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Dematerialization Through Services - A Review and Evaluation of the Debate

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Foreword

The present report is the first interim report of the research project *Dematerialization: the potential of services and information technology* funded by the Academy of Finland and conducted at the Department of Management, Helsinki School of Economics and Business Administration. The research project is also included in the *Environmental Cluster Research Programme* of the Ministry of Environment.

From the point of view of the environmental administration, dematerialization relates to efforts to promote a preventive environmental policy that integrates sustainable development into the foundations and dynamics of the economy. The sustainable use of natural resources is one of the central challenges identified in the *Finnish Government Programme for Sustainable Development*. In this context, dematerialization means the de-linking of economic activity from its material base, thus enabling welfare to grow while decreasing the use of natural resources. It is not merely an issue of technical innovation, but also implies fundamental changes in the structure of the economy. The present report explores one set of changes that holds promise for dematerialization: a shift from products to services.

While the role of services in dematerialization has been discussed intensively for some years, there is as yet very little systematic research on the issue. The ideas presented are promising, but they require critical evaluation before they can lead to action. The present report sets out a framework that brings clarity to the enthusiastic, but also eclectic, debate. It will also serve as a conceptual foundation for empirical research, which is greatly needed in the field.

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1 Introduction

Services are increasingly referred to in the discussion on sustainable production and consumption patterns. It is argued that a shift from producing and consuming products to producing and consuming services is central to a sustainable economy. For example, the World Business Council for Sustainable Development's (WBCSD 1996) list of eco-efficiency measures includes the item "increase the service intensity of products and services", along with more traditional environmental measures.

The shift to a service economy has been presented as one means to reach *dematerialization*, i.e., a reduction in the materials intensity of economic activities[1]. Dematerialization is today seen as increasingly central to ecological sustainability, although a broad operational agreement on goals and means is still lacking. In this context, the service approach has raised a lot of interest, but also some scepticism. Some authors suspect that services, when evaluated on a life-cycle basis, may not be less environmentally damaging than products (e.g. Nørgård 1995; Graedel 1998). However, because different authors refer to different phenomena when discussing services, their environmental and other consequences can only be evaluated after the debate on services and sustainability has been unravelled and clarified.

The current discussion on services and dematerialization is confusing because it includes threads from many different, but converging debates. One approach is *macroeconomic*, and focuses on the relative share of the service sector in the whole economy. It is observed that the share of services is continually growing in industrialized economies, and speeding up this development is seen as a means to achieve a sustainable, dematerialized economy. Another approach looks at services from a *business strategy* perspective. The sales of products can be replaced with services (e.g., Stahel 1996). Examples of this approach include energy utilities' Demand Side Management (DSM) initiatives, or firms selling rental and leasing services instead of the ownership of products. The third approach relates to *product development*. Here, service is understood as a synonym of customer need. It is not products that customers require, but the services – the essential functions – that products provide. Focusing on these essential functions is said to provide new opportunities to reduce the use of natural resources (e.g., Tischner and Schmidt-Bleek 1996).

Furthermore, services and dematerialization have resonances with other current topics, such as the "information society" and "knowledge management". Products are today increasingly viewed from a knowledge-based perspective, rather than as physical entities. Thus, even manufacturing companies are encouraged to focus more attention on the services provided by their products.

This article analyses the discussion on services and sustainability, and attempts to clarify the debate in terms of:

- what is meant by services and the service economy by the different commentators?

[1] Dematerialization is defined differently by different authors. Some define it as the reduction in materials use per product, or per product function. Others understand dematerialization in terms of a less materials-intensive national economy. Broadly, however, the idea is that the use of less materials would bring about positive environmental, and potentially other, consequences (Cleveland & Ruth 1999).

- in what ways can services potentially contribute to dematerialization and other socially desirable goals?
- what are identified as the conditions and driving forces of a less materials-intensive service economy?

A large number of researchers and other commentators are currently participating in the discussion on products and services. This paper is an attempt to contextualize this discussion, and consider the arguments analytically. Many of the arguments cannot be evaluated without more empirical evidence, but the present paper sets up a conceptual framework to enable such an evaluation[2].

In the following, an outline of the debate is given, presenting some of the main streams in this discussion. Then, examples of the shift from products to services are presented, in order to enable us to understand what kinds of changes they actually refer to. This provides the basis for constructing a conceptual framework for evaluating the potential for dematerialization through services. Finally, the feasibility of a shift to a more service-based economy is discussed in terms of economic and institutional conditions.

[2] This paper is an introduction and conceptual framework for the ongoing project Dematerialization: the potential of services and information technology at the Helsinki School of Economics and Business Administration, Department of Management (see http://www.hkkk.fi/organisaatiot/research/programs/dema/dema.htm).

Dematerialization as a background for the service discussion

2

The rise of the discussion on services relates to an increasing focus on *dematerialization* as a key approach to ecological sustainability. Many leading figures speak for the need to decrease the intake of materials into the economy radically: by a factor of 4 (von Weizsäcker et al. 1997), by a factor of 10 (Schmidt-Bleek 1994; 1998) or even by a factor of 20 (Jansen and Vergragt 1994). This departs from many traditional approaches to environmental policy, which focus on wastes, especially toxic or harmful ones, flowing out of the economy into the environment.

Many different kinds of arguments have been presented to support the goal of dematerialization. One is based on a pragmatic realisation that some wastes are not problematic by nature, but because of their extensive amount (such as CO_2). Factor targets can in fact be derived from the need to limit greenhouse gas emissions below a critical threshold (von Weizsäcker et al. 1997). Furthermore, carbon dioxide is a waste that cannot be economically controlled at the output stage, but only by decreasing the use of carbon-rich fuels. In fact, it has been recognized that relatively few waste substances can actually be monitored and controlled at the output end, i.e., mainly those emanating from stationary, point-source sources.

More and more, an understanding is spreading that it is the *speed* and *scope* of human interventions which threaten the operation of ecosystems (e.g. Commission for Sustainable Development 1995). A scientific argument in support of this view is that it is extremely laborious and time-consuming to determine the environmental harmfulness of even a single substance. Thus, it has been argued that it would be wise, in the face of ignorance, to limit anthropogenic flows of substances to a (politically defined) proportion of the natural substance cycles (Baccini and Bruner 1988).

Dematerialization and factor targets can also be argued for from the perspective of global equity and the need for economic development in the South. Schmidt-Bleek's (1994) main argument is that currently, one-fifth of the world population in the rich countries of the North consume four-fifths of world resources. If developing countries were to attain northern lifestyles, material flows would grow five-fold. Taking into account expected growth in population, this would translate into eight times the current global material flows by the year 2040. Such a growth in materials use and dissipation would probably place an insupportable strain on natural life support systems.

Dematerialization has also gained interest in the wake of discussions on eco-efficiency (WBCSD 1996). This concept links economic and ecological efficiency into a mobilizing goal for business and other stakeholders with a concern for the economy (Cramer 1998; Ad hoc committee 1996). Whereas end-of-pipe pollution control measures mainly meant more costs for industry, the concept of eco-efficiency raises the idea of cleaner production (i.e. less pollution at lower cost) to the strategic level of business management. On a macro-economic level, the attractive idea has been presented that resource productivity could be improved to the same extent as labour productivity during the past century. Thus, economic growth could be de-linked from materials use, and opportunities for employment could be enhanced (e.g., Schmidt-Bleek 1998).

Dematerialization has the potential for achieving many good things at the same time. However, it is not without its critics (see, e.g., Rejinders 1998, Ad Hoc

Committee 1998). In UN discussions, quantitative targets for dematerialization have mainly been supported by some European countries, whereas extractive industries in developing countries have been critical and unenthusiastic. Environmental science has produced another kind of criticism, directed at indicators (such as materials intensity) that do not differentiate between different substances and locations. However, in spite of some reservations directed at over-simplified claims, the concept has gained surprising support among such different constituencies as business and environmentalists.

The shift towards a service economy can be seen as one means to reach dematerialization. In comparison with more technological approaches (e.g. biotechnology, new materials, nanotechnology), the service shift refers to *social innovations*. Some of these may be totally new forms of wealth creation, while others are perhaps extensions of existing practices. The current discussion on the issue is conducted on many different fora, and refers to different levels, sectors and phenomena in the economy. In the following, the debate is overviewed in order to identify the key dimensions of the "service hypothesis".

Who is talking about the shift from products to services, and what are they saying?

3

There are a large number of different, but overlapping, academic and policy discussions which refer to the shift from products to services as a solution to problems of the environment and sustainability. In the following, some of the most distinct strands of this discussion are briefly described. These include the debate on ecological modernization, the concepts of MIPS and Factor 10 launched by the Wuppertal Institute, and concepts of a service economy and functional sales. Further stands of this discussion are ongoing in national and international policy circles, in the business environmental management literature, and in writings on sustainable product development. A brief overview is also given of the empirical studies that are starting to address the issue.

Whereas most of the discussion is conducted by proponents of the service-hypothesis, some critical comments have also been raised. These are presented in the final part of this section.

Ecological modernization and ecological restructuring

The concept of *ecological modernization* encompasses some of the oldest strands of the discussion on the shift from products to services. As an evolutionary theory of industrial society, it is linked to theories of post-industrial society, such as the work of Bell (1976), Gershuny and Miles (1983) and Inglehart (1987). The environmental implications of ecological modernization have been discussed most in Germany and in the Netherlands.

A detailed review of the history of ideas on ecological modernization is presented by Spaargaren and Mol (1992). Originally, e.g., in the work of Huber (ref. Spaargaren & Mol 1992), ecological modernization was set out as a technologically determinist, evolutionary theory: industrial society will evolve in the direction of ecological modernization on its own momentum. This implicit technological determinism is evident in such articles as Ausubel's (1989), which displays evidence on, e.g., the progressive de-carbonization of fuels to support this evolutionary view of industrial society.

The well-known research by Jänicke et al. (1989) provides some broader support for the self-directed nature of ecological modernization. These researchers set out a hypothesis of *de-linking*, in which economic growth is seen as being continually less dependent on the use of materials and energy. Jänicke et al. have also tested this hypothesis in a number of studies (e.g., 1989; 1997), and found some evidence to support the idea of de-linking (see also Hoffren 1999). However, some recent studies (e.g., Mäenpää and Juutinen 2000; Cleveland & Ruth 1999) have presented counter-evidence that calls into question the de-linking hypothesis[3].

Whereas ecological modernization has been put forth as a social theory of post-industrial society, it has also been developed into a political programme. In recent years, some authors have explicitly differentiated between *ecological modernization*

[3] The earlier work of Gershuny (1978) can also be seen as a counter-evidence. He demonstrates that the growth of consumption from 1954 to 1974s in the UK has not been decreasingly materials intensive but rather the opposite (Gershuny 1978;74).

as a self-directed shift toward cleaner technologies, and *ecological restructuring*, as an explicitly political, macro-economic programme (e.g., Jokinen & Koskinen 1997). The aim of ecological restructuring is to speed up the shift from an economy based on heavy process industries and intensive energy use to an information-intensive and service-intensive society. The clearest political implication of this programme is the increasingly frequent call for an *ecological tax reform*, i.e., a shift from the taxation of labour to the taxation of natural resource use.

Jackson (1996) has a more specific interpretation of the role of services in the restructuring of the economy. He interprets the service orientation as an effort to *reunite commerce and manufacturing*, which have grown separate in the course of the spread of mass-production. Thus, production would be redirected toward customers' needs, rather than following the logics of mass-production. This approach is elaborated on in Schmidt-Bleek and Lehrner's (1999) visions of a 'customized economy' (*die Maßwirtschaft*).

As early as in 1983, Gershuny and Miles foresaw that the growth of employment-intensive services would gain its momentum from information technology (Gershuny and Miles 1983, 126-128). Today, ecological modernization resonates with the topical discussion about the 'information economy' or the 'new economy'. The connections between natural resource productivity and the new economy are based on the idea that information replaces natural resources as a factor of production, thus unleashing economic growth from the constraints of the traditional factors of production (Kelly 1996; Schmidt-Bleek and Lehrner 1999).

The vigorous growth of the information economy in the past few years has brought a deterministic tone back into the discussion on ecological modernization. The rise of the information industry, and the relative decline of materials-based industries, seem inevitable. However, there are also those who point out that there are more and less sustainable pathways for an information economy (e.g., Hawken et al. 1999; Schmidt-Bleek and Lehrner 1999; Kahilainen 2000).

The shift from products to services is implicit throughout the discussion on ecological modernization. Theories of *post-industrial* society refer to services in terms of the growth of the service sector, the displacement of blue-collar work with white-collar work, and the replacement of aspirations to materials growth with non-material values (Spaargaren and Mol 1992) – today echoed in writings on the 'immaterialization' of consumption' (Kahilainen 2000) and the rise of information as the central factor of production (e.g., Kelly 1996). The discussion on *ecological restructuring* refers to services in terms of "less capital intensive and more technology-intensive and service-intensive production structures", "qualitative economic growth", "full employment" and "ecological tax reform" (e.g., Jokinen and Koskinen 1997). In the discussion of *ecological modernization, services* thus seem refer to *(1) a specific structure of wealth-creation in society*, and within this framework, especially to *(2) labour-intensive and (3) knowledge-intensive forms of wealth-creation.*

MIPS: products as "service-producing machines"

The discussion on services and dematerialization has recently gained much input from work conducted at the Wuppertal Institute in Germany, including the concepts of MIPS and Factor 10. Schmidt-Bleek (1994; 1996; 1998) and other researchers at the Institute have revived the concept of "service efficiency", which originated in materials balance economics (Kneese et al. 1970), and introduced it to a broad audience. Service efficiency is defined as providing a maximum of useful end-services to consumers using a minimum of materials and energy, thus risking minimal environmental disruption.

Lehmann and Schmidt-Bleek (1993) have formalized the concept of service efficiency in the term MIPS, meaning Material Inputs Per Service. MIPS has been

proffered as a measure of the sustainability of goods and services. Work on MIPS at the Wuppertal Institute has contributed to two distinct developments. One is the attempt to evaluate the total consumption of natural resources of national economies through materials flow accounting (e.g., Hoffren 1999). The other strand consists of interventions and suggestions for business development and practice. Here, the "service"-part of the MIPS-term gains special significance. Products are conceptualized as "service-producing machines". Schmidt-Bleek (1994; 1996; 1998) and colleagues call on consumers, business managers and product designers to re-evaluate what services or needs products in the market actually aim to fulfil, as it is not the products as such which provide consumer satisfaction, but services such as warm living space, meals, information or recreation.

Schmidt-Bleek and colleagues illustrate this new approach to service provision with a number of examples from different fields (Schmidt-Bleek 1994; 1998). Alternative ways to fulfil the service provided by a lawn-mower are discussed extensively. Holiday home exchange is another example of focusing on the service (i.e., holiday accommodation), aimed at consumers. A number of business-to-business examples are also presented. These include Mercedes' "Charter Way" service (providing business customers with product distribution capacity, rather than trucks), and examples related to the leasing of textiles (towelling, bed-linen, work clothing).

The MIPS-concept has also been used in product development (Schmidt-Bleek and Tischner 1996). One example is a product called FRIA, which replaces the conventional refrigerator: a new household cold-storage system built into the outer wall of an apartment, thus utilizing the heat differential between the inside and the outside of the house, and providing a product that is reportedly five times as durable than the traditional refrigerator (Tischner 1993; Schmidt-Bleek & Tischner 1996). Another product-development example is a small motorcycle lock which replaces long chains usually used to lock motorcycles, and dematerializes the provision of this service or utility by a factor of 10 (Schmidt-Bleek 1998).

In this approach, services are defined as *utility or usefulness, or capacity to bring about needs-fulfilment*. The authors state that goods and services obtained by the consumer in the market are 'service-producing-machines' (Tischner & Schmidt-Bleek 1993). Although advocations to adopt a service-approach are addressed also to business managers and product developers, the central character in this discussion seems to be the consumers, whose needs should be re-evaluated, and who should themselves start to re-evaluate their needs.

Product life extension, the service economy, and functional orientation

The Product Life Institute in Geneva has been dealing with the issue of services in the context of product life extension for the past two decades. The original ideas, (published, e.g. in a report to the Commission of the European Communities) linked product life extension with a circular economy, in which two loops – material recovery and product-life extension – link products or their materials back to their utilization. Product-life extension is here defined in terms of activities such as the reuse, repair, reconditioning and technological upgrading of goods. These services are presented as an environmentally superior way of "closing the loop" compared with material recycling, and they are also more labour intensive, thus enabling value creation to stay within the local economy (Stahel and Reday 1976, ref Stahel 1994). Services are central to product-life extension also in altering the incentive structure of companies. In later work, Stahel (1994a, 1994b) introduces the concept of *the producer as "fleet manager"*. Product life can be extended in a financially profitable way if manufacturers turn to selling the use of the product, rather than the product itself.

If the manufacturer maintains ownership of the product throughout its lifetime, it has an incentive to design more durable products, and take care of their maintenance so that they stay in use for as long as possible. Examples from business-to-business contexts are cited: Speno International, a company providing in-situ grinding of railway rails (rather than the equipment) to railroad companies, and Xerox Corporation, which "started out as a photocopier manufacturer, and today has turned into a document company, focusing on the whole commercial documentation process" (Stahel 1994a).

Stahel (1996) places the "new services" within a broader framework of *demand and supply solutions for a higher resource productivity*. These include four levels of activities: (1) sufficiency solutions, (2) systems solutions, (3) more intensive utilization of goods and (4) longer utilization of goods. *Sufficiency solutions* refer to organizing activities in more intelligent ways in which the need for the product is eliminated (e.g., hotels asking guests to reuse towels). *Systems solutions and more intensive utilization* of goods include sub-categories such as "selling results instead of goods", "shared utilization of goods" and "selling utilization instead of goods". Here, examples include traditionally shared infrastructures such as roads, lighthouses, concert halls and railways, but also the utilization of pools of products such as vehicles, or textile leasing of uniforms, towels and hospital linen. Finally, a *longer utilization of goods* refers to product life extension, but also services related to remanufacturing and remarketing of goods.

In a somewhat similar vein, Zundel (1995) has discussed the concept of *functional orientation*. According to Zundel, the concept offers the opportunity to differentiate between the product and the function that the product provides, and to utilize this difference to decrease material flows and the environmental harmfulness per functional unit in a sustainable way. Especially *chemical services* are elaborated on, including automatic dosing equipment, chemicals take-back and recovery, and function-specific design and customer advice for pesticides. Other examples include "eco-leasing" and least-cost planning of energy utilities[4]. Zundel sees many interesting opportunities for extending the model of least-cost planning beyond the energy sector (solvents, fertilisers and PVC are discussed), but also adds that this would require government steering mechanisms to alter the market conditions.

Current policy discussion and planning

"Sustainable production and consumption patterns" is a term which was placed firmly on the policy agenda in the 1992 UN Conference on Environment and Development. Unsustainable production and consumption patterns were identified as a central obstacle to sustainable development, and changing these patterns was defined as a task especially for the industrialized nations of the world, i.e., the OECD countries. Since then, issues that border on the service and dematerialization discussion have appeared in a number of international policy contexts[5].

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[4] Least-cost planning refers to planning in energy utilities in which investments in new production capacity may be postponed or replaced through more cost-effective demand management activities, such as supplying customers with energy-saving equipment.

[5] For example, services are mentioned as one strategy for sustainable production and consumption in a number of documents by the OECD (OECD 1997), at a conference organized in collaboration with the OECD (IIED 1998) and in some UN background papers (CI 1998). Here, usually the role of services appears as one way to curb unsustainable consumption practices. E.g., the Consumers International background paper (CI 1998) states: "In order to change consumption patterns, consumers require the provision of services and social infrastructure that achieve the same ends by less environmentally damaging means. The switch from paper to electronic mail, from cars to public transport or from buying goods to hiring them are prime examples. Governments should examine the potential for transforming consumption patterns through meeting needs in new ways, for example by using services instead of products, and take appropriate action."

One of the frameworks in which services appear in the policy discussion is the discussion on a *sustainable information society*. Here, services usually refer to new kinds of IT-services (EC 1998). For example, a recent study for the Finnish Ministry of Environment highlights the potential for a sustainable information society (Sairinen et al. 1999). The report discusses the possibilities of information technology to further the processes of *immaterialization* (immaterial forms of wealth creation and consumption, such as virtual products or services delivered via the Internet) and *dematerialization* (decrease in the materials intensity of physical products or systems for their delivery). Most commentators see both positive and negative environmental potential in the current development of the information society. However, visions of a sustainable information society are interesting, because they reflect a common cause between economic, environmental and social aspirations. On their part, they serve to create interest and expectations toward actors in the field (e.g., the IT industry) to take concrete steps to provide dematerialized services.

A growing interest the concepts of *eco-efficiency and on ambitious dematerialization targets*, such as factor 4 and factor 10 provides another background for "new services" in the policy debate. Mostly, "eco-efficient services" are referred to as individual interesting examples, which are mentioned in passing[6]. However, for example the Nordic Council of Ministers has initiated a number of research projects in the area (e.g., Mont 1999). Some interest is also reflected in EU funding directed at research projects and programmes in the field (see p. 16), and services and information technology have gained attention in the Environmental Cluster research programme of the Finnish Ministry of Environment.

Services are also entering the policy debate in ongoing development of environmental product policy in Europe. A recent EU-funded study on *Product Policy in Europe* (Oosterhuis et al. 1997) introduces "New forms of production and consumption" as one of three central trends in *environmental product management*, i.e. private sector initiatives that contribute to environmental goals. These new forms of production and consumption include (1) new forms of product ownership (leasing, renting) and (2) product consumption (sharing, pooling), as well as (3) new forms of optimal usage of products (least cost planning, substance agencies).

The authors overview the environmental effectiveness, economic efficiency and feasibility of these new forms of economic activity. They are identified as potentially interesting from an environmental point of view, but their economic efficiency and feasibility are as yet difficult to assess, as there is little experience of such practices. The authors state that governments cannot mandate such new economic forms, but can only influence them by supportive measures, such as extending public procurement toward public leasing or sharing, eco-labelling products that are especially long-lived, developing ecolabelling for services, tax differentiation, and including the option of eco-leasing in requirements for product take-back (Oosterhuis et al. 1997).

Most of the policy documents on sustainable development have taken a rather cautious approach to "new services", but some targeted studies have been initiated in the Netherlands. One example is the study 'Sustainability and Quality Lifestyles in the 21st Century initiated by the Dutch Ministry of Environment, exploring the potential for changes in energy consumption, product use and disposal, eating preferences and personal mobility through the provision of services that minimise

[6] For example, the report of the Finnish Ad hoc committee (1998) on Eco-efficiency and Factors devotes one paragraph to the issue (p. 36), which discusses services in terms of re-use, remanufacturing, repair, shared product use and rental. It states that consumers need not own products to make use of the services they provide. It goes on to envisage a shift toward a service society, in which consumers can turn to using services such as public transport, car rental, laundry services or summer house rental. This is said to lead to environmental benefits due to more efficient use of products, and also to higher product quality and larger consumer choice. The report (p. 35) also includes an example of the possibility to reach a factor 10 reduction in fuel use for commuting through the introduction of distance working.

the need for transportation and private ownership (VROM 1993 Matthews, 1995). More recently, the Dutch Policy Document on Environment and Economy (1998) set out a plan to evaluate the potential of Product Service systems for sustainable economic growth. At present, the first phase of this plan has been addressed by a study on the environmental and economic potential of product service systems, including development of an assessment method, and evaluation of ten case studies (Goedkoep et al. 1999, see also p. 16 in the present report).

The "new services" have not gained a central position in environmental policy, but they are referred to more and more in a number of different contexts, such as *national programmes for sustainable development, futures studies focusing on the information society, and ongoing planning for a European product policy*. A focus on services is seen as one way to reconcile environmental considerations with economic and social goals, such as growth, competitiveness, employment and consumer welfare. It is obvious that 'new services' can be encouraged only indirectly by policy instruments. As there still are many uncertainties related to their environmental merit and economic feasibility, few concrete measures have been proposed.

Services in the business environmental management literature

'Increased service-intensity' has become topical in the business environmental management literature only in recent years. One reflection of the status of this topic can be gained from a review of articles published in the journal *Business Strategy and the Environment* (BSE). An article by Fleming (1992) was the first to introduce the issue under the heading of "qualitative growth", which the author sees as the necessary next step in environmental management. After that, the issue was not discussed until Hukkinen (1995) explored the environmental product concept in terms of industrial ecology and organizational boundaries. One of the three changes or challenges he envisages includes an orientation toward dematerialization and services.

In 1998, the first article explicitly discussing new "eco-efficient services" appears in *BSE*. Meijkamp (1998) presents an evaluation of a car-sharing initiative in the Netherlands, discussing both the feasibility and potential environmental effects of service approaches. Welford et al. (1998) note the ongoing discussion on "new, eco-efficient services", while their article[7] can be seen as an attempt to ensure that existing service companies recognize their environmental responsibilities and possibilities. Dobers and Wolff (1999) present future scenarios for various industrial sectors, including a "dematerialization scenario". Services, such as mobility services and functional sales, are presented as business models that may have an important role in future dematerialized industries.

A new volume on *Green Marketing* by Greenleaf Publishing in 1999 (updating a book by the same name from 1992) includes a number of articles promoting the service approach. Eco-efficient services are the main focus in two of the articles. Hockerts (1999) outlines different categories of eco-efficient services, with examples ranging from car-paint overspray control services and 'document facility management' to the more conventional forms such as rental, sharing and leasing. The article also includes a suggestion for how companies could start innovating to discover new eco-efficient services. Belz (1999) focuses on "performance sales instead of product sales" as the future concept for progressive companies. Examples include copier and carpeting leasing, as well as consumer acceptance of sharing goods such as cars and washing machines. Three other articles discuss eco-efficient services as one approach to greener marketing (Ottman 1999; Peattie 1999; Beard and Hartman 1999).

[7] This article appeared in a companion journal to BSE, Eco-Management and Auditing.

Eco-efficient services seem to have been more topical in Europe (especially German-speaking countries) than in the US[8]. However, an extensive report on the subject has recently been published by Tellus Insitute on commission of the US EPA (White et al., 1999). The report explores the potential for *servicizing*, which is defined as the "the emergence of product-based services which blur the distinction between manufacturing and traditional service sector activities". The report explores alternative organizational forms of servicizing , as well as business opportunities and potential environmental impacts through seven case studies. Many resonances between servicizing and current business trends, such as customer integration, are identified. A special focus of the study is to evaluate how servicizing may contribute to extended product responsibility by "extending manufacturers' involvement with, and responsibility for, the product to phases in the life cycle outside the traditional seller-buyer relationship" (White et al., 1999: 23).

Another US contribution to the discussion on services can be found in the book *Natural Capitalism* by Hawken et al. (1999). They link services to the idea of *lean* production, and avoiding all forms of waste throughout the production chain. They set out 'service and flow' as the third central principle of their concept of natural capitalism: "lean thinking makes customer-defined value flow continuously with the aim of producing zero waste" (p. 134; see also Lovins et al. 1999). As champions of this new approach, the authors discuss Carrier, a company leasing air-conditioning systems, Electrolux professional cleaning systems, and Interface carpets, a company leasing modular carpeting systems.

Most recently, the new concept of *product-service systems* has been launched in Europe. The Dutch Policy Document on Environment and Economy defines product-service systems as "a marketable set of products and services capable of jointly fulfilling a users' need". This concept highlights the *continuity between products and services*, and the fact that market offerings represent a mix between the two. Mont (1999) has conducted a review of the diffusion of the concept of product-service systems, concluding that companies do not yet see it as a source of competitive advantage, due to the lack of practical, realistic models, and to the lack of market demand.

In the business environmental management literature, services are mainly understood as "service business", i.e., revenue that is gained from other than the sales of products, although the concept of *product-service systems* may gain a foothold in this area in the future. Services are often seen as existing on some kind of a continuum, with more and less product-based ones. Especially the White et al. (1999) report raises the issue of *organization*, both within the service providing company and between suppliers and customers, and Mont (1999) emphasizes the role of communication between service providers and customers. Services are interesting in this context because they provide *different incentives* for suppliers with regard to materials use than the traditional manufacturing business model.

Some of the literature aims to promote the service approach, while other authors are more analytical, and try to explore whether it entails environmental and commercial benefits. Many of the case-studies presented in this field have emerged from *other than environmental considerations*, and few of the services discussed have been actually marketed on environmental grounds.

[8] Some articles in the new Journal of Industrial Ecology touch on the subject in passing (e.g., Graedel 1998). The work of Lovins (1999) also includes examples of and arguments for the service approach.

Services in the environmental design and engineering literature

Debate on the *need for or function* of the product has been topical in product design recurrently. Examples include the functionalist programme in the 1920s to 1940s and debate on the social function of products and designs in the 1960s and 1970s (e.g. Papanek 1976). The link with environmental product development was explicitly raised to broader attention only later. One of the first papers on this subject that gained broader attention was an article on *dematerialization* by Herman et al (1989) in *Technology and the Environment* published by the National Academy of Engineering. Here, dematerialization is first defined as the "decline over time in weight of the materials used in industrial end products". After discussing the limits to this kind of dematerialization (durability, usability, safety), the authors introduce the question: *"If the product cannot be practically and safely reduced beyond a certain point, can the service provided by the product be provided in a way that demands less material?"* [9]

Product function, or the need for the product, seems a natural interpretation of the concept of service intensity in environmental design and engineering. However, discussion on the issue in the design community is not limited to this approach. For example, according to van Weenen (1994: 6), sustainable product development "deals with elementary demands, essential product functions, the systems in which products function, the nature, availability and selection of natural resources, and the distribution of those resources among nations and generations". The use of natural resources should be balanced with the essential needs and growing population in developing countries. On the one hand, this implies matching resource quality and end-use need, i.e., preserving high-quality resources for demanding uses and essential needs. On the other, it calls for product development to question "actual needs and wants, required functions and new environmentally oriented and creative ways of meeting acknowledged and respected demands" (van Weenen, 1994: 7)

Subsequently, the United Nations Environment Programme (UNEP) Working Group on Sustainable Product Development (UNEP-WG-SPD) was established in the beginning of 1994, chaired by van Weenen, as a response to the need to develop more sustainable production and consumption patterns. The working group defines sustainable products and services as "solutions that realise critical energy and material resource savings. They are context sensitive, future orientated and designed to fulfil elementary human needs in an equitable and environmentally harmonious way". The UNEP-WG-SDP definition also emphasizes the need to reduce resource use substantially in industrialised countries (Factor 4, 10, 20), and to counteract the adoption of unsustainable production and consumption lifestyles in un-industrialized countries by providing functional and cost effective alternatives to meet needs.

The UNEP-WG-SPD conducted an expert survey with members of the SPD-network on the topic of Sustainable Service Design in 1997. The survey found that respondents felt that sustainable service design should be seen as one strategy toward sustainability among many others: services can help decrease the use of materials and energy depending on how they are designed. Respondents also identified some problems in the service approach, such as a tradition of ownership, and the risk that people care less for products they do not possess. On the basis of the survey, a Expert Group on Services was founded under the UNEP-WG-SPD.

Another recently emerged forum in this area is the *Journal of Sustainable Product Development*. A review of three recent issues of this journal (8,9 and 10) shows the

[9] At this early stage in the debate, these authors also present some sophisticated critique of such ideas as "the paperless office" and the potential of telecommunications to replace the need for transport. They advocate for materialization impact analyses for new products and technologies.

diversity of the discussion on service intensity in this context. Issues related to services intensity are referred to in five of the 13 articles in these issues:

1. Cooper (1999) discusses services in the context of a *circular economy*. He emphasizes the shift from the manufacturing sector to service sector activities such as *reuse, repair, upgrading and recycling*. He refers to this development as a shift toward a *service economy*, which leads to an increase in *labour-intensive after-sales work*.

2. Han Brezet is interviewed on key challenges for sustainable product and service development (Charter 1999). Brezet prioritizes the need to evaluate the environmental impact of emerging *service industries*, especially information and communication technologies (ICT).

3. Masera (1999) discusses the introduction of sustainable product development in the context of small indigenous enterprises in Mexico. Sustainable product development is seen to consist of environmental and resource efficiency, on the one hand, and of considering *the need for the product, and of local employment opportunities*, on the other.

4. Walker and Nielsen (1998) make links to the discussion on service intensity under the heading of *systemic design*. A case study is presented of the conceptual development of *alternative ways to deliver services*. The case study concerns alternative designs for a personal computer, including *shared use* (i.e., only portable interfaces are personal, all other computer resources are shared), which is made possible by positing the broader context of a "sustainable community". The authors highlight the need for society to "rethink our ways of living and working", and for government policies and design curriculum changes to support systemic design.

5. Stevels and Brezet (1999) discuss the usefulness of LCA in environmental product development, and recognize that LCA, while working fairly well on the product level, is problematic on the level of service systems. The design of such systems requires the consideration of infrastructures, supportive products and service co-ordination, which are difficult to evaluate using standard LCA procedures. They call for the development of methods to evaluate fundamental, e.g., factor 20, eco-efficiency improvements.

From the previous brief review, we see that service intensity is discussed in a variety of ways in environmental design and engineering. In companies, concepts such as *usefulness or product function* seem to be most prevalent. Other approaches introduced earlier, such as the *circular service economy* (reuse, remanufacturing, etc.) and systems design also recur. *Services that replace products* are referred to especially with respect to *information and telecommunication* services. A new approach introduced by this strand of the discussion is the focus on meeting *essential needs* and creating local *employment opportunities*.

Empirical studies on "eco-efficient services" in Europe

Most of the literature on "new" or "eco-efficient" services is speculative, normative, or at best based on a limited number of anecdotal examples. In the past few years, some empirical studies have also been initiated. Few of them have been completed yet, but when the findings are published, they will probably provide a more

comprehensive picture of the current situation of "new" or "eco-efficient" services in Europe.

The research project *Eco-Services for Sustainable Development in the European Union* focuses on consumer services[10]. It aims to find out to what extent, and under which conditions, consumption without ownership can be an alternative for consumers, and contribute to sustainability. The first interim report of the study (Interim Report 1999) provides an overview of the provision of rental, leasing, pooling and contracting services available in Austria, Germany, the Netherlands and Spain. The study includes market surveys of conventional and "new" services, such as car-sharing (or pooling). The market for rented goods is relatively large in some areas (vehicles, leisure equipment), but environmental considerations are usually not at the forefront in these markets. Environmental aspects seem to be more prominent in services for sharing and pooling. For example, car-sharing organizations exist in all the four countries, and there are 76 organizations providing such services in Germany.

Another EU-project, *Creating Eco-Efficient Producer Services*, focuses on new eco-efficient services in the business-to-business field[11]. The study analyses the drivers of and barriers to eco-efficient producer services at level of individual companies, business-to-business relations, and the broader society. The project includes five stages: concept development, interviews, case studies, analysis of policy implications, and preparation of training material for business. Business sectors to be included in the study include building construction, maintenance and management, industrial ecology, industrial gasses and chemicals, professional laundry and cleaning, electronic appliances and equipment for the business sector, document services, transportation and communication (Nijhuis et al. 1998; GRI 1999). Another empirical study in this field is an overview of examples of the shift from products to services by Rocchi (1997), including a somewhat more detailed analysis of chemicals services and car-sharing services.

Sustainable Households is an EU project that concentrates on the production and evaluation of scenarios of household activities by 2050. The service approach is one dominant strand in the drivers of change. Quist (1998) discusses the food system and identifies, as possible future scenarios, one of traditional household food preparation, one that that relies on the shared use of goods, and a third one that relies on commercial services such as restaurants and home delivery. Vezzoli (1998) discusses the clothing system in a similar manner, identifying a range of possible organization from self- made clothing and their maintenance to a market-alternative.

The German Ministry of Education and Research (BMBF 1998) has funded a research project on eco-efficient services as a strategic factor of competitiveness in the development of a sustainable economy. The work includes a large set of descriptive case studies that concentrate on housing and on mobility. The focus is on the current market situation and the competitiveness of service offerings. The empirical data consist of interviews with representatives of service providing companies. The interviews are supported by data on, for example, the economic break even points of car sharing, or the average gain of living space when two customers of a housing service company exchange apartments.

Goedkoep et al. (1999) have evaluated the environmental and business advantages of ten *product-services systems* in which the 'service' component contributes to a substantial part of the economic value creation. The case studies

[10] The research team for this study consists of researchers from IZT (Germany), IÖW (Austria), IVAM (the Netherlands) and Institute for Prospective Studies (Spain).

[11] The project team consists of researchers from AVANZI (Italy), Gothenburg Research Institute, GRI (Sweden), Institute for Prospective Technological Studies (Spain) Institut für Ökologisches Wirtschaftsforschung (Germany), UK Centre for Environmental and Economic Development (Great Britain), Vrije Universiteit Amsterdam (the Netherlands) and the Centre for Technological and Policy Studies, TNO-STB (the Netherlands).

include, e.g., an organic food subscription service, an insulation layout and take-back service, a pest-free guarantee service, a laundrette system, a car-sharing system, and time-sharing of luxury yachts. Three of these were evaluated quantitatively in terms of economic added value per environmental impact, and all were evaluated by an expert panel. The authors conclude that individual product-service systems can prove beneficial to the environment while creating new business. Moreover, the case studies also indicate the potential of product-service systems to unlink environmental pressure from economic growth.

In addition to a number of empirical studies concerning car-sharing (e.g., Meijakamps 1998), surveys are starting to address *consumer acceptance* of other kinds of "eco-efficient services". For example, Schrader (1999) has surveyed German consumers' attitudes to "consumption without ownership" with respect to laundry services and car-sharing services. The most important obstacles to these new forms of consumption appeared to be convenience (availability of the service at any time), whereas consumers also seemed to appreciate the environmental and economic advantages of such new service types. Littig et al (1998) have conducted a telephone survey of attitudes towards renting, shared use and lending of consumer goods in Vienna. The dominating motive for engaging in renting and shared use is the financial benefit related to the arrangement, although shared use is also associated with other motives.

Critical comments on the service discussion

Nørgård (1995) presents some evidence against what he calls the "myth of the harmless service sector" in the context of energy consumption. His starting point is criticism of the economists and politicians who maintain that economic growth can continue despite environmental constraints due to the low energy intensity of the service sector.

Using evidence compiled by the Danish economist Jespersen (1994, ref Nørgård 1995) he shows that whereas the *direct* energy intensity of the service sector is lower than of the manufacturing sector, the total energy intensity (including indirect energy consumption) of private services (e.g., trade, hotels, transport) is comparable to that of manufacturing[12]. Only public services, such as education, health, administration and childcare, are significantly lower in energy intensity[13]. Similar results have been obtained in calculations of energy consumption per employed. Nørgård concludes that economic growth within environmental constraints cannot be salvaged through growth in what traditionally have been public sector services, as these personal services would then have to grow by a factor of 12-15 to maintain a 3,5% growth in GDP.

Welford et al. (1998) point out that it is frequently assumed that service provision is likely to be less environmentally damaging than the provision of products. They agree this may be the case, due to the lower need for materials compared with manufacturing industries. However, a growth in the service sector may lead to an increased need for transport of goods or passengers, with ensuing environmental burdens. The materials-intensity of services may be growing due to a shift toward more self-service and more capital-intensive forms of service provision. The authors also indicate that service sector companies are currently very backward in adopting environmental management practices, and frequently even fail to recognize that their activities have environmental impacts. The issue of social and ethical components of sustainable development is also raised: here, service companies do not seem to have any advantage over manufacturing

[12] (6,9 TJ/ECU for private services vs. 8,4 TJ/ECU for manufacturing).
[13] (3.1 TJ/ECU)

companies. To solve these problems, the authors develop a model for sustainable business management specifically addressed at the service sector.

Recently, quite a few authors have noted that the service discussion requires some qualifications. For example, both White (1999) and Mont (1999) point out that there is a lack of data on the environmental implications of introducing 'new services'. It has also been noted that while there is much enthusiasm about the dematerialization potential of services, actually only very few companies are deliberately designing eco-efficient services. According to Brezet, the majority of the service industry pay virtually no attention to environmental aspects, such as infrastructure and products used to operate these services. Brezet highlights the need to develop new methods to evaluate the environmental impact of services; standard LCA techniques may not be sufficient or the most suitable approach (Charter 1999; see also Stevels and Brezet 1999). Indirect impacts on materials use, such as the impact on consumption patterns, should also be addressed (for examples, see Meijkamps 1999; IÖW 1999).

Littig (1999) has criticized the technical bias of the service discussion. The discussion has focused on business management and on questioning the traditional concept of value of products, but has lacked the viewpoint of the social sciences. Very little attention has been paid to the social functions of products, or to the new social settings required by shared product use (Littig 1999).

What are the "new services" and how can they contribute to dematerialization?

4

Examples and classifications

The scope of what specific service offerings are discussed in the context of the "new service discussion" is extremely broad and eclectic, as we saw in the previous section. Table 1 summarizes some of the examples that frequently appear in the literature.

Table 1. Typical examples of services in the "new service discussion"

Example	Source
Appliances	
• IBM networking services	White et al. 1999
• Xerox document delivery service	Rocchi 1997, White et al. 1999
• Electrolux Professional Cleaning Appliances service	White et al. 1999
• Centralized voice mail	White et al 1999
Chemical services	
• Pesticides (Ciba-Geigy pest control)	Schmidt-Bleek 1998; Hockerts 1999
• Chemicals management (Dow Safe Chem chemicals planning, management and take-back)	White et al. 1999
• Painting & overspray control services (e.g. Herberts GmbH provides car paint shops with training in recycling paint overspray)	White et al. 1999
Energy services	
• Least cost planning, demand-side management • Customer advice, energy audits, rental/financing of energy saving appliances	Zundel 1995; White et al 1999
Facility management	
• Commercial furnishing and inventory control • Grounds management • Waste management & minimization services	White et al. 1999
Furniture, decorations and textiles	
• Office furniture (Gammert GmbH)	Hockerts 1999
• Carpet leasing (Interface, DuPont)	White et al. 1999; Hawken et al. 1999
• Art paintings rental	Schmidt-Bleek 1998
• Textiles rental and cleaning services (work outfits, bed-linen, etc.)	
Transport	
• Daimler Charter Way (trucks delivered to customer on demand)	Schmidt-Bleek 1998
• Smart minicar service (larger vehicle available to minicar owners on demand)	Hockerts 1999
• Honda's intelligent community vehicle system	White et al 1999
• Car sharing, car pools	Hockerts 1999
• Videoconferencing, telecommuting	Weizsäcker et al. 1997
Traditional consumer and business-to-business services	
• Laundry services	Belz 1998
• Restaurant services	Matthews 1995
• Car leasing, leasing and rental of other vehicles and equipment	Interim Report 1999

Some authors have developed classifications, which help to clarify what the "new service discussion" is actually about. Some of the most typical classifications include the following:

Consumer and business-to-business services

One important classification is the division between business-to-consumer and business-to-business services. Many of the examples of "new" services are from the business-to-business field (e.g., all examples in White et al., 1999; and many of those mentioned in Hockerts 1999, Stahel 1997 and Schmidt-Bleek 1998). Business-to-business services include chemicals "rental" or management, leasing of equipment with or without additional services such as training, document delivery, etc. Consumer services mentioned in this area often include traditional ones, such as

product rental or shared use, although they may involve new institutional forms, such as car-sharing.

Non-material and product-based services

Frequently, authors categorize services according to their connection with existing products (e.g. White et al. 1999; Hockerts 1999; Interim report 1999, see also Mont 1999). Typical examples include the following:

- White et al. (1999) classify services into (1) non-material services and (2) material-based or product-based services. *Non-material* services are delivered via a supporting infrastructure and goods that remain in the hands of the service provider. This category includes *traditional service*s such as banks, health care and hair salons, as well as *dematerialized services* that reduce or totally do away with the need for products (e.g., centralized voice mail). The specific focus in the White et al. report is on *product-based services*, which are divided into *product* function services and product extension services. In *product function* services, the service provider owns the physical good. Customers have the use of the product, but product maintenance and end-of-life deposition may be the responsibility of the service provider (e.g., chemical management services or leasing of vehicles and equipment). In *product extension services*, the service provider need not own the product, but services such as maintenance, upgrading or product take-back are provided together with the product, thus increasing the manufacturers' involvement with the product beyond point-of-sale.

- Hockerts (1999) classifies eco-efficient service concepts into three categories: product-oriented services, use-oriented services and need-oriented services. *Product-oriented services* offer services that are additional to the product that is sold. These may include training, consulting, maintenance and disposal services. *Use-oriented services* involve more intensive customer integration; the product is no longer sold, but only its use (e.g., rental and leasing services, and services for the pooling and sharing of goods such as car-sharing). *Need-oriented services* entail an even more radical step away from traditional production and manufacturing. The service is not related to a specific product, but is geared at providing the customer with satisfaction or a specific result. Examples include least-cost-planning (e.g. energy utilities, pesticide management) and facility management (e.g. in building management).

Institutional arrangements of service provision

Institutional arrangements are discussed, e.g., by White et al. (1999) and by Hockerts (1999). White et al. (1999) identify four alternative ways for the provision of product-based services. (1) Firstly, the service provider may be totally separate from the product manufacturer. Independently from traditional distribution channels for products, product-based services may be provided by a specific *service provider*, either within the customer organization or external to it (e.g. maintenance or cleaning services). (2) Services may also be provided by *service intermediaries*, who buy products from manufacturers and supply their services to customers (e.g. care rental). (3) Services may be more integrated with manufacturing, e.g. supplied by a specific *service division within a manufacturing company* (e.g. Daimler-Benz's service offerings). (4) Finally, although no examples can be found, it could be possible to envisage a joint entity, manufacturing products for use in the production of servicized offerings. Each of these alternatives provides a different set of incentives for product and service design.

Different actors' perspectives on the service can be also seen in the different classifications. Hockerts' (1999) classification takes the customers' point of view, i.e. what is provided to the customer: help with using the product, the use or of the product, or the result, whereas White et al. (1999) explore the institutional arrangements of service provision from the point of view of the company supplying the service. Their focus on product-based services reflects an interest in how manufacturing companies may start to conceive of themselves more as service providers.

Eco-efficient services?

The issue of what actually are *eco-efficient* services is not extensively discussed in the literature. Many of the examples presented are not new at all, but fairly traditional, or at least, extensions of existing, traditional business models. Extremely few have been set up for the explicit purpose of promoting eco-efficiency or offering "environmentally sounder" services. What is new about these services is the context of eco-efficiency and dematerialization in which they are presented in the literature. Explicitly (e.g. Hockerts 1999) or implicitly, the idea is that by extending these concepts, and applying them in other companies or for other products, a progressive dematerialization of the economy can be brought about.

Conceptually, it is possible to separate services that (at least potentially) *promote dematerialization from ones that do not have any direct impact on dematerialization*. Traditional services, such as medical and legal services, transport services, etc., do not have a direct impact on dematerialization insofar as they do not change the way people deal with materials (although indirectly, the growth of some of these sectors may influence the materials intensity of the national economy).

Services that potentially promote dematerialization may be further divided into ones in which dematerialization is the *explicit purpose*, and ones in which dematerialization is a *side-benefit*. Most of the examples presented in the discussion are of the somewhere in between (very few originated on environmental grounds, but many aim at cost reduction through material savings) and this division is more a dimension than a dichotomy. Furthermore, services with dematerialization as a *side-benefit* may be divided into *traditional* and new ones. Conventional forms of, e.g. renting and leasing could be termed "traditional", whereas chemicals management or car-sharing could be called "new services".

An integrative classification

Most authors in the field agree that it is difficult to make a sharp division between products and services, and that it is an issue of degree (e.g. Scholl et al. 1998; Interim Report 1999). All products include some service components (e.g. delivery), and all services require the use of some products (e.g. premises).

Apart from this, the different authors rely on varying definitions of "service". For example, a service can be defined as including, in addition to a repeatable, standard component, a singular component per each transaction (Kotler 1997). This definition would restrict the scope of services to tasks performed by human labour individually for each customer. This would mean that information technology based services (e.g. search machines) would not be included as services, because they are executed by pre-designed programmes. Design activities in general would not count as services, either. A broader definition would be to define service as added value for the customer, i.e., economic activities which replace the customer's own labour with activities conducted by the service provider, either personally, automatically or in advance through planning and design.

The following list summarizes some of the different definitions or interpretations of the service approach that could be found in the ongoing discussion:

1. Non-material services

Services seem to be conceptualized mostly in terms of traditional or new service sectors in the discussions on ecological modernization and ecological restructuring. From this macroeconomic approach, the essential issue is which sectors of the economy grow in the future. Thus, the shift to services can be seen as the growth of the service sector, the white collar sector in general and information and telecommunications (Gershuny & Mill, 1983) . Another aspect, which comes closer to the other definitions here is the growth in the service intensity of goods (services and information as production factors).

Traditional and new *non-material* services include services that are not, as such, alternatives to products. This includes traditional services such as medical and personal care, training, legal services, insurance, banking, etc. It also includes new services, such as different kinds of IT-services, which do not directly replace products (e.g., virus control). The link to dematerialization is mainly through the decline of traditional smokestack and extractive industries, more knowledge-intensive production and potentially, changes in consumers' lifestyles and preferences. This is often presented as a natural path for developed, post-industrial economies, and one which can be catalysed and speeded up through an ecological tax reform.

2. Result-oriented services

Many authors identify a category of services that obviate or decrease the need for products, materials or energy by providing the desired result in another way: "functional orientation" (Zundel 1995), "needs-oriented services" (Hockerts 1999), dematerialized services (White et al. 1999). This type of services can be seen as including various forms of contracting, such as energy services, in which the customer's need (e.g., for heat, electrical power, etc.) is central. These results can be provided with a combination of different products, knowledge and labour. Typically, contracts are defined in terms of the result, and not of the amount of a product or service delivered[14].

Result-oriented services are services in which the focus is on fulfilling customers' needs that were earlier met mainly by use of materials and energy through superior planning, training and redesign of the customer's activities. Such services include energy saving contracts, facility management, waste minimization services, etc. Typically, customers pay for results or for a fixed service level, and not according to materials used. Result-oriented services can be provided by a producer (e.g. an energy utility), but are frequently offered by another company, or a different business unit, than the one producing the product (e.g. centralized voice mail, facility management). Thus, they may imply a different institutional organization than manufacturing or production-based business.

3. Product-based services

Product-based services are related to the use of a product. However, in contrast to traditional manufacturing, it is not necessarily the ownership of the product that is sold to the customer, but its use, which may also include services to assist in using the product (such as chemicals management). Some product-based services may even be based on customer ownership, but with an extended responsibility of the manufacturer for the product even after point-of-sale (extended maintenance warranties, product-take-back commitments). From least to most "radical", at least the following three types of product-based services can be identified:

[14] In this classification, it is difficult to place some traditional services, such as public transport or restaurants and catering. They may be viewed as non-material services, insofar as they do not directly replace products. However, they may also represent one form of results-based services, when, e.g. public transport is marketed as an alternative for private transport through a "mobility service".

1. From manufacturing to reuse, repair, maintenance, upgrading, etc.("circular economy"
2. From manufacturing to leasing, rental, etc. services ("*fleet manager*" approach)
3. Extending the scope of business to service provision: instead of selling products, use self-manufactured products and own labour and expertise to provide customers with services (e.g., chemicals management). This type of service could be termed *product use management services*.

Whereas the first type of product-based service is relatively close to conventional manufacturing business, it includes some additional service components. Rental and leasing services are not new, but a new development is that traditional manufacturing companies (e.g. Daimler-Benz) are starting to offer these kinds of services, as well. Finally, the product use management services are relatively close to the previous category of *result-oriented services*. While the transaction still involves a specified product (and not a result), a larger amount of the value-added comes from the use of labour and expertise in employing the product for the benefit of the customer.

4. Ecodesign with service approach

The way services are discussed in the environmental design literature does not relate to a service business model, as such. Rather, the service is the utility provided to customers by products. By focusing on this utility, products can be redesigned to use less materials. Examples include Schmidt-Bleek's (1994; 1998) new motorcycle locks and the FRIA cold-storage chamber (redesign to gain same function with radically less materials). These new solutions may emerge from eco-design efforts in traditional manufacturing companies, but frequently, they depart so radically from existing product concepts that they are launched in the market- if at all - by new competitors.

Extensions of the service approach

In addition to the previous four categories, the service literature also includes other broadly related references. Thus, for example Stahel (1996) places the service discussion in a broader framework, which also includes systems design and sustainable technology. Individual products or services may be replaced with *built-in-systems or "shared" infrastructures* (existing examples include libraries and the system of lighthouses shared by ships). Furthermore, the discussion may be extended to consider a *better design of the task* to obviate the need for products or services (one example is the traditional practice of ploughing by night, which avoids the need for herbicides by depriving weed seeds from the flash of light needed to germinate).

Furthermore, the discussion on services often includes references that extend the discussion beyond existing business models and economic goals (Ekins and Max-Neef 1992). Thus, in addition to dematerialization, issues raised include global equity, essential needs, local employment, community, alternative measures of national wealth and well-being, value-change, and sufficiency (e.g., BMBF, 1998). While these are not necessarily the 'core' of the service discussion (i.e., are not referred to by all), they illustrate the breadth of issues that a focus on services may lead to.

Relationship between services and dematerialization

We have discussed services as one means to reach the goal of *dematerialization*. Other alternatives include technological innovations that lead to less materials use. On the other hand, increasing service intensity may have other consequences besides dematerialization. Many authors discuss issues of employment, quality of life, sustainable development and global and intergenerational equity in the context of the service approach. Thus, dematerialization, at least if narrowly understood as

using less materials, may be only one of the (beneficial) consequences of adopting a service approach.

On the other hand, we have previously seen that some authors are critical toward claims that services are automatically environmentally benign. Although many authors recognize that not all services are essentially eco-efficient, there is no commonly agreed or systematic definition of what "eco-efficient services" are.

Absolute and relative dematerialization potential

One of the dimensions in the discussion on the dematerialization potential of services goes back to different definitions of dematerialization. We can, on the one hand, define dematerialization as an *absolute* decrease in materials input per a specific function (Schmidt-Bleek 1994), and we could also conceive of an absolute dematerialization of the whole economy (i.e., decrease in the materials use of a nation). On the other hand, dematerialization can also be defined *relative* to the volume of economic activity (e.g., materials use / value-added, materials use / sales price, materials use / GDP). This is the definition used, e.g., by the World Business Council for Sustainable Development (WBCSD). Relative dematerialization leads to a decoupling of economic growth and materials use.

To evaluate the *absolute* dematerialization potential of a service, we need to define the function that the service aims to provide, its pattern of materials use, and the pattern of materials use which it replaces. For example, decorative plant rental replaces customer-owned plants. This form of business usually also involves care of the plants by the service provider. Through this service, fewer plants may be needed, and they may survive longer due to more professional care. On the other hand, more transport may be involved than in the case of customer-owned plants, due to weekly trips for plant tending by employees of the decorative plant rental company. The materials flows related to the production of plants needs to be compared with the materials flows related to additional transport.

The evaluation of *relative* dematerialization, on the other hand, can be done in economic terms. If an increased share of revenues are gained through additional labour input, one could conclude that the service leads to relative dematerialization. *Relative dematerialization* is what is achieved through growth in the service sector on the level of the national economy, or in service activities (e.g. consultancy), on the level of the individual firm.

In the case of services that replace products, it is the *absolute* dematerialization potential that is of interest. For individual services, this of course requires a detailed assessment. However, it is possible to outline the general mechanisms through which services may contribute to dematerialization. By looking at these relationships more closely, we can also identify the *conditions under which services may or may not lead to dematerialization.*

Mechanisms through which services may contribute to dematerialization

The potential for dematerialization through services can be illustrated by a decomposition analysis of the efficiency of a product (e.g., Scholl et al 98; Malaska et al. 1999). The resource efficiency of a product can be viewed as consisting of two factors: the *eco-efficiency of production*, and the service yield (the utility gained) of the goods produced. Both factors can contribute to absolute dematerialization in relation to the service or utility gained from a product[15]. The benefits in materials efficiency that

[15] However the division is rather arbitrary and the terminology mixed. Malaska et al. (1999) use dematerialization to describe the efficiency improvement in manufacturing and immaterializzation to describe efficiency improvement in consumption, Scholl et al. (1998) use respectively eco-efficiency and level of performance. In an earlier work Nilsson & Bergström (1995) use the terms thrift for manufacturing efficiency and effectiveness for consumption efficiency. Quist (1998) combines efficiency of provision and efficiency of consumption in to efficiency, but introduces a factor for changes in consumption patterns, sufficiency. These two result in efficacy, which is the figure that should be compared to the factor-targets of reduction of total materials intensity (Quist , 1998).

can be gained *from a shift from products to services* relate to the latter factor, i.e., the number of services, or the amount of utility, gained from an individual product or material[16].

The environmental benefits envisaged by different authors (e.g. Stahel 1996; Scholl et al. 1998; White et al. 1999, Littig 1999) from a shift from products to services can be condensed under four headings:

- Lower manufacturing volume
- Less impact during the use phase of the product
- Lower stock of products
- Higher rate and quality of utilization of end-of-life products

How do services contribute to these ends? In this respect, two characteristics of services (vis-à-vis traditional product sales) are important: the organizational opportunities they provide, and the economic incentives that they imply. The existing organizational and economic conditions are not geared to encourage longer product lives. Products are neither used as long as they could be, nor are they designed for a long life span. (e.g., Stahel 1996). Recognising this situation, the service approach provides opportunities to extend the service yield of products, both independently of, and through, better product design.

Organizational benefits of services include the possibility for *new forms of product use*, such as renting, sharing, pooling and functional sales. These enable products to be *used more intensively* than user-owned ones (Scholl, 1998). This increases the probability of higher service yield (more utility gained) before the product becomes obsolete due to its technology, fashion or other reasons. Some authors combine the strategies of more intensive use and product life extension (Scholl et al 1998, Stahel 1996). The reasoning is that both can be assumed to lead to higher service yields per product and thus to lower manufacturing volumes.

More intensive use does not necessarily lead to higher service yield. However, more intensive use has potential environmental benefits even if it does not affect the manufacturing volumes. Intensive use leads to a *lower stock of materials* in use. There are, for example, less cars in use even though the number of cars manufactured in given time remains the same. A lower stock of goods *reduces the fixed environmental burdens per service*. More importantly, a leaner and more rapid product flow also increases the flexibility of product-systems.

Flexibility facilitates the utilisation of the best available technology. Thus, for example, the technical mileage of cars used via car-sharing could be 'used up' more swiftly than with an owned car and thus the average technology in the cars would be newer (Scholl 1998). In this respect Jackson (1996; 134) criticises the strategy of product life extension. He suggests that the high average lifetime of Swedish cars of 17 years may be counterproductive for environmental conservation. Flexibility, however, also facilitates radical innovations in product-service systems.

Services as a way of organizing markets may allow *scale-related efficiency gains* (e.g., transportation services), better utilization of batch processes (e.g., laundries), or even the use of continuous processes (e.g., bakery vs. home baking). Results-based services, in which the service provider takes responsibility for product operation, provide the opportunity for another organizational benefit: the facilitation of *more professional product* use. These in turn may lead to less impact during the use-phase of the product.

The service model may also enable the selection of goods *that are more suitable to the task* than arrangements based on sales and ownership. Ownership reduces the flexibility of selecting the product used for satisfying a need. This is the idea in the Smart minicar offering of Daimler-Benz: the option of obtaining a larger car when

[16] The service discussion as presented above relates fundamentally to the efficiency discussion and leaves sufficiency, that is, fundamental changes in consumption patterns, outside the discussion.

needed reduces the need for 'overkill' (i.e., preparing for all contingencies) when purchasing a car.

Services may also entail advantages in the utilization of end-of life products. When the service provider maintains ownership for an entire pool of goods, *end-of-life product take-back and re-utilization* of products, components or materials is facilitated. If the take-back flow can be controlled and estimated more precisely than when products are sold, it can also be integrated more firmly into the production system of new goods.

The potential benefits listed above can be achieved in many different social settings or market configurations. Consumers or other product users can, off course, share products informally, but service organizations (such as car-sharing co-operatives, car rental companies, taxi services or self-service laundries) provide a practical way to organize shared product use.

The *economic incentives* for dematerialization in a service model relate, fundamentally, to two factors. One is the *shift of the costs for product acquisition and ownership from the end-user to the service provider*. Thus, revenues are not gained from selling as large a number of products as possible. Instead of being a profit centre, the product becomes a cost centre (White et al. 1999). This provides incentives to extend product life, because revenues are not gained according to the number of new products sold, but according to how many times the same product can be "resold".

The second type of economic incentives relates to results-based services. Here, also the *costs of product operation are borne by the service provider*. This should increase the efficiency of materials use during the use phase of the product through two kinds of incentives. Firstly, the return on investment in more efficient equipment is direct and less risky for a professional service provider, and customers need not make elaborate calculations of total costs and depreciation. Secondly, individual savings may be insignificant from the customer's point of view, but the aggregate savings for the service provider may be substantial.

Economic incentives and organizational possibilities may be distinguished from one another analytically. In practice, they interact, and this interaction is important, as well:

- Services provide the opportunity for as organized re-use channels for end-of-life products. This may promote recycling and reuse by itself. It also provides incentives for extended product life, as product disposal becomes a cost factor for the service provider. This may also create incentives for product development to design more durable and repairable products than is the case currently.

- Service models are an institutional arrangement that may enable customers to select goods that are more suitable to the task, as they are not tied to the selection of goods that they own. There can also be an economic incentive here: the fixed costs related to product ownership may stimulate its use even when not needed (e.g. private cars). For example car-sharing clients used more public transport than they did when owning a car (Meijkamp 1997, Baum and Pesch 1994, ref Scholl et al 1998).

- Service models provide organizational opportunities for an intensification of product use. Furthermore they may provide the incentive to use *more efficient technology* because the shared use of products makes it less expensive to invest in the most progressive technology.

Although the service model implies new organizational opportunities and economic incentives, these possibilities and incentives do not occur, or lead to dematerialization, in all types of services:

- While service providers are encouraged to take on more responsibility for products, customers may behave less responsibly. Rented and leased *products may be handled more carelessly* than owned ones, especially if the contract includes guaranteed maintenance or replacement. Manufacturers may also find reason to *increase safety margins* to reduce the need for maintenance and repair when they become responsible for the costs of these activities.

- Careless use may also contribute to *less efficiency at the use stage*. Contracts for results-oriented services may be ineffective in saving energy or materials if the user's role is crucial. For example, heating costs paid for through housing rent (which could be seen as a traditional form of energy contracting) have been criticized for providing residents with no incentive to economize in heating.

The full potential of *incentives for dematerialization cannot be utilized if manufacturing companies' R&D activities are not involved*. If the cost of the product is significant in providing the service, the service model should provide incentives for designing goods with a longer life span. Similar incentives should arise for design for reuse and recycling. If the manufacturer would also assume responsibility for product operation (result-oriented services), products could be designed for more efficient use. However, this is usually not the case today. Direct incentives for economizing in materials are lacking when the "fleet manager" (i.e., service provider) is not the manufacturer.

While the service model may lead to a number of incentives for a better materials economy, these incentives are obviously contingent on a number of factors:

- How does the service model influence product users' behaviour when dealing with products, and their consumption patterns in general? What is the role of the customer vs. the service provider in terms of energy and materials use?
- Do the costs of materials for product manufacturing and use (even when aggregated by the service provider) exceed the costs of labour and design efforts?
- Is the service provider directly involved in product manufacturing and design?

The importance of the different kinds of incentives for materials conservation varies from one service type to another (Table 2). When compared with eco-design with a functional or service approach, we can see some *organizational and economic advantages in service-based* business, such as the provision of product-based or results-based services. In service business, revenues are decoupled from materials use. On the other hand, non-material services may contribute to less materials intensive consumption patterns, but their potential for dematerialization is dependent on changes in the structure of consumption (i.e., changes in the functions that consumers require) – changes that do occur, but are difficult to influence. So services that replace products, or their ownership, hold the potential for dematerialization while maintaining the desired functionality. Hence, they may be one way to *facilitate ecological restructuring with minimal market intervention*.

Theoretically, the organizational and economic potential for dematerialization should be stronger for result-oriented services than product-oriented services, if contracts are made on the basis of results. However, the factor costs of production in different sectors vary, so the relative importance of materials vs. other costs cannot be established in general. Furthermore, technical and operational aspects, as well as cultural behaviour patterns, may have an influence on the outcome (Littig et al 1999). Thus, the final analysis of whether the organizational opportunities and economic incentives related to the service business model actually lead to dematerialization should be evaluated on a case-by-case basis.

Table 2. Dematerialization potential of different categories of services

Potential for dematerialization while maintaining product function			Revenues decoupled from materials use
	Eco-design with service (funtional) approach (e.g., FRIA-refrigerator)	• Large *technical potential* for absolute dematerialization on product level • No specific *organizational* advantages • *Economic incentives* for dematerialization limited, depend on customer awareness of benefits (revenues are still gained from selling products)	
	Product-based services (e.g., car-sharing)	• *Technical potential* for dematerialization in some cases • *Organizational potential* for dematerialization by enabling shared product use, more intensive use, better recovery and reuse • *Economic incentives* for dematerialization exist (product becomes cost factor for service provider), but may not be utilized	
	Result-oriented services (e.g., energy service contracting)	• Large *technical potential* for absolute dematerialization • *Organizational potential* through more professional planning and execution of tasks, as well as shared product use, more intensive use, recovery and recycling • *Economic incentives* for dematerialization may be great (service provider benefits from savings in both production and operation costs)	
	Non-material services (e.g., hairdresser, psychologist, virus control, information searches))	• Potential primarily for *relative dematerialization* (less-materials intensive growth); in principle, could lead to absolute dematerialization through extensive changes in the structure of consumption	

However, an exploration of the organizational and economic aspects of a service model points out some interesting possibilities that go beyond its potential for dematerialization as such. The general idea of more intensive product use, and results-based contracts, opens up views of a *leaner, more flexible economy*. With fewer resources tied up in sunk costs and material investments, more scope would be left for innovation. Fewer companies would have vested interests in specific materials, substances or technologies. In a way, one could even term this kind of an economy a *precautionary economy*, with less difficulties in adapting to the growth of environmental knowledge than the present economy has.

Another potential environmental benefit that can be observed in a service model is that it quite naturally implies an *extended producer responsibility* for products (White et al. 1999). Besides promoting product-life extension and resource recovery, this form of market organization may also help to reduce the dispersion of toxic substances. When professional service providers are responsible for end-of-life products, they have an incentive to make sure that problematic substances are avoided in products. On the other hand, more *professional product use* (as, e.g., in chemicals management services) may decrease the risk of the dispersion of environmentally harmful substances. Thus, it is not necessary to accept the supremacy of dematerialization as an environmental target to see interesting possibilities in a service approach for sustainable development.

Is a service approach feasible? 5

The discussion on services and dematerialization is an interesting combination of normative and determinist statements. This is most clear in the discussion on ecological modernization and ecological restructuring, where discussants under the first heading seek for evidence that ecological modernization is proceeding, whereas proponents of ecological restructuring take a distinctly normative stand. It can also be seen in the business management literature, where some authors are clearly normative (e.g., Schmidt-Bleek 1994; 1998 and Stahel 1996) whereas others discuss dematerialization as one plausible scenario, which in turn may increase the popularity of service business models (e.g., Dobers and Wolff 1999). Although various authors refer to factors that facilitate or obstruct the spread of service models, few have systematically evaluated the conditions for a shift to a service economy.

In the following, a conceptual framework is presented, which discusses the conditions for a service economy in terms of economic and institutional conditions. The economic conditions relate to how current price structures shape economic organization, and whether dematerialization through services could be achieved under existing conditions. The institutional framework departs from a naturalistic view of the economy. Criteria for consumer well-being and business performance are socially constructed, both by constitutive rules (beliefs of what the world is like), social values (what is good) and regulative institutions, such as rules and public authorities (Scott 1995). Thus, perceptions of and conditions for efficiency are socially constructed. They can, and do, change, although they cannot be controlled in detail.

The service discussion addresses both business-to-business services and consumer services. The institutional contexts of these two areas are very different, albeit the similar nature of the incentives. Whereas organizational changes in business-to-business markets could be thought to follow economic incentives more closely, consumer services are faced with a wider range of social aspects, which may influence the conditions for the adoption of such new practices.

Economic conditions for a service economy

Previously, we saw that much of the discussion on services was based on the idea that the service-based business model provides incentives to save materials. The underlying idea is that market actors make decisions that are sub-optimal from the point of view of the ultimate utility of the final customer. A shift toward services integrates the value chain and places the supplier more closely into the customer's operations. The supplier takes on such tasks as product ownership and maintenance, even product use. Through superior economies of scale and higher competence, the supplier is able to optimize materials use better than the customer, who is impeded from optimizing by informational and other transaction costs[17]. The more the transaction is about the product function, and not the physical product, the less the supplier has the incentive to sell excess material.

[17] This assumption implies that the supplier company is internally transparent and hierachical, with all units fully co-operating for the benefit of the whole. In real life, today, units often operate under internal market conditions, and may suppress information from one another and run into conflicts of interest and competition for power. White et al. (1999) discuss this problem in the case of a company with separate divisions for product manufacturing and service provision, the interests of which may be mutually incongruent.

From this perspective, the idea of a service economy implies the redefinition of the boundaries of the firm. When the manufacturer takes responsibility for the product beyond the conventional point-of-sale, the manufacturer may have the incentive to extend product life, improve product use, or in other ways save materials used per product function.

According to the theory of the firm, company boundaries have evolved to encompass those activities that can be most efficiently conducted within the internal organization of the firm, and exclude others to market transactions (e.g., Coase 1937). If this statement is taken literally, then there would be no potential for shifting the economy toward services under current price structures. One would have to assume that existing business models are the most efficient ones under current market conditions.

However, there are many reasons why current firm boundaries may be suboptimal, even if we do not question the efficiency of the market mechanism. In the following, some of these are outlined, each followed by an example, based on the example of Interface (rental, modular) carpeting (see Hawken et al. 1999: 139-141), of why customers may not themselves come up with this solution.

- **Information assymetries, bounded rationality and transaction costs:** Customers usually know less about the products they buy than their suppliers. Thus, they maybe unable to select the optimal solution, let alone request their suppliers to produce a new product or service according to their needs (information assymetry). They usually do not even search for an optimal solution, but rely on limited information and use satisficing heuristics (bounded rationality). This is because information gathering and processing has a cost (transaction costs). In the carpet example, customers probably would not bother to think about the optimal way to gain the utility provided by carpeting.

- **Market distortions:** Under perfect competition, and with sufficient information, the customer might be capable of selecting the alternative that is most economically efficient. In reality, in addition to information deficits, there are barriers to entry in almost all markets, and finished goods markets are usually characterized as oligopolies (few producers). Furthermore, practices such as advertising may distort markets by focusing customers' information on irrelevant aspects. In the carpeting example, customers may not find modular carpeting in the market, and may not be able to find a supplier for it. They may also be enticed to buy new carpeting by advertising from wall-to-wall carpeting manufacturers.

- **Unpriced externalities:** Even if the customer could select the most optimal product or service alternative on economic grounds, the economic optimum is not equal to the least materials-intensive alternative. Materials are seriously under-priced with regard to their environmental externalities. Although many customers today may value environmental considerations, environmental aspects are usually not visible in the product or service offering due to the intransparency of markets with regard to externalities. Customers are thus unaware of the environmental loading caused by replacing their whole carpeting when worn out, instead of only replacing the worn modules.

Whereas a service approach may go some way to solving the two first problems, it may not help very much in solving the problem of unpriced externalities. As materials are cheap and labour expensive, it may well be that the current model of manufacturing and selling products, rather than services, makes economic sense even in an integrated value chain under current price conditions.

A dynamic view of the economy does not view demand and supply as fixed or static. If this were the case, we would be in the best of all worlds[18]. However, innovation and learning occur all the time. Even within an economic framework, a number of alternative dynamic equilibria can be assumed to exist. This is the economic viewpoint adopted in the strategic management literature: firms are profit-maximizing and rational, but yet, they make real choices: open up new markets, and shape their own, their customers' and their competitors' future through these choices (Hamel and Prahalad 1994; Porter and van der Linde 1995).

From the point of view of the dematerialization potential of services, this dynamic framework suggests that not all efficient solutions have been identified yet. Entrepreneurial companies may see a competitive advantage in adopting the service-based business model, and potentially forcing it on less well-adapted competitors. As stated before, the examples mentioned in the literature have evolved under current price structures, many without any explicit environmental considerations. Perhaps they could be extended to even more areas already now? And what if institutional conditions change?

Institutional conditions for dematerialization through services

It is interesting to note that many of the ideas that the discussion on eco-efficient services builds on date back two or three decades (e.g. Kneese et al. 1970; Stahel 1976). However, until now, very few services have been designed explicitly to address environmental concerns, or are marketed on environmental grounds. The shift from products to services has very recently gained a broader audience and increased interest. This may help to place the service approach in a new, more fertile frame of reference.

Some institutional changes can already be discerned. Firstly, the issue is being raised to the awareness of business managers, policy-makers and the general public. Until very recently, the idea of services has not been included in conceptualizations of 'environmentally sound' products (e.g., eco-labelling criteria). In the past few years, eco-efficient services have entered the academic and leading business discourse on environmental management and design. Popularizing the idea, as such, may already lead to new innovations in companies and increased demand among customers.

The service approach has many resonances with other current business trends, such as *lean and flexible production* (at least in terms of cutting down inventory), knowledge-intensity (many companies prefer to picture themselves today as somehow in the business of producing or transforming information) and *customer integration* (companies attempt to go upwards in the value chain and get as close to the customer as possible). Many European industries are facing saturating markets: services may be a way to find new business opportunities and sustainable growth (e.g., Fleming 1992; Stahel 1996). Goedkoep et al. (1999) emphasize the role of product-service systems as sources of business with high added value. There may also be a link between a service approach and *shareholder value*: services may be linked to positive aspects such as *efficient use of capital* and low sunk costs. Many of the new services are also linked to *information technology*, which is connected with great expectations in capital markets (Stahel 2000).

Policy-makers are also starting to discuss the service approach more seriously. Resource efficiency and dematerialization have gained acceptance as goals for environmental policy. Many current policy developments, such as climate policy, integrated product policy and fiscal policy, may in the future shape the institutional conditions for a shift from products to services. Developments in the *ecological tax*

[18] See Ayres (1998) for a more general discussion and critique of Panglossian scepticism toward the possibility of radical improvements in resource efficiency.

reform would most probably support a shift from products to services. In more concrete terms, instruments such as *extended producer responsibility* in Europe may provide companies with some incentives for adopting a service approach. When companies are made responsible for the costs and organization of product disposal and recovery, the "fleet manager" idea of rental, leasing and pooling becomes at least slightly more attractive. Other measures suggested include information provision and advancing service alternatives in public procurement (Oosterhuis et al. 1997; Goedkoep et al. 1999).

There are many institutional impediments, as well, to the service approach. A *tradition of ownership* and accumulation of material possessions may obstruct the spread of service strategies in consumer goods markets, as can the infrastructure of consumption based on buying and owning goods. Many of the most promising examples of service approaches have, in fact, been found in business-to-business markets. *Under-priced materials and over-taxed* labour may however obstruct the spread of service approaches even in business-to-business contexts. *Accounting and taxation practices* influence how profitable it is to own equipment, and whether it makes sense to rent equipment or outsource operations. *Legal uncertainties*, such as those related to new forms of contracts, may also influence the viability of new services (Interim Report 1999). Thus, the shift from products to services may require a review and reform of a number of the current institutional conditions that set the stage for business activities.

6 Summary and discussion

Discussion on the potential of services to lead to dematerialization has recently emerged on many fronts. While the contexts vary, and the definitions and examples of new services are eclectic, *four distinctive service* types can be identified: (1) non-material services, (2) result-oriented services, (3) product-oriented services and (4) ecodesign with a service approach.

Non-material services do not directly replace products – rather, they are interesting mainly as new focal points of less material intensive economic growth. *Result-oriented* services at least partially replace products or materials with information and labour inputs by focusing on providing customers with a specific result, rather than a specific product (e.g. energy saving contracts). *Product-oriented services* (product take-back, rental and management) provide customers with the use of the product (potentially accompanied by additional services) for a limited time, and thus may reduce the number of products needed. The *ecodesign approach* focuses on designing products anew from the perspective of customer needs – services are here understood as a flow of satisfaction derived from the use of durable goods.

While the examples of new service offerings discussed in the literature are limited, they indicate that service-based business can be profitably launched, at least in some cases, also under current market conditions. In these examples, service providers are able to meet customers' needs more competitively than companies selling products. However, production factor costs may frequently be such that a service approach is not attractive under current market conditions. This does not mean that new services could not emerge: customers' awareness and capacity to demand services, and results rather than excess products, seems to be focal here. The amount of literature on the issue indicates that such awareness-raising has begun, and it remains to be seen how far the new ideas will spread.

Policy-makers have toyed with the service idea for some years, but have not yet given it their whole-hearted support. This may be due to the anecdotal nature of the discussion and the difficulty in determining the environmental or other merits of such an approach. Much research in the field is ongoing, and this paper has attempted to identify the dematerialization potential of various types of services by clarifying the debate. Two types of dematerialization were defined: relative (reduction of materials per value-added) and absolute (reduction of materials per function). Furthermore, two types of mechanisms through which services may promote dematerialization were identified: organizational opportunities and economic incentives.

Services provide one way to organize a more efficient use of materials and products through *shared* product use, *more intensive* use, more *professional* use and better *end-of-life management*. Service providers may also have better *incentives* to economize in materials use: revenues are *de-linked from material flows, and saving resources* may actually become the principal *source of revenues* (e.g., energy services). However, there are also *counter-incentives*, and the strength and direction of incentives varies from one service type to another. The evaluation of the dematerialization potential of services will need to be continued in empirical research in a variety of cases. However, an exploration of the organizational and economic dematerialization potential of different types of services shows when and where such consequences can be expected.

Although this paper has explored services mainly from the point of view of dematerialization, there are other interesting aspects of services from the perspective of sustainability. For example, the discussion on services seems to serve to *broaden the debate* on environmental management and ecodesign to reconsider issues such as customer needs and product functions. Issues such as use value, quality of life and sustainable growth may re-open and recontextualize very fundamental economic and societal issues. A service model may improve the management of materials and substances by increasing producers' responsibility for and control over the product. The service approach also introduces the idea of a functional (or precautionary) economy, in which investments in current products and infrastructure are minimized in order to enable a maximum of flexibility for continuous innovation in the face of uncertainty.

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Author(s)	Eva Heiskanen, Mikko Jalas Helsinki School of Economics and Business Administration	
Title of publication	Dematerialization through services - A review and evaluation of the debate	
Abstract	The report investigates the possibilities for decreasing materials flows in the economy by a shift towards services. The report consists of a literature review and a critical evaluation of the arguments presented in the debate. The review considers different approaches to a service orientation, such as ecological restructuring, the MIPS concept developed at the Wuppertal institute, needs-oriented product development, as well as services as an environmentally oriented business approach. The most typical examples and classifications in the service debate are also reviewed. All services do not promote dematerialization, and from the point of view of dematerialization, traditional services are not necessarily the most interesting ones. A common aspect in services with a potential for dematerialization is that they integrate the value chain. In principle, a shift toward services has potential for dematerialization in a number of different ways. Professional service provision is a natural way to organize the shared and more intensive use of goods. The take-back and recovery of end-of-life goods is simplified. Professional service provision also facilitates scale-related gains, and the efficient, skilled execution of tasks. The economic incentives with respect to materials use are also somewhat different in services than in product sales. The business of a service provider is not dependent on a growth in materials throughput. In contrast, for service providers, material products are a cost factor that should be minimized. Reducing material flows may even form the basis of the business, as in energy service companies. Services do not, however, automatically lead to dematerialization, as many case-specific factors (e.g., the cost structure of services, and the role of the customer in energy consumption) influence the materials efficiency of services.	
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