19,3%*	21%	26,2%	22,1%	12,2%	31%
Living	25,1%	30,8%	40,8%	33,4%	23%	23,6%
Transport	14,1%	22,4%	19,5%	17,3%	35,9%	18,5%
Recreation	9,1%	8,3%	7,2%	15,1%	0,5%	6%
TOTAL	67,6%	82,5%	93,7%	87,9%	71,6%	79,1%

**If restaurant visits were included the figure would be 28,9%*

2 The SCORE science network (2005-2008) , funded by the EU's 6th Framework Program and UNEP, supports the development of the UN's 10 year Framework of Programmes on Sustainable Consumption & Production (SCP).

Within these three domains we describe the changes and challenges from both the consumption and production side, and will be further illustrated with some non-exhaustive key figures. Although based on scientific data and projections, these figures are merely meant as illustration and support for the better understanding of the impacts and urgencies we are facing.

2.1.1 The overall challenge: climate change and human development

Before looking at the three domains we will picture some overall challenges we face. Table 2.2 shows figures on the evolution of some global issues.
Climate change (and in its wake the financial and economic crisis) and human development are among the most impressive challenges we have on our plates today.

The UN Millennium Development Goals cover eight human areas closely linked with the need for a sustainable development.
There are only five years left until 2015 to achieve these goals. The 2009 UN progress report is clear; advances in the fight against hunger and poverty have slowed down and are even reversed and overall progress has been too slow to reach most of the targets.

Growth of the world population is another major factor, including the shift, mainly in the developing world, towards megacities. Today, virtually one out of two people on the planet is a city dweller. In 1975 urban population was 813 million in developing countries to 704 million in developed countries.
In 2005 it was 2.3 billion in less developed to 344 million in more developed countries (UN-Habitat World Urban Forum III, June 2006, Vancouver).

Thanks to scientific research and the IPCC it is now generally accepted that global warming should not exceed 2°C if we are to avoid major damage.
Former World Bank economist Nicholas Stern leaves no doubt. The cost of inaction will be higher than the cost of climate mitigation action programmes. He showed that doing nothing will cause an economic recession with a yearly loss of 5 to 20% of the global GDP (Stern, 2006).

Economic damages from weather-related disasters hit an unprecedented $204 billion in 2005, nearly doubling the previous record of $112 billion set in 1998 and reflecting the high number of disasters affecting built-up areas. Three of the 10 strongest hurricanes ever recorded occurred in 2005[3].

Climate change does however not affect us evenly. The South and developing countries, where many poor people live in low coastal areas and megacities, will be most affected. UNDP (2007) judges that if we fail to tackle climate change the poorest 40% of the world population will be condemned to a hopeless existence.

Human impact also becomes clear in our ecological footprint, already more than one planet. The ecological footprint, developed in the 1990's by Matthis Wackernagel and William Rees, is a measure expressing how much bio-productive land is needed for meeting human consumption.

It consists of various factors: land use for infrastructure, agricultural activities and fishing, and (potential) land use for compensating CO2 emissions from non-renewable energy resources. Our ecological footprint is on average 2.3 ha/pp, however the planet provides resources for only 1.9 ha/pp. We overshot the earth capacity already in 1975. (See table 2.2)

Recent decades have also changed the relationship society-forest. The FAO has observed a number of trends for forests and forestry (FAO, 2007, page 79). To mention a few:

- Deforestation and forest degradation will continue in most developing regions; a reversal of the situation would depend on structural shifts in economies to reduce direct and indirect dependence on land. In most developing tropical countries, agriculture and land use continues to expand.
- The possible effects of climate change may increase the incidence and severity of forest fires and pest and disease infestation and may alter forest ecosystems. There will also be increased attention on the role of forests in carbon conservation and sequestration and in substitution of fossil fuels.
- For many developing countries, wood will remain the most important source of energy. The use of wood as fuel will increase in both the developing and the developed world. The development of improved fuel conversion technologies that enhance energy efficiency would particularly favour this shift.

Economic growth has become the main indicator for human activity. In many Western countries we could speak of un-economic growth, which is when the negative effects of growth exceed the benefits of growth. The real wealth of a nation then decreases instead of increases (Jones & De Meyere, 2009).

There have been several attempts for alternative measuring of our wealth, such as the Index of Sustainable Economic Welfare (ISEW) of Daly and Cobb (1989). The ISEW is an adjusted economic indicator which attempts to incorporate costs and benefits not traditionally measured in monetary terms.
It brings together a wide range of economic,

3 www.worldwatch.org/node/4250

social and environmental issues, such as: habitat loss, localised pollution, depletion of non-renewable resources and climate change; social costs associated with crime, divorce, commuting and unequal income distribution; and the health costs of road or workplace accidents.

So far the ISEW has only been drawn up for a few industrialised countries. These countries already reached, between the 1970's and 1980's, the tipping point where economic growth becomes 'un-economical'.
The UNDP and the WHO also found indications that the higher the income inequality, the higher the prevalence of emotional distress (depression, anxiety, substance abuse, impulsivity) (James, 2007). The EC calculated (based on data of the WHO) that by 2012 the highest percentage of job fall out in the EU is caused by depression.

The 'Happy Planet Index' shows that around the world, high levels of resource consumption do not reliably produce high levels of well-being, and that it is possible to produce high well-being without excessive consumption of the Earth's resources.
The EC is now reflecting on the improvement of indicators that better reflect the new context and can complement current GDP with environmental and social indicators, building on other international efforts (EC, 20.8.2009). Also the World Business Council for Sustainable Development describes in its 'Vision 2050' the need for new measures of success and redefining progress (WBCSD, 2010).

Meanwhile we are faced with an economic crisis that cuts deep. The ILO reported a few months after the 2008 financial meltdown the loss of 50 million jobs. Some 2 billion people struggle to get by on less than two dollars a day, lacking access to food, water, health, and energy. Over 25% of young people in the world are unemployed, and around 70% of the world's wealth is concentrated in the top 10% of the world population.
Unprecedented challenges in a world that so drastically changed over the past few decades.

Table 2.2 Some key global evolutions

** ecological footprint scenario's based on moderate 'business as usual'.*
*** average of men and women together.*

Sources:
Ecological Footprint Network, IPCC Climate Change 2007 Synthesis report, WWF, UN Habitat (2006,2007),UN World Urbanization Prospects : The 2003 Revision, UN World Population Prospects : The 2006 Revision,

	1960	1970	1980	2000	2020	2040
World Ecological Footprint (nr. of planets)	0,5	0,7	0,9	1,2	1,5*	2*
	1960	**1970**	**1980**	**1990**	**2000**	**2005**
World bio capacity (resource supply) (ha/pp)	3,75	3,2	2,6	2,2	2	1,8
		1970	**1980**	**1990**	**2000**	**2004**
Global anthropogenic GHG emissions (GtCO2 – eq/yr)		28,7	35,6	39,4	44,7	49
	1960	**1970**	**1980**	**2000**	**2020**	**2040**
World population (billions)	3,5	4	4,4	6,2	7,5	8,9
	1960	**1970**	**1980**	**2000**	**2020**	**2040**
** life expectancy at birth (years) more developed regions	69	71	73	75	79	81
	1960	**1970**	**1980**	**2000**	**2020**	**2040**
** life expectancy at birth (years) least developed regions	39	44	47	52	59	65
	1960	**1980**	**2000**	**2010**	**2020**	**2030**
Urban population world wide (%)	30	40	49	53	59	62

2.1.2 Food

Food is one of our basic needs. It consists of multiple human, ecological and economic aspects. Apart from fulfilling our basic need it is also connected to: consumption, production, employment, trade, pricing, access, land use, soil quality, nutritious values, health & safety, emissions, rural development, poverty and population, etc.

Food, in its production and consumption, also creates major impacts related to (fossil) energy use, material use, GHG-emissions, health risks, malnutrition, land use, soil quality, and unequal access.
Worldwide, agricultural activity, especially livestock production, accounts for about one fifth of the total GHG-emissions, thus contributing to climate change and its adverse health consequences, including the threat to food yields in many regions. Today we live in a world of multiple food paradoxes.
According to the FAO, 2009 has been a devastating year for the world's hungry, marking a significant worsening of an already disappointing trend in global food security since 1996. The global economic slowdown, following the food crisis in 2006–2008, has deprived an additional 100 million people of access to adequate food. Although from the 1970's until around 1995 there was a decrease, since then and particularly since 2006 there have been marked increases in hunger in all of the worlds' major regions.
Currently 1.02 billion people are estimated to be undernourished.
On the other hand 1.6 billion people are overweight of which 400 million suffer from obesity, mainly due to unhealthy food choices and habits (high caloric and low nutritious fast food and too much meat).

Consumption

Our food habits have dramatically changed, both in quantity and quality, in only a few decades.
Towards 2050 global population will increase by a further 2.5 billion and in this period per capita income will more than double. This will cause a large increase in the demand for food and put extra pressures on land use. 'Worldwide, agricultural production is projected to rise by approximately 80% (crops) to 100% (animal products), between 2000 and 2005' (NEAA e.a. 2009, page 30)

The animal products intake per person per day in the industrialised countries has increased from around 600 Kcal in the 1960's to 880 Kcal by 2040 (Mc Michael J.A. e.a. 2007). Worldwide meat (and dairy products) production and consumption continues to increase, not only due to population growth, but particularly to the increase of income and living standards.
Another major change took place in the way we purchase food and the way it is presented to us. In the 1960's until even the late 1980's, food was sold through local groceries, originating from regional food chains with a relatively limited choice. Super- or hypermarkets, managed by large multinational retail chains, now have become the dominant providers of our food, non-food, and daily-use appliances, with a seemingly unlimited choice.

The shift to industrialised food production (see below), new technologies (freezers, microwaves), and ever smaller family units, changed both the content and type of food on the shelves. We now are used to frozen food, ready-made meals, industrially processed food with added sugar, salt and artificial additives, and products from all over the world.

These changes also influenced the amount of materials used in the food chain for packaging, storing, conservation, and transportation. According to the French Environmental and Energy Agency Ademe, a pack of coffee (250 grams) containing individual portions generates 10 times more packaging than the equivalent of a non-portioned packaging.

A similar development has taken place for restaurants. We moved from eating regional cuisine with fresh and seasonal products, to the whole world on our plates. Also the concepts and conditions under which we eat have changed. We now eat fast food and non-nutritious snacks available 24 hours a day in cooled and lighted machines, from night shops, petrol stations, or other self-service concepts.

Another development in supermarkets (and other shops) is the increased efficiency and productivity, often leading to the abolishment of labour in favour of machines and electronics, e.g. energy consuming deep freezers and cooling systems, IT and electronics for stock management, new types of payment and cash points, and self-service systems.
The latest developments are self scans and self pay machines; no contact with staff needed any more.

Table 2.3

** food consumption refers to: animal products, other crops, oil crop, and cereals/rice/maize*

Sources: World Resource Institute http://earthtrends.wri.org, Global water withdrawal: UNEP GEO 4 Report 2007, OECD Environmental Outlook, 2008,

	1960	1970	1980	2000		
World meat consumption (kg/pp/per year)	21.1	24.8	28.1	38.6		
	1970	**2000**	**2030**	**2050**		
Global food consumption* (kcal/cap/day)	2450	2750	3250	3500		
	1960	**1970**	**1980**	**2000**	**2020**	**2040**
Global water withdrawal Agriculture (km³)	1300	1500	2100	2500	3000	3400
	1960	**1970**	**1980**	**2000**	**2020**	**2040**
Global water withdrawal Industry (km³)	150	190	240	400	550	700

Production

Over the past decades we have drastically changed the way we produce and grow our food and non-food products (biofuels). Advances in plant and animal breeding throughout last century facilitated mechanisation in agriculture and increased yields and quality, enhanced by the rapid development of inexpensive chemical fertilizers and pesticides since 1945. As a result of these advances, growth in agricultural productivity in the USA averaged 1.9 % annually between 1948 and 1999.

The FAO showed that the world productivity increased 2.3% per year since 1961, but estimates that it will decrease by 2030 by 1.5%, and 0.9% between 2030 and 2050.
Today a Western farmer can produce 200 times more than before and a farmer in the US produces even 2000 times more than an average farmer in Rwanda.

Agriculture is still an important job provider, particularly in the South. Almost half of the world population is active in agriculture. Worldwide agriculture uses 70% of water. Irrigation can increase food production; however the downsides cannot be neglected. Since 1950 the irrigated surface has doubled, while water use for agriculture, household and industrial use has tripled!
According the FAO modern agricultural methods create several other effects (Steinfeld e.a.2006):

a. Farms became more specialised and with that the number of produced commodities per farm has decreased. This also meant a loss of varieties of plants.
b. The number of farms decreased, but the average size increased (more monocultures which also affects soil quality),
c. Agro-exports dominate the global economic relations. Consequence is transportation of food and derived products sometimes with bizarre effects. Example: France exports just as much milk to the UK as it imports from the UK, and the UK exports just as much ginger bread as it imports.
d. Emerging of greenhouse farming (energy intense, more CO2 emissions).
e. Use of fertilisers and pesticides which pollute water and soil and create (in)direct health risks in food chains over large territories.
f. Increased soil degradation; about 40% of our agricultural land today is in decay, also due to other practices such as deforestation and uncontrolled irrigation.

Trends

Apart from above impacts there are the challenges of genetically modified Food (launched in the USA in 1996), industrialised aquacultures, and new biotechnologies to cultivate and create new types of food, such as 'artificial' meat. The new phenomenon of 'land grabbing' by foreign investors and the use of marginal lands for production increases the pressures on: land-use, local development and access to and control over land.
As a reaction to the industrialised and global farming new trends emerge e.g. biological and eco-friendly farming, combined with local supply chains and direct sales to consumers. There is the Slowfood movement in Italy and AMAP (Associations pour le Maintien de l'Agriculture Paysanne)[4] in France. AMAP is a partnership between consumers and producers with direct exchange of locally grown products and farming methods are based on biological farming (producers have often the AB logo) using a maximum of plant variation and with respect for biodiversity and rhythm of nature.

The increased pressures on land use for food, non-food production (biofuels, food for cattle), but also for buildings and infrastructures (transport), challenges the reframing of our agro-industrial model towards innovative and sustainable solutions, including sustainable materials, resource and land-use.

4 See:http://www.reseau-amap.org/

2.1.3 Living - housing

Living refers to both living in buildings and the buildings itself (residential or other occupation). Seen from a complete life cycle perspective the housing and building sector in the EU is responsible for about 30% of the total ecological footprint, 25% of the total GHG-emissions and 40% of energy use (see table 2.1). Buildings also have impacts on: health (indoor air quality and climate), water and energy use, land use compared to other functions, e.g. nature, agriculture, roads, and the quality of the buildings at large.

World population and the demand for housing are still growing. An increased number of single households combined with an aging population increase the overall energy consumption and the number of household appliances needed.

Long term increase in energy prices (peak oil) has direct social effects. The poor, socially vulnerable, and people who (have to) stay in pay an uneven part of the cost. Energy use in houses has increased over the years, mainly due to the increase of living standards, changed concepts of comfort, and the number of electrical and electronic and household equipment (for heating, cooling or leisure) that came available on the market.

Consumption

The shift in our Western lifestyles and our changed concepts of comfort & cleanliness together with the technological advancements created many new household and lifestyle products. For personal hygiene we moved from washing at a sink to taking a daily shower or bath. On average we use 39% of our (drinking) water for shower and bath, 22% for dishwashing and laundry, and 20% for sanitary systems. Today we possess and have access to a sheer endless variety of electrical appliances and equipment for different functions in and around the house. The list of 'comfort from a socket' is endless and involves all aspects of our living, from kitchen utensils & cleaning and garden and tools, to personal care & hygiene and play & pleasure.

There are several effects of this increased consumption of all kinds of electrical appliances:

1. Increase in water and electricity use, direct and indirect (stand-by use), and CO2 emissions.
2. The amount of materials needed to extract, produce, transport, and recycle this equipment (see table 2.4).
3. The rebound effect; when equipment becomes more energy-efficient we tend to use more (leave lights and equipment on, drive more kilometres, etc.).
4. We need more and more square meters of living space to store all this equipment.
5. Our households in the developed world become smaller. We need the same amount of appliances used by less people (more single households).
6. Health and wellbeing. Almost without noticing we 'exclude' our own body from daily muscle activity and direct tactile contact with (growing and preparing) food, gardening and our own body. Obesity is not just a matter of food intake, but also how we are able to maintain our body in a healthy physical state and stay in touch with it.
   As German philosopher Peter Sloterdijk eloquently puts it: 'The 21st Century is the century in which we will only use one part of our body, the finger; for pushing buttons on our mobile phones, remote controls, cash machines, etc.'

The turnover of goods has increased and repair is often not an option anymore. The last 20 years the worldwide number of mobile phones subscribers has grown to about 4.1 billion mobile phones in 2008, compared to approximately 1.1 billion in 2002, and less than 500.000 in 1998 (OECD, 2009).
The average lifespan of a mobile phone has decreased from 3 years in 1991 to 18 months in 2002. 'However, the technical lifespan of a mobile phone is about 10 years therefore promoting reuse is a good way of supporting sustainable use of materials' (OECD, 2009, page 40). A European mobile phone recycling company estimated that alone in Belgium around 25 to 30 million 'old' mobiles still lay around at home.

Another consumptive aspect of living refers to the energy and material use of the building itself. In the housing sector, construction and usage are often separate. We have developed more flexible lifestyles (also due to greater demand for flexibility in the job market and leisure activities) and changed our demands for living, which influences the size and functions of housing according to our life stages (now 4 generations in a human life) and combined and integrated challenges for spatial planning and the use for land for agriculture, living, working, nature, mobility, etc.
And last but not least there are all the materials and objects with which we fill our houses.

Production

The production side for living applies to materials used for both the building and appliances to equip the building. The past decades the use of materials, energy, water, and land for living, has increased, including CO2 emissions.

'Forecasts for reserves of some finite resources found commonly in everyday products, such as copper, zinc and silver have horizons within the lifetime of many of us, 30-40 years. Indium, which is an essential and rare metal used in LED lights (which are seen as highly energy efficient alternatives even to compact fluorescent lamps), is so rare that there are less than

15 years' worth of reserves left at 2006 global consumption levels' (EEB, May 2009, page 7). Also see table 2.4

Materials in buildings

We witness an increase in material use in volume and number. Although the size of electronic equipment (computers, phones, cameras) has decreased, the size of many appliances increased. Coffee machines, toasters, but also cars have become much bigger, heavier. This also has an effect on the space we need to live in and store the appliances.

In the USA each person has average 90 m^2 to live in and every car has 5 to 7 places to rest (from private garage to public parking). Volkswagen calculated that its model 'Golf' had doubled weight in 30 years since the first issue in 1974.
Cars have become more fuel efficient and safer (airbags, stronger coachwork), but the extra material used, including comfort aspects such as air conditioning, undo the previous benefits.

As we spend more and more time inside buildings we are confronted with the indoor air quality and its health consequences, which are directly linked to the materials we use. The phenomenon became even clearer when so called zero-energy buildings or passive houses emerged without the appropriate handling/installation of ventilation systems.

A lot of our daily used objects (furniture, IT equipments, electronics, etc) contain toxics, which create environmental damage, but also have (sub) chronic health implications. These health impacts often occur over a long time period as we are exposed to a cocktail of toxics and chemicals.

Although more research is still needed, there are indications that for instance Bisphenol A (building block for plastics) and Parabens (a class of chemicals widely used as preservatives in cosmetics and pharmaceutical products) can create cancer or have negative effects on the reproductive system.

Building materials

Construction activities consume more raw materials by weight
(about 50%) than any other industrial sector. The construction materials sector accounts for 3-4% of the total EU gross domestic product and directly employs 2.5 million people (RE-SPIRO, 2007).

Several developments can be distinguished in the building sector covering construction, design, planning and the use of (new) materials, going from more end-of-pipe solutions towards more integrated green building approaches.

The first development (in the 1990's) was the notion of high CO2 emissions and the need to reduce energy use in buildings. This led to a variety of actions, such as insulation, more efficient heating systems, use of renewable resources, and use of rainwater (for washing and toilets). Then reuse and recycling of valuable building materials (wood, concrete, ceramics, etc.) and the production of more environmental friendly building materials emerged.

The concept of green buildings goes a step further. Here materials are looked at from a lifecycle perspective referring to: resource efficiency, indoor air quality, energy efficiency, water conservation, and reducing maintenance and replacement cost. In some countries in Scandinavia and Austria wooden houses (from regional forests) are more common. The type of materials used for building(s) is crucial and new materials emerge.

Trends

Potential technological breakthroughs will also reduce CO2 emissions in manufacturing processes. In the medium and long term, new CO2 capture and storage techniques will be adapted to cement works. 'In some R&D projects and even already at the experimentation stage, developments are made to drive down CO2 emissions significantly (by as much as 80%)' (ETUC, 2005, page 136).

Cements are already blended with for example ground granulated blast furnace slag, thereby reducing the emissions due to energy requirements for clinker production and with the lower use of limestone. Concurrently, new cements are being developed which require lower firing temperatures, and containing various alkaline secondary raw materials, once more limiting the use of limestone. More far reaching developments are also expected, proceeding toward carbon neutral or even carbon negative cements.

A transition towards sustainable and smarter buildings requires an integrated approach at many levels. Architectural design of healthy, flexible and detachable buildings made of sustainable materials have to meet sustainable urban planning and closing the loop for energy -, material- and water use in a coherent and complementary network of functions (work, living, leisure and city, village, nature, etc.).

This includes the need for new visions on (reframing) the way we use land and space for our buildings and human activities at large.
In this evolution we will move from 'passive' houses (zero-energy use) towards 'active' houses (producing energy). In parallel a transition of the electricity production and supply will be needed towards smart grids and the use of renewable energy sources.

Urgencies will push these developments.
For instance, China is currently facing an unprecedented challenge as it will need in the

next 10 to 15 years new homes for around 400 million people moving from rural to urban areas. This cannot be achieved with the same building methods and materials, because of the devastating environmental impacts at extraction, production, construction and usage level.

New type of 'eco-cities' will emerge where mobility, food production and quality of life are integrated from the beginning.

Table 2.4: predicted peak and depletion of different fuels and metals, and main area of usage.
Source: ITRE, March 2009

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

2.1.4 Mobility

The way we move and the intensity of mobility and transportation has drastically increased over the past decades in three areas: private mobility, business transportation, and leisure. Global mobility is responsible for about 20% of the GHG-emissions. Motorised transport and vehicles currently depend for more than 95% on oil and are responsible for almost half of the global oil use (IEA/Fulton, 2004).

Furthermore, transport has impacts on many other areas, e.g. health, land and material use, and fuel (oil) consumption.
The same as for the other two domains pictured in this study, mobility faces true challenges for a climate change policy, where both private and professional transportation has increased and will further increase.

Apart from CO2 emissions transport is also responsible for exhaust emission of fine particles that affect health and provoke respiratory diseases, allergies and heart disease. This trend will continue with rising temperatures and increased traffic jams and urbanisation (large cities).

Although cleaner engines will decrease the effect per driven kilometre, the rebound effect tends to increase the total pollution level. Furthermore, cars have become faster, bigger and more powerful. In Belgium between 1995 and

2005 the number of cars with an engine smaller than 1400 cc has decreased by 28%, whereas the number of cars with an engine with more than 1700 cc has increased by 25%. German research calculated that a car is used less than one hour per 24 hours.

Traffic accidents remain a global public health problem, says the WHO in its 2009 Global Status Report on Road Safety. It indicates that more than 3000 people die on the world's roads every day.

Tens of millions of people are injured or disabled every year. Children, pedestrians, cyclists and the elderly are among the most vulnerable of road users (WHO, 2009, page 8). Furthermore, motorised traffic increased the noise pollution, which increases health risks, e.g. high blood pressure, cardio-vascular diseases and depression.

Gender

What is less known is that men and women have different approaches towards consumption. Women make the majority of purchasing decisions for food, clothing and household goods. Men tend to buy the capital goods such as homes, automobiles and electronics. In a Swedish study on energy consumption by gender in Germany, Greece, Norway and Sweden in four domains (transport, housing, food and recreation) substantial gender differences were found. 'Transport (absolute) energy use and emissions are mostly related to male travel patterns, a fact that may be of use when devising policies for energy efficiency and gender mainstreaming involving information campaigns, legislation or economic policy instruments' (Räty, R. 2009).
Although consumer choices are influenced by various factors, e.g. income levels and social conditions, there is evidence that women throughout their lives are more concerned about longer-term well-being of families and children.
Studies of the OECD (2008a, 2008b) and others (GRI & FCI, 2009) suggest that women are more sustainable consumers than men, as they tend to be more inclined to buy organic and eco-labelled products, give more consideration in their purchases to ethical issues such as child labour and fair trade, and more often use public transport.

Consumption

The Institute for European Environmental Policy (IEEP) studied the contribution of the growth in car travel to the decline in human energy expenditure and how the shifts in travel patterns in the UK contribute to climate and obesity crisis. The study describes that rising car ownership has been accompanied by changing land-use patterns to accommodate increased car use.
'Within the built environment, the land development patterns (i.e. public transport and pedestrian-friendly vs. car-orientated) and the mode of transport investment (i.e. in public transport, walking and cycling paths vs. highways) are closely inter-related and between them they have a profound effect on physical activity levels.
This evidence suggests that the design of the physical environment in which we live, work, and play results in a choice set where active forms of transportation and healthy food options are relatively inconvenient, and are more costly in terms of time and money, than less healthy alternatives. … Mason has highlighted that since the 1980s the proportion of overweight, obese and inactive Australians has increased in parallel with greater car reliance.' (IEEP, Davis e.a., 2007, page 20).

There is a strong correlation between car ownership and rise in mobility. Planning policies have widely enabled this shift, by for instance: out-of-town shopping centres, housing development which was ill suited for public transport, the cost reductions of owning, insuring and maintaining cars, and walking and cycling where insufficiently included.

Car use has increased. Where car drives in the UK in 1989 annually drove 55 miles for education (school) and 319 miles for shopping. This was in 2005, 82 miles for education and 444 miles for shopping. (See also table 2.5)

China has in 2009 overtaken the USA as largest car market. In 2009 13.6 millions cars were sold in China, an increase of 46% compared to 2008. In 1977 1 million Chinese possessed a car, in 2008 that was already 51 million. Between 1990 and 2003 the transport related fuel use doubled, while between 1980 and 2003 the number of personal kilometres was six fold.

Growth is rapid in all transport modes and reflects the substantial growth in commodity trading (especially container freight), but also the increased recreational activities and air travel. E.g. the number of passengers transported by air in the EU-15 increased from 200 million in 1975 to 600 million in 2000 (Eurostat, 2010).

Production

Despite many technical and safety improvements applied to vehicles, the past decade has mostly been lost through increases in average vehicle size, weight, power, and other energy using appliances, such as air conditioning. What net efficiency gains have occurred have been overwhelmed by growth in and demand for motorised transport overall, ensuring that greenhouse gas emissions continue to rise. Such a trend is even worse in developing countries, where technology tends to be older and private transport growth faster.

Although new types of systems such as hybrid and electrical cars and fuel cells, were introduced, no real breakthroughs yet, as petrol and, to a lesser extend, LPG remain the main fuel sources for the car. Compared to other industries and technological developments (ICT, telecom) the essence of the car and its Internal Combustion Engine Vehicle (ICEV) has not changed.
From a thermo dynamical point of view, this type of engine is not (and cannot be) efficient, due to its low output of the conversion of heat into driven power.
In future the car engine must be re-designed. Hybride vehicles can play an important role in this transition. Electrical vehicles are more environmental friendly (even if the necessary electricity is produced by the conventional energy mix).

Trends

The transition towards more sustainable transport modes involve multiple aspects, e.g. the improvement of safety, fuel
efficiency and alternative fuels, rail and maritime transport, access to public transport, new type of engines, etc. All new transport modes and technologies also requires SMM for the extraction, production, building, maintenance, and recycling of vehicles and its infrastructures (road, rail, other).
"At the same time, the adoption of technologies and policies to dampen vehicle travel growth must be much more strongly encouraged. High-quality mass transit, inter-city transport and 'intelligent infrastructure' will be necessary if aggregate transport levels are to be reduced through greater use of lower-emissions modes of transport. … The adoption of local fuel sources and lower-technology, clean mass transit systems may be most appropriate" (IEA, 2002).

	1970	1980	2000	2010	2020	2030
Transport and total world oil demand (MTOE)*	1975	2500	2950	3500	4100	4800
	1975/76	1985/86	1989/91	1995/97	1998/00	2005
UK- distance travelled (miles pp/per year)	4.740	5.317	6.475	6.981	7.164	7.208
	1995	2000	2001	2002	2003	2004
Road passenger transport ** EU-27 (billion pkm)	4,35	4,79	4,88	4,97	5,00	5,08
	1998	2000	2002	2004	2006	2008
International Tourist arrivals (millions)	610	682	702	762	847	920

Table 2.5
** MTOE: Million Tons of Oil Equivalent*
*** for passenger cars, motor coaches, buses + trolley busses.*
Sources: IEA-Fulton, 2004, http://www.iea.org/papers/2004/transporthree.pdf, IEEP-Davis A. e.a. August 2007,
World Tourism Organization, January 2010

2.2 Why is SMM relevant?

Biotic and abiotic materials, metals, and minerals, in whatever form or size are part of every aspect of our lives. The amount of and the way we use materials and products is influenced by a mixture of factors, e.g.: increased demand (population growth, changed ideas on comfort, convenience and health, etc.), fast technological and scientific advancements, changes in life-styles, increased income and mobility, etc.

'Research from the Wuppertal Institute (Acosta et al. 2007) reveals that 10 production sectors account for more than 50 % of German Total Material Requirements (TMR). Three areas are of strategic importance because here a huge number of technological interactions among production sectors take place:

- stones, construction, and housing (construction)
- metals and car manufacturing (mobility)
- agriculture, food and nutrition (food)' (ITRE, 2009).

Up-cycling

High turnover of goods creates enormous waste streams consisting of precious materials. On average 90% of materials is wasted on the way of making products available to end-users. Most recycling is rather down-cycling than up-cycling, as materials loose their initial strength and qualities as they are often not designed for recycling into high value applications. Better

design for up-cycling is needed.

Time

Time plays an important role in modern production processes - 'time is money'. Energy and resource intensive production processes (heating, steam, pressure, etc.) are used to assemble and disassemble products. Innovations often focus on increasing eco-efficiency and labour productivity, which lead to further mechanisation with more energy and material use and often the abolishment or outsourcing of labour.

Health

There is a business case to also develop safe and healthy products from scratch and assess them on their effects throughout their full life cycle. For instance, in the Cradle to Cradle assessment methodology of materials, chemicals are reviewed on (EPEA, 2009, p. 14):

- Impacts on exposed organisms (Acute toxicity, Irritation, Toxicity to the immune system, Endocrine disruption potential, Carcinogenicity, Aquatic toxicity, Terrestrial toxicity)
- Disruption of generations (Mutagenicity, Reproduction toxicity, Developmental Toxicity, Genetics)
- Disruption of the food chain (Bioaccumulation Potential)
- Life cycle (Biodegradation / Persistence, Metabolism)

If the world follows traditional patterns of consumption and production it is estimated that global resource use would quadruple within 20 years (EC, COM 2005).
Whether renewable and non-renewable resources and materials are used to make products or act as sinks that absorb emissions (soil, water, air) they are crucial to the functioning of the economy and the quality of our lives.

In order to address these multiple global challenges and to achieve SMM, more is needed than merely changes in the products and the production processes. Resource use and (land) scarcity cause a variety of environmental impacts, e.g. loss of biodiversity. SMM goes beyond one policy domain and it can contribute to achieve other targets as well, e.g. CO_2 emission reductions, create new jobs, improve green innovations, and support other important policies on health, gender equality, agriculture, etc.

As we have seen with food, living and mobility, it is not just a matter of using less material in existing products, being more efficient, or avoiding waste, it is much more about innovations on the system level itself; to move from eco-efficiency to eco-effectiveness and conservation; to eco-sufficiency.

It is about transformation and changes in the systems of provision and our behaviour. Such changes are unlikely to occur by normal market processes alone. A proactive policy approach is required.

2.3 What are the future challenges for SMM?

Long-term planning and policy design together with steering mechanisms are required to facilitate, support and further mainstream sustainability transitions. The public sector can act as a driver for change, develop a vision and implement an appropriate mix of support mechanisms and incentives.

An effective change strategy towards SMM will require the integration of several aspects, such as: responsible extraction, use and re-use, healthy and safe technology development, fair distribution of resources and materials, different ways of consumption, and product & service effectiveness. This implies that apart from the current focus of EU policies on (renewable) energy use, also land use and SMM need to be further integrated. This also creates challenges for coherent and integrated policy approaches that contribute to the creation of a sustainable and resource-light world.
From a geopolitical perspective, energy autonomy should go hand in hand with materials autonomy.

This demands an effective mix of strategies for change, taking into consideration the different drivers for human behaviour. The British Department for Environment, Food and Rural Affairs (DEFRA) has developed the so called 4E model for policy interventions: Enable, Encourage, Exemplify and Engage.

These challenges will differ according to the type of actor; governments (local to global level), industry and business, academia, consumers, and civil society actors. The main focus in this report is, however, on business and, even more so, on government(s).

Main SMM challenges for business:

a. **Adopt new business models:** with product and service innovations and integrate SMM and CSR in the strategy and operations of business.

b. **Life cycle thinking and design for environment:** closing the loop with a full life cycle approach, including social aspects (S-LCA) and using safe and healthy materials.

c. **Innovation beyond production efficiency;** further R&D and the application of closed loop and fully integrated natural and industrial systems, e.g. biomimetics, biomaterials, Cradle to Cradle, industrial ecology, ecodesign, etc.

d. **Implementation of sustainable products & services.** Choice editing; only put sustainable products on the shelves.

Main SMM challenges for governments and policy:

a. **Policy mix of instruments:** covering all angles (enable, encourage, engage, exemplify), e.g. financial, fiscal, costs structures & pricing, standard setting, sustainable public procurement, …

b. **Policy integration:** shift from dispersed policy domains and decisions towards better integration and synergies, also involving political judgement of the different impacts and prioritising targets on the basis of an overall policy for sustainable development.

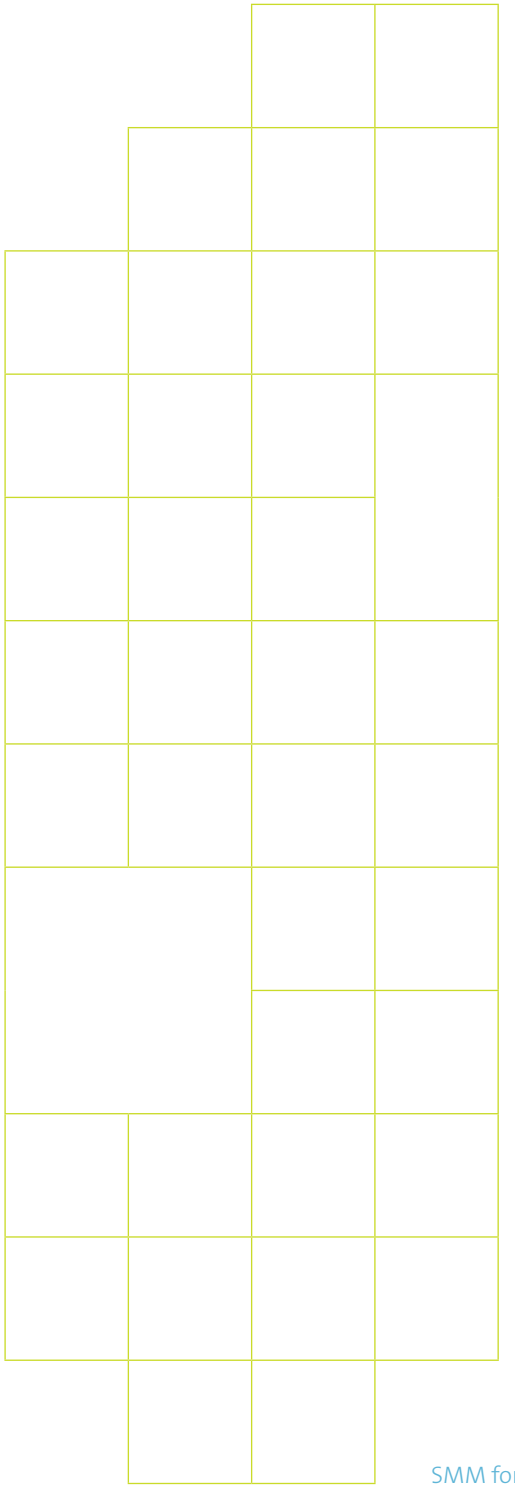
c. **Policy assessment:** measuring policy progress, e.g. Sustainable Impact Assessment, and further development of (sustainable, SMM) indicators.

d. **Development of indicators and improvement of measuring:** resource productivity, material and resource flows (natural resources, land use, water, energy), in/out-put models (socio-economic modelling), indicators for measuring total material flows and requirements (TMF and TMR), progress indicators, etc.

e. **Stimulate R&D and knowledge development** for innovations in (new) domains that go beyond an increase in productivity, create societal value and support multi-disciplinary networks and initiatives.

f. **Towards a new macro-economic model.** Complementation of the GDP with social and environmental indicators, shift in taxation from labour towards environment, systems approach towards sufficiency (see chapter 3), factor 10, etc. Developing a macro-economic model that is not dependent on minimum consumption growth for its stability.

In a change model towards sustainable materials management both drivers for change to SMM and limiting the role of drivers for change away from SMM need to be addressed. After an insight in different examples of SMM cases and country policies in chapter 3, chapter 4 will indicate how policy development can be steered towards Sustainable Materials Management.



Chapter 3 – SMM examples: cases and country policies

This chapter describes a number of interesting examples of SMM from different sectors (business, public, or other) and highlights main policies and interesting initiatives from seven countries: Belgium, Germany, Japan, Spain, Sweden, The Netherlands and UK.

SMM initiatives come in many forms, at different scales, from different domains, and reflect a wide spectrum of possibilities. They can be distinguished by different levels of maturity.

In order to better understand these differences the described cases are arranged based on a so called **SMM Maturity Model** (Box 3.1). This model is based on the concepts and evolutions of SMM as described in chapter 1 and it combines three types of parallel evolutions, namely: type of economy, organisational development and level of 'integratedness' (scope).

Firstly, it reflects the evolutions of the economy from an eco-efficiency towards an eco-effectiveness. Following shifts can be distinguished:

- a factor driven economy where human capital and labour form the basis, which can be seen in developing countries (not included in below model),
- towards an efficiency driven economy, with increased educational levels of human capital and efficiencies at product, labour and financial and input level,
- towards an effectiveness driven economy, with sophisticated business and organisational strategies and innovative entrepreneurship.

Secondly, it shows the developments from a focus on business-process-product towards chain-system-society. This means a shift from a more internal business focus and activities on products and technological processes, towards an extended and external focus towards the whole (supply) chain, addressing SMM within a wider system, including input from a variety of external stakeholders, and considering the impacts on society at large.

Thirdly, it shows the developments at the level of integration of the extraction, use and reuse of valuable materials, products and resources, the move from an end-of-pipe thinking, waste management, and prevention, towards eco-design and full responsibility for the products throughout the value chain, up to completely closed loop material and product systems that integrate renewable energy and resource use, responsible extraction, avoid polluting and toxic substances and enable continuous use of materials; integrated systems design.

The SMM model also includes the levels of organisational learning as described in chapter 1:

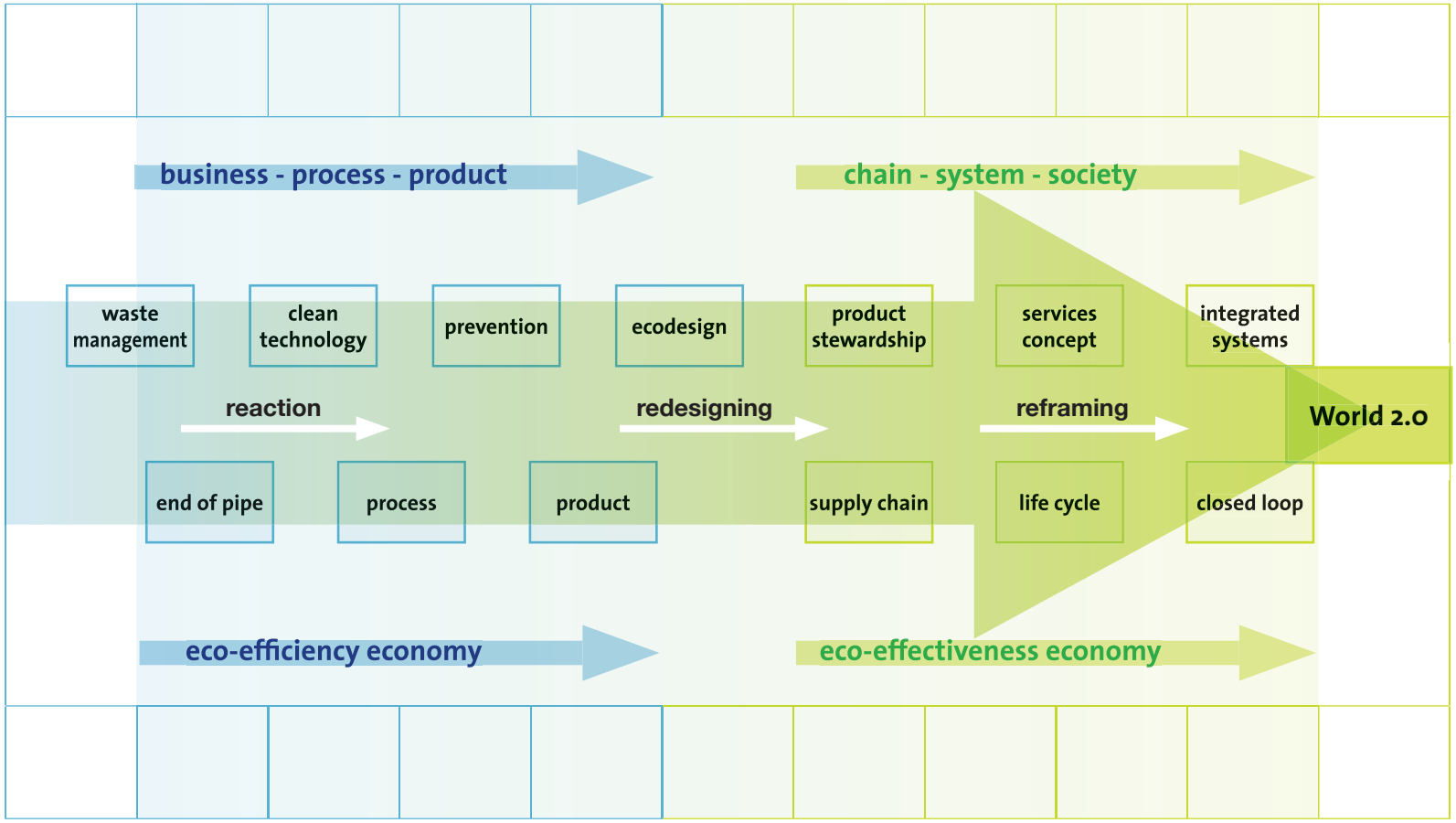
- **Reaction:** at the business-process-product and eco-efficiency stage
- **Redesigning:** at the chain-system-society and eco-effectiveness stage
- **Reframing:** the 'world 2.0' stage is a resource-light and sustainable society, with appropriate production and consumption patterns and an integrated political framework (policy, business, consumers).

Some explanation on the items presented in the SMM Maturity Model in Box 3.1.
In real business practice and policy below items often are addressed simultaneously. The distinctions made here are merely for understanding the different possible type of actions.

- **End-of-pipe:** traditional waste management
- **Process:** improving efficiency or cleaner technologies of the production process
- **Product:** the product itself is re-addressed, be it another design, different type of materials used, different functionalities, etc.
- **Supply chain:** At this stage the supply chain is considered (upstream and downstream), including external stakeholders. This does however not yet imply the *full value chain*, seen as a closed loop.
- **Life cycle:** also here there is a tendency to also start to consider social aspects in the supply chain, but this is not yet necessarily a *full life cycle* in terms of considering all aspects.
- **Closed loop:** such as the Cradle to Cradle concept. However also here it is not necessarily a *smart closed loop* where also land

use or energy requirements are taken into consideration.

- **World 2.0:** this is the imagined world, version 2.0. A world where SMM moves from an eco-efficient and eco-effectiveness economy towards a sufficiency economy. SMM is then a fully integrated and systemic concept contributing to sustainable development. Resources and materials are used in a responsible, fair and just way, without harming health or the eco-system, and providing opportunities for all mankind to establish a decent quality of life and well-being.



Box 3.1

3.1 SMM cases

In this paragraph the following 12 clusters of themes on SMM will be further described, including case studies from a variety of industries and other societal actors:

1. Waste collection, treatment and recycling
2. Reuse and repair
3. Collection and linear upgrading/recycling/reuse/recovery of (inorganic) residues
4. Eco-design
5. Product Service Systems
6. Cradle to Cradle
7. Choice Editing
8. Biomaterials and natural ecosystems
9. Transition Towns
10. Knowledge Networks for Transition
11. IT in SMM
12. Closed loop industry systems for (inorganic) residues

For each cluster there is an indication of where the cluster can be positioned on the maturity model. It is clear that several aspects on this maturity scale can occur simultaneously and often cannot simply be separated.

The presented clusters and case studies indicate the great variety and potential to a gradually more integrated SMM. World 2.0 examples are not yet fully developed, but some cases do evolve or have potential in that direction.

Each cluster theme on SMM is structured as follows:

- name of the theme, its key elements, countries of the cases, and its maturity level
- general theme introduction
- case descriptions
- strengths & weaknesses,information & sources

Cluster theme 1:	**Waste collection, treatment and recycling**					
Key elements:	Organisation of collection and recycling					
Case examples from :	Belgium, UK					
SMM maturity level:	End-of pipe	Process	Product	Supply chain	Life cycle	Closed loop

Introduction

The scale of operation of a single community or company is often too small to enable economically and technologically sound recycling/recovery. Third parties have to be involved that organise a collective recycling/recovery management for several communities or companies. Only in case the delivery of a sufficient amount of waste can be guaranteed, it is worth doing these investments. Public policy can provide the conditions to allow such business being successful.

Collective waste collection and recycling/recovery systems, including the possibilities for energetic valorisation are still end-of-pipe techniques when the focus is on getting rid of the waste and find some value to cover the expenses. This stage can, however, be surpassed when the materials gets high value on the market due to the presence of technology that can produce high quality (purity ...) streams, due to presence of technology that can accommodate these materials in the production process and due to the existence of products in which these materials are applied.
Public policy and economic interest of the third party can be the drivers for continuous innovation in this process. In doing so more and more recycled materials are developed towards an implementation of the closed loop principles. Hence, these materials do not lose value.

It can even go beyond this stage if it is combined with an Enhanced Producer's Responsibility (EPR) and prevention policy. If the producer can also profit from the third party's performance, the producer will be encourage to take in to account the possibilities of the final waste.

Case 1.1: FOST PLUS (Belgium).

FOST PLUS is a private company established by companies that apply packaging in their process. They are the members of FOST

PLUS. FOST PLUS envisages the recycling of packaging from household waste. The European packaging directive 2004/12/EG and the Belgian 'agreement on collaboration' indicate the minimum collection and recycling rates that need to be attained by companies that apply packaging.

Companies can rely on certified instances such as FOST PLUS to achieve these rates. Many EU member states have no third party like FOST PLUS that is responsible for reaching the recycling rates and apply other approaches. FOST PLUS reaches today the highest recycling rates in EU. More and more member states start to copy this approach.

The success of FOST PLUS is related to the population density of Belgium and it is the single certified instance in Belgium able to implement the same standard for more than 10 million citizens. FOST PLUS is acting as intermediate body looking for the most profitable recycling/reuse option that is present on the market and implementing its collection system in as many as possible communities. It is the recycling market that offers its capabilities towards FOST PLUS.

Energy recovery is not considered as recycling. Allowed recycling options are listed in the directive and the agreement on collaboration. The opportunities for creating drivers for innovation and development towards a closed loop are not fully maximised.

Case 1.2: VAL-I-PAC (Belgium).

VAL-I-PAC is similar to FOST PLUS but envisages industrial packaging waste. Directive 2004/12/EG and the 'agreement on collaboration' also addresses industrial packaging and indicates the recycling rates that should be attained by appliers of packaging materials. Companies responsible for achieving these rates can rely on VAL-I-PAC. The regulation envisages an Enhanced Producer's Responsibility (EPR) on the level of the partner applying packaging. VAL-I-PAC takes over this responsibility and encourages the reduction of packaging waste. An annual reduction strategy needs to be made and forwarded to the Intergovernmental Packaging Commission (IVC).

Case 1.3 Scrapshop, UK

Scrapshop is UK's "Premier Business Waste Exchange" on a free online platform. It was started in 2009 by Green Buying Ltd which is a joint venture partnership between the companies Buying Support Agency Ltd and WSP Environmental Ltd. Scrapshop offers organisations and businesses information about redundant stock and surplus raw materials, according to the principle that one's waste is another one's material. Requests for wanted materials can be placed as well as offers on available material. Through this, potentially useful material is kept in circulation, saving resources.

Case 1.4 Adamec Recycling GmbH, Germany

The Adamec Recycling GmbH from Fürth, Germany, has developed an innovative recycling plant for electronic waste. This plant allows the separation and recycling of all kinds of electronic waste, e.g. of complete electric devices such as computers, washing machines and vacuum cleaners. For example, plastics containing halogen can be separated from non-halogen containing plastics, allowing a much higher part of the plastics to be brought back into the material cycle. Through this, the use of non-renewable energies as well as emissions to water and air including GHG emissions can be reduced.

Strength and weaknesses of the cluster theme

The collective set up of collection and recycling systems is very successful for several waste streams such as glass and paper that have value on the market very close to that of the raw materials. Almost 100% recycling is achieved. These materials, albeit after energy input, end up in the same product as where they were derived from.

The weakness of the system is that the success of recycling may trigger rebound effects. Another weakness of involving third parties (who take over responsibility) is that this can result in a decrease in responsible behaviour of the first and second parties.

Attention is required for the drivers for innovation into the direction of fully closed loop systems. Who profits from acting in the more sustainable way?

Further information:

Case 1.1: www.fostplus.be
Case 1.2: www.valipac.be
Case 1.3: www.scrapshop.co.uk
Case 1.4: www.adamec.de

Cluster theme 2:	Re-use and repair					
Key elements:	Re-use , repair for BtoB and BtoC					
Case examples from :	Austria, Belgium, Sweden, UK					
SMM maturity level:	End-of pipe	Process	Product	Supply chain	Life cycle	Closed loop

Introduction:

Re-use is part of the waste hierarchy of the three Rs: Reduce, re-use, re-cycle. The concept discourages disposal of products to reduce landfill and environmental impacts associated with the end of a product life. In contrast to recycling, re-using does not mean the breakdown of the product into its components but simply to repeat its function or to find a new use for it, thereby extending its lifetime. New purchases of the same product are avoided and thus material is saved, contributing to environmental sustainability.

A common example is the deposit bottle (glass) which is used several times (collecting, cleaning and refilling) before the glass is finally remanufactured. Further examples comprise i.e. computers, household items and industrial spare parts. For SMM represents more of a consumer focus.

Case 2.1: Concept of charity shops ('Kringloopcentra'), Belgium, UK + other countries

Oxfam: With its first store opening in 1947, Oxfam's charity shops have become an English institution. An estimated 700 stores are operated by Oxfam in the UK and have expanded to Germany, Ireland, Netherlands and Hong Kong. The not-for-profit organisation collects donations of unwanted clothes and household items in designated stores where volunteers clean, arrange and sell them. An online shopping option has also been developed by Oxfam that even includes free delivery that is financed by donations.

The proceeds of these second-hand schemes are used for the charity itself thus meeting the social equity principle of SMM. By these schemes Oxfam encourages re-use of consumer items on an impressive scale that saves much natural capital and reduces material waste considerably.

Case 2.2: Repanet: spare parts data base and network, Austria

Repanet is a non-profit association dedicated to connecting and creating local/regional repairing networks. The Spare Parts Network Austria is a data base for businesses extracting or using spare parts. The extractors ought to put these into a data base in order to make them available for repairers and in such decreasing repairing cost respectively enabling repairing.

It focuses especially on electronical giant equipment. Repanet aims at networking, distribution and exchange of information, and reuse of spare parts. Repanet is member of RREUSE: A specialised European network of national and regional social economy federations and enterprises with activities in re-use and recycling.

Case 2.3: ReUse-Computer Society, Germany

The ReUse-Computer Society promotes the re-use and the further use of used computer and IT equipment. The association is self organized and decentralised and members are private individuals, companies, public administrations, or social institutions. The society has developed a standard refurbishment process and a series of routine checks to establish quality standards. The reuse approach is transferable to other regions, branches or products.

Case 2.4: Freebay Internet Platform, UK

Freebay is a website that seeks to provide a communication medium for reusing unwanted household items across the whole of the UK. It is a not for profit initiative that has made it their mission to encourage re-using, thus providing a service that contributes so environmental sustainability. Their slogan recognizes that "we all have stuff we need, and we all have stuff to get rid of". Visitors of the website are invited to email in descriptions of items they have in excess along with their contact and place of pick up. Seekers can get these items for free and the purchase of a new product with the material cost of manufacture is avoided.

Examples include TV, freezer and diving suits which would be difficult and expensive to dispose of especially with toxic waste regulation in place. Freebay therefore creates win-win-win situations for the discarder, seeker and for the environment. Furthermore it extends its platform to a social causes allowing organizations such as daycares to seek items needed for furnishing. It therefore fulfils the definition of SMM perfectly: promoting sustainable material use, avoiding economic and resource waste while aiding social equity. -*

Strength and weaknesses of the cluster theme
Re-use and repair are easy to implement and therefore worth encouraging. The approach promotes economic efficiency and saves material to preserve natural capital. It makes sense not only in terms of reducing waste pressures on the environment but also in economic terms for consumers. Especially weaker socio-economics groups can reap much benefit from such schemes and therefore the social impact is positive. It also provides opportunities for different business models, such as social entrepreneurship and social economy.

However, mainstreaming of this approach will be confronted with cultural barriers (e.g. quest for novelty). Furthermore, re-use and repair do not change the production processes unless a product is designed to be durable so that it can be re-used. This approach remains narrow, only delaying the disposal phase of the product life cycle and does not adopt a more far-reaching understanding of SMM. Furthermore if extended to a large scale it could be met with resistance from businesses since higher consumption is a main motive for profit.
At the same time it opens up entrepreneurial opportunities that have much market potential as can be seen from the examples. From a policy point of view, this option remains to be relevant as a low hanging fruit that can bring direct environmental and social benefits extendable to different countries and sectors.

Further information:
Case 2.1: http://www.oxfam.org.uk/, http://www.charityshops.org.uk
Case 2.2: http://www.repanet.at/, http://rreuse.org
Case 2.3: http://www.reuse-computer.de
Case 2.4: http://www.freebay.uk.com/

Cluster theme 3:	Collection and linear upgrading/recycling/recovery of residues (various industries)					
Key elements:	Upgrading, Reuse, Recycle, recover					
Case examples from :	Belgium (+ others), Japan, Spain					
SMM maturity level:	End-of pipe	Process	Product	Supply chain	Life cycle	Closed loop

Introduction

The industrial system is a source of various (inorganic) material residue streams. These residues include for instance (1) construction and demolition waste (concrete, fibreglass, asphalt, bricks, plaster, wallboard etc.), (2) residues from industrial landfills (slags, fly ash, construction and demolition waste) and (3) residues from high temperature processes (steel and non-ferrous industry, waste incineration, coal-fired electricity plants and others (lime, refractory and chemical industries)).

Sustainable Materials Management implies that these residues are reintegrated into the technosphere, thereby closing material loops. The relevant industries for the acceptance of these material streams are, amongst others, the concrete and cement industry, the heavy clay ceramics industry, the producers of glass ceramics and stone wool and the construction sector.

The reintegration into the technosphere can be based on, in decreasing order of preference, (3.1) upscaling into a higher added value product, (3.2) reuse (re-employment of the same materials to be reused in the same applications or to be used in lower grade application), (3.3) recycling (utilising the waste as a raw material in other applications), or (3.4) recovery (including waste-to-energy or waste-to-material).

Linear upscaling/reuse/recycling/ recovery implies that one waste stream is used for one particular application, without any additional form of industrial symbiosis. Note that the reintegration can also be performed in a more integrated way, where waste streams are combined with other material streams in order to obtain innovative products with added value (to be discussed in cluster 11)

Case 3.1: Ground Granulated Blast Furnace Slag as cement replacement (ArcelorMittal Ghent, Belgium, and other EU Countries with integrated steel factories).

Blast furnace slag is generated when iron ore is reduced by coke at 1500°C in a Blast Furnace, being the first step in the flowsheet of steel production. Molten iron and slag are

drawn off at regular intervals from tap holes at the base of the furnace. For each ton of iron about 230-300 kg of slag is produced. When this slag is slowly cooled by air, a crystalline product is formed, which can be used as an aggregate for concrete and road construction (i.e. recycling: (3.3)). However, a higher value product is obtained when the slag is quenched with an excess of water (granulation), air and water (pelletisation) or steam, through which a granular product arises. This so-called Ground Granulated Blast Furnace Slag has latent hydraulic properties. After grinding it may serve several applications.

GGBFS has been used in composite cements and as a cementitious component of concrete for many years. In the European cement standard EN 197-1, nine cements containing slag are listed which may have slag contents between 6 wt% and 95 wt%. Since the late 1950s the use of GGBFS as a separately ground material added at the concrete mixer together with Ordinary Portland Cement (OPC) has gained acceptance. Worldwide, it can be expected that the expansion of GGBFS use will continue for the foreseeable future.

In Europe the production of 1 ton OPC generates about 1.2 ton CO2 on average, while the production of 1 ton blast-furnace slag cement containing 50 wt% GGBFS generates only 0.54 ton CO2. These data include emissions from the calcination process, the fossil fuel burning, and the use of electricity. For some countries maybe the potential saving is much higher.

Thus the use of slag is a very effective and economic method to reduce the energy consumption and the CO2-emissions inherent in cement production. Beyond that mortar and concrete made with GGBFS have a lower content of Chromium-VI, which can be responsible for skin irritations of workers handling the material without any skin protection (see EUROSLAG, Technical Leaflet No.1).

To conclude, producing GGBFS from what would otherwise be considered as a waste stream (to be landfilled) or a relatively low value product (aggregate), is a SMM-example where an upgrading of the waste stream is performed, including major economical and environmental benefits.

Case 3.2: Gyproc recycling/reuse (Belgium).

Gyproc is an example of the reuse of a material from the 'construction and demolition waste' class. Old Gyproc boards are collected and recycled to produce gypsum. The latter is subsequently reused to produce novel Gyproc boards. In practice, Gyproc co-operated with New West Gypsum Recycling, a Canadian company specialised (since 1980) in the recycling/reuse of Gyproc boards. To guarantee the required minimum volume, the initiative is supported by all members of the "Belgisch Luxemburgse Gips Vereniging".

The Gyproc case is an example of a recycling/reuse strategy where the same application is targeted, without adding new value to the product.

Case 3.3 „BIOCELL", Biohaus Goierri S.L. Basque Country, Spain

BIOCELL is a certified organic material made from newspaper flakes with similar structure to snowflakes, mixed with boracic salts to protect it from rodents, vermin and fire. This makes it an effective natural insulator for use in constructions and buildings. The Biohaus Goierri S.L. is a company specialised in biological and wooden buildings and shows that the use of natural, renewable materials in construction is not only possible in most cases, even superior to a synthetic solution.

Case 3.4 "SlurMix", AMITA, Japan

"SlurMix" is an alternative fuel for the steel and cement industry, developed by AMITA. It is made by compounding and homogenizing certain types of waste oils, oil-containing sludge and waste solvents, which could before only be disposed through combustion. The residues remaining after combustion can then again be used as a raw material in manufacturing cement. SlurMix' calorific value is about 4,500kcal/kg of so that it could be an alternative fuel of coal which leads reduction of green house gas emission and saving natural resources. This means that SlurMix ultimately results in zero waste product.

Strength and weaknesses of the cluster theme Rising raw material and energy prices, scarcity of metals, climate change and other environmental concerns stimulate the need to transform waste streams (from old and novel sources) to high value products while also achieving net CO2 benefits. As part of the transition to a low-carbon closed loop economy this requires that, for high temperature residues, not only exergy and valuable materials are extracted from the residues but also that the cooled residue is recycled as a high value resource. Major landfilling costs are thus avoided, the use of primary resources and net CO2 emissions can be drastically reduced, while obtaining innovative materials with sustainable environmental and technical properties. However, this waste-to-product transition is hampered by both technical barriers (e.g. unsuitable process technologies, unstable and inferior quality of the material) and non-technical barriers (e.g. underdeveloped legislation and markets, different legislation in EU member states, poor societal experience with industrial ecology).

Concerted EU action is required to accelerate the waste-to-product transition. This implies the harmonisation of EU legislation in this field and more support for inter- and transdisciplinary research.

Further information:

Salah El-Haggar, Sustainable Industrial Design and Waste Management, Elsevier Academic Press, 2007.
http://www.gyproc.be/at-team/duurzaam-bouwen/gyproc-recycling/nl
http://www.euroslag.org/media/LeafletGBS.pdf

Cluster theme 4:	Ecodesign					
Key elements:	Closed-loop value chains, cradle-to-cradle, system redesign					
Case examples from :	UK, France, Germany, Switzerland					
SMM maturity level:	End-of pipe	Process	Product	Supply chain	Life cycle	Closed loop

Introduction:

Ecodesign is a philosophy that has evolved out of Green Design (making products superficially less energy and resource intensive) and is also referred to as sustainable design. The underlying aim is to design products with social and environmental considerations in mind from the beginning (start of pipe solution). This means using sustainable materials (especially avoiding toxicity), designing for all stages of the life cycle beyond disposal (cradle-to-cradle) and reconsidering the product itself in terms of the service it provides (leading to service systems rather than more products). Eco-design is mainly product related.

Case 4.1: FRIA, a resource efficient cooling concept for foodstuffs at home – Ursula Tischner, Germany

No simple refrigerator, the product design orients itself on the service: to keep foodstuff cold and fresh in the most eco-efficient way possible. The focus is on durability, user-centric design and best material selection. An integrated cooling chamber is the most eco-efficient design meaning that it is embedded into architecture of a home. The cooling element is built into a wall therefore all wear and tear parts are to be exchangeable to ensure a long product life span as well as the possibility for personalised design. During winter, outside air is sufficient as a cooling medium. With drawers instead of one big door, the opening remains small when taking out food and drink so the energy consumption during the use phase is optimised. The end of life phase of the refrigerator is considered in the initial design process.

Materials used are dismountable, separable and exchangeable but also recyclable. The material variety is therefore as narrow as possible. Already recycled materials are suggested like leftovers from the cork producing industry. As a system wide approach, leasing of the refrigerator is considered: If the cooling unit is rented, the production firm can guarantee that all components of the refrigerator are fed back into the production process to close the loop.

Case 4.2: Climatex® compostable upholstery fabric, Rohner Textil AG, Switzerland

A non-toxic fabric designed especially for wheelchairs around users needs. Surveys found that it is most important that seating fibres are strong and that they 'breathe'. This was achieved with the ramie fibre, which, when mixed with wool, makes a product well suited to soaking up and dissipating moisture for climate control seating comfort. Instead of filtering out toxic chemicals at the end of the production process, they were never introduced in the first place.

The aim was to create a cradle-to-cradle product that would be 'nutrious', that is biodegradable at the disposal phase. Waste material from weaving can be converted into felt to be subsequently used as non-wovens for upholstery work or as a mulch in gardening. The water used for the production process is consequently of astonishing quality, equal or even better to when it arrives at the factory. The fabric has won numerous design awards including the International Design Resource Award 2001.

Case 4.3: The Mooncup® - UK and The Fleurcup – France

A very common and repetitive issue for women is the use of materials for the menstrual bleeding. The products used have quite some impacts. Each woman will in a life time have about 400 times her period, using about 12.000 tampons. This corresponds with 120 kilo of wasted cotton, at a cost for the consumer of about 2.500 €. Already only in the USA each year 7 billion tampons plus 12 billion sanitary towels are used. These products all end up in landfill or in the sea and recycling is hardly an option!
Both in the UK and in France a 100% medical silicone and hypo allergic menstrual cup has been developed that substitutes the traditional materials used for a menstrual period.

The cup is applied as a tampon and can be cleaned by simply rinsing it with water. It lasts many years. According to Fleurcup a woman would only need up to 10 of them for the whole life span. They even come in fashionable colours (dyes from medical use).

Benefits: Clear reduction of waste and reduction in material use through smart design.

Strength and weaknesses of the cluster theme Ecodesign represents a fundamental reconsideration of product design that is successful because it addresses the triple bottom line: environment, social equity and economy. Furthermore eco-design considers product value chains as dynamic systems rather than the linear life-cycle understanding usually applied. The examples show the practicability of this approach and offer a complete solution to making production and consumption more sustainable. However, the difficulties of mainstreaming the concept are an obstacle.

The FRIA example was never taken up by a refrigerator producer and the compostable upholstery fabric idea was pitched to sixty chemical companies by McDonough Braungart Design Chemistry before Rohner Textil AG accepted the project.
Ecodesign promises innovation which is a recognized competitive factor for business. To unlock its potential, a paradigm shift is needed to think of products as holistic service delivery systems. While much change needs to be organic within the business community, incentives and awareness-raising of the eco-design approach is a wanted catalyst.

Further information:
Case 4.1: http://media.leidenuniv.nl/legacy/chainet%20abskuhnd.pdf
Case 4.2: http://www.climatex.com/en/products/climatex_lifecycle.php5
Case 4.3: www.mooncup.co.uk, www.fleurcup.com

Cluster theme 5:	Product Service Systems					
Key elements:	From ownership to usership, redesign					
Case examples from :	The Netherlands, USA					
SMM maturity level:	End-of pipe	Process	Product	Supply chain	Life cycle	Closed loop

Introduction

Product Service Systems (PSSs) have been a major concern of research into SCP for many years. According to Gerd Scholl, PSSs can be divided into (1) services providing added value to the product life-cycle (e.g. maintenance and upgrading), (2) services providing enabling platforms for customers (e.g. renting or leasing), and (3) services providing final results to the customers (e.g. mobility services, delivery of warmth). Another important distinction is the one between BtB (business to business) and BtC (business to consumer) PSS schemes.

Particularly interesting from a SMM point of view are those PSSs where ownership of products is replaced by usership. These are all types of consumption in which the consumer does not possess the legal title to the product. Rather than owning the product (e.g. car, washing machine, copying machine), the customer is guaranteed a smooth access to the relevant equipment. Considering that the producer remains the owner of the product, the driving force for ecodesign (modularity, high efficiency and durability etc.) and closed loop systems (reuse/recycling of components) is strongly enhanced. Such PSS systems thus trigger changes in both consumption and production and in the relationships linking the act of producing and consuming. The extent of systemic change depends on the degree of changes in the entire PSS value chain and not merely on function delivery. The EU SCORE!-network has noted that PSSs systems are able to reduce the environmental impact of particular consumption types with a factor 2-3. (Tukker, et al, 2008)

Case 5.1 Community laundry rooms, Sweden

Globally Community laundry rooms are quite an exotic phenomenon. In Sweden most of the apartment buildings - where about 40% of the population lives - have communal laundry rooms. “In many aspects it is a good way of economizing with resources. Fewer machines are needed, people concentrate their laundry work and fill the machines better. Washing

clothes is a serious subject in Sweden. Everyone who has ever lived in a Swedish flat with a communal laundry room knows that.

Taking somebody else's washing time or forgetting to clean the tumble dryer's lint filter are major sins, and many conflicts have arisen around these terrible violations. But communal laundry rooms also have great benefits, not least environmentally."

Case 5.2: GreenWheels, (BtC), The Netherlands

Car sharing is an alternative system for satisfying the mobility needs of people. Members of commercial car sharing organisations have access to several types of cars, which they can book through a telephone or internet booking system and pay for by a monthly bill. The majority of existing car sharing schemes are provided by actors other than car producers.

Therefore, no design changes to cars occur (limiting its stretch within the SMM Maturity Model to Process-Product). At the moment car sharing is still a niche market which is not (yet) supported by normative and regulatory institutions. Moreover, the idea of car usership contradicts the established norm of car ownership, thereby drawing up a massive barrier for its mainstreaming.

Car sharing organisations are working at enhancing the image of sharing cars as a status good and attempt to make the system more convenient..
One particularly interesting PSS car sharing system is that of GreenWheels in the Netherlands. Jan Borghuis, one of the two Greenwheels founders, improved the Berlin-based StattAuto Car Sharing system with the help of modern ICT applications such as on-board computers, chip cards and mobile telephony.

Realizing their ideas, they put their first three cars on the Rotterdam roads in June 1995. Undoubtedly helped by a partnership with the Dutch Railways, their success soon surpassed that of their German example. At the start in 1995 GreenWheels was the first car sharing scheme that completely equipped their car sharing fleet with onboard computers. In a few years the automated car sharing system was completed with web reservation, contact-less chip cards, GSM data communication.

In 1997 GreenWheels implemented the first 20 vehicles that were directly accessible with a contact-less chip card, without a separate key-manager system. This system led to a new one-car-locations distribution strategy that made car sharing more accessible than ever. The one-car-location distribution is best demonstrated in the City of Amsterdam with its 450 locations most of which within easy walking distance from each other.

Case 5.3: Xerox Cooperation, USA

Xerox's Asset Management Program is one of the most elaborated PSSs in the BtB market. Products are leased under a multi-year contract, which guarantees customer satisfaction through functioning machines and payment of a fixed price per copy. Xerox has redesigned its products and process for remanufacturing. By the end of the 1990s the European demand for remanufactured Xerox equipments exceeded the supply rate with 50%. Following the success of Xerox other large manufacturers of office equipment shifted to leasing and manufacturing.

Case 5.4: Desso Carpets (C2C), The Netherlands

The Desso carpets and surface materials cater a wide range of products for domestic and business use, to leisure & travel, and sports systems. Desso decided to embrace the Cradle to Cradle (C2C) concept and wish to 'design to (de)assemble' healthy and safe products. This means investigating every material used and finding substitutions for any unhealthy, toxic, or environmentally damaging material in e.g. the yarn, backing, dyes, glue, etc. Integrating the C2C into the visions, strategy and operations of the company makes SMM central to the business.

The Desso development plan includes several targets for the next 10 years, such as:

- reach 50% use of post-consumer products as process input for new carpets,
- reach 100% purchased renewable energy for processing and manufacturing,
- reach the goal of factory effluent water that is cleaner that the water it is discharged on,
- establish unique, tailored take back and recycling systems,
- all stages in the product life cycle actively support the reuse or recycle of materials at the highest possible level of quality.

One of the major challenges in this concept is take-back systems. Developing this C2C business also means creating new business models and working closely together with other partners. For instance, waste collectors become vital in the design process of a C2C product; they know what it takes to take materials apart.

Besides, they now become providers of high value materials for business. In 2009 Desso started a close co-operation with the Van Gansewinkel Group (waste management) and Ahrend (office materials), both active internally with C2C, to set up an integrated service system for BtB to furnish office space (business, health sector and school buildings) and organise take back.

Strength and weaknesses of the cluster theme
Using healthy and safe materials in closed loop systems creates new business opportunities,

where the take back systems need further development and new partnerships. These C2C and PSS concepts also change the business models and several industries are challenged (in the whole material chain) to provide and be open about the origin of materials in the products.

Extensive work has shown that the symbolical and other barriers are much greater for BtC than for BtB.
At the level of system innovation, clear differences can also be found within PSS schemes. Changing the ownership structure along the product life-cycle does not guarantee major sustainability benefits, as traditional cases of car leasing and renting demonstrate. As indicated by the SCORE!-network, systemic changes are needed in the structure of consumption-production interactions and novel ways of delivering function.

The ability to do so depends on the creation of new organisations (e.g. car sharing) or on adjusting existing regulatory and normative frameworks. One of the missing gaps is a clear understanding of how major changes can be instigated in the realm of consumption and behavioural change. Social marketing to improve the chances for mainstreaming of (especially) BtC PSSs will be essential, while (local) governments should or could offer more accommodating environments

Further information:
Case 5.2: http://greenwheels.nl
Case 5.4: http://www.desso.com/Desso/home/EN/About_Desso/Cradle_to_Cradle.html

Cluster theme 6:	Cradle to Cradle					
Key elements:	Closed cycles for products, urban planning and buildings					
Case examples from :	Austria, The Netherlands					
SMM maturity level:	End-of pipe	Process	Product	Supply chain	Life cycle	Closed loop

Introduction

The Cradle to Cradle (C2C) concept was developed by German chemist Michael Braungart and American architect and designer William McDonough. They took on the notion of nature's living systems which are intrinsically flexible, diverse, abundant, and are based on constant material flows as nutrients within the ecosystem. The idea is to develop products in such a way that they are safe and healthy for man and environment. This means: 'remaking the way we make things'. Products and materials will stay in either a biological or a technological metabolism. This means that materials are/become a biological or a technical nutrient and are biodegradable or used as high quality resource in other industrial processes. C2C employs manufacturing, distribution, and recovery systems that allow those material inputs to be put back into productive use. Products are designed to go from 'cradle to cradle', and not from 'cradle to grave', as is currently often the case with our waste. In the C2C concept there is no more waste as all materials are nutrients for other products and applications.

This also creates new business models and a shift from eco-efficiency towards eco-effectiveness.
It is not about 'doing more with less' and reducing waste (cradle to grave), but about 'doing right from scratch.'
C2C creates a transition from the current industrial model, that 'takes, makes and pollutes', to a system with healthy and safe products, whose materials stay in cycles. This also implies a shift from ownership to 'usership.'

Products are only used by consumers for the time needed and the product will return into the remanufacturing chain. A well know example is Xerox, which does not sell copiers, but copying. Here business takes on full product responsibility over the full life stage. See also case example 5.4, Desso.

This concept does not only apply to products but also to urban and regional planning and architecture; with 'design for living'. This means that from the design stage on the various functions, of living, working, recreation, transport, nature, food production, etc., are fully integrated. The use of resources and renewable energy and water treatment are conceived from a full life cycle perspective, from production, occupancy and use, to recovery. The built environment is of high quality creating safe, healthy,

and pleasant environments for its users. This concept creates buildings as trees and cities as forests.

Case 6.1: Van Houtum Papier, Netherlands

This 75 year old family business is a producer of tissue paper for the European market and employs around 200 people. It produces a full product line of toilet paper, towels, wiping rolls, dispensers and soap. Van Houtum sells its washroom solutions to wholesalers and end-users (cleaning companies, public authorities, etc.). The paper used for these products is 100% recycled, FSC certified and has the European Ecolabel. It is the first fully biodegradable and C2C certified toilet paper in the world. This means that no toxic substances are used throughout the production process. This 'Satino' paper is used in toilet paper and paper towels. The company works closely with suppliers of 'old' paper to ensure quality, adapted its production processes to the use of 100 % biological materials, and the packaging is 100% recyclable. The paper spenders are not sold but rented to the users to ensure take-back and full recycling. Furthermore, the company uses its own power plant with an efficiency of 80%. The electricity and generated heat are used for the production process and water maintains in the production cycle, which means a use far below branch average. Residues from recycling (paper fibres, lime, etc.) become a nutrient for next door's cardboard manufacturer, who produces the cardboard boxes for the Satino toilet paper and towels.

Case 6.2: 'Klavertje 4', Venlo region, The Netherlands

'Klavertje 4' (Cloverleaf 4) is a collaboration between the Province of Limburg, Chamber of Commerce and the Venlo region to develop ambitious sustainable projects. The Venlo region is an important centre for agro-food and flowers and has a central logistics function, beyond its own border.
Together with McDonough + Partners a Masterplan for the region has been established, under the name of Klavertje 4. This masterplan is based on seven principles, e.g.:

- connect place and context,
- manage and value food,
- create clean air, water and soil,
- design for future generations.

The region applies in its approach for innovation and sustainability a three tier approach:

1. built environment
2. economic drivers (industry)
3. knowledge infrastructure.

Several projects have already been developed. One of the projects is the 'Floriade 2012'. With 66 acres this, one of the world's largest, horticulture fair will be established based on C2C, using solar and biomass for energy supply, and natural and local water use and purification. Its future functions will continue under the name 'Greenpark Venlo', and will include a platform for innovation and a new Campus, with among others a chair for C2C.

Case 6.3: Steiermark as C2C model region, Austria

'Pilotprojekt' is an initiative, established in 2006 by a variety of local actors from different backgrounds (sociologists, engineers, business, design, etc.) in the Austrian Steiermark region, in order to establish a C2C example region and create the necessary conditions. This platform searches to reinforce existing networks (already working on sustainable development, etc.) and institutions, to identify available strengths and competences, and raise awareness and further develop knowledge on C2C for business actors, public authorities, and others.

Strength and weaknesses of the cluster theme
The strengths of the C2C concept include the closed loop approach; with the focus on making healthy and safe products which are designed 'right from scratch' and, thanks to continuous reuse (i.e. the consumer is no more the end-user), they can remain in biological or industrial cycles. This creates new business models for production, usage of products, take back procedures and remanufacturing, including potential for jobs.

There are several potential weaknesses. The first is related to its 'technofix' character. It is assumed that a smart C2C design in itself (together with a ready supply of renewable energy) can fully mitigate the ecological impact of consumption. Limits to consumption are in this view, therefore, no longer necessary. This can result in non-desirable (consumption) feedback mechanisms. Environmental sociology has shown that the challenges for mature SMM are more complex. Radical technological improvements need to be complemented by behavioural change. Social sciences are thus a key ingredient for any integrated strategy towards the realisation of SMM. Secondly, C2C does not yet sufficiently address other key sustainability issues for SMM such as restrictions in phosphate, water and land availability (e.g. for production of food). Thirdly, for C2C to work more effectively there needs to be an abundance of cheap renewable energy (to close material cycles). On the short term this is clearly not the case as the world is confronted with monumental challenges as peak oil, peak gas etc, which will make the transition to an economy fully driven by renewable energy more complicated. In an energy constrained world, C2C should, therefore, focus on closing materials cycles in a smart way (thereby minimising the use of energy). Finally, one also has to realise that it is physically impossible to obtain a 100% efficient materials loop, as there will always be some losses in materials due to corrosion, wear, dilution, irreparable contamination

etc. Nonetheless, C2C is an important element of SMM.

Further information:
Case 6.1: www.vanhoutumpapier.com
Case 6.2: www.regiovenlo.nl, www.kvk.nl
Case 6.3: www.pilotprojekt.at

Cluster theme 7:	Choice editing					
Key elements:	Editing towards sustainable behaviour					
Case examples from :	UK, The Netherlands					
SMM maturity level:	End-of pipe	Process	Product	Supply chain	Life cycle	Closed loop

Introduction

One of the simplest ways governments and business (particularly retailers) can contribute to making the economy more sustainable is through 'choice editing'. In the words of the British Sustainable Development Council (SDC) choice editing "is about shifting the field of choice for mainstream consumers: cutting out unnecessarily damaging products and getting real sustainable choices on the shelves." (SDC, p.3)
Recent work by the SDC concluded that not the green products consumer has been the main driver of greener products but rather choice-editing
by retailers and public policy. This approach does not aim to change levels or patterns of consumption but helps consumers automatically choose sustainable products without the need to change habits or routines.

Choice editors can simply remove environmentally offensive products from commercial consideration (e.g. incandescent light bulbs), while at the same time providing more sustainable alternatives (e.g. LEDs). A second choice editing strategy is to slowly trim away the worst products and practices by labelling and tightening product norms (cf. Japan's top runner program for energy efficiency). A third strategy makes offending choices less attractive or increasingly difficult, by using taxation and product placement/positioning.

Finally, choice editing may also target the 'choice architecture'. Methods to do this include for example a creative use of defaults, whereby consumers are automatically presented the sustainable alternative (and must intentionally refuse this option if they want to choose the less sustainable option).

Choice editing can be particularly effective in the retail sector. Healthier shopping habits can be stimulated through product placement and shelving strategies (e.g placing the most sustainable products at the most popular shelve heights and positions in a supermarket, while partially 'hiding' unsustainable and unhealthy products).

This strategy is more effective than ecolabeling, which has been shown to – by itself – influence only a minority of shoppers. On the other hand, choice editing combined with ecolabeling and product norms has the potential to change consumer practices across the board.
An additional strategy to choice editing is the creative use of Sustainable Public Procurement. It is acknowledged that transforming government procurement is essential, not only because of the current scale of its environmental impacts, but also as a symbolic and highly visible signal of changing norms.

As indicated by the British SDC, sustainable procurement is an issue of credibility and trust. It is also about making sustainable consumption front-of-mind for people in the settings in which they lead their daily lives, pointing to solutions. Furthermore, sustainable public procurement can drive technological innovation in

the green direction. Public procurers may help unblock investment in innovative sustainable technologies.

By issuing procurement calls committing the government to purchasing only products that meet stringent standards – if they can be delivered below a specified cost threshold and by a specified date – the risk can be shared between manufacturer and buyer. In a later stage innovative green products will become cheaper so that they can be mainstreamed to the general public. Seen in this way, sustainable public procurement can amplify the effect of general choice editing strategies.

Case 7.1: Home improvement retail/B&Q, UK.

In some cases retailers will undertake choice editing on a unilateral basis, to build an environmentally positive brand image; B&Q, which chooses to stock only Forest Stewardship Council certified timber, serves as an example. Allen Knight, former Environmental Policy Co-ordinator for B&Q explained that this company embarked on sustainable wood "even though there was no indication of consumer demand for certified products."

He observed that "customers do not ask for certified products because they are unaware of them: Raising awareness and creating markets are the retailer's role."

Case 7.2: Retail/Marks & Spencer, UK

Marks & Spencer has made choice editing a central plank of its marketing strategy (it's so-called 'Plan A'). M&S's 'core standards' ensure it only sells free-range eggs, has banished non-fairtrade coffee and hydrogenated fats (linked to heart disease) and sources all its fish from sustainable stocks. "Our customers expect high basic standards," says Barry, "and in some areas they want us to give them the absolute gold standard."

Case 7.3: Sustainable Public Procurement, The Netherlands

The program 'Duurzaam Inkopen' stimulates the Dutch authorities to integrate not only environmental but also social aspects in their procurement choices of products and services. The Dutch Government has the ambition to achieve Sustainable Public Procurement for 100% of its buying activities in 2010. For Councils the target is 75% in 2010, reaching 100% by 2015. To assist the authorities in this process, the Ministry of VROM (Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer) has developed a number of criteria for different product/service groups. This is an example of how the public sector, as a consumer, can 'edit choices' and influence both the supply side and the users, consumers (citizens) of it purchases.

Strength and weaknesses of the cluster theme

As noted in State of the World 2010 by Michael Maniates there remains immense potential for choice editing to drive fundamental changes in consumption. However, at least two obstacles stand in the way. The first is the persistent belief that product labelling alone can do the job. Even when logical and clear, labelling places the burden on the consumer to drive needed social and ecological change with their buying behaviour. It reinforces the myth of consumer sovereignty. A second, more fundamental and structural impediment to the power of choice editing is its prevailing focus on 'consumption shifting' rather than 'consumption reduction', once more according to Michael Maniates. Nevertheless, EU Policy could be designed in a direction where at least the low hanging fruits of choice editing can be reaped, even without entering the more fundamental debate about biophysical limits to growing consumption levels. Clearly unsustainable and unethical products need to be phased out as soon as possible.

Additionally, EU public procurement policies could be revised in order to stimulate the drive for sustainable public procurement even further. This seems to be desirable as in some cases (e.g. School lunch programs in UK) EU public procurement rules are still considered as a barrier for more sustainable procurement choices.

Further information:

- SDC Report Visioning Sustainable Retail: http://www.sd-commission.org.uk/publications/downloads/Sustainable_Retail_Event.pdf
- Michael Maniates, 'Editing out Unsustainable Behavior', in State of the World 2010, WorldWatch Institute, 2010
- Kevin Morgan and Roberta Sonnino, 'Rethinking School Food: The Power of the Public Plate', in State of the World 2010, WorldWatch Institute, 2010.
- SDC/NCC Report, I will if you will, 2006 [http://www.sd-commission.org.uk/publications/downloads/I_Will_If_You_Will.pdf]

Case7.3: www.senternovem.nl/duurzaaminkopen

Cluster theme 8:	Biomaterials and natural eco-systems					
Key elements:	Biomimetics					
Case examples from :	Brazil, Germany, Colombia, Australia, UK, USA					
SMM maturity level:	End-of pipe	Process	Product	Supply chain	Life cycle	Closed loop

Introduction:

Nature is at the very heart of things here and so are its materials. The use of biomaterials implies a shift from the use (mining, extraction, production) of metals and other materials in our products to the use of biomaterials, organic processing and renewable resources. Nature provides us with a huge variety of resources and can serve as example to find solutions for our human needs, be it for transportation, heating & cooling, separation, cleaning, nutrients, energy, regeneration, resilience, communication and tracking, etc.

This approach is called: biomimetics, also known as biomimicry, bionik, or naturetech.

Biomimetics is the study of the structure and function of biological systems as models for the design and engineering of materials, processes, and products. It is the abstraction of Nature, which has already done R&D for billions of years and figured out what works, what is appropriate and what lasts. Ecosystems have evolved to ever more effective nutrient and energy cycles, bringing enormous diversity while developing resilience, flexibility, and performance. New innovative products and (in) systems can be developed that mirror nature without applying our current energy and resource intensive industrial processing of materials by for instance heating, pressure, or steam. Key to the concept of so called 'cascading', using materials in a variety of applications in the natural chain. Interdisciplinary research is central to the work of biomimetics. Particularly the domains of agro/food and health care are along the frontrunners of the application of biomaterials and biological processes.

Case 8.1: Orthox's Spidrex® - UK

A development by Oxford University UK. Orthox Company focused on developing medical devices designed to regenerate damaged cartilage and bone tissues. Employing a revolutionary "scaffold" technology, 'Spidrex®', which is based on a protein, found in silk fibres, Orthox has a pipeline of devices aimed at helping the body to heal defects in bones and joints which would in many cases lead to implantation of a permanent metal or plastic prosthesis. Orthox's Spidrex® tissue scaffolds have been developed by parent company Oxford Biomaterials, and have a porous structure which supports human cell growth while being gradually absorbed and replaced by regenerating cartilage or bone tissue. Spidrex® tissue scaffolds combine these features with great resilience and a high mechanical strength which can be closely matched to the strength of the tissue being repaired, giving them a clear advantage over traditional materials. This silk-based material can also be used for sutures and re-growth of nerves.

Silk is broken down into individual molecules. It is then built back up into tissue scaffolds using a series of tricks learned from about how spiders spin silk. The way spiders process their protein means that their web is exceptionally powerful and resilient compared with other silks. By using the same techniques, the implant takes on these properties and is therefore resilient to repetitive compressive forces.

Benefits: This 100% natural product replaces the use of high performance titanium and stainless steel for these applications (no more extraction from mining, pollution, production). This can be achieved by planting around 250.000 ha. of mulberry trees on desolate and infertile land, which apart from the generation of top soil also can create an estimated 12.5 million jobs (according to Zeri Foundation).

Case 8.2: Yeo Valley, biomaterial for packaging, UK

This case describes two ways to use biomaterial for packaging: (1) traditional materials such as paper and (2) bioplastics from renewable resources.

The dairy product company Yeo Valley based in North Somerset in south-west England redesigned the pots for their products. The improvement resulted in producing them from recycled paper and separated polypropylene inlet. The use of this material combination allows the reduction of plastic material, because of the stabilising effect of the paper thus the plastic inlet can be thinner. At the end of life of the dairy product the paper and plastic inlet can be recycled separately.

Another option for packaging biomaterial is the use of bioplastics from renewable resources i.e. corn starch, vegetable oil, pea starch, or microbiota. Some, but not all, bioplastics are designed to biodegrade. Since the growing of crops and the processing of biomaterial based

products this industry is still fossil-fuel based (production of pesticides and fertiliser, energy use). Environmental advantages can be less emissions and substitution of fossil-fuels. However, the environmental performance needs to be assessed by standardised criteria.

Case 8.3 Terra Preta Nova, Brazil – Germany

Terra Petra Nova is an artificial replication of the Amazonian original soil made from natural ingredients (humus, shell limestone, charcoal, micro organisms). Developed by a small German business (TERRA PRETA® e.K.) it is capable of renewing the soil's nutritive substances and increasing the growing speed of plants when it is mixed with normal soil (max. 20% seem to be perfect). Additionally, by binding 2.5 times more carbon then normal soil it may reduce GHG emissions.

Benefits: Improving the soil fertility increases the acre productivity. This can help to mitigate land use pressure and reduce GHG emissions.

Case 8.4: Coffee waste and mushrooms, Colombia

This project was part of the 'pulp to protein' project of the ZERI (Zero Emissions Research and Initiatives) Foundation. The first idea was to eliminate waste from coffee production; in the process 99.8% of the coffee plant is wasted. In cooperation with Prof. S.T. Chang (then dean of the faculty of Life Sciences at The Chinese University of Hong Kong) and researcher Carmenza Jaramillo Lopez, the ZERI Foundation discovered that coffee pulp waste was an ideal catalyst for farming tropical mushrooms—a healthy, low cholesterol and fat-free source of protein.

The waste from the mushrooms is then again used as food for cattle and pets. After seven years of testing in Colombia, the mushroom project was introduced to Colombian coffee farmers in very remote areas of high malnutrition and poverty. More than 3000 farmers were trained between 2003 and 2007. The beneficial project improves the environment and creates additional revenue for coffee producers, thus sustaining their livelihoods. As a result of the program, an estimated 10.000 jobs were created in Columbia. The program won the SCAA's 2009 Sustainability Award.

The ZERI Foundation estimates that if all coffee waste was converted to mushrooms and if all mushroom waste was fed to cattle, it would equal 16 million tons of food a year. If two jobs were generated by the mushroom project for each of the estimated 25 million coffee farms in the world, then coffee waste has the potential for creating a staggering total of 50 million jobs globally. The Foundation says the same can be done with tea farms. Today, the concept is also taken up in Zimbabwe.

Meanwhile on the 'other end of the coffee bean' two graduates from Berkeley University in California took the idea even further and started in 2009 the BTTR Ventures (pronounced Better) business. It stands for 'back to the roots', encompassing the idea of a company that stands for sustainability, progress, and social responsibility. It is turning one of the largest waste streams in America, the tons of coffee ground waste generated daily, into a highly-demanded, nutritious, and valuable food product; gourmet mushrooms.

Currently, BTTR Ventures is transforming over 6000 lbs a week of coffee grounds from Peet's Coffee and Tea into delicious oyster mushrooms, the BTTR Garden (grow-it-at-home mushroom kit), and rich compost (spent mushroom substrate). The business concept will be expanded to other areas in the USA, and large coffee and tea producers show interest in this new concept.

Benefits:
Cascading activity systems with optimal use of all biomaterial throughout the value chain. Creating local (in the South) employment, local food security, and contributing to local eco-systems.

Case 8.5: Red algae deafen bacteria, Australia

Seventy per cent of all human infections are a result of biofilms. These are big congregations of bacteria that require 1000 times more antibiotic to kill them and are leading to an "arms race" between the bugs and the pharmaceutical companies.
It is also increasing antibiotic resistance and the rise of "super bugs" like methicillin-resistant Staphylococcus aureus that now kills more people than die of AIDS each year.

Researchers of the University of New South Wales discovered delisea pulchra, a feathery red alga or seaweed found off the Australian coast. During a marine field trip, scientists noticed that the algae's surface was free from biofilms despite living in waters laden with bacteria.
Tests pinpointed a compound—known as halogenated furanone—that blocks the way bacteria signal to each other in order to form dense biofilm groups.

A company called Biosignal has been set up to develop the idea which promises a new way of controlling bacteria like golden staph, cholera and legionella without aggravating bacterial resistance.
Products include contact lenses, catheters and pipes treated with algae-inspired furanones alongside mouthwashes and new therapies for vulnerable patients with diseases like cystic fibrosis and urinary tract infections.

Benefits:
Decrease disease and health risks. The bacte-

rial signal-blocking substance can also reduce pollution to the environment by reducing or ending the need for homeowners and companies to pour tons of caustic chemicals down pipes, ducts and tanks and onto kitchen surfaces to keep them bug-free.

Case 8.6 Lotus-Effect® and BIONA research programme, Germany

Bionic research and development of a research group of the University of Bonn, Germany, together with partners (e.g. Evonik Industries, Lotusan) led to a surface innovation with so called Lotus-effect®. This effect was derived from the self-cleaning capabilities of the lotus plant, that means surfaces with a Lotus-effect® are non-wettable and self-cleaning. The effect is applied to many products such as façade paints, roof tiles, and non-optical glasses. Through this self-cleaning effect, the lifespan of all kinds of materials can be increased and therefore resource use decreased. The Lotus-Effect example is part of the research programme 'BIONA - Bionic innovations for sustainable products and technologies' of the German Federal Ministry of Education and Research.

Strength and weaknesses of the cluster theme
The true strength of the biomimetics concept and use of biomaterials lies in real innovations. Not doing less with the same, but using natural systems and mechanisms to provide cascades of nutrients and new solutions that serve our human needs while creating added value. It introduces innovations that permit less capital investment, strengthen local communities and builds up social capital, by creating (local) jobs, improving health and supporting the ecosystem. It also creates new business models, which combine economic, social and ecological values. While using nature's solutions for a variety of our human challenges, also here the sustainable use of materials, land, water, and energy remain important.
Possible weaknesses could occur when 'solutions from nature' are done without considering the sustainable use of resources, energy, land, etc.

Further information:

Case 8.1: www.orthox.co.uk
Case 8.2: www.sustainabilitysouthwest.org.uk/projects/pioneers_of_packaging/
Case 8.3: www.truehealth.org/terrapretainterview.html
Case 8.4: www.zeri.org and http://www.bt-trventures.com
Case 8.5: http://www.solutions-site.org/artman/publish/article_398.shtml
Case 8.6: www.lotus-effekt.de/, www.biona.de, www.bionik-net.de

Cluster theme 9:	Transition Towns					
Key elements:	Community and City development for sustainability, eco-cities and eco-villages					
Case examples from :	UK and other countries					
SMM maturity level:	End-of pipe	Process	Product	Supply chain	Life cycle	Closed loop

Introduction:

Transition Towns originating in the UK (2005), where about 200 towns are active, and the idea increasingly spread to other countries, e.g. Wales, Ireland, Australia, Canada, France, Netherlands, Belgium, Italy, Japan, USA, New Zealand, etc.

The basic idea starts off when a small group of motivated individuals within a community come together with a shared concern: How can our community respond to the challenges and opportunities, such as peak oil and climate change'? Transition Towns are local communities (villages, districts, towns, etc.) that create change from bottom-up and make the shift away from oil and gas dependency.

The Transition Initiatives represent a way of engaging people and communities to take the far-reaching actions that are required to mitigate the effects of peak oil and climate change. Furthermore, these initiatives are designed to result in a resilient life that is more fulfilling, more socially connected and more equitable, and address the big question: For all those aspects of life that this community needs in order to sustain itself and thrive, how do we significantly increase resilience and drastically reduce carbon emissions? Resilient here refers to: diversity, flexibility and proximity.

In the Transition Initiative Primer, a document to support the set up of a transition initiative, Ben Brangwyn and Rob Hopkins define it as follows:

'The Transition Model is a loose set of real world principles and practices that have been built up over time though experimentation and observation of communities as they drive forward to build local resilience and reduce carbon emissions'. This Transition Model is, according to the authors, a recognition of:

- Climate Change and Peak Oil require urgent action.
- Life with less energy is inevitable and it is better to plan for it than be taken by surprise.
- Industrial society has lost the resilience to be able to cope with energy shocks,
- Regarding the world economy and the consumptive patterns within it, as long as the laws of physics apply, infinite growth within a finite system (such as planet earth) simply is not possible.
- If we plan and act early enough, and use our creativity and cooperation to unleash the genius within our local communities, then we can build a future that could be far more fulfilling and enriching, more connected and gentle on the earth than the lifestyles we have today'.

This community based, 'bottom-up' and 'organic' model leaves ample freedom for human creativity to organise, communicate, and find solutions that fit the local context. The initiatives can vary in level of sustainable ambitions, operating structures, and scope.

Since 2006 there exists a world wide Transition Network.

A similar type of initiative is the eco-village, also with an international network. The 'Global Ecovillage Network' is a global confederation of people and communities that 'meet and share their ideas, exchange technologies, develop cultural and educational exchanges, directories and newsletters, and are dedicated to restoring the land and living "sustainable plus" lives by putting more back into the environment than we take out'.

Another model of transition towns, in this case called 'eco-cities', is a more top-down approach, where city councils and local government create a coherent and integrated sustainable policy for the whole city

Case 9.1 Totnes, Transition town, UK

Totnes was the UK first transition town initiative, set up by Rob Hopkins. It is a town of 9000 inhabitants in Devon, South of England. Hopkins, teacher at Kinsale, got inspired by the permaculture; a crop culture in closed loops and locally embedding. This creates resilience. The idea is that also the economy should be locally embedded. In 2008 about 10% of the population was involved in diverse projects, e.g. factory of pellets (from locally and sustainably grown wood) and biomass, house construction of cob (made from material from the local river), and the organic farm Riverford of 440 ha; consisting of three farms, a dairy company and 4 shops.

The town has its own currency in which people can pay in 75 shops and restaurants.
Recently (2009) an Energy Descent Action Plan (based on a plan from Kinsale in 2005) was set up. This project has been awarded £39,000 by Esmee Fairbairn Foundation for one and a half posts in order to drive this project forward. Furthermore, alternative leisure activities are developed and numerous activities to raise awareness on the possibilities of different life styles.

Case 9.2 Malmö, eco-city, Sweden

Malmö's industrial base in the 1980s, the city had a chance to start over. It created eco-friendly neighbourhoods of transformed tenements and old shipyards. Much of Western Harbour now runs solely on renewable energy, including wind and solar, while organic waste from the area is turned into biogas. In Augustenborg and Sorgenfri, roof gardens reduce runoff and insulate homes, while a carpool system with special lanes for pedestrians and cyclists help cut vehicle use. Using a holistic approach to its greening, the city is investing in centres of learning on urban sustainability, such as the Institute for Sustainable Urban Development, outdoor education, continuous education for educators and climate experiments in schools.

The concept for sustainable education is also informal learning; learning wherever and whenever meetings happen – at cafés, study groups, at workplaces.
Only too aware that buildings consume almost half the world's energy and spew out nearly a third of greenhouse gases, Malmö plans to reduce its CO2 emissions by 25% between 2008 and 2012, well above the Kyoto Protocol's target of 5%. Malmö says that making its infrastructure greener is the quickest and easiest way to avoid a climate catastrophe.

Malmö today is a leading signatory to the European Union's Covenant of Mayors on greenhouse reductions. Here they burn household waste to generate heat and electricity. By going off-grid they don't lose energy in transmission. It aims to become more and more of a greener eco-city.
Malmö won in 2009 a UN Habitat honour award for its innovative, holistic approach to becoming a 21st century eco-city.

Case 9.3 Curitiba, eco-city, Brazil

Thirty years ago Curitiba unveiled a master plan to address urban issues with environmentally friendly public transit and social programs. At the start of the programme the town counted 500.000 inhabitants, currently about 1.8 million. In 1964 the then Mayor Ivo Arzua issued a call for proposals to prepare Curitiba for new growth. He not only had a vision for the town to minimize urban sprawl, reduce downtown traffic, preserve Curitiba's historic district, and provide easily accessible and affordable public transit, but he achieved it through participatory processes, unseen in that time of dictatorship. Curitiba's bus system is composed of a hierarchical system of services.

Minibuses routed through residential neighbourhoods feed passengers to conventional buses on circumferential routes around the central city and on inter-district routes. The backbone of the system is composed of the Bus Rapid Transit, operating on the five main arteries leading into the centre of the city. Passengers pay a single fare for travel throughout the system with unlimited transfers between buses at terminals where different services intersect.

Commercial activities were developed along the transport arteries, with hardly any parking facilities in the centre. The master plan also involved other programmes to improve the quality of life, e.g. a public housing, the 'Cambio Lixio' trash exchange programme, where (poor) people can collect waste in exchange of transport tickets.

A decentralized and accessible government has been a cornerstone of Curitiba's planning philosophy since the Master Plan was approved in the 1960s. Curitiba's "citizenship streets", mini-malls of government branch offices located throughout the city, are perhaps its best example of bringing city hall down to size. Some 40 years later, the Curitiba Master Plan has become an international blueprint for sustainable city design.

Strength and weaknesses of the cluster theme
The strength is that 'ordinary' individual people that are also citizens, consumers, mothers and fathers, etc. do unite, connect, act and take on responsibility for the creation of their own sustainable community.

It is often hard to receive loans or funding for projects, as most financial institutions or governmental bodies are not adapted to these kinds of clients and initiatives. (the system is slow to adapt). The initiatives do often conflict with existing (local) systems and regulations. Transition towns face the problem of efficient mainstreaming to all segments of the population, including the 'Honestly Disengaged' people.

Without some type of top-down support and feedback mechanisms, these bottom-up initiatives tend to stay locked in their niches (even in Totnes only 10% of the population is involved). Concurrently, the transition town approach face more hurdles in a city environment, where levels of connectivity and lack of space (e.g. for local food production) are considerably lower than in rural environments.

Dynamics for change and creation of healthy cities with clean air, energy-autonomous,

and quality of life for all, can come from both motivated citizens and from motivated political leaders in towns with a vision for the future. Public authorities can be driving forces for these sustainable developments, both by giving the example and by supporting further engagement and initiatives of citizens

Further information:

www.transitionnetwork.org and http://villesen-transition.net (French)
Transition Initiative Primer (12 August 2008): http://transitionnetwork.org/Primer/Transition-InitiativesPrimer.pdf
Global Eco-villages network: http://gen.ecovillage.org

Case 9.1: http://totnes.transitionnetwork.org
Case 9.2: http://www.malmo.se/sustainablecity
Case 9.3: http://www.pbs.org/frontlineworld/fellows/brazil1203/master-plan.html and http://www.urbanhabitat.org/node/344

Cluster theme 10:	Knowledge networks for transitions					
Key elements:	System innovation, reflexive governance, transdisciplinarity, sociotechnical changes					
Case examples from :	Belgium, EU, The Netherlands					
SMM maturity level:	End-of pipe	Process	Product	Supply chain	Life cycle	Closed loop

Introduction

SMM and, more generally, sustainability issues (e.g. climate change) are what social scientists call 'postnormal problems'. The characteristics of such problems include:

- The knowledge basis is characterised by large uncertainties, knowledge gaps and imperfect understanding of the complex systems involved;
- Decisions need to be made before conclusive scientific evidence is available;
- Potential impacts of wrong decisions can be huge;
- Values are in dispute;
- Many (hidden) value loadings reside in problem frames and assumptions made;
- Massive social and political interests may block system change.

In order to adequately tackle postnormal problems, the traditional 'modern' (disciplinary) approach no longer suffices. It is increasingly recognised that complex problems require novel approaches. Interdisciplinary and, even more importantly, transdisciplinary processes are needed for sociotechnical changes. Interdisciplinarity is established by the merging of methods from different disciplines. Industrial ecology is an example of such a fusion of concepts.

Transdisciplinarity goes a step further. According to the Zurich 2000 definition this type of research takes up concrete problems of society and works out solutions through cooperation between actors and scientists. Key concepts are mutual learning among science and society, integration of knowledge and values from society into research, thereby better reflecting the complexity and multidimensionality of sustainable development and SMM.

Besides the traditional criteria of scientific knowledge (validity, reliability), room is created for novel criteria such as social robustness, societal responsibility, effectiveness, and legitimacy. Knowledge is thus jointly produced, which generates more capacity for societal and political change when faced with systemic crises. To take SMM to a higher level, knowledge networks for transitions will be of paramount importance.

Case 10.1: Transition Arena/Plan C, Belgium, + other Arenas in The Netherlands

Transition management (TM) is a novel way, developed in the Netherlands, to stimulate long-term policy designs using a reflexive governance approach. Central to TM is the Transition Arena, a platform for transition-oriented interactions between societal actors, related to persistent problems. Arenas facilitate creative interaction, knowledge exchange, learning and discussion among so-called frontrunners, i.e. innovators and strategic thinkers from different backgrounds (state actors, business actors, civil society, academia).

The multi-actor approach is key for the success of the transition. Visions for the future are jointly developed, key barriers are identified, transition pathways are constructed and experiments,

which go well beyond established socio-technical practices, are set up. Since adopting this approach in its Fourth National Environmental Policy Plan in 2001, the Dutch government has facilitated a range of such transition arenas in sectors such as energy, agriculture, water management etc.

In Flanders this approach was also adopted leading to two main transition arenas, namely DUWOBO (sustainable living and housing) and Plan C. Plan C (Transition Network for Sustainable Management of Materials) is an ambitious network in Flanders of people from the private, civil society, academia and public sector that share a common vision of a world that manages its usage of materials in a sustainable way. In 2006 the OVAM (Public Waste Agency of Flanders) took the initiative to bring people together to build a common understanding how Flanders can contribute to this vision and trigger system innovation in its region.

The initiative brought more than sixty people together from diverse organisations. The network generated also more than 100 ideas of experiments that could contribute to the envisioned transition and system innovation. Plan C has the ambition to initiate 20 experiments for system innovation by 2014.

Case 10.2: SMaRT-PRO² Industrial Research Fund KULeuven-Platform, Belgium

Sustainable Materialization of Residues from Thermal Processes into Products is an inter/transdisciplinary Knowledge Platform that investigates the combined sustainable upcycling of carbon dioxide and solid residues from thermal industrial processes into sustainable and innovative products. The various routes are investigated with respect to the required process, the resulting product and the economic, ecological, legislative and societal potential.

The Platform consists of 25 K.U.Leuven experts – in the field of technology, economy, psychology and legislation – who work together to transform knowledge into applications. In order to bring forth industrially and socially relevant results and to enhance “mutual learning” and legitimacy, a Sounding board – consisting of industry, authorities and civil society – interacts on a regular basis with the Platform. In the future, this Platform will be broadened to the European level as well (COST-Action proposal “Valortherm”).

Case 10.3: SCORE!, EU

The Network project SCORE! acts as one of the EU`s central support structures for the UN`s 10 Year Framework of Programs for Sustainable Consumption and Production (SCP). The ~200 SCORE! experts are working together with actors in industry, consumer groups and eco-labeling organisations. This Knowledge network analyses the state of the art in SCP research, and promote cases of (radical) sustainable consumption for mobility, agro-food and energy use. These areas cause 70-80% of the EU`s environmental impact and should therefore be integrated in SMM policies.

Case 10.4: DHO Netherlands, integrating sustainable development in higher education (The Netherlands).

This knowledge network ‘Duurzaam Hoger Onderwijs’ (Sustainable Higher Education) was set up in 1998 with the purpose to integrate Sustainable Development (SD) into higher education study programmes, not as an add-on module but fully integrated. The main idea was that, in order to act sustainable in this complex and global world, new competences are needed. The network is an arena where many actors work together, where theory and practice meet and where expertise around sustainable knowledge innovation can develop. The network consists of about 1400 people.

In order to improve the knowledge sharing an on-line Community of Practice (COP) has been established. Multi-partners and knowledge sharing are needed to advance the implementation and mainstreaming of SD into all higher education.
The network therefore consists of teachers, managers and researchers from higher education and representatives from business, government, civil society and student organisations. The purpose is that students gain insights of SD within their own discipline and are able to work interdisciplinary and inter-cultural, learn systems thinking and long term perspectives, and can apply it in future (real society) work domains. In order to guarantee and develop the quality of SD in higher education, AISHE, Auditing Instrument for Sustainability in Higher Education, has been developed. The audit is executed by an external certified auditor.

Funding: one third through a combined programme of several ministries and contracts with education organisations. Funding from the Ministry of Education is limited compared to other ministries (e.g. Environment). Funding this type of interdisciplinary programmes does not ‘fit’ the current funding based on individual institutions.

DHO NL is a success thanks to a strong Advice Council of top people with drive and knowledge on SD, an indispensible interdisciplinary and intercultural approach for SD, and the networking role is taken on based on community building and created with professional partners (e.g. internet provider).

Strength and weaknesses of the cluster theme
The strength of knowledge networks lays in the interdisciplinary, cross sectoral and intercultural

approach for sustainable development. Knowledge networks for sustainability transitions and TM face several hurdles, including the hijacking of the agenda by regime incumbents, a shift to technocratic approaches, lack of attention for social issues, lack of democratic legitimacy. Nevertheless, TM and multi-actor networks are essential to move towards a World 2.0.

Further information:

Case 10.1: http://www.plan-c.eu
Case 10.3: http://www.score-network.org/score/score_module/index.php
Case 10.4: http://www.dho.nl/over-dho.html and http://www.plado.nl

Cluster theme 11:	IT for SMM					
Key elements:	Reverse logistics, supply-chain management, tracking systems					
Case examples from :	Germany, USA					
SMM maturity level:	End-of pipe	Process	Product	Supply chain	Life cycle	Closed loop

Introduction:

Technologies that optimise the tracking of supply chains are important tools for SMM. This is because they can facilitate efficient movement of products downstream i.e. from producer to consumer but also upstream (reverse logistics). European legislation that mandates directives relating to packaging (Directive 99/31/EC), cars (Directive 00/53/EC), and electrical/electronic equipment (Directives 02/96/EC and 02/95/EC) makes reverse logistics even more topical. Tracking Systems are a further tool for companies to manage supply chains for material efficiency. Nevertheless practical IT solutions for supply chain management make SMM practical and efficient for industry to apply.

Case 11.1: E-Commerce and supply chain management software

E-Commerce comprises several applications from an internet-based procurement and sale systems to comprehensive electronic support of industrial supply chains (i.e. e-procurement, e-production, e-distribution, e-customer, e-supply chain management and e-demand chain management). The evaluation of e-commerce application in large-scale electronic and automotive industry enterprises (IBM, Siemens, Hewlett Packard, Daimler Chrysler, Ford) show positive effects towards increased resource productivity and remarkable potentials of dematerialisation of resources and energy flows. Furthermore, software tools especially designed for SMEs can help to calculate and visualise material and energy flow systems (i.e. Umberto, GaBi, SimaPro). Through mapping out production process systems either in a manufacturing site, throughout a company, or, along a product life cycle, it aids companies to develop material efficient supply-chain management. The results are evaluated using economic and environmental performance indicators, and costs are quantified and located to show hot spots in the supply chain.

Case 11.2: Radio Frequency Identification (RFID)

RFID is used across many industries from animal to postal tracking but offers a potential IT solution for supply chain management. By being able to tag products on their delivery and location efficiency of inventory tracking and management can be increased considerably, e.g. in the textile industry appr. 10% of the goods are lost worldwide because of wrong declarations, theft or damage. The automatic recognition of date of expiry and the detection of mistakes/defects offers the opportunity for an improved quality management. Thus while RFID are used successfully in the mobility sectors (e.g. zipcars), this software is yet to mature in the consumer goods market.

Strength and weaknesses of the cluster theme IT for SMM has great potential in giving enterprises tools to effectively manage supply chains and to monitor the product and material flow up- and downstream. The advantage for logistical efficiency, material and natural capital savings would be valuable for the SMM approach. The barriers seem to be the implementation of large scale tracking technologies. On a smaller

scale software is available for supply chain mapping but especially SMEs may not have the resources to employ these tools.
However, positive or negative environmental effects only can be revealed if the implementation of IT-solutions involves environmental monitoring, controlling and management. Therefore more research is needed into IT for SMM and support for enterprises to use tested supply chain management instruments could come from policy incentives. Social and environmental implications of IT have gained attention in recent years (http://makeitfair.org/) although environmental analysis and design focused mainly on energy efficiency (Green IT).

Further information:

Case 11.1: http://www.izt.de/fileadmin/downloads/pdf/IZT_WB52_Falluntersuchung_E-Business.pdf, http://www.umberto.de/export/download/umberto_en/umberto_i_fly_en.pdf
Case 11.2:
http://www.t-systems.de/tsi/en/28874/Home/Solutions/Industries/OverviewRetail/AutoIDRightTimeEnterpriseServices/1-res

Cluster theme 12:	Closed loop industry systems for (inorganic) residues (various industries)					
Key elements:	Integration, Closing the Loop, Industrial ecology, Enhanced Waste Management, Enhanced Landfill Mining					
Case examples from :	Belgium, Denmark					
SMM maturity level:	End-of pipe	Process	Product	Supply chain	Life cycle	Closed loop

Introduction

The industrial system is a source of various material residue streams. These residues include (1) construction and demolition waste (concrete, fibreglass, asphalt, bricks, plaster, wallboard etc.), (2) residues from industrial landfills (slags, fly ash, construction and demolition waste) and (3) residues from high temperature processes (steel and non-ferrous industry, waste incineration, coal-fired electricity plants and others (lime, refractory and chemical industries)) and (4) others (organic, biological residues). Sustainable Materials Management implies that these residues are reintegrated into the technosphere, thereby closing material loops. The relevant industries for the acceptance of these material streams are, amongst others, the concrete and cement industry, the heavy clay ceramics industry, the producers of glass ceramics and stone wool and the construction sector.
The reintegration into the technosphere can be based on linear schemes (see cluster 3) or fully integrated processing routes. In the latter case one can refer to the concept of “industrial symbiosis”. This implies that waste streams are combined with other material streams in order to obtain innovative products with high added value. The closing of the material loops now occurs in a more complex way. Synergies between material streams are now actively sought.
By combining for example two by themselves low or medium value material (waste) streams, a high-value product can be developed, given that certain requirements are met. This is for example the case with the bricks produced from slags and CO2 (12.1).

Rather than focusing on highly innovative products incorporating waste residues, the closing of the loop can also be performed at a more local level by planning for so-called “eco-industrial parks” (EIP’s) (12.2). An eco-industrial park is an industrial park in which businesses not only cooperate with each other but also involve the local community. EIP’s intend to increase economic gains and improve environmental quality. EIP’s can be developed as (1) greenfield land projects, where the eco-industrial intent is present throughout the planning, design and site construction phases, or (2) through retrofits and new strategies in existing industrial developments.

In the latter case several barriers may arise. Based on the concepts of industrial ecology, collaborative strategies not only include by-product synergy (“waste-to-feed” exchanges), but also take the form of wastewater cascading, shared parking, green technology purchasing blocks, shared logistics and shipping & receiving facilities, multi-partner green building retrofit, district energy systems, and local education & resource centres. EIP’s are an example of a fully integrated SMM systems approach, in which designs and processes/activities are integrated to address multiple objectives.
Finally, the closing of the material loop can also be extended in time, when old or future material streams are integrated with one another (11.3), as is the case in the concepts of

Enhanced Waste Management and Enhanced Landfill Mining

Case 12.1: CARBSTONE (VITO/Recmix BVBA), Belgium

Carbstone is a construction product which is developed from the combination of finely ground (low value!) basic stainless steel slags with CO2 in an autoclave (increased pressure and temperature). Mineral carbonation of the lime and magnesia from the slag is key for developing the brick structure. It was shown that the brick obtained sound environmental and mechanical properties. Similar technologies are being used to combine even more (individually seless) waste streams.

Case 12.2: Kalundborg EIP, Denmark

In Kalundborg (Denmark) an Industrial symbiosis EIP network exists where companies in a region collaborate to use one another's by-products (including thermal residues) and share key resources. At the center of this EIP is a 1500 MW coal fired electricity plant, which has material and energy links with the community and several other companies. Surplus heat from this electricity plant is used to provide heat energy for 3500 local houses in addition to a nearby fish farm, whose sludge is then sold as a fertilizer.

Steam from the power plant is sold to Novo Nordisk, a pharmaceutical and enzyme manufacturer, in addition to a Statoil plant. This reuse of heat reduces the amount of thermal pollution that is discharged to a nearby fjord. Additionally, a by-product from the power plant's sulfur dioxide scrubber contains gypsum, which is sold to a wallboard manufacturer (see also Cluster 3). Furthermore, fly ash and clinker from the power plant is used for road building and cement production, thereby also targeting higher added-value applications.

Case 12.3: EWM/ELFM/CtC (ELFM Consortium, Group Machiels), Belgium

During the past 50 years, major paradigm shifts have occurred in waste management in Flanders as well as in the rest of Europe, both for municipal solid waste (MSW) and industrial waste (IW). Following Lansink's stepladder waste management has evolved to a stronger focus on material recuperation and recycling (e.g. glass, paper etc.) and waste prevention. In a novel view on waste management – Enhanced Waste Management (EWM) – prevention and reuse/recycling become even more important, while the idea of landfills as 'a final solution' is discarded.

Landfills can become part of EWM, provided they are considered as 'temporary storage places awaiting further treatment'. In this approach, landfills become future mines for materials, which could not be recycled with existing technologies or show a clear potential to be recycled in a more effective way in the near future. This idea is related to the fact that today's practice of incineration eliminates the possibility for reuse of materials resulting in increased material costs and decreased welfare.

Closely related to EWM is the concept of Enhanced Landfill Mining (ELFM). As indicated above, the waste brought to new storage facilities needs to be mined after a limited time. Next to new landfills, ELFM is also applicable to old landfills. This is essential to deal with the (waste) legacy of the past. Historically, billions of tonnes of waste have already been dumped and stored in landfills worldwide.

Given the fact that recycling and energy technologies are still improving, and given the volatile but steadily increasing prices of commodities and carbon emissions, new opportunities are arising.
ELFM includes the valorisation of the historic waste streams as both materials (Waste-to-product, WTP) and energy (Waste-to-energy, WTE), with the ratio being dependent on the type of waste streams and the state-of-the-art technology for material recuperation and energy production. Material recuperation can be either direct or indirect (i.e. when an additional step is required).

Enhanced landfill mining also incorporates the goal to prevent that CO2 arising during the energy valorisation process is emitted in the atmosphere. ELFM becomes part of the transition towards a fully closed loop material system. The ideas generated through ELFM become directly relevant for the future development of EWM with respect to the mining of the temporary storage places mentioned above.

Currently, ELFM is being investigated through the case 'Closing the Circle', a 15 million ton landfill in Houthalen-Helchteren (REMO Milieubeheer, Group Machiels). The project comprises the combined maximum recycling of materials and the valorisation of the energy potential of the recycling residue, targeting the production of sustainable electricity and heat with plasma technology. CO2-neutrality is targeted through the combination of Carbon Capture and Storage, mineral carbonation of the residues and vegetable production using CO2 as a fertiliser. Due to its system innovative character, ELFM was selected as a transition experiment of Plan C, the Flemish transition arena targeting SMM.

Strength and weaknesses of the cluster theme

As is the case with cluster 3, economical and environmental concerns stimulate the need to transform waste streams (from old and novel sources) to high value products while also achieving net CO2 benefits. However, this waste-to-product transition is hampered by both technical barriers (e.g. unsuitable process

technologies, unstable and inferior quality of the material) and non-technical barriers (e.g. unfair competition from under-taxed primary resources, underdeveloped legislation and markets, different legislation in EU member states, poor societal experience with industrial ecology). Concerted EU action is required to accelerate the waste-to-product transition.

This implies the harmonisation of EU legislation in this field and more support for interdisciplinary and transdisciplinary research. In the case of EIPs barriers arise when trying to convert present industrial sites into EIPs. In this case planners are confronted with the historical legacy of poor land planning choices. Other potential barriers may arise due to the fragmentation of various policy domains

Further information:

Salah El-Haggar, Sustainable Industrial Design and Waste Management, Elsevier Academic Press, 2007.
http://www.vito.be/VITO/NL/HomepageAdmin/Home/Bedrijven/Afval/Carbstone/hoogwaardige_bouwmaterialen.htm
J. Ehrenfeld and N. Gertler (1997), "Industrial Ecology in Practice. The Evolution of Interdependence at Kalundborg", Journal of Industrial Ecology, 1 (1), 67-79.
EFRO Project: 475 Kennisvalorisatie – Cleantech, Closing the Circle, een demonstratie van Enhanced Landfill Mining (ELFM).
- Geysen, D., e.a., 'Enhanced Landfill Mining – A Future Perspective on Landfilling', Sardinia, 2009.

3.1.1 Policy directions based on SMM cases

The case examples show the range of possibilities from eco-efficiency measures towards approaches targeting eco-effectiveness, and even eco-sufficiency. The necessary shift from more traditional waste management and efficiency towards sustainable materials management faces several challenges. Several case examples indicate the possible shift towards initiatives that represent more maturity in terms of SMM as defined in this report. However, fully mature SMM cases are still quite marginal, mainly because:

- they are not yet sufficiently backed by appropriate policy actions for up-scaling and mainstreaming,
- they imply further changes at system level, including a change of mind-set and behaviour, new business and welfare models, etc.,
- further inter- and transdisciplinary research is needed to develop the potential of these promising concepts.

Using a bottom-up approach, the following policy actions can be derived from the distinct clusters.

Cluster1 – Waste collection, treatment and recycling:

Waste collection, treatment and recycling are a low hanging fruits. Harmonise regulations at EU level and raise the level of collection and recycling systems as well as waste hierarchy to the best performing countries. Extend waste management to further waste streams, regions and cascading concepts based on research and development programmes. Implement integrated product policy at all levels. Strengthen product responsibility of producers (see Eco-design directive). Set minimum standards to cut the "dirty end" of toxic products/parts/materials. Give incentives for TOP Runners to raise the level. Develop and implement 'waste prevention indicators' to enable assessment of waste avoiding performance. (see OECD Working Group on waste Prevention and Recycling)

Cluster 2 – Reuse and repair:

Develop standards for refurbished products esp. electronic products. Integrate reusability criteria in the Eco-design Directive.

Cluster 3 - Collection and linear upgrading/recycling/recovery of residues:

Concerted EU action is required to accelerate the waste-to-product transition. More funding for interdisciplinary and transdisciplinary research in the field of residue valorisation and SMM is required. This should be reflected in future calls of the EIT and the FP. Concurrently, efforts to harmonise EU legislation with respect to the use of secondary resources are essential. In order to provide a more level playing field, novel taxation systems on the use of primary materials (e.g gravel) are needed.

Cluster 4 – Ecodesign:

Extend the scope of the Eco-design Directive and include SMM related criteria: resource efficiency, reusability etc. Monitor the progress. Therefore include mandatory supply of product data by companies and sectors.

Cluster 5 – Product Service Systems:

Promote the use of social marketing techniques to gain wider acceptance (especially in BtC environments) for PSS schemes. More funding for social marketing research and SMM is required. This should be reflected in future calls of the FP. Local authorities should provide more stimulating environments for BtC PSS schemes.

Cluster 6 – C2C:

Similar to other concepts such as, ecodesign, closed loop industry systems, using biomaterials, nature and biological systems as example for our societal challenges, C2C will need further support at for instance R&D level. C2C, and those other concepts, needs to be enlarged towards country and urban planning, where SMM is currently hardly addressed. There is a need for more knowledge sharing and awareness raising.

Cluster 7 – Choice editing:
EU public procurement policies should be revised in order to make sustainable public procurement the default choice for all authorities (from local to national levels).

Cluster 8 - Biomaterials and natural eco-systems.

- promoting further inter- and multi-disciplinary R&D in order to find applications for nature's solutions and to enhance to necessary speed up for market introduction of new product applications of systems.
- promoting new application areas for biomaterial and natural eco-system products and processes in countries through knowledge transfer programmes and cooperation.
- assuring that investments can be regained on international markets through preferential trade agreements,

Cluster 9 - Transition towns and eco-villages.
Public authorities, particularly at regional and local level, should invest in and develop sustainable urban planning. Furthermore, it can enable the use of sustainable options, such as affordable and easy-use systems for public transport, cycling (e.a.) and walking, use of renewable energy (subsidies, …), integrated water systems (rain water collection, natural and local purification), recycling for energy and fertilizing, biogas production, etc.

Local authorities can also create a supportive environment for bottom-up transition experiments from citizens, such as transition towns and eco-villages.

Cluster 10 – Knowledge networks for transition:
All authorities (from local to continental levels) should provide additional funds for setting up knowledge networks for (sustainability) transitions. In particular, set up transition management (TM) arenas in vital domains such as SMM, mobility, food, housing and energy systems etc. and allow regular policies to be steered by the TM outcomes. To allow for maximum democratic legitimacy these arenas need to include those actors who will be affected by decisions, especially the marginalised. Set up challenging TM experiments in the field of SMM (e.g. ELFM, Cluster 11).
A Transition Platform for SMM could be established at EU level.

Cluster 11 – IT for SMM:
Establish research programme to evaluate resource use, impacts, barriers and success factors of IT for SMM. Promote pilot projects. Develop incentives to support enterprises to implement the lessons learned of successful pilots and their supply chain management tools.

Cluster 12 – Closed loop industry systems:
Invest in the greening of existing industrial parks. For new parks, make EIP's the default choice in the planning procedure and ensure the waste-to-product transition (see recommendations Cluster 3)

3.2 Country policies on SMM

Country: Belgium	
Population : 10.8 million	Amount of passenger vehicles : 5,9 million
Surface Area : 30.528 km²	GDP: 31.300 €/capita
Ecological footprint : 5,6 ha/capita	CO2-emission : 13 tonnes CO2 eq./capita

Introduction

Flanders: The general coordination of waste management in Flanders was established after the decree of July 2nd, 1981. Since then, the Public Waste Agency, OVAM, is the responsible public body. The initial focus was on establishing the waste management infrastructure and cleaning up dumps from the past. The focus quickly moved towards waste prevention resulting in a very successful reduction of the amount of household waste and high recycling rates. Sustainable materials management is now an important part of the strategic policy with a focus on the development of a long term vision of a closed loop society. Several instruments to reach the long term goal are applied such as eco-efficiency-scans, eco-design, eco-innovation, specific waste management strategies.

Wallonia: The environmental sustainability planning of the Walloon region (Plan d'Environnement pour le development durable PEDD) dates from March 1995 and describes 257 actions to be taken in order to integrate environmental protection in the development of the Walloon Region. The actions determine the directions to be followed in specific fields in medium and long term. Specific actions are defined for waste (Plan Wallon des Déchets, Horizon 2010), sustainable production & consumption, planning, information, education. The responsible authority is the Department of Natural Resources and Environment (DGRNE).

Brussels: Brussels policy in relation to sustainability is of course strongly related to the development of the city as written in the operational programme 2013 'Samen investeren

in stedelijke ontwikkeling' (Investing together in urban development). Part of this program is the project Brussels Sustainable Economy (BSE) in which attention is given to the development of jobs by means of environmentally friendly activities.

Initiative 1: (Flanders) Material management as part of environmental policy

Traditional end of pipe waste management is shifting towards a policy in which the whole material chain is integrated. The goal is to decrease the pressure on environment of materials use and decrease the materials dependency of Flanders. Partnerships with other authorities, citizens and companies will be set up to reach this goal. Policy initiatives indicated under the umbrella of material management are part of the policy planning since the period 2008-2010. Several initiatives already started in previous planning periods such as waste prevention, eco-efficiency, sustainable consumption, secondary raw materials, etc.
The Goal of the current planning period is to develop and incorporate new ideas in policy or in the next planning document 2011-2014.

Initiative 2: (Flanders) Sustainable housing, building and construction

Several policy initiatives address the sustainability of the building and construction sector. Sustainable use of materials and waste management is part of it. Several years ago, building and construction was responsible for most of the waste produced by all industries. As a result of the specifically developed management for demolition waste starting from 1995, its amount now decreased to almost zero.
The technology is readily available to produce high quality construction and demolition waste which is Copro certified. Landfill costs and the certification by means of the Copro quality label increased the recycling rate of construction and demolition waste (http://www.copro.eu).
The new plan 'Environmentally responsible use of materials and waste management in building and construction (period 2006-2010)' focuses on:

1. A materials performance certification for buildings;
2. Innovation and a change on system level in the sector.
   The centre for sustainable building (CEDUBO) aims at providing information, stimulating and implementing sustainable building.

Initiative 3: Tools to improve environmental performance

In order to increase awareness and stimulate sustainable production and consumption, OVAM developed several tools, disseminates knowledge and hosts meetings. Some tools are described below.
The eco-efficiency programme of OVAM (Flanders) addresses SME's and offers them a free service performed by professionals in which the potential for improvements are scanned. This not only means environmental savings but most often also direct financial savings. The scan already resulted in several new developments in products and production processes.
Product testing is a calculation tool that allows scoring the environmental quality of consumables. Companies with a sustainable consumption pattern can use the tool to optimise the consumer's decision.
MAMBO is a tool to calculate the effective costs of producing waste including aspects like spoiled raw materials and energy. Most knowledge that is obtained during several years of experience is free to access.
Ecolizer allows designers to score the environmental impact of their design.

Also the Walloon Region developed several tools for example to minimize waste production or to change consumer's habits: the website http://www.ecoconso.be is an example of a site where the consumer can find information of sustainable products and where questions can be asked in that respect. The Walloon region developed several guidelines to help citizens in minimizing their waste, selecting food, etc.

Initiative 4: (Wallonia + Brussels) Cap2020, Eco-build

The Walloon cluster Cap2020 and the Brussels cluster Eco-build groups companies and people active in the field of sustainable construction in order to promote sustainable construction by increasing the amount of companies able to do so. The cluster activities are designated to stimulate knowledge exchange, dissemination, awareness building in the construction sector. This considers the selection of materials as well as handling of wastes during construction activities.

Further information:

http://www.ovam.be
http://environnement.wallonie.be/
http://www.ibgebim.be
http://www.brusselsgreentech.be.

Brussels programme: http://www.bruxelles.irisnet.be/cmsmedia/nl/operationeel_programma_pdf.pdf?uri=ff808181181a2c3e01181c9cee5a0078.

Country: Germany	
Population : 81,8 million	Amount of passenger vehicles: 45,9 million
Surface Area : 357.104km²	GDP: 30.310 €/capita
Ecological footprint : 4,4 ha/capita	CO2-emission : 12 tonnes CO2 eq./capita

Introduction

Germany is aiming at further development towards a material flow economy and a doubling of its resource productivity in 2020 compared to the level of 1994 as stated in its national sustainability strategy in 2002 (Bundesregierung 2002). Increasing resoure productivity is the core strategy in sustainable resource management. Overall the indicator moves into the right direction but is too slow to meet the target, e.g. energy productivity in Germany increased by 40,1% (since 1990) and resource productivity increased by 35,4% between 1994 and 2007 (for more information see Bundesregierung, 2008). Thus, the BMU and UBA commissioned a research project "Material Efficiency and Resource Conservation" in 2007 to analyse resource efficiency potentials and develop a policy mix for business, politicians and consumers.

Further instruments are used to reach the target: Ecodesign standards, waste regulation (i.a. product responsibility), technology promotion, phase-out of subsidies that increase resource use, labelling or market incentive programmes towards the implementation of productivity increase, and resource dialogs. In the following paragraphs a short overview on the most relevant regulations and laws on resource productivity is presented.

Initiative 1: Set the target

of doubling of its resource productivity in 2020 compared to the level of 1994 as stated in its national sustainability strategy in 2002 (Bundesregierung 2002). Increasing resoure productivity is the core strategy in sustainable resource management. Overall the indicator moves into the right direction but is too slow to meet the target, e.g. energy productivity in Germany increased by 40,1% (since 1990) and resource productivity increased by 35,4% between 1994 and 2007 (for more information see Bundesregierung, 2008). Thus, the BMU and UBA commissioned a research project "Material Efficiency and Resource Conservation" in 2007 to analyse resource efficiency potentials and develop a policy mix for business, politicians and consumers (see initiative 5).

Initiative 2: Improvements of waste management from the 1970s to 1990s

In 1972 the Waste Avoidance and Waste Management Act has been entered into force. Since the 1980s the "Reduce, Reuse, Recycle" approach has been fostered. In 1991 the product responsibility was part of the packaging ordinance for the first time determining a take-back obligation for used packaging. The packaging ordinance has contributed to the closure of closed loop recycling management, the avoidance and recycling of waste and thus to the protection of resources.

Germany's recycling quota of today are leading worldwide. This is because in the following years rules for product groups, waste avoidance and high recycling quotes have been established. Nowadays there are ordinances for packaging, batteries, electric and electronic appliances, as well as for environmental friendly waste disposal according to the product responsibility of the producer and the distributor.

Initiative 3: Closing the loop and establish waste hierarchy

Thus, in 1994 the Closed Substance Cycle and Waste Management Act has entered into force, which was designed to integrate product responsibility into economic decision-making in order to build a life-cycle economy and avoid the generation of waste. The Act established a hierarchy of avoidance, recovery, and disposal that emphasises waste avoidance in production, promotes low-waste products, and provides incentives for waste recovery practices.

Initiative 4: Incentive programme material efficiency and protection of resources

In 2004 the Federal Government has introduced the incentive programme material efficiency and protection of resources and commissioned the German material efficiency agency - demea to encourage entrepreneus to increase their material efficiency: through information, the material efficiency award, and two incentive programmes: (1) The programme "VerMat" supports consulting SMEs and aims at the diffusion of already existing knowledge by consultants. (2) "NeMat" supports the facilitation of networks especially in SME and tries to use synergies and advantages of cooperation of companies.

Initiative 5: Establish the Network Resource Efficiency and research project MaRess

Increasing resource productivity is the core strategy in sustainable resource management. Overall the indicator moves into the right direction but is too slow to meet the target, e.g. energy productivity in Germany increased by 40,1% (since 1990) and resource productivity increased by 35,4% between 1994 and 2007 (for more information see Bundesregierung, 2008). Thus, the BMU and UBA commissioned a research project "Material Efficiency and

Resource Conservation" in 2007 to analyse resource efficiency potentials and develop a policy mix for business, politicians and consumers. In 2007 the network resource efficiency was founded and scientifically steered by the research project Material Efficiency and Resource Conservation (MaRess)". The Network consists of stakeholders from politics, companies, associations, trade unions, research and society and has been created in order to put Germany's national economy in the first row in the economic, gentle and environmental friendly use of resources by bundling and exchanging know-how and experience with resource protective production, consumption, products, services, trade and management.

Initiative 6: Implement Eco-Design Directive and Green Public Procurement, Improve Blue Angel Standards

Product related instruments have been developed. Since March 2008 the "energy consuming products law" - the EU ecodesign directive - is implemented in German law. Germany played a major role in promoting the eco design directive. It accounts for energy consuming products with a great potential to save energy. Producers can be forced to attach information to their products in order to enable consumers to compare the environmental impacts of products. Labels, such as the Blue Angel, and green public procurement play an important role in the protection of resources in Germany, as well.

Initiative 7: National dialogue on sustainable consumption and production

In 2004 the National dialogue on sustainable consumption and production (SCP) has been started as national implementation of the so called "Marrakesh process" that frames an international ten-year framework for sustainable production and consumption. The dialogue platform aims at an understanding of common targets and innovative approaches that mobilize SCP potentials of businesses and civil society.

Specific initiatives

Top down:

Netzwerk Ressourceneffizienz (www.netzwerk-ressourceneffizienz.de),
Research project "Material Efficiency and Resource Conservation" (http://ressourcen.wupperinst.org), German Material Efficiency Agency (www.demea.de), Blue Angel Label (www.blauer-engel.de), National dialogue on sustainable consumption and production (www.dialogprozess-konsum.de), Green public procurement (www.beschaffung-info.de)

Bottom up:

Many initiatives exist i.e. Baden-Württemberg ECO+, Förderverein Kompetenzzentrum Umwelt Augsburg-Schwaben e.V., Integrated Product Policy (IPP) - Initiative Bayern, Modell Hohenlohe - Netzwerk betrieblicher Umweltschutz und nachhaltiges Wirtschaften e.V., PIUS-Projekt

Further information:

National sustainability strategy and progress reports www.bundesregierung.de/Webs/Breg/EN/Issues/Sustainability/sustainability.html
National Waste Policies: www.bmu.de/english/waste_management/aktuell/3865.php
Research project "Material Efficiency and Resource Conservation" http://ressourcen.wupperinst.org/en
National dialogue on sustainable consumption and production (only German) www.dialogprozess-konsum.de

Country: Japan	
Population : 127,7 million	Amount of passenger vehicles: 70,5 million
Surface Area :377.930 km²	GDP: 33.446 €/capita
Ecological footprint : 4,3 ha/capita	CO2-emission: 10,2 tonnes CO2 eq./capita

Introduction

A vision of a recycling oriented society has been developed in 1999 which was backed by a Fundamental Law for Establishing a Sound Material-Cycle Society. In 2003 a Declaration of Commitment to Development of an Eco-oriented nation and in 2004 of a virtuous circle for environment and economy in Japan for 2025 has been developed.

Initiative 1: 3Rs and Japan's Sustainability Strategy

Japan follows the strategy of 3 R (reduce-reuse-recycle) since June 2007 when Japan started its strategy 'Becoming a Leading Environmental Nation Strategy in the 21st Century - Japan's Strategy for a Sustainable Society'. Domestic and international actions are part of the strategy to push the 3Rs in order to achieve sustainable material cycles. These actions can be divided in four categories: 1. Actions for creating a sound material-cycle society in Asia. 2. Upgrade Japan's 3Rs technologies and systems. 3. Contribute to mitigating climate change through the 3Rs. 4. Push the 3Rs Initiative in the G8 process. The strategy thus

addresses various levels of actions. Japan itself is addressed but also Asia as a region and the G8 on an international level, as well. It is not clear yet whether the G20 will also be addressed in order to promote the 3 Rs initiative.

Japan aims at achieving a zero-waste society at home and to cooperate in furthering zero-waste goals abroad. This is substantiated by extensive legislation. For instance, Japan has integrated extended producer responsibility principles into its legislation to manage wastes and has developed green purchasing programs. The 3Rs in Japan include an emphasis on appropriate transboundary movement of materials and waste within the region.

The Ministry of Environment in Japan promotes the 3Rs by working with various organizations such as the Institute for Global Environmental Strategies, policy research, regional strategies, seminars, among others. The Ministry of Trade, Economy, and Industry and the Institute of Developing Economies-Japan External Trade Organization (IDE-JETRO) are other partners.

The successful implementation of the 3 Rs is also reflected in the following laws: The Law for the Promotion of Effective Utilisation of Resources, Waste Managing and Public Cleansing Law, regulations according to the characteristics of respective items being container and packaging, home electric appliances, construction materials, food wastes, end-of-life vehicles, and green purchasing. The fundamental Law for Establishing a Sound Material-Cycle Society stresses a utilisation hierarchy starting with resource reduction, reuse, material recycling, thermal recycling, and final disposal in a cascading use.

Japan took the German 'Kreislaufwirtschaft' and the European Act on Life Cycle Management as a role model and orientation. Targets for 2010 are: Doubling of Resource productivity relating to 1990, an improvement of the rate of reuse and recycling of 10% share in 2000 to 14% in 2010, and an improvement of the final disposal amount by 75% on a 1990 basis.

Initiative 2: Zero-waste target

Japan aims at achieving a zero-waste society at home and to cooperate in furthering zero-waste goals abroad. This is substantiated by extensive legislation. For instance, Japan has integrated extended producer responsibility principles into its legislation to manage wastes and has developed green purchasing programs. The 3Rs in Japan include an emphasis on appropriate transboundary movement of materials and waste within the region.

Initiative 3: TOP Runner programme

Another crucial programme has been created: The TOP Runner programme has been developed in Japan and secures that the highest energy efficiency rate of the products reached becomes standard for all companies in Japan (the so-called Top Runner). This energy efficiency standard has to be reached in a certain period of time.

The Top Runner programme has been created in 1998 by the Japanese Ministry of Economy, Trade and Industry (METI). It was part of the New Energy Conservation Law with the aim to increase energy efficiency in energy-using products. A policy framework targets 21 product groups in the residential, commercial and transport sectors. These sectors are responsible for a significant increase of emissions since 1990. Each product category is divided into further subgroups with varying energy efficiency targets. The following four industries are focus: the car industry, the household and office appliance industry and the ICT industry. One of the features of the Top Runner programme is that the supply-side of product markets is targeted while governmental incentives are not part of the programme. Targets are updated constantly.

The 3Rs Strategy is taken as a role model and counts as a success. With regards to the Top Runner programme Japanese stakeholders tend to agree that it has been effective, as well. Nevertheless data on comprehensive quantitative information are still needed in order to assess the success of the TOP Runner programme. Information is not publicly available. Standards for a wide range of products might require a great administrative burden.

Further information:

www.japanfs.org/en/
http://greenz.jp/en/
http://www.env.go.jp/recycle/3r/en/approach.html
www.meti.go.jp/policy/recycle/main/english/index.html

Country: Sweden	
Population : 9.3 million	Amount of passenger vehicles: 4,8 million
Surface Area : 441.370 km²	GDP: 30.800 €/capita
Ecological footprint : 6,07 ha/capita	CO2-emission: 7 tonnes CO2 eq./capita

Introduction

The promotion of sustainable development (SD) is considered to assure a healthy and sound environment for present and future generations. Policy strongly focuses on changing the behaviour of citizens and producers. The producer's responsibility for waste management and sustainable use of materials is a key principle. The Swedish Parliament expressed 15 quantified ambitious national environmental objectives for sustainable development. For most objectives, it is unlikely that they will be achieved in the foreseen time. However, it was a choice to express high ambitions and call for a big change requiring efforts. The 15 objectives are grouped in three action strategies:

- More efficient energy use and transport;
- Non-toxic and resource efficient cyclical systems;
- Management of land, water and the built environment.

Initiative 1: Integrated Sustainable Development Policy

Environmental regulation is integrated in SD by the 'Environmental code' in 1999, being the framework design to promote SD and integrating all previous environmental regulations. The code is based on a number of fundamental principles such as the precautionary principle, polluter pays, product choice, resource management, appropriate spatial planning, ... Swedish EPA selected economic instruments for the environment to be implemented. In the report 'Economic Instruments for Environment', the role of the Swedisch EPA (Natur Vårdsverket) in relation to public action for environmental sustainable management is described as follows: 'In many cases voluntary efforts are not sufficient, however, because it will take too long to attain our objectives. Various environmental instruments have therefore been introduced to encourage people to change their behavior and lifestyle, thereby speeding up the transition towards sustainable development. The tasks of the Swedish EPA include proposing the use of various environmental instruments. This in turn involves proposing, analyzing and assessing economic instruments, but the Agency also uses legislation, information and communication, as well as spatial planning.' The report describes an interesting set of economic instruments that can be used to change behavior.

Initiative 2: Green tax reform

Green taxes, such as CO2 tax, in Sweden date back from 1991. The green tax reform aims to redistribute the revenues and to use taxation as an instrument to environmental control by promoting environmentally sound activities and choices. The tax envisages households as well as industry. Sweden was among the first countries to install the 'feebate' system in a way to get support from industry for the greening of tax reform. Revenues were proportionally returned to businesses that increased efficiency of the plant. This boosted the innovation and emission reduction. Another example is the Swedish tax on natural aggregates to encourage alternative and recycled materials.

Initiative 3: Waste council installed as advisory body of the Swedish EPA

There is a waste council installed, consisting of 15 waste management related representatives, acting as an advisory body of the Swedish EPA. The body consists of representatives of the building sector because it is clear that the building sector can make use of various waste materials. The metallurgical sector is involved because this sector traditionally produces high amounts of waste. The main driver is the Swedish government but it highly involves local authorities as well as the private sector in its activities. Although the awareness and interest is big, the main examples are still in an experimental phase.

Initiative 4: Strong involvement of local authorities with investment programs such as LIP and KLIMP

Financial public support is, at this moment, required in order to encourage private parties to participate in sustainable development. Several investment programs where set up to accommodate this public support in which the national government addresses the local governments to come up with projects. It is considered that the local community is better placed to stimulate a change. Local authorities are strongly encouraged to come up with ideas and execute cases.

Initiative 5: Local governments invest in sustainable living and housing

Several locally sponsored projects are related towards energy efficiency and renewable energies. The bigger projects are related towards the development of more sustainable towns in which besides energy also the use of construction materials and waste management are incorporated. Examples are the development of eco-cities such as Malmö and Hammarby Sjostad.

Further information:

http://www.naturvardsverket.se

Country: The Netherlands	
Population : 16,6 million	Amount of passenger vehicles: 8,6 million
Surface Area : 37.354 km²	GDP: 34.500 €/capita
Ecological footprint : 4,39 ha/capita	CO2-emission: 13 tonnes CO2 eq./capita

Introduction

An important driver for waste management was a motion in 1979, which emphasised the importance of prevention, reuse, and the transformation of waste into energy. Where the interventions from government initially (in the 1980's) were more control driven, they have since moved from reducing waste to reducing the environmental pressures.
Since 1997 the Dutch Ministry for Housing, Spatial Planning and the Environment (VROM) has central responsibility for waste management.
It describes in its National Waste Management Plan 2002-2012 several challenges, e.g.:

- Although the end-of-pipe management of waste (environmental protection) is quite successful, there is still insufficient influence on the amount of waste produced, which is still growing.
- The cost of waste management is not sufficiently integrated in the product price; the 'polluter pays' concept is still limited.
- Legislation is often too complex to stimulate adequate waste management in companies.
- Concerning the relationship with the EU level: there is not yet a level playing field between all member states, which effects competitiveness between companies and waste management targets of national governments

Initiative 1: National Waste Management Plan 2 (LAP) 2009-2021

The subtitle of this plan, 'Towards a material chain policy' indicates the direction in which waste policy is moving. Major successes have been achieved with 'traditional' waste policy (focus on the end stage of the chain) and this will, where possible, be further optimised.
However, large-scale reduction in environmental pressure in the product chain caused by waste substances and the depletion of energy sources and raw materials cannot be achieved with the traditional policy and instruments. This would lead to a situation where any further environmental gains would intensify environmental pressure elsewhere in the chain.

A real contribution from waste policy to sustainability requires more integrated considerations of the whole material chain in which the waste substances originate. Different concepts, such as Cradle to Cradle, ecodesign, and improved eco-efficiency are seen as added value to deepen and broaden the framework for integrated chain management. The ultimate goal is a single integrated policy framework for the whole material chain.
This shift in concept also could imply that there will be no third waste management plan, but a materials management plan.

Goal for this planning period is to achieve at least 20% reduction in the environmental pressures generated in seven priority streams and related to three most dominant aspects of environmental pressures: volume of CO2-emissions, pollution of toxic substances, and land-use.
The chain approach also calls for different policy instruments. New partnerships and multi-disciplinary platforms are likely to result in the necessary innovations. An important role for government lies therefore in setting up and creating the framework for the process. Possible policy instruments are: stimulation programmes (e.g. ProMT: Environment & Technology Programme), tax breaks (e.g. environmental investment allowance (MIA) and 'greening' the tax system), producer responsibility, voluntary agreements, others, such as: sustainable procurement, ecodesign, and EU SIP and SCP Action Plans.

Initiative 2: Sustainable Public Procurement (SPP)

Resulting from two main EU initiatives, the Integrated Product Policy (2003) and the revised EU SD Strategy (26 June 2006), in which member states were encouraged to develop SPP Action Plans, the Dutch government set sharp targets for SPP: 100% by 2012 for national public authorities, 75% for towns and 50% for provinces, district water boards, universities and higher education. SPP is both a strong push as well as a driver towards the market to develop more sustainable products and services. The European Parliament CSR Resolution (13 March 2007) also asked the EC and all EU governments at national and local level to take serious efforts to use the EU Public Procurement Guidelines (2004/17 and 2004/18)) as a lever to stimulate corporate social responsibility (CSR) in business.
In order to create a common ground for the tendering procedures for all public authorities (clarity to the market) and use the knowledge of business on products and innovations, the Dutch government has, in a process together with a variety of business sectors, developed minimum sustainable criteria for 45 product groups, varying from catering, hardware, travel and vehicles, to office buildings and interior, cleaning, clothing, wood, and construction works.

Further information:

1 National Waste Management Plan: www.lap2.nl (in Dutch)
2 SPP: www.senternovem.nl/duurzaaminkopen (in Dutch)

Country: The UK	
Population : 62 million	Amount of passenger vehicles: 31,7 million
Surface Area : 242.900 km²	GDP: 29.600 €/capita
Ecological footprint : 5,59 ha/capita	CO2-emission: 11 tonnes CO2 eq./capita

Introduction

The UK department for environment and rural affaires (Defra) launched in 2005 its new strategy for sustainable development, 'Securing the Future' covering improving environmental performance of product and services, resource efficiency, sustainable consumption, innovation, waste reduction and recycling, strong partnerships (http://www.defra.gov.uk/sustainable/government/publications/uk-strategy/index.htm). UK made a big step forward during the last 5 years coming from a situation in which waste policy had a low profile compared to other environmental issues. The EU legislations and in particular the landfill directive pushed waste management on the UK agenda requiring a fundamental change to the previous practice. Key drivers for the changed waste management approach, described in the different regional action plans, are the landfill directive and the waste hierarchy. Both aim less waste production, more reuse and recycling (3 R). The environment agencies waste and resource management strategy 2010-2015 addresses the requirements for more efforts. The EA will stimulate resource and waste management by dissemination, by stimulating innovation, by supporting regional and local authorities to collect and provide data and info, to assist in making up regional and local strategies and plans.

Initiative 1: Actions to reduce landfill - participation of local authorities and companies

Local authorities and private companies are all involved in the process of change in UK. The national authority mainly provides resources. The main driver for change is the expected increase in costs for landfill including a strong increase in tax, certainly if the EU targets are not met. The debate resulted in better data collection/dissemination and more budgets available for related authorities, research and investments. In general, much attention is given to dissemination, education and financial support. Several programmes stimulated better waste management. Existing examples are related towards improved recovery and/or recycling which are covered by for example the waste strategy of England with its focus on resource efficiency, site waste management planning (SWMP) and construction waste strategy (SMART waste, BREMAP, MINRES, WRAP, BERR-website, …). Several actions where set up to bridge the 3R gap between UK and other EU member states. The 'waste protocols project' studies the recycling possibilities of the main types of waste such as biodegradable waste, blast furnace slag, construction and demolition waste, marine dredged materials, steel slag, waste incineration bottom ash, ... The quality protocol sets out criteria for the production of a material out of waste (http://www.environment-agency.gov.uk/business/topics/waste/32154.aspx).

Initiative 2: Role of construction sector

The construction sector is in the UK responsible for 120 million tonnes of construction, demolition and excavation waste a year being almost 1/3 of all waste in UK. WRAPS initiative of halving waste to landfill in the construction sector attracts much attention and seems to be a real driver for change by directly addressing to companies in the sector (http://www.wrap.org.uk/construction/). The building and construction sector it self is an important candidate to accommodate various waste streams. The MINRES project aims to increase knowledge on recycling waste materials in construction applications. Several cases where set to start mainly initiated by the authorities. The debate around the use of waste in cement kilns showed the pragmatism and the interest in economic viable options for waste treatment (http://www.smartwaste.co.uk/minres). As for 7 of April 2005 (Clean Neighbourhood and Environment Act), it is a legal requirement for all construction projects in England to have a Smart Waste Management Plan (SWMP) to optimise waste management of building and construction activities (http://www.smartwaste.co.uk/swmp.jsp?id=18).

Initiative 3: UK Aggregate tax

The UK aggregate tax came into effect in 2002. It is targeted at the extraction of sand, gravel and crushed rock. The tax is levied on all extraction and imports to the UK with the exemption of recycled aggregates. The objectives are to adjust for environmental costs of the quarrying operation. The tax is also intended to reduce the demand for natural aggregate and encourage the use of alternative materials where possible. All tax revenues are recycled to the business partly through a newly established fund for environmental benefits. The result of the tax is a decrease in raw materials use and increased recycling.

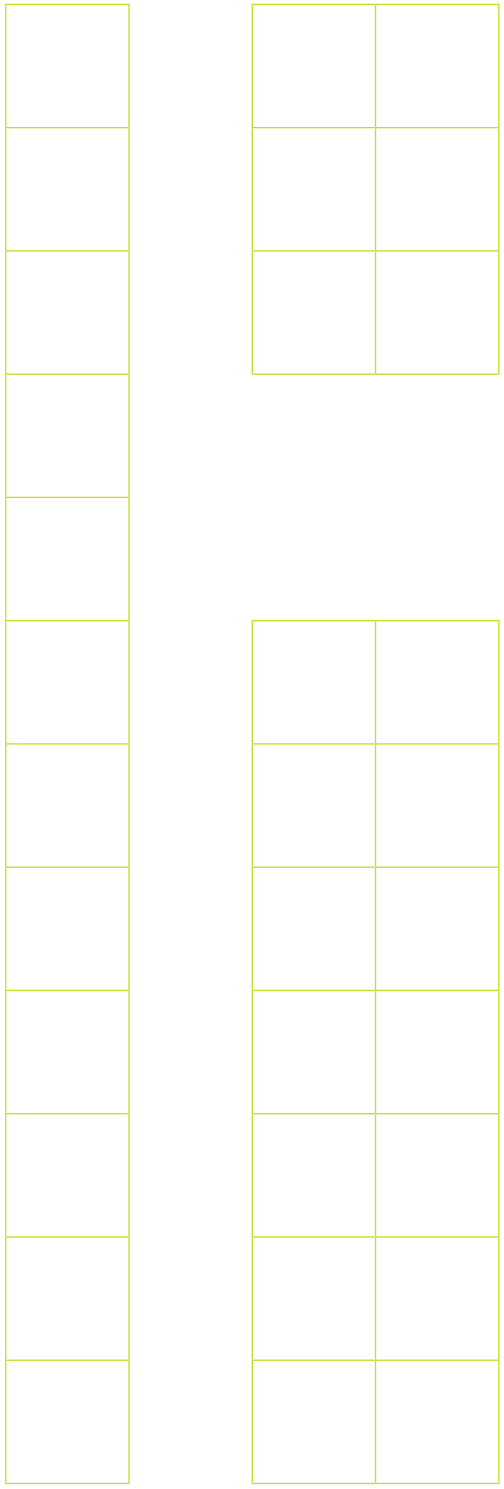
Initiative 4: Eco-Schools

The Government in England wants every school to be a sustainable school by 2020. The Department for Children, Schools and Families (DCSF) launched their Sustainable Schools Framework in 2006. It is the long term aspirations for schools to mainstream learning about sustainable development issues and sustainable practices into everyday school life.

Eco-Schools is an international award programme that guides schools on their sustainable journey, providing a framework to help embed these principles into the heart of school life. 'Eco-Schools' is one of five environmental education programmes run internationally by the Foundation for Environmental Education (FEE).

Further information:

http://www.defra.gov.uk
http://www.environment-agency.gov.uk
http://www.wrap.org.uk/
http://www.smartwaste.co.uk/
http://www.eco-schools.org.uk



Chapter 4 – SMM Future policy directions

Introduction

The policy directions given for each of the clusters in Chapter 3, § 3.1.1, are 'bottom-up', based on the current concrete developments in markets and society. Many of these cases and their underlying concepts have potential for more mature forms of Sustainable Materials Management. However, to reach these maturity levels as described in Chapter 3 and drastically increase resource productivity, further up-scaling is absolutely vital. Furthermore, the shift from eco-efficiency to eco-effectiveness and even to eco-sufficiency implies changes at system levels. This requires high level political support and action as these changes cannot be achieved at local levels or by market mechanisms and citizens alone.

This transition towards SMM faces multiple challenges and should address both systemic technological and socio-economic shifts and innovations, and the capacity for change of our human behaviour. Changing our habits and behaviour takes effort, demands conscious action and the need for some type of return.

In general there is a need for resource efficiency and effectiveness, innovative production processes, new business models, and shifts in consumption patterns. Large-scale reduction in environmental and social pressures in the whole product chain, including depletion of energy sources, land-use, and raw materials cannot be achieved with traditional policy and instruments. As 'the EU is the world region that outsources the biggest part of resource extraction required to produce goods for final demand (private and public consumption), thus exceeding a potential self-sufficiency of natural resource use (ITRE, 2009, p.3)', these challenges should be particularly addressed at EU level. Policy measures at EU level are also necessary to avoid fragmenting incentives for products and processes in the Internal Market. Different kinds of, and sometimes even counterproductive, incentives and legislative measures, labelling systems, etc., not only prevent a level playing field for business and the necessary stimulation for more SMM in the EU, but also risk to not address sustainable materials management as an integrated concept, where production systems and consumption patterns are inextricable linked at all levels of human living, as we have seen in Chapter 2.

In order to stimulate and support the further transition to SMM, several policy directions should be taken at EU level. Starting with the necessity for a coherent policy mix, four major areas for policy interventions at EU level are distinguished:

1. Policy Integration
2. Measuring and indicators
3. Research & Development
4. World 2.0 transition

The need for a complementary policy mix

As an overarching principle there is a clear need for a complementary policy mix. One can refer to the so-called 4E-model, which was developed by the British Department for Environment, Food and Rural Affairs (DEFRA) in cooperation with the Sustainable Development Council (SDC). Although the 4E-model was designed in the context of the transition towards sustainable consumption it can be translated to a SMM context as well.

The starting point for the 4E-model is that governments, businesses and consumers need to make different choices if we are to achieve the vision of sustainable consumption and sustainable development. Up to now small victories have often been obliterated by the sheer level of consumption (rebound effects). The 4E-model proposes a new approach based on research on what really influences the way consumers, businesses and the public sector choose. The model gives greater recognition to some of the social and practical factors and barriers that influence and limit our choices. It recognises that a much more pro-active approach to change consumer habits is needed, beyond market liberalism. Traditional regulation has been a driver of higher environmental standards and rising levels of social protection. Clearly, it will continue to have a role to play. The Government's approach to regulation means looking for alternatives to "classic" command and control regulation such as taxes. Where regulation remains the best option, the

best results will be delivered when regulations are focused on outcomes and are backed up by clear information and consistent enforcement. While there will continue to be a very important role for regulation and enforcement, regulation alone will not be able to deliver the changes we want to see. We need to make sure that we are using the levers available in a consistent way.
The new strategy therefore focuses on the need to enable, encourage and engage people and communities in the move toward sustainability; recognising that Government needs to lead by example. Engagement is not just a one-way process of communicating at people or relying on conventional 'above-the-line' persuasion. Engagement requires a clear commitment to community action, deliberative processes and involving people in change on their own terms. The distinguishing feature of sustainable consumption policy will be the way in which it engages with people to create and retain its mandate.

The 4E-model is a framework consisting of four main cornerstones to support the development of a coherent policy mix, in this case in the context of a EU SMM policy.

Recommendations for the basic building blocks of a policy mix for SMM:

Enable:

- Impose stringent product and efficiency norms, which gradually toughen in time;
- Provide a regulatory environment where ecodesign, EIP's, PSS-schemes etc. are facilitated or become the default choice;
- Provide convenient access to collecting, reuse and recycling centres;
- Realign national and EU R&D Programmes, stimulating interdisciplinary projects

Encourage:

- Make work of an ecological tax reform, targeting the internalisation of all externalities, using a combination of taxes, subsidies and quota systems;
- Pay specific attention to unfair competition which creates barriers for the widespread use of (recycled) secondary materials, biological materials, renewable energy etc.
- Foster and uncover sustainable material management pioneers (e.g. compulsory labelling of goods: cf A++ refrigerators; cf. material efficiency award in Germany)

Exemplify:

- Governments and EU should lead by example: Sustainable Public Procurement should become the norm (in the areas of building/refurbishment, energy and lightening, IT, transport, electrical appliances, food and drink etc.);
- Local governments should invest in green/sustainable city planning;
- Consistent pro-active policies on local, regional, federal and European level on the basis of an overall policy on sustainable development (see policy integration)

Engage:

- Invest in community change projects such as Transition Towns, Ecoteams, Ecocities, etc.;
- Support deliberative fora developing socially robust knowledge;
- Invest in trans- and interdisciplinary knowledge networks and transition arenas on local, regional, federal and European level;
- Integrate SMM and SCP into education programs (cf. DHO Netherlands) (secondary school, higher education and informal learning networks)
- Support all other strategies by changing the mindset: raising the topic (e.g. campaigns, integrate media, support networks), qualification (e.g. in schools, vocational training, virtual resource university), visualisation of successes (e.g. good practices, promote material efficiency award) (see Hennicke & Kristof 2008)

Policy actions should consider the importance of the human factor (including gender-specific differences) in these change processes. Policy measures should work, within this policy mix, on three elements of human behaviour: motivation, ability and opportunity. Necessary changes can take place when appropriate (behavioural, e.a.) alternatives in favour of SMM are available to both producers and consumers. Convenience is of paramount importance to mainstream sustainable behaviour.

4.1 Policy Integration

When framing policy integration for SMM one has to keep in mind the combination of policy integration and sustainable development (see Bornemann 2008).
Policy integration addresses the problem of unexpected and unwanted effects of policies (external effects) and addresses the insufficient problem solution capacity in terms of complex problems (e.g. sustainable development). Policy integration is about greater coherence of policies, in order to reduce redundancy, policy gaps and contradictions within and between policies. Policy integration can take place in two ways: as a process of coordinating and blending policies into a unified whole or by incorporating concerns of one policy into another.
SMM is also part of the wider Sustainable Development agenda, which also focuses on the interdependencies within and between the several dimensions (social, ecological, economic, long-term, generations and place), and demands an integrative approach including ecological, social and economic perspectives, involvement of several societal actors and relevant governmental levels (local to global).
Policy integration for SMM aims at comprehensive control of mutual externalities between different policies, processes and results. Currently the European Commission focuses on

a different approach: the EPI (Environmental Policy Integration) approach, i.e. horizontal integration of environmental issues into sectoral policies (Cardiff process). However, the EPI is one-dimensional and aims at reducing environmental impacts of sectoral policies, thus resulting in ecological sectoral policies. Considering the range, depth and complexity of SMM, sectoral policies are bound to fail and fragment the chances for a truly sustainable materials management. Whereas policy integration for both sustainable development and SMM, means integration both horizontally and vertically, along the full value life cycle and material chain, while aiming at comprehensive control of mutual external effects of policies.

Recommendations for policy integration:

A. Unify: Develop an integrated EU SMM Strategy that unifies the separate resource related strategies and which defines concrete measures in an overall **SMM Action plan** (incl. monitoring).

We therefore recommend to review existing EU strategies and programmes and include progressive national and business approaches, e.g. as shown in chapter 3. The following existing EU strategies should be combined:

- EU Thematic Strategy on the sustainable use of natural resources
- EU Raw Materials Initiative
- Communication of the European Commission on integrated product policy (incl. IPP Tool Box)
- EU Thematic Strategy on waste prevention and recycling
- EU Action Plan on SCP and a sustainable industrial policy. Link developed SMM Action Plan to SCP Action Plan
- EU Eco-Design Directive: include resource efficiency criteria and apply to all products; include e.g. buildings; establish research programme on adaption of the Directive to service-oriented approach
- EU Forestry Strategy
- EU Strategy for Biofuels

B. Incorporate: Extend and focus in existing programmes, strategies and incentives on SMM, for instance review following initiatives:

- EU Lisbon Strategy and EU 2020 Strategy: review the coming EU 2020 strategy before it is formally accepted later in 2010
- EU Strategy for sustainable development: link the developed SMM Strategy to the sustainability strategy
- EU Strategy for integrating the environment into EU policies: Extend this strategy through integration of sustainability into EU policies
- EU Competitiveness and Innovation Framework Programme (CIP)
- EU Green Public Procurement: extend to sustainable public procurement
- EU Environmental Technologies Action Plan (ETAP) and national roadmaps
- EU Programme for clean and competitive SMEs
- Common Agricultural Policy (CAP)
- Revise EMAS regulation which helps companies to make more effective use of resources.

C. Set long-term targets. Develop visions for sustainable future markets, set demanding and binding SMM targets.

The above suggested policy review (also at other political levels) should be accompanied by the development of long-term visions, targets and scenarios for SMM and powerful implementation strategy, and analysis of economic implications. Anticipate and avoid rebound effects (counterproductive volume and income effects of specific efficiency increases). The combination of efficiency, effectiveness (using natural loops), and sufficiency strategies (adapted to social contexts and circumstances) is needed. Integration that aims at cross-departmental policy, with time frames beyond legislative periods or market phases, leads to a reliable and long-term frame for innovations and investments and to changing consumption and production patterns towards long-living products (products as 'service delivery', as new solutions to provide the services we need).

D. Establish strong European institutions.

Successful implementation needs leadership and strengthening of existing institutions and mechanisms. There is a need for a cross-departmental European structure, similar to the German Green Cabinet or the Belgian Interdepartmental Commission for Sustainable Development (CIDD), comprising all political departments and working on implementation and monitoring of the national sustainable strategy. At the European level no such institution exists, although the EC is responsible for the sustainability strategy. A cross-departmental European Green or SD Cabinet could focus on the integration process and strategy development as well as monitoring (including collaborating with Eurostat, see § 4.2 measuring and indicators).

E. Establish global SMM building blocks.

Establish a UN Dialogue on SMM, e.g. at the UN Commission on Sustainable Development, the core institution working on following topic clusters in 2010/2011: e.g. changing unsustainable patterns of consumption and production, protecting and managing the natural resource base of economic and social development, means of implementation, and institutional framework for sustainable development. Furthermore, link institutions to high-level knowledge platforms (e.g. the International World Resource Forum) and foster international sector dialogues supported by R&D Programmes including SMM.

4.2 Measuring and indicators

The mantra 'You cannot manage (and recognise) what you don't measure' is also relevant for SMM. Measurement and indicator sets are crucial as they enable (SERI 2009):

- Sound decision-making and monitoring progress.
- Setting priorities and taking concrete action. Current EU policies often remain on a level of intention declaration and do not suggest concrete steps and action to achieve the proposed objectives.
- Avoiding blind spots of monetary indicators (i.a. many ecosystem services have no market, resource scarcities are not reflected by markets appropriately) by using physical and qualitative indicators. A life-cycle wide perspective should be applied in order to avoid burden shifting to other regions/countries/between resources.
- Indicators support clear communication with target groups (available resources, per capita consumption, overshoot/limits) and visualise gaps between current patterns and envisaged targets.

Analysis based on indicator sets allows to tackle the most urgent impacts, to identify the most resource intensive sectors, to measure the impacts of consumption patterns, to quantify resource efficiency potentials and the related costs, and to identify trade related burden shifting.

There is a need for urgent action towards absolute resource use reduction, or a decrease of material input. However, currently the EU focuses on the analysis of environmental impacts and faces a 'paralysis by analysis' of impacts. Within these impacts there is a strong focus on energy and CO2-emissions, but not on materials use. There is an urgent need to perform research on cause-and-effect-chains of resource use and impacts. Reducing material input automatically reduces impacts.

Recommendations for set of indicators:

Use a set of indicators to measure the resource intensity and progress towards the reduction of absolute resource use in order to implement the Factor 10 goal. Directionally safe and robust data are needed, focusing on the material intensity of a product, service, sector or economy, including the so-called hidden flows (products require more natural material than is contained in their final form).

Controlling and managing the economy with respect to environmental impacts in a systematic and cost-effective way can happen only at its input side. A comprehensive indicator set should cover the following five main input categories: biotic (renewable) and abiotic (non-renewable) materials, water, land area and air (OECD, 2007b): "These five categories cover the main environmental topics: scarcity of natural resources (non-renewable materials, renewable materials and water), land use change and deforestation, extensive energy use, waste and climate change (greenhouse gas emissions)." (Burger et al. 2009).

Several input-oriented indicators are available: The indicator 'ecological rucksack' measures the invisible material burden (so-called Hidden Flows) or the total input of natural resources required by any product or service 'from the cradle to the point of sale'. (Schmidt-Bleek 2004). The indicator MIPS stands for the life-cycle-wide 'Material Input Per unit of Service' and allows to monitor material flows. It measures the material and energy input of a product/service throughout its life-cycle (production of raw materials, manufacturing, transportation, use, disposal) and measures the decoupling of the economy from resource use (Lettenmeier et al. 2009, Ritthoff et al. 2002). On the level of the total economy, the material use can be measured e.g. by the indicator Total Material Requirement (incl. imports, used and unused domestic extraction, associated indirect material flows) (Schütz/Bringezu, 2008). Also water use indicators have been developed such as Water Rucksack, Water Footprint, and Virtual Water. Output-oriented methods such as Life Cycle Assessment (LCA) or Carbon Footprints focus on the measurement of the environmental impacts (emissions, depletion of natural resources, toxicity, acidification, and eutrophication). The Ecological Footprint is another indicator that combines different environmental categories in a single aggregated indicator, which involves land use aspects with resource use and greenhouse gas emissions (Wackernagel, 1994).

To help achieve amore rapid transition towards integrated SMM, we therefore recommend the following steps with respect to indicators:

1. **Implement a comprehensive and robust resource use indicator set in the EU and Member States.** Therefore check existing suggestions for an indicator set: Firstly, the Sustainable European Resource Institute (SERI) developed an indicator set that comprises the resource input categories of abiotic and biotic materials, water, and land area and considers greenhouse gas emissions and includes both the microlevel (product etc.) and the macrolevel of the economy. Secondly, the completed project PROREGIS suggests an indicator set and provides the framework for the establishment of a data base and centre on resource intensity of raw materials, semi-manufactured goods, finished products and services. Besides, it includes qualification of people in using adequate data for optimising their processes and delivering services. A third project develops an indicator set for products, services and the business level (BRIX – Business Resource Intensity Index). The EU should use the outcomes of these studies to develop a robust indicator set (through a stakeholder

process), to be implemented at EU level.

2. **Establish one Data Centre where data on resource intensity can be internationally harmonised, validated and periodically updated.** Therefore, the existing resp. planned 10 European Data Centres should be merged in one Data Centre, which provides information that is structured along the implemented indicator set and extended by the main output indicators. The European Data Centres shall serve the sustainability policies of the EU and provide measurements and data. 10 European Data Centres have been or will be established on the following topics: Waste (already available), Natural Resources, Products (IPP), Soil, Forestry, Air, Climate Change, Water, Biodiversity, and Land Use (EUROSTAT 2010). The new Data Centre should provide a basis for SMM measurement incl. the distance to the target indicators (that visualise the way to go to achieve the SMM target), the overshoot of resource limits indicators, scenarios for future developments while making a link to sustainability policies (incl. social impacts). The existing structure of the 10 Environmental Data Centres currently presents isolated topics. The more integrated structure along the established indicator set could be as follows:
   - TOPIC 1 (Macrolevel): resource use (along the resources categories according to the developed indicator set: abiotic and biotic materials, water, land, air). Topic 1 should present results and knowledge at the macrolevel (international comparison, EU, Member States, sector specific).
   - TOPIC 2: (Microlevel) should present resource use of products, households, consumers.

3. **Assure a strong statistical link of EU and Member States statistics to the indicator set and political SMM targets.** To assure the links between the EU and Member States (and international linkages) and to restructure the European Data Centres, a European cross-departmental collaboration is needed (see §4.1 European Green/SD Cabinet). The statistical linkage process should be headed by Eurostat to guarantee public access to the database, data generation (see next recommendation) and harmonised and transparent methods.

4. **Develop strong and mandatory mechanisms for data generation of resource intensity at sector and company level.** Similarly to policy challenges, the data generation of resource use resp. in businesses and households is a challenge too. Data could be generated at product level e.g. each time with the application of product patents (e.g. list of used materials, water, land use). Further data generation especially at the household level is needed. Therefore, support a research programme on material intensity at household level to identify resource intensity and consumption patterns. Address adaptation of existing EU labels towards an integration of SMM indicators, e.g. the EU Flower Label and EU Organic Label. Provide incentives to implement these labels.

5. **Support the establishment of national SMM agencies.** Promote the set up of national SMM Agencies (similar to the German Material Efficiency Agency) and provide funding for SMM campaigns, knowledge transfer among European stakeholders, incentive programmes, establishment of a network of qualified consultants.

6. **Design and start capacity building campaigns for sector and company level:** Promote target group specific information and support e.g. training programmes in companies to use statistics and knowledge, e.g. the European project Euro Crafts 21, Vocational Education for Sustainability in European Craft Sector, a project that supports future-orientated enterprises that consider capacity of sustainable management as a factor of success. The project develops and tests appropriate qualification and consulting possibilities especially for employees in SMEs in the European craft sector. The campaign should be commissioned by the national SMM Agencies and co-ordinated and monitored at the European level e.g. by the European Green/SD Cabinet.

7. **Reinforce the EU Sustainable Impact Assessment (SIA)** with a resource-specific indicator set for SMM. As a key decision-making tool, SIA helps to frame problems, identify policy impacts on all dimensions and scope solutions: “Sound analysis is important in helping to identify the underlying trade-offs between economic, environmental and social objectives in priority-setting and policy making for sustainable development. Such assessments seek to develop information on changing economic, environmental and social conditions, pressures and responses, and their correlations with strategy objectives and indicators” (OECD, 2006). A SIA is the most integrated form of ex-ante assessment and serves both as a methodological policy instrument for developing integrated policies which take full account of the three SD dimensions, including cross-cutting, intangible and long-term considerations, and as a process for assessing, together with other stakeholders, the likely economic, social and environmental effects of policies, strategies, and action plans before they have

been formulated (ex-ante). The European Commission has one of the most integrated SIAs. In its 'Impact Assessment Guidance', explaining the whole process and procedures, a large number of criteria are used to assess policies in the three impact domains (EC, 2009). However, specific indicators for SMM are currently not part of these criteria.

8. **The suggested actions position the EU as a role model**, focusing on how to reduce absolute resource use (see World 2.0) and to institutionalise SMM. The EU should also take the lead in the development of international, global standards and harmonisation procedures. In relation to the UN Commission on Sustainable Development work in 2010/11 the EU should initiate the set up of an International SMM Data Centre and a dialogue about harmonisation of used indicators and measurements.

4.3 Research & Development

A first recommendation can be made in the area of R&D funding with respect to the ecological challenges. The EC has spent ample efforts in the area of climate change policies. In order to meet its energy efficiency, renewable energy and CO2 emission targets, the EC is supporting a number of R&D projects and actions in the energy related domains. Energy autonomy is – rightfully – high on the agenda. However, in the field of materials autonomy (also water and land use) and the related SMM challenges, much less efforts are being made. Nevertheless, a true sustainability approach needs to focus both on the energy and the materials policies and in their integration. Future projects in the area of sound SMM progress indicators, integrated closed-loop industry systems, understanding drivers of unsustainable consumption patterns and options for behavioural change, etc. are thus essential for the transition to SMM and should be subject of future EIT and EC FP7/FP8 calls, and for EU structural Funds and specific SME programmes.

Secondly, complex and multi-facet problems such as sustainability and SMM issues require novel research and educational approaches that focus more explicitly on inter- and transdisciplinary networks and settings. However, on the European level (EU FP, COST-Actions etc.) a large part of the funding is still reserved for the traditional single-domain projects focusing on technology, e.g. ESSEM (Earth System Science and Environmental Management) or MPNS (Materials, Physics and Nanosciences). Within EU COST, for example, all projects not fitting into one of the categories are grouped into a TRANSDOMAIN cluster, which receives relatively few resources. In this way, research groups are implicitly steered towards single-domain projects, thereby losing the required level of integration. SMM-related problems require by definition a TRANSDOMAIN approach for which, subsequently, less funding is available. We therefore recommend reserving substantially more means for multi-domain, integrative projects and networks.
Thirdly, **at global level, knowledge transfer to developing countries** on how to develop their capacity to sustainable materials management, adequate measuring and monitoring, impact assessments, etc. should be established, also related to the UNEP-led initiatives on SCP.

4.4 World 2.0

As outlined by the EU SCORE! Network (EU FP6), (Tukker et al., 2008), the goal of reducing environmental pressure by consumption and production can be reached via three routes: (1) greening production and products, (2) shifting demand to low-impact consumption categories, and (3) lowering material demands. Since society seems to be adverse to interfere directly with consumer choice and markets, it is not surprising that government plans for SCP often narrow down to the first point under banners such as 'dematerialization', 'resource productivity' and 'decoupling'. Indeed, these are the main focal points of SMM. But history has shown that this strategy alone fails, due to what has been loosely termed the 'rebound effect': the growth of material consumption (which is the basis for continued economic growth in the present macro-economic model). In practice only relative decoupling seems to occur in any meaningful way. In other words, despite increasing attention for sustainable development policies, overall progress towards ecological sustainability has been painfully slow.

In order to obtain true ecological sustainability - which is considered to be the 'conditio sine qua non' for genuine sustainable development ('World 2.0') – far higher levels of absolute decoupling are required. Generally speaking, in the OECD Countries an absolute reduction of the environmental load of around 90% ("Factor 10") is required within the next three to four decennia.

Based on the laws of thermodynamics, numerous environmental scientists question the possibility of infinite decoupling of environmental impact from economic growth. One of the tense debates in the sustainable development arena is, therefore, the question if we can continue to base our economy on the growth paradigm, or that we should in fact also reduce consumption (at least in the West). However, any policy maker proposing e.g. a 'cap' on consumption levels, probably, would not last long. Smart strategies will thus be required to deal with these 'metaproblems'.
The SCORE! Network provides a pragmatic, phased approach to deal with the different types (levels) of sustainability problems we are facing. Analogous to the SMM Maturity Model proposed in the present report, they subdivide these problems in (1) the "low hanging fruits"

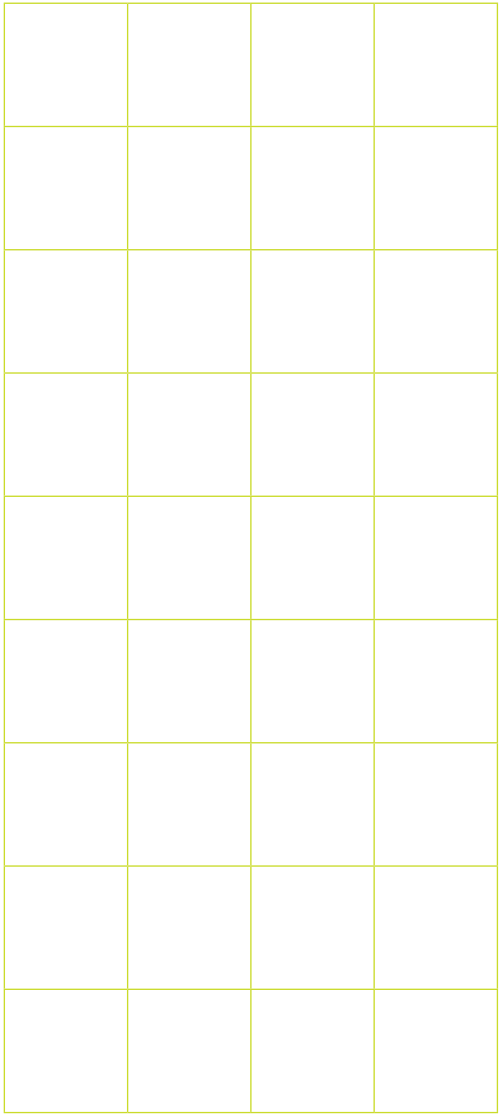
which need the immediate implementation of straightforward SMM and SCP policies, (2) “problems where only a rough agreement on the goals and approaches exist”, which require experimentation and novel governance systems such as transition management (timeframes of 10-20 years) , and (3) “problems that question mainstream beliefs”, including the (biophysical) “limits to growth” debate (timeframe of > 20 years).

The type 3 ‘metaproblems’ are the more difficult issues to tackle. They really require discussion of widely held beliefs and paradigms in society. It concerns informed deliberation on issues such as: “(a) the underlying growth engine in our markets; (b) how and if markets contribute to fairness and equity; (c) how consumption supportive to sustainability can be discerned from consumption that is destructive for institutions and non-market goods providing quality of life; (d) how to develop novel and dematerialized ways of realizing social aspirations, and how this relates to novel business and welfare models; (e) how to maintain a fair power balance in the triangle of business, government and consumer (e.g. by questioning the role of advertising and media)”. It is clear that all these issues pose fundamental questions about the way how our market based economic system functions and about the institutions that have been developed to support it. Gathering credible evidence of how consumption and production systems and the associated materials managements can be organized more effectively in providing quality of life, showing inspiring examples of alternative ways of doing things, are tactics to be pursued. While this is achieved, existing beliefs and paradigms can be modified from there.

Recommendations

1. Already existing exercises on EU level, such as the “Beyond GDP” and “Redefining Prosperity” debates should be further explored.
2. More research on developing financially stable and prosperous alternative macro-economics models is also urgently required, with the goal of transitionising the economy towards a World 2.0 and achieving the Factor 10 goal.
3. To accelerate the transition to World 2.0 and a fully mature SMM a **multi-stakeholder European SMM Transition Platform**, similar to the Flemish ‘Plan C’ (see cluster 10 - Knowledge networks for transitions) can be established.

Last but not least financing the enhancement of SMM is a critical factor. In order to address the critical shortage of investment and funding at the stage of pre-commercialisation an EU Trust Fund for ‘Eco-innovation’ could be set up, which includes SMM and concepts as C2C, biomimetics, eco-social entrepreneurship, etc. The focus shall be on system innovation for SMM, which also includes: low carbon emissions, land and water use, creation of social value, etc. The UK established Carbon Trust Fund may serve as a model.



References

Chapter 1

Argyris, C., & Schon, D.A. (1978). ***Organizational learning****: A theory of action perspective. Reading, MA: Addison-Wesley.*

Ernst & Young, ***Developing the Foundation for Integrated Product Policy in the EU.*** *Report for the EC, DG Environment, 23 June 2000*

European Commission (EC) (2008), Communication from the Commission on the sustainable consumption and production and sustainable industrial policy action plan. Brussels, 16.7.2008 – COM (2008) 397 final

European Commission (EC) (2005), ***Communication from the Commission - Thematic Strategy on the sustainable use of natural resources. Brussels****, 21.12.2005 – COM (2005) 670 final*

James, Oliver (2007), ***Affluenza****, How to be successful and stay sane. Vermillion, London*

Ministries of VROM & Foreign Affairs (2009). ***Schaarste en transitie, kennisvragen voor toekomstig beleid.*** *November 2009, The Hague*

OECD (2001), ***Environmental Strategy for the First Decade of the 21st Century****, 16 May 2001*

OECD (2009), ***Setting and using targets for sustainable materials management****. Working Group on Waste Prevention and Recycling, ENV/EPOC/WGWPR(2009)11, Paris*

OVAM (2007), ***International policy analysis sustainable materials management****. Mechelen, Belgium*

SERV (2007), ***Maatschappelijk Verantwoord Ondernemen, van goede indruk maken naar goede indruk achterlaten.*** *Report on CSR by Sustenuto for the Flemish Socio-Economic Council (SERV), Brussels, 5 October 2007*

Shove, E. (2003), ***Comfort, cleanliness and convenience****.* ***The social organisation of normality.*** *Berg, Oxford/New York*

Wuppertal Institute (Hg.) (2010, forthcoming), ***Handlungsoptionen zur Steigerung der Ressourceneffizienz im Konsumalltag.*** *Ressourceneffizienz Paper 12.2, Wuppertal*

Chapter 2

Arthus-Bertrand, Yann (2009), ***Home, Afspraak met de planeet.*** *Lannoo, Netherlands. In cooperation with UNEP (booklet belonging to the DVD 'Home').*

Centre on Sustainable Consumption and Production (CSCP), ***Eco-innovation – putting the EU on the path to a resource and energy efficient economy.*** *March 2009. Commissioned by the European Parliament's Committee on Industry, Research and Energy (ITRE).*

EPEA (2009), ***Comparison Cradle to Cradle products with other products – Performance Assessment.*** *Hamburg, September 2009*

European Trade Union Confederation (ETUC) et al. (February 2007), ***Climate change and employment - Impact on employment in the European Union-25 of climate change and CO2 emission reduction measures by 2030****. Brussels. With financial support of the EC, DG Environment, United Kingdom department of Environment, Food and Rural Affairs (DEFRA), Spain department of Environment, Italy department of Environment, of Belgium SPF Sécurité de la chaîne alimentaire et Environnement, Finland department of Environment, and Ademe and DIACT (France).*

Davis, A., Valsecchi, C. and Fergusson, M. (2007), ***Unfit for Purpose: How Car Use Fuels Climate Change and Obesity.*** *Institute for European Environmental Policy (IEEP), London.*

EU brochure (2005): ***Clean up your act, dos and don'ts for a greener world.*** *Brussels*

Global Reporting Initiative (GRI) & International Finance Corporation (IFC) (2009): ***Embedding gender in sustainability reporting, a practitioner's guide.*** *Amsterdam*

European Commission (EC) (2009), ***Communication from the Commission to the Council and the European Parliament: GDP and beyond, measuring progress in a changing world****. Brussels, 20.08.2009, COM(2009) 433 final*

FAO, Steinfeld, H. e.a. (2006), ***Livestock's long shadow, environmental issues and options.*** *Rome*

FAO (2007), State of the World's Forests. Rome, 2007

IEA, Fulton, L. (2004), ***Reducing oil consumption in transport, combining three approaches****. IEA/EET Working paper, OECD/IEA, Paris*

ITRE, European Parliament's committee on Industry, Research and Energy (March 2009), ***Eco-innovation – putting the EU on the path to a resource and energy efficient economy****. Authors: Wuppertal Institut, SERI, UNEP, e.a. European Parliament, Policy Department Economic and Scientific Policy, Brussels*

Jones, P. T., De Meyere, V. (2009), ***Terra Reversa, de transitie naar rechtvaardige duurzaamheid.*** *EPO/Jan van Arkel, Vlaanderen and Nederland.*

Lettenmeier, M. e.a. (2009), ***Resource productivity in 7 steps, How to develop eco-innovative products and services and improve their material footpint.*** *Wuppertal Institute, Wuppertal*

McMichael, J, Anthony e.a. (September 2007), ***Food, livestock, production, energy, climate change, and health****. in Energy and Health 5*

National Geographic Nederland-België Magazine (2009), ***Special Edition, 240 tips – Gids voor een klimaatvriendelijk leven.*** *Diemen, Netherlands*

Netherlands Environmental Assessment Agency (NEAA), Stockholm Resilience Centre and Stockholm University (Oct. 2009), ***Getting into the Right Lane for 2050.*** *Bilthoven, Netherlands*

OECD (2008a), ***Environmental Policy and Household Behaviour: Review of Evidence in the Areas of Energy, Food, Transport, Waste and Water.*** *Paris. Available at http://www.oecd.org/dataoecd/19/22/42183878.pdf.*

OECD (2008b), ***Gender and Sustainable Development – Maximising the Economic, Social, and Environmental Role of Women.*** *Paris. Available at http://www.oecd.org/dataoecd/58/1/40881538.pdf*

OECD, (9 November 2009), ***Working group on waste prevention and recycling: Critical metals and mobile devices, an SMM Case Study****. ENV/EPOC/WGWPR(2009)8, Paris*

Räty, R., Carlsson—Kanyama, A. (2009), ***Energy consumption by gender in some European countries.*** *Energy policy, Elsevier, doi:10.1016/j.enpol.2009.08.010*

RESPIRO (2007), ***Guide on socially responsible procurement of building construction works.*** *Brussels. The RESPIRO (responsibility in procurement) project was co-funded by the EU. Available at: www.respiro-project.eu*

Schmidt-Bleek, F. (2008), ***The Earth, Natural Resources and Human Intervention.*** *Haus Publishing Ltd, London.*

Stern, N. (30-10-2006), ***Stern review on the Economics of Climate Change.*** *Royal Institute London*

TerraEco Magazine, ***Mensuel du Développement Durable.*** *Nr. 7 (October 2009), Special (December 2009), and January 2010. Nantes*

The Happy Planet Index: www.happyplanetindex.org

TNO (Netherlands), SERI (Austria/Germany) and IIIEE (Sweden), (October 2008). ***Sustainable Consumption Policies Effectiveness Evaluation (SCOPE2).*** *Delft, Netherlands. Project executed under the EU's 6th Framework Programme on the effectiveness of policy instruments for SCP.*

UNDP (2007): ***Human Development Report 2007/2008.*** *New York*

World Business Council for Sustainable Development (WBCSD, February 2010), ***Vision 2050, the new agenda for business****. Geneva*

WHO (2009), ***Global Status Report on Road Safety, Time for Action.*** *Geneva, 2009*

Chapter 3

OECD (27-Jan-2009), Environment Directorate Environment Policy Committee Working Group on Waste Prevention and Recycling, ***Report of the 2nd survey on SMM related activities.*** *Paris*

El-Haggar, Salah (2007), ***Sustainable Industrial Design and Waste Management****, Elsevier Academic Press.*

Eurostat (2008), ***Statistics in focus,*** *Transport. Jonas Noreland, 35/2008*

Harland, C.M. (1996), ***Supply Chain Management, Purchasing and Supply Management, Logistics, Vertical Integration, Materials Management and Supply Chain Dynamics.*** *In: Slack, N (ed.) Blackwell Encyclopedic Dictionary of Operations Management. UK, Blackwell*

Hopkins, Rob and Lipman, Peter. (February 2009), ***Transition Network, Who we are and what we do.*** *London, UK www.transitionnetwork.org*

McDonough, William and Braungart, Michael (April 2002), ***Remaking the Way We Make Things.*** *North Point Press, USA*

Mollenkopf, Diane, Russo, Ivan, and Frankel, Robert (2007), ***The returns management process in supply chain strategy.*** *International Journal of Physical Distribution & Logistics Management, Vol 37 Issue ,7 , pages 568 – 592*

Tukker, A. e.a. (2008), ***System Innovation for Sustainability 1****, Greenleaf Publishing, 2008.*

Schmidt-Bleek, F. and. Ursula Tischner (1997), ***Produktentwicklung: Nutzen gestalten - Natur schonen****. Vienna, WIFI Austria*

State of the World 2010, WorldWatch Institute.

Voss, Jan-Peter, e.a. (2009), Designing long-term policy: rethinking transition management. Policy Sci. (2009), 42:275-302.

http://www.powertransmission.com/issues/0409/supplychain.pdf N OECD COUNTRIES

http://www.scdigest.com/assets/On_Target/09-02-23-1.php

References for the data of the countries:

Eurostat: indicators for economy, sustainable development, transportation:

http://nui.epp.eurostat.ec.europa.eu/nui/show.do?dataset=nama_gdp_c&lang=en,

http://nui.epp.eurostat.ec.europa.eu/nui/show.do?dataset=tran_r_vehst&lang=en

Japan: population, transport and CO2 emissions:

http://www.stat.go.jp/english/data/nenkan/1431-02.htm

http://www.stat.go.jp/english/data/nenkan/1431-12.htm

http://www.stat.go.jp/english/data/nenkan/1431-26.htm

UN, country snapshots: *http://unstats.un.org/unsd/environment/Questionnaires/country_snapshots.htm*

WWF*, Europe 2007, Gross Domestic Product and Ecological Footprint.*

Chapter 4

Angrick, M. (2008), ***Ressourcenschutz für unseren Planeten.*** *Marburg*

Bornemann, B. (2008), ***Policy Integration for Sustainable Development: What does it mean and how can we analyse it?*** *Paper for the 2008 Berlin Conference on the Human Dimensions of Global Environmental Change International Conference of the Social-Ecological Research Programme, Berlin, 22-23 February 2008, Lüneburg*

Briassoulis, H. (2005), ***Complex Environmental Problems and the Quest for Policy Integration****.*

In: Briassoulis, H. (ed.), ***Policy integration for complex environmental problems: the example of Mediterranean desertification.*** *Ashgate studies in environmental policy and practice, Ashgate Publishing, Ltd, pp. 1-49*

Burger E., Giljum S., Manstein C., Hinterberger F. (2009), ***Comprehensive Ecological Indicators for Products: Three case studies applying MIPS and Ecological Footprint****, Vienna, Austria*

Euro Crafts, Euro Crafts 21 - ***Vocational Education for Sustainability in European Craft Sector.*** *See: http://www.wupperinst.org/en/projects/proj/index.html?projekt_id=244&bid=43&searchart=projekt_uebersicht (17.03.10)*

European Commission (15 January 2009), ***Impact Assessment Guidelines****, SEC(2009)92, Brussels.*

EUROSTAT (2010): ***Environmental Data Centres.*** *URL: http://epp.eurostat.ec.europa.eu/portal/page/portal/about_eurostat/activities/environmental_data_centres (17.03.10)*

Geibler, J.v. (2009), ***Nachhaltigkeit in globalen Wertschöpfungsketten: Nicht-staatliche Standards im internationalen Biomassehandel.*** *Dissertation Ruhr-Universiy Bochum, Bochum*

Hogl, K. (2008), ***Zum Prinzip 'Politik-Integration', Presentation of Department of Economic and Social Science at Institute of Forest,***

Environment and Resource Policy. *BOKU - University of Natural Resources and Applied Life Sciences, Vienna*

Grunwald / Kopfmüller (2006), ***Nachhaltigkeit.*** *Frankfurt/New York*

Kristof, K., Hennicke, P. (2008): ***Impulsprogramm Ressourceneffizienz: Innovationen und wirtschaftlicher Modernisierung eine Richtung geben.*** *MaRess-Policy Paper 7.2. Wuppertal*

Lettenmeier, M., Rohn, H., Liedtke, C., Schmidt-Bleek, F. (2009), ***Resource productivity in 7 steps:: how to develop eco-innovative products and services and improve their material footprint.*** *Wuppertal Institut, Wuppertal Spezial ; 41, Wuppertal*

Meijers, E., Stead, D. (2004), ***Policy integration: what does it mean and how can it be achieved?*** *A multi-disciplinary review. Delft, Netherlands*

OECD (2006), ***Good Practices in the National Sustainable Development Strategies of OECD Countries, OECD Horizontal Programme on Sustainable Development****, Paris.*

OECD (ed.) (2007b), ***Measuring Material Flows and Resource Productivity.*** *The OECD guide. ENV/EPOC/SE(2006)1/REV3, Environment Directorate. Paris.*

Persson, Åsa (2004), ***Environmental Policy Integration: An Introduction****. Stockholm.*

Peters, G. (1998), ***Managing horizontal government: The politics of coordination. Research Paper No. 21.*** *Ottawa: Canadian Centre for Management Development.*

Ritthoff, M., Rohn, H., Liedtke, C (2002), ***Calculating MIPS: Resource Productivity of Products and Services****, Wuppertal Spezial no. 27e, Wuppertal*

Schmidt-Bleek, F. (ed.) (2004), ***Der ökologische Rucksack: Wirtschaft für eine Zukunft mit Zukunft.*** *Stuttgart*

SERI (ed.) (2009): ***A comprehensive set of resource use indicators from the micro to the macro level****. SERI Working papers No.9, Vienna, URL: http:/seri.at/wp-content/uploads/2010/02/SERI-Working-Paper-9.pdf*

Tukker, A. e.a. (2008), ***System Innovations for Sustainability 1: Perspectives on radical changes to sustainable consumption and production****. Greenleaf Publishing, Sheffield*

Wackernagel, M. (1994), ***Ecological Footprint and Appropriated Carrying Capacity: A Tool for Planning Toward Sustainability.*** *Ph.D. Thesis. School of Community and Regional Planning. The University of British Columbia.*

WRR - Scientific Council for Government Policy (2002), ***Sustainable Development. Administrative Conditions for an Activating Policy [Duurzame ontwikkeling : bestuurlijke voorwaarden voor een mobiliserend beleid]****. Reports to the Government No. 62. Sdu, The Hague.*