

Sustainable Consumption and Resource Management in the Light of Life Cycle Thinking

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ABSTRACT

Approaches to address unsustainable ways of societal development constantly proliferate, but total consumption of resources and aggregate environmental impacts continue rising. This could partially be explained by weak attempts to develop comprehensive sustainability strategies that address the entire life cycle of products and especially resource extraction and use phases. This paper seeks to explore to what extent these life cycle stages and associated impacts are taken into account when various actors employ life cycle thinking and how these concerns can be better attended to in policy-making, business strategies and lifestyle choices. To accomplish this, we evaluate the efforts of the main stakeholders in reaching sustainable consumption and sustainable resource management, and impediments to further progress, and study whether and how deficits in these phases coincide and can potentially contribute to more holistic practical realization of life cycle thinking. We demonstrate that new approaches are needed to be able to tackle the international dimension of production and consumption. Copyright © 2007 John Wiley & Sons, Ltd and ERP Environment.

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Introduction

LIFE CYCLE THINKING DEMONSTRATES AN IMPORTANT PARADIGM SHIFT IN THE WAY WE ANALYSE and address environmental challenges, because it inherently analyses impacts of products and services from cradle to grave, i.e. from resource extraction to final waste disposal. Fortunately, life cycle thinking is penetrating various levels of society and becomes embedded into practices of various actors. It is 'becoming part of current, late-industrial culture in the Western world' (Heiskanen, 2002). In the last decade considerable efforts have been undertaken by the EU and European countries

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to devise comprehensive strategies to address environmental impacts along the entire life cycle. However, practical applications of life cycle thinking often fall short of the life cycle systems approach. Life cycle stages that received significant attention and consequently demonstrate considerable progress are production and, to some extent, waste management and product design. Although these efforts are undoubtedly important and results are often quite impressive, the aggregate environmental impacts of industrialized economies – total consumption of resources, air, water and soil pollution and waste volumes – continue to increase. Analyses by OECD and EEA of household consumption demonstrate that in European countries environmental pressures are mounting, because consumption growth is outpacing production-related technology gains (OECD, 2001, 2002; Michaelis and Lorek, 2004; EEA, 2005).

These studies demonstrate that some life cycle stages have not been in focus of policy makers or businesses to the same extent as production phase. These phases include resource extraction and transformation into materials and agricultural goods, use and consumption phase and final disposal of post-consumer goods. The established consumption–production structure – global supply chains and embedded material- and energy-intensive consumption patterns and lifestyles – makes it difficult to evaluate associated environmental impacts and devise strategies for their reduction. This article focuses on the resource extraction and use phases, since the final disposal phase has been addressed, at least in cases when disposal of post-consumer goods takes place in European countries. We seek to explore to what extent these life cycle stages and associated impacts are taken into account when various actors employ life cycle thinking or life cycle tools and how these concerns can be better attended to if a truly holistic life cycle perspective will be applied in policy-making, business strategies and lifestyle choices. To accomplish this, we evaluate the efforts of the main stakeholders in reaching sustainable consumption and sustainable resource management – concepts specifically suggested for addressing these two life cycle stages. Although previous studies have raised concerns over the need to more fully incorporate these life cycle stages into life cycle studies (Mont, 2001; Bleischwitz and Hennicke, 2004; Dalhammar, 2004), this issue has not been elaborated in terms of whether and how deficits in resource extraction and consumption phase coincide and can potentially contribute to more holistic practical realization of life cycle thinking.

We demonstrate that new approaches are needed to be able to tackle the international dimension of production and consumption. Integrated Product Policy, national strategies of sustainability, even EU Directives would likely fail to address the challenges connected with these trends. Of course, this is not to deny the necessity of European domestic policies, but the claim is made that international mechanisms also ought to be developed.

After briefly introducing life cycle thinking in the next section, we examine conceptual understanding and practical application of sustainable consumption (third section) and sustainable resource management (fourth section) concepts by various actors, main barriers to realizing them and briefly discuss how efforts on sustainable consumption and sustainable resource management could be strengthened. In the fifth section, we investigate and conclude with potential synergistic effects of approaches that may encourage better integration of upstream (resource extraction and transformation) and downstream (use, re-use etc.) phases.

Life Cycle Thinking at a Glance

Life cycle thinking (LCT) is a broad concept that helps conceptualize environmental problems as a system-level issue. It means that all environmental aspects from cradle to grave are considered and possibilities for environmental improvement of products and services are found along their life cycles. Life cycle thinking is especially important in the light of deficits of eco-efficiency approaches and abundance

of rebound effects – unintended consequences of improvements leading to higher overall environmental impacts.¹ Often, these so-called rebound effects offset the progress reached in product design and production phases and lead to increased impacts in the consumption and disposal phases (Worldwatch Institute, 2004). In this sense, life cycle thinking is an important approach, which at least conceptually may help consider all life cycle stages and their impacts.

It is indeed becoming an inseparable part of every day reality for many manufacturing businesses. Companies can no longer afford being concerned only with product quality and production efficiency. Business realities demand new ways of framing decisions based on consideration of the entire product life cycle (Heiskanen, 1999). In addition to conceptual considerations, practical realizations of life cycle thinking in business strategies are numerous and include life cycle analysis (LCA), which lays ground for design for environment, eco-labelling and environmental product declarations, supply chain management and environmental management systems. Life cycle thinking is therefore helpful for companies in mapping out and reducing environmental impacts of their products and activities. It triggers companies to look beyond the company gates in terms of problems and solutions, to transfer environmental awareness along supply chains and to create new incentives for environmental improvements.

For governments, on the other hand, life cycle thinking presents certain challenges. On the one hand, life cycles and product chains span across national borders and therefore no national authority has the power to manage global value chains. On the other hand, a life cycle perspective brings forward global interests for a clean environment, while the legitimacy of national authorities typically depends upon domestic voters, whose interests do not necessarily reflect global environmental commons or degradation occurring in other parts of the world. Recent concerns with end-of-life products and waste raised outside Europe may illustrate our point. Life cycle thinking thus underlines the need for international cooperation and for best-practice policy diffusion.

To individual consumers, life cycle thinking as a concept is largely not known. However, social and environmental concerns regarding ‘the world behind the product’ demonstrate that life cycle thinking may become a habitual element of consumers’ purchasing decisions. Eco-labelling and life cycle costing are some of a few policy tools directed towards individual consumers based on life cycle thinking. While the idea behind eco-labelling is to promote green products, the goal of life cycle costing is to increase the market of green products with running costs that are advantageous to consumers.

The brief outline of LCT applications by various actors demonstrates that practical use of life cycle thinking falls short of the holistic perspective provided by conceptual developments due to complexity of life cycles of products and services. From the perspective of European environmental policy this implies that improvements reached in Europe are often offset by impacts taking place in other life cycle phases taking place in other geographical areas, namely the following.

- *Resource extraction and transformation into materials and agricultural goods.* Due to globalization and liberalization of trade many supply chains span across the globe. Resources can be extracted in one country, processed in another, used in production in a third and as products in many countries and finally shipped for disposal to yet other parts of the world. Often, resource extraction and transformation together with its impacts are increasingly outsourced to non-European countries. This makes it possible to report relative decoupling of direct material input *per capita* from GDP *per capita* in terms of mineral consumption in some countries (European Commission, 2002a, see chapter 5). In this sense, focusing on resource use and leaving out environmental impacts of resource extraction may lead to a false sense of achievement.

¹ For example, increased efficiency of production leads to decrease of product prices, which allows a person to buy more of these products, which leads to higher impacts from use and disposal phases. Or, eco-design of product, for instance, fuel efficiency of cars, is offset by increasing number of cars on the road and increased environmental impacts.

- *Use/consumption phase.* Lifestyles of industrially developed countries are based on material- and energy-intensive consumption. Their impacts affect not only the European environment, but also other, largely developing, countries, which are still principally net exporters of primary goods, i.e. resources, and importers of manufactured goods. Therefore, developing countries depend to a larger extent than industrialized countries on resources derived from nearby ecosystems and have better understanding of associated impacts than consumers in industrialized economies. However, this does not stop the dissemination of unsustainable Western lifestyles to developing countries through material- and energy-intensive products and services, advertising and deliberate trade policies.

This brief outline of life cycle thinking applications demonstrates that, although conceptually life cycle thinking has a huge untapped potential for providing comprehensive solutions for many problems, comprehensive practical applications are difficult to find. Applications that merely focus on product design and production phases do not provide the full picture to decision-makers, businesses and consumers and reduce the possibility of finding potential solutions to environmental problems. Since the resource extraction and use phases have not been paid sufficient attention within the life cycle thinking perspective, we employ the actor perspective to investigate how environmental and social impacts of these stages have been addressed. In the following sections, we specifically focus on two concepts that have been suggested for addressing sustainability issues of these phases: sustainable resource management and sustainable consumption.

Addressing the Use Phase of the Life Cycle

As was shown above, the problem of the use phase is that increasing growth in consumption is putting strains on the environment. Studies that focus on energy usage and associated carbon dioxide emissions have found that approximately 70–80% of national energy use and greenhouse gas emissions may be related either to household activities directly or to activities required to deliver goods and services to households and to manage the waste flows generated by households (Moll *et al.*, 2005; Tukker *et al.*, 2005). Furthermore, an additional 10–12% is attributable (directly or indirectly) to the provision of public sector services. In many cases, direct and indirect impacts associated with consumption take place outside Europe. Direct impacts include emissions from resource extraction and transportation,² while indirect come from the well known challenge of applying Western lifestyles in the developing countries and by European exports to those countries. The so-called sustainable consumption concept therefore ought to be analysed insofar as it addresses these challenges.

Sustainable Consumption Endeavours of Main Stakeholders

Sustainable consumption is generally defined as the consumption of goods and services that meet basic needs and quality of life without jeopardizing the needs of future generations (OECD, 2002). This broad definition includes not only consumption by private consumers, but also by institutions (businesses and organizations); not only consumption of resources (appropriation of resources from nature), but also final consumption (OECD, 1997). The following sections outline approaches for sustainable consumption employed by different types of consumer – public sector and government, businesses and private consumers.

² Robust mapping of resource flows embedded in imports is therefore of great importance when studying household resource demands (Lenzen *et al.*, 2004; Peters and Hertwich, 2005).

SC and Public Sector

Sustainable consumption can be exercised by the public sector in two ways: through development of policies for sustainable consumption and through incorporating sustainable consumption practices into its own purchasing activities.

Policies for sustainable consumption can in their turn be divided into policies that directly affect consumers and policies that set institutional and especially infrastructural conditions that enable consumers to make environmentally and socially sound or unsound decisions. Overview of consumption-oriented environmental policies indicates that there are very few strategies that specifically focus on addressing consumption (Dalhammar and Mont, 2004). Policy instruments that indirectly address consumption range from the removal of environmentally harmful subsidies to the increasing use of green taxes and awareness raising campaigns to inform consumers about the environmental and social impacts of production and consumption (Mont and Plepys, 2005). Among strategies that directly target consumption patterns is the EU's Integrated Product Policy, which aims at greening products along their life cycles. However, very little attention is paid in IPP specifically to sustainable (environmental and social) sourcing of products and services. Almost none of the existing approaches and policies specifically mentions the challenge to address consumption *levels*, i.e. the scale of goods and services produced. From international perspective a very important question is whether strategies for addressing sustainable consumption developed in industrialized countries and based on an individualist's worldview are compatible with sometimes more sustainable lifestyles of developing countries.

The sheer size of the public sector in total purchasing transactions makes its potential impact on the environment self-evident. The public sector can influence the production sector and help bring more environmentally and socially sustainable options from niches to mainstream markets by including environmental and social demands in their procurement practices and administration. Examples of such procurement programmes include those that promote the purchase of local and environmentally sound products and services, labelled products or fair trade products. Denmark, Sweden and Japan are well known for their ambitious policies in this regard.

SC in Business Strategies

The majority of existing business-oriented environmental management tools and concepts mostly improve production processes and product features, but leave out the question about consumption patterns and levels (Christensen, 1997). However, businesses have large potential to contribute to sustainable consumption both in their role as suppliers and as customers. Examples of business strategies for sustainable consumption mainly include eco-procurement, greening of products and advertising of more sustainable consumption patterns (UNEP, 2005b).

In their role as suppliers, businesses design products and services that satisfy consumer needs with fewer resources used during production or use stage.³ Business strategies of dematerialization and eco-efficiency are well suited for reducing resource use per unit of product or per unit of function.⁴ Creating environmentally sound products is just one side of the coin, another being creation of markets for environmentally sound products and services and expansion of customer base for green products (Bleischwitz and Kanda, 2004; WBCSD, 2005). Businesses use various strategies and tools ranging from eco-labelling and environmental product declarations to direct advertising of eco-sound products and services. A rather recent contribution to marketing campaigns is introduction of the concept of life cycle costing to individual consumers. Electrolux can serve as an example of a company that uses life cycle cost information to facilitate purchases of its more environmentally sound products, the initial price of

³ See examples from industry in Industriförbundet (1997).

⁴ See examples in Fussler (1996) and von Weizsäcker *et al.* (1997).

which is higher than similar products of other producers, but the life cycle cost is lower due to the reduced use of electricity and water (Sundström, 2005). One of the most promising strategies for businesses to reduce environmental and social impacts of their activities is to green supply chains. Many examples demonstrate the possibility and importance of influencing upstream life cycle stages (Hass, 1996; Wycherley, 1999; van Hoek, 2001). It has been demonstrated that not only large companies can do this, but also relatively small companies find possibilities and economic and marketing rationale for doing so (see for example Kogg, 2003).

SC in Households

Sustainable consumption in households can be divided into supply-oriented strategies for engaging individual consumers in consuming more environmentally sound products and services and demand-oriented collective actions of people or entire communities devising their own ways of using and consuming products and services that reduce rebound effects haunt many supply-oriented strategies.

Supply-oriented strategies can be divided into three main approaches. The first approach includes efforts of governments and businesses to design, produce and supply green products and services to the market. The second approach aims at assisting businesses in creating markets for green products by informing consumers about environmentally sound alternatives, mostly through eco-labelling. The third approach is information provision to consumers regarding their use patterns and includes various awareness raising materials, consumer campaigns and, recently, information about life cycle costs.

Collective initiatives include experiments with substituting products with services by sharing and pooling material goods, or by leasing and renting them, aiming to increase the intensity of product use and thereby reduce the material intensity of each use episode. Such collective initiatives include cottage renting and hotel sharing programmes, community-based washing centres, car sharing and pooling schemes, co-housing communities, local exchange trading schemes etc. In addition to these examples, there are also more ideologically oriented environmental approaches, advocating living in eco-villages and in general simpler lifestyles (Segal, 2003). Unfortunately, like many other collective actions or initiatives undertaken beyond market economy, many of these grass-root attempts are temporary and need support to become institutionalized in society and embedded into everyday life of many more people, who do not see themselves only as consumers, but in the first place as individuals. The UK sustainable development strategy is one of the first documents that emphasizes realization of the vision of sustainable communities (HM Government, 2005).

When it comes to addressing the resource extraction phase by consumers, very little is actually happening. Due to global supply chains, consumers in the industrialized countries are becoming more and more decoupled from places where resources are extracted and where large environmental and social impacts occur (Shanahan and Carlsson-Kanyama, 2005). Lack of understanding about impacts associated with consumption of consumers in industrialized countries on ecosystems and people in developing countries is one of the reasons for lack of consumer action. Examples of Shell and Nike boycotts of the late 1990s demonstrate the power and the willingness of consumers to act once they obtained information on practices of companies in other parts of the world. One example of informing consumers is the 'fair-trade' labelling marking products produced in an environmentally sound and socially responsible manner in developing countries. The goal of this type of label is to create favourable conditions for small producers in developing countries, especially for agricultural produce, such as tea, coffee, bananas etc. Studies demonstrate fast expansion of 'fair-trade' labelled foods, which may serve as an indicator of growing awareness of European consumers about unsustainable global food production systems (La Trobe, 2001). In this way European consumers may express their willingness to contribute to more socially and environmentally sound progress in developing countries.

Impediments to Further Progress in SC

As the preceding sections demonstrated, consumption issues have so far been addressed by various actors – governments, businesses and private consumers – largely through technical solutions and information tools, focusing on improving production and product design. The results of these strategies are still insufficient because impacts associated with consumption in industrialized and developing countries are on the rise. Below some of the reasons for this situation are discussed.

Consumption Complexity: Goods, Infrastructure and Happiness

To start with, our understanding of the forces shaping certain consumption patterns and levels is still rather limited, largely due to the complexity of consumption processes and meanings people attach to consumption.

People purchase goods and services for their qualities and functions, as well as for their symbolic or identity value (Bauman, 1990). They use products to ‘help create the social world and to find a credible place in it’ (Douglas, 1976). Surveys indicate that although people want to have financial security and live in material comfort, their deepest aspirations are non-material ones. People express a strong desire for a greater sense of balance in their lives – to bring material gains into harmony with the non-material rewards of life (Consumers International, 1997). Material consumption is needed, but on its own it does not make people happy (Max-Neef, 1995). A growing body of research suggests that a person’s sense of well-being is based not only on one’s own consumption, but especially on the consumption relative to a reference group – ‘keeping up with the Joneses’ (Howarth, 1996). This shows that individually rational behaviour can lead to collectively suboptimal results judged from environmental point of view.

Consumption choices are not only based on individual choices, but also to a large degree depend on existing and available infrastructure and on established social norms. Even if consumers are willing to make sustainable choices, they often find themselves locked in into unsustainable practices, unsustainable infrastructures and unsustainable choices of products and services (Sanne, 2002).

These two levels of factors influencing consumption choices were identified in a recent extended study on how more sustainable consumption can be motivated (Jackson, 2005b). It was found that behavioural change towards sustainable consumption must occur at the collective level – individual changes are clearly insufficient. This has implications both for governmental policies and for business strategies for sustainable consumption.

In addition to these two levels, there is also an international dimension of consumption. Cultural embedding of consumption choices and the level of individualization in society may both serve as an entrance point for more sustainable consumption routines, or on the contrary may serve as a barrier.

Limitations of Information Tools

Provision of information to consumers is often named as one of the main tools in raising consumer awareness and changing consumption patterns. However the problem is that, even in cases when information is provided to consumers, this may not necessarily lead to changes in consumer behaviour. Furthermore, a number of consumer researchers report that even if attitudes of people are highly favourable to the environment, changes in pro-environmental behaviour can be quite minimal (Jenkinson, 1997). This can be explained by cognitive limitations of people to take deliberative action and by emotional influence in purchasing situations.

So far, one of the main tools to inform consumers about environmental and social impacts of products has been eco-labels. Proliferation of eco-labels or producer eco-claims can increase consumer confusion. Purchasing eco-labelled products may also legitimize increasing consumption of more

environmentally sound products, leading to overall increase of consumption levels (Thøgersen, 2000). Another important problem is that due to practical problems, criteria of eco-labels based on life cycle thinking are not as holistic as they could be. For example, products that are labelled as produced locally may rely on supplies from far away (Shanahan and Carlsson-Kanyama, 2005). In these cases consumers buying such products think that they support local production, while in fact they support global supply chains. Finally, although in some countries eco-labels reached significant market penetration in a large number of product groups (e.g. Sweden, Germany), in the majority of countries eco-labels are still novices.

Consumption Levels and Rebound Effects

Despite the undertaken activities in improving production processes and products through eco-efficiency and dematerialization, there is evidence that both for the EU and world-wide GDP is growing at a faster rate than improvements in eco-efficiency (van der Voet *et al.*, 2005). Thus consumption is outpacing the gains from improvements in production and products. Increase of aggregate level of consumption can be traced back to changing consumption patterns and consumption levels. It can partially be explained by increasing population and the level of affluence: the number of people in developing countries that enter the world consumer class is also continually increasing, and has already reached 1.7 billion members (Worldwatch Institute, 2004).

In addition to consumption levels, consumption patterns are also changing, leading to increasing environmental and social impacts. For example, products are becoming larger (houses, cars); consumers have multiple versions of products (TVs, computers) and more luxurious versions of goods (Schor, 2005). In addition, due to globalization, people in different countries consume more and more virgin and exotic resources, including fruits, wood and pets, and travel to more and more remote areas. This increasing consumption is possible partially because products are produced in low-wage countries where salaries are kept artificially low, where working conditions are extremely poor and where no environmental or social costs are incorporated in the product price.

There is also increasing evidence of rebound effects, in which improvements in efficiency actually become an incentive for increased consumption, which offsets productivity improvements reached through eco-efficiency and dematerialization strategies (Heiskanen, Jalas *et al.*, 2000).

Deliberate Support of Unsustainable Consumption

One of the main problems with disseminating sustainable consumption patterns and levels is vested interests of businesses and governments in existing structures and institutions of consumption. The goal of continuous economic growth has been translated and embedded in society as economic growth largely based on material- and energy-intensive production and consumption. For businesses, goods of final demand are the driving forces of their activities and – assuming a never-ending growth of wants – the very source of business development and growth. Businesses are therefore in continuous search of cheap labour and resources, leading to poor working conditions in developing countries, falling prices for many products, which do not allow decent salaries to workers, and increasing quantity of products consumed, sending a completely skewed message to consumers in rich countries (Schor, 2005). There are cases when companies use the lack of legislation in developing countries to export or even smuggle post-consumer products for some sort of recycling or even simply for final disposal. Thus, the problem is that companies that act responsibly and proactively in European markets may act less responsibly when they operate in developing countries.

For governments consumption is directly linked to voters, and GDP, which is associated with quality of life, and therefore consumption, is a very important parameter of a healthy economy. One of the ways

to maintain GDP growth is to underprice natural resources relative to social costs, which takes place because of governmental subsidies and poorly defined property rights and due to market failure to incorporate the (negative) externalities linked to the use of natural resources (Arrow *et al.*, 2004). Therefore, at least in some cases, businesses and governments deliberately stimulate material- and energy-intensive consumption. One example is the Americanization of North East Asian consumption patterns and the shift to unsustainable consumption, while traditional patterns of North East Asia are less energy intensive and more sustainable (Kasa, 2003). In this example, the Americanization leads to introduction of larger vehicles, less developed public transportation, reliance on processed food, high energy consumption and more consumer durables, as well as consumption of a high volume of beef, which has a much higher energy intensity than the traditional fish-based diet (Durning, 1992). Another example is the US response to the European development programme to help small banana growers in Grenada (Schor, 2005). In these cases, instead of moderating production volumes of certain goods as response to reduced demand or to improve environmental standards, US producers use US political power to impose their own, not always sustainable, products or production methods to other countries. Often, international financial organizations, e.g. IMF, support such measures and directly contribute to unsustainable growth (Kasa, 2003).

Towards Strengthening Efforts on SC

In order to strengthen efforts on sustainable consumption, the issue needs to be recognized at the highest political level. Within political actions one can distinguish the Marrakech Process as an instrument to develop and implement the long-term plan to accelerate the shift towards sustainable lifestyles that promote social and economic development across the world. The Marrakech Process launched by UNEP and UN-DESA includes regular global and regional meetings supported by informal expert task forces and roundtables to promote progress on the 10-year Framework Programme for Sustainable Consumption and Production. So far, eight task forces have been established and led by various countries; for example, the UK leads the task force on sustainable products, Sweden that on sustainable lifestyles etc.

Another political instrument to promote sustainable consumption efforts is the National Strategies for Sustainable Consumption and Production. A few countries have developed National Strategies for Sustainable Consumption and Production (UK and Finland),⁵ and are in the process of their implementation. Some criticism has been heard that, although undoubtedly progressive and useful, national strategies do not assist with practical steps towards making current consumption levels and patterns more sustainable. Another criticism is that national strategies insufficiently address effects of Western lifestyles in countries that supply resources and products.

Therefore, a recent suggestion for a more concrete action from a range of forums is the development of National Action Plans for Sustainable Consumption (UNEP, 2005a). During a working meeting of the Swedish Taskforce on sustainable lifestyles it was suggested that National Action Plans for Sustainable Consumption should be coherent with regional-level developments in sustainable consumption and production, such as the EU Action Plan on SCP that is currently in preparation. The National Action Plans for Sustainable Consumption should not only comprise strategic long-term goals, but also contain short-term tactical steps. To ensure that goals and targets are being met, indicators for measuring progress towards sustainable consumption and production should be developed and used. There should be minimum requirements for what National Action Plans should contain and what kinds of goal they should strive for. Some governments may need help in developing the National Action Plans for

⁵ See for example DEFRA and DTI (2003) and KULTU Committee (2005).

Sustainable Consumption, and assistance should be available from other governments with development and especially implementation of the plans.

For companies there are also plenty of possibilities for improvement, especially in their operations and markets that are situated in less industrialized countries. One possibility is to ensure that similar environmental and social standards are being followed in all countries where companies operate. Such standards can include rules for extraction sites, responsibility in terms of reducing impacts on the environment and responsibility to conduct remediation activities after the extraction site is closed. Other possibilities are to develop alternative ways for collecting and recycling of products that are subject to European extended producer responsibility legislation in countries where there is no EPR legislation in place and where there is a lack of infrastructure for taking care of end-of-life products, or to question the material intensity of products and services and to redesign systems of provision so that less material- and energy-intensive offers would become a more viable business solution, e.g. business models based on functional sales and product-service systems.

Addressing the Resource Management Phase of the Life Cycle

Environmental policy has a long tradition of addressing pollutants and waste. Much less emphasis has been given to the cradle of economic activities, i.e. to resource extraction and to the production of materials. Certainly, this is where any life cycle starts and, accordingly, policies should draw attention to it. Environmental impacts resulting from the extraction and use of natural resources can be analysed in terms of (a) the amounts of resources used (Adriaanse *et al.*, 1997; Matthews *et al.*, 2000), (b) land use alterations (MMSD, 2002; Schütz *et al.*, 2004) and (c) further environmental impact caused by the management of resources (van der Voet *et al.*, 2005).

Beyond environmental concerns, there are *social and ethical concerns* linked to products that are often consumed in developed countries and produced in the developing world. In this way industrialized countries externalize some environmental burdens associated with natural resource provision by developing countries (European Commission, 2002b; Korytarova and Hubacek, 2005; Peters and Hertwich, 2005). In such a context, the relative decoupling of resource use from GDP growth – as claimed by the EU Lisbon strategy and Gothenburg strategy alike – is not necessarily achieved through reduction of material intensity of goods and services, but through international trade of these products from developing countries that absorb environmental externalities (Muradian and Martinez-Alier, 2001). Such outsourcing of environmental problems may even be supported by some narrowly defined environmental policies with focus on pollution from production phases. In international conferences such as the Johannesburg Summit in 2002 and the Gleneagles G-8 Summit in 2005, there is a growing concern about mounting inequities and disparities between those who benefit from the achieved economic growth and those who have been excluded from the growing prosperity or who are even being harmed by it.

Looking at these dimensions altogether, any sustainable resource management (SRM) should address environmental pressures, as well as equity concerns and cost-related issues.

Sustainable Resource Management Endeavours of Main Stakeholders

SRM in Policy Making

Sustainable resource policies are still relatively rare. On the contrary, most countries still subsidize resource extraction and the production of energy fuels (OECD, 2003). Sustainable resource policies that are worth mentioning here are the numerous examples to foster renewable energies, a few examples on sustainable buildings as well as an economic incentive such as the UK aggregate tax (Bleischwitz and

Hennicke, 2004). This contrasts with the huge number of approaches that foster resource productivity/eco-efficiency from the business perspective (see below). Looking from the other angle, from a waste policy perspective, most policies underline the need to care for natural resources. When it comes to implementation, however, these policies regulate final disposal and give incentives towards recycling – and still fail to address properly waste avoidance and saving of resources (Bleischwitz, 2004a).

A starting point for any comprehensive resource policy is the recently launched European thematic strategy on sustainable management of natural resources (COM(2005) 670 final), which aims in the long run – in vague terms – at doubling current resource productivity increases to at least 3% p.a. Towards such aims, the strategy calls for better knowledge of environmental impacts as well as of business opportunities. Such a knowledge base shall be created with the help of a European Data Centre and an international panel on sustainable resource management. The strategy also pledges national as well as for sectoral strategies. Despite its weaknesses in terms of policy formulation, the strategy seems to open the door for compiling prevailing approaches to manage natural resources and – especially – to tackle the use of non-renewable resources. The latter is also facilitated by the concern for high raw materials prices and security of supply resulting from world market demand.

SRM in Business Strategies

A strong driver for a sustainable management of natural resources is the current concern for high prices. Since autumn 2001 the world prices for energy and metal resources have increased by about 70% on average. This price increase turns out to be more moderate on a Euro basis due to a favourable Dollar exchange rate. Nevertheless, between 2003 and 2004 the average prices for industrial raw materials have increased by 14% on a Euro basis. In particular, nickel, which is used for the production of high-grade steel, and steel scrap have recorded long-standing maxima; surpassing price increases are registered on the tin, copper and lead markets. In 2005, the largest producer of iron ore – the Brazilian CVRD – could push through a price increase of 71% in negotiations with Japanese steel producers. Iron ore prices are thus at a long-term peak. Because manufacturing industry cannot completely pass on these price trends to their customers, they have strengthened their efforts to rationalize the use of natural resources.

Alongside these economic concerns, the growing propagation of corporate social responsibility leads to a wider view on materials. Manufacturing companies no longer define resource management in terms of materials entering their premises. Social and environmental impacts of resource extraction in developing countries become their responsibility as well as the use of products and services. Dealing with resource extraction without considering demands from consumers would be too selective. Thus, finding synergies between resource extraction and use-oriented strategies is not only a matter for policy makers, but as much a matter for businesses and civil society.

The World Business Council for Sustainable Development (WBCSD) is perhaps the most prominent group fostering sustainable resource management. Being a corner stone of 'eco-efficiency' attempts, the concept of eco-efficiency assists companies in their quest for continuous improvement in minimizing their use of resources and pollutants. It encourages creative strategies of preventative management by integrating environmental considerations throughout the whole life cycle and promotes an active shift from a particular product to multi-use products and services. The approach also reflects a change in environmental management. Increasingly, the environment is being regarded as an opportunity for innovation, and not as a threat to a company. This shift is also related to a parallel change in environmental policies from cleaning-up activities towards integrated and precautionary measures (Bleischwitz, 2004b). Whereas cleaning-up and pollution control measures necessarily add additional costs to companies, the new approach allows for cost reduction and innovation. Measures aiming at recycling of waste, saving energy and other natural resources reduce existing costs within companies. In addition,

new markets emerge that are triggered by both regulation and companies' self-interest. Companies actively enhancing eco-efficiency are able to improve their product design, procurement, manufacturing processes, product maintenance and customer relationships.

SRM in Consumers and People Actions

The currently weakest part of sustainable resource management is on the consumers' side. Consumer organizations support the overarching agenda of sustainable production and consumption (see e.g. the recent Oslo Declaration), but do not put much emphasis on how extraction processes take place and how different firms transform materials into useful goods and services. They also lack of information on what amount of resources is needed in a life-cycle perspective to produce consumer goods (see for a pioneering study Jackson, 2005a). Yet, neither labels nor any related tool provides such information for consumers. In addition, there is hardly a measurement tool allowing accounting for the use of resources for private households – except for water, electricity, heating and gasoline use. This is clearly a missed opportunity.

Impediments to Further Progress in SRM

Markets for natural resources are distorted; one can distinguish four types of deficit: information deficits, subsidies, geo-economical deficits and institutional deficits.

Information Deficits

Information on external costs related to the use of materials does not yet exist. This is different to research results on externalities related to energy use.⁶ Yet, environmental impacts are captured through selected LCA studies and a few databanks, which can be accessed on a voluntary basis. Because of these deficits, the EU's thematic strategy on SRM calls for a data centre able to generate and to provide hands-on information. On a less comprehensive level, price information on the purchasing costs for materials is available, which can be used to increase resource productivity at a company's level. Fischer however arrives at the surprising conclusion that firms barely consider the cost saving potentials in materials yet (Fischer, 2004).

A result of information deficits on externalities is that resource extraction and transformation together with its impacts are increasingly outsourced to non-European countries. This shift allows for reporting relative decoupling of direct material input *per capita* from GDP *per capita* in terms of minerals consumption in some countries (European Commission, 2002a, see chapter 5). In this sense, focusing on resource use and leaving out environmental impacts of resource extraction may facilitate a burden shifting to developing countries. It has been pointed out that hidden material flows in non-European countries where resources are extracted and their environmental impacts should be accounted for by European countries – consumers of these resources (Bringezu *et al.*, 2004). Besides the obvious case of metals (for which scenario analysis is still poor), another case is energy use, which is growing and is predicted to grow (EEA, 2002), reaching by 2030 70% reliance on imported energy (Duncan *et al.*, 2004).

Subsidies

Subsidies are quite common in the field of resources because mining companies contribute to the security of supply and to catch-up processes on the one hand (Arrow *et al.*, 2004). Subsidies facilitate lower

⁶ See for example www.externe.info

prices for customers on the other hand, i.e. for industry and end-consumers. Once a subsidy is implemented, its reduction or abolishment is difficult, e.g. for reasons such as rent-seeking interests. The OECD study estimates that the annual subsidies for the energy and raw material extraction worldwide add up to about US \$ 270 billion (OECD, 2003). The subsidies of the OECD countries for the mining sector amount to 83% of subsidies in that sector world-wide. Worth noting, subsidies on energy and transport have an adverse side-effect on resource use, since processing and trade of materials becomes artificially cheap.

Geo-Economical Deficits

The impact of technological progress on SRM is ambiguous. Following Reynolds, a nameable part of former long-term decline in price can be ascribed to the advanced productivity in raw material extraction (Reynolds, 1999). Improved extraction technologies, work processing and logistics have lowered the supply costs and facilitated price reductions in the past. This, however, implicates a delusive signal for upstream users: declining prices may signalize an improved supply situation, but when – at a later point – real supply shortages get through, the subsequent price increase comes very abrupt. Furthermore, long-lasting declining prices have the disadvantage of deferring new investments. Since the beginning of the 1980s – the period of the last raw material boom – new investments have been barely realized, so that the high demand to be observed in recent years now reveals the limits of current capacity utilization.

The geo-economical analysis of the raw material availabilities indicates cyclic exploration activities. New capital investments turn out to proceed similarly. Enterprises usually wait for high price phases before they conduct new explorations and new investments. In view of the high price level, large-scale exploration projects are currently being initiated and conducted worldwide; the exploration expenditures are estimated to have roughly doubled since the year 2001 (Ericsson, 2005). However, an optimistic conclusion would be too early. For scientific-technical, political or economic reasons no reserve detected is successfully being developed later on. Mining concessions, licensing procedures and unpredictable technical or political difficulties increase the extraction costs. The degradation of certain reserves, e.g. oil slate or deep-sea deposits, initially requires market-ripe extraction technologies and risk assessments.

Institutional Deficits

The perspective of new institutional economics suggests that raw material reserves, which several enterprises purchase property rights of, have the characteristics of common-pool resources: someone has to undertake the risks of the initial development. Once the initial risks are overcome, a rapid path of extraction is struck in order to pre-empt free-rider attitudes of other shareholders. This particularly applies to liquid and aerial reserves. The pathway of extraction is suboptimal altogether.

Another institutional deficit on international raw material markets originates from the 'moral hazard' phenomenon. In recent years, managers of e.g. the oil company Shell took this bait. The company paid bonuses to managers who were able to show increasing reserves within their field of activity. In consequence of this, the company internally overestimated the oil reserves; the figures were partly even intentionally manipulated. The incorrect planning did not become apparent until external analysts critically questioned the issue. Therefore, the economical analysis does not only require considering geological uncertainties as important factors, but also the incentive structures within the information processing. 'Moral hazard' leads to an overestimation of degradable future resources, consequently to lower current prices and incentives for consumption. The phenomenon does not only affect enterprises. Extraction quantities of the OPEC are each ascertained on the basis of the calculated availabilities of the member states. An inducement for an overassessment is given here, too.

Sector	Material Input (bn €)	Estimated reduction potential (bn €)
Manufacturing of metal products	18.6	0.8–1.5
Manufacturing of constructions for electricity generation, distribution etc.	10.2	1.5–3.0
Chemical industry (without primary industry)	11.1	1.8–3.4
Manufacturing of synthetic products	10.8	1.0–2.0

Table 1. Material input and reduction potentials within the next 7–10 years in four selected sectors
Source: ADL *et al.* 2005, p. 7.

The institutional dimension also matters for supply chain management. Firms need to cooperate in order to exchange know-how on sustainable resource management. Moral hazard may invite firms not to report cost savings to their customers while tracking efficiency potentials as long as they can keep prices high. Supply chain management therefore needs to establish incentive systems able to exploit opportunities over the whole chain.

Towards Strengthening Efforts on SRM

Sustainable resource management has an obvious starting point in the costs for purchasing and using materials. Therefore, the issue of material efficiency currently gains attention in the manufacturing industry. Recently, a study carried out on behalf of the German Federal Ministry of Economics estimated the technological potentials of material efficiency for small and medium-sized enterprises in Germany (ADL *et al.*, 2005). The following potentials were elaborated: decrease of substandard goods/improvement of quality, optimization of manufacturing processes, resource-saving product design, material recycling, higher efficiency of devices and machines and – as a strategy – value chain spanning optimization. Table 1 shows some results. The study recommends inducing a public programme for material efficiency increase in medium-sized industry.

Beyond increasing material efficiency, further efforts will search for substitution potentials from environmentally intensive non-renewable resources to environmentally more benign resources. Radical innovations tackling whole production and consumption patterns also need to be explored that would involve consumers from the beginning and satisfy their needs with less material and energy intensity. Any early involvement of users is not only important in terms of acceptance: some radical change may also be led by pioneering users articulating needs, which will shape future market demand of majorities (Truffer, 2001). Such involvement is especially relevant for resource-intensive sectors such as food production and nutrition, housing and mobility, where consumers can be seen as a driving force of demand.

Conclusions: Towards Synergies Between SC and SRM

Resource management includes resource extraction, transformation and managing materials, while consumption refers to the use phase of products and services, and includes product purchasing, use and disposal by consumers. As demonstrated in the article, linkages and interrelations between them so far have not been fully explored. Our claim is that more synergies can be found between these stages if a holistic approach is applied with the goal of reducing environmental pressure along the entire life cycle. Resource extraction and consumption are worth considering together not only due to possibility to

reduce life cycle environmental pressure, but also in order to improve socio-economic sustainability of current systems of production and consumption. Life cycle thinking leads to reducing marginal costs of abatement where it is most beneficial. In addition it is suggested that the global environmental impacts of EU material consumption patterns should be evaluated ensuring that not only needs are satisfied for European consumers, but also value added is created in resource supplying economies and importing regions outside Europe. Creating more direct links between resource management and consumption may help gain trust and, at the same time, increase consumer and citizen awareness about social and environmental impacts of their everyday purchasing decisions and the difference that they can make by exercising their consumer power in a sustainable manner. It certainly will also facilitate a more inclusive and participatory world economy, to which Europe would contribute not just in political terms, but also by the efforts of its companies and consumers.

By applying the life cycle perspective and connecting consumption and resource extraction phases, cooperation among actors along the supply chain may be improved, and less environmentally burdensome and socially unacceptable ways for resource extraction and value delivery may be identified. Improvements along the life cycle could factor in environmental and social issues as innovation triggers. Search for innovative solutions could be expanded from one-actor, one-technology solutions into multi-actor socio-technical modes across different industries in different countries. While supply chain management focuses on vertical integration, a cross-industry perspective would also foster horizontal integration across industries and include participation of possible users (Bleischwitz, 2004b). Extending the scope of innovation activities will help find new opportunities that lie at the crossroads of technical and social, economic and behavioural disciplines and would bring into balance the resource base with consumption demands. Social science of course is demanded to contribute to these efforts.

Chances of improvements of resource extraction phase will be higher if Western lifestyles can be changed towards less material- and energy-intensive consumption modes. Thus, alternative modes of consumption need to be promoted and institutionalized. The quality and quantity of products and services on the market need to be questioned: from products seen as one-way, throw-away items that require substantial amounts of resources into capital assets that provide value to customers during a long period of time and reduce the amount of resources to be extracted. In addition, increasing the amount of recycled materials used in the economy⁷ can also alleviate pressure on reserves of virgin natural resources. To facilitate these changes, businesses need to redefine their profit centres from the number of products sold to the value delivered to consumers. At the policy level this shift should and could be supported, as demonstrated in Finland's National Programme to Promote Sustainable Consumption and Production, which sets the goal of getting more from less by selling fewer material goods, but providing a higher quality of life.

The following two cases may illustrate possible synergies between resources and consumption.

- The basic need of housing and the most resource-intensive sector (construction) may be joined in an effort to modernize the building stock throughout Europe to reduce energy and material intensity. For this the analysis of housing needs could be conducted; an EU Technology Platform on aggregates, other construction minerals and housing technologies could be established and consumer information provided. Houses could be designed and remanufactured to be convenient, flexible for an aging society, comprising facilities for common use and equipped with latest technologies for communication and more comfortable living. Material intensity would be reduced due to functionally integrating the different physical elements (including insulation and lighting).

⁷An idea such as 'urban mining' (Baccini and Brunner, 1991; Baccini and Bader, 1996) refers to both the need to transform prevailing cities in time of demographic change and to access new sources of materials.

- Combined value chain and resource management systems may be established to satisfy customer needs in the areas of nutrition and mobility. Looking at life cycle, resources and consumption patterns, both areas are internationally oriented. Food production as well as metals therefore will be included in attempts to address sustainable consumption in nutrition and mobility. This involves activities from agriculture, water management and mining on the one hand, services and revisiting demand and needs on the other hand. Strategic efforts may consist of developing resource-light regional food production and local mobility systems with light vehicles running on alternative fuels and based on principles of car pooling and sharing.

The examples illustrate also an expanding scope for assessment methodologies from product chains and single technologies towards functional areas of consumption and their production patterns. Tools such as environmental input–output analysis, life-cycle analysis and material flow analysis therefore ought to be compared and merged in order to assess strategies and to identify suitable options. In addition, participatory elements among the actors involved and the constructive interplay between the reflexive policy-maker and a plurally responsive citizenry (Dake and Thompson, 1999) will have to be included in research. European research projects such as the ‘sustainability A-test’⁸ are useful efforts in such a direction. Much more stringent and internationally oriented efforts however will have to be made in order to grasp the challenges ahead.

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⁸ www.sustainabilitya-test.net

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