Product-Service Systems

Final Report

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Executive Summary

A new trend of product-service systems that minimise environmental impacts of both production and consumption is emerging. This report shows existing attempts to build a theoretical framework of present product-service systems, provides an overview of underlying principles of product-service systems in order to bring the issues into sharper focus and serves as a background for identifying possible investment needs in studying this realm. In addition, a large number of examples have been provided, drawn from a large variety of companies, to illustrate the value creation founded on good environmental performance that is achieved through applying different methods of environmental policy (recycling, customisation, multi-functionality of product and product system, etc.).

The examples of projects conducted by research institutions show that the aforementioned companies' activities are mostly of marginal value in dealing with and addressing one or several stages of a product's life cycle, but not the entire system. They also show that shifting the corporate focus from selling product-service systems rather than products is not seen as a competitive advantage, nor has it been practised. Two factors lead to such a result. The first one is that even at an academic level, product-service systems have not yet been developed. Another reason is that there is no external demand for providing product-service systems. Currently, companies' activities for improving environmental performance reflect the external requirements of legislation and consumers; companies are just fixing problems identified by these external demands. All companies lack a system approach, which improves system parameters and conditions, provides competitive advantage to companies and allocates resources more efficiently to where they are mostly needed at a particular moment.

There are three main uncertainties regarding product-service systems’ applicability and feasibility: readiness of companies to adopt them, readiness of consumers to accept, and environmental features. Existing research projects do not yet minimise the uncertainties.

The main findings of this report are as follows:

- The economic implications of introducing product-service systems stem from the theoretical possibility to decouple economic growth from natural resources consumption, the necessity to optimise the resource productivity rather than labour productivity, opportunities of mass customisation and applications of information technologies.

- The environmental implications of introducing product-service systems are poorly studied. The environmental analytical community is just beginning to apply systems approaches to characterise the impact of product-service systems, and links between such analyses and policymaking do not yet exist. There are no indicators of PSS environmental performance and little is done about data collection systems. The rebound effect is also inherent in product-service systems and can only be analysed on a case-to-case basis.

- There are several social implications resulting from the shift from selling products to providing product-service systems. As services are usually more labour intensive than manufacturing, an opportunity exists for developing customised product-service solutions that will provide employment and satisfy the customers. Product-service systems empower consumers who can affect every stage of a product life cycle through making environmentally aware purchasing decisions and can change their own consumption patterns to minimise overall environmental impacts.

What have become apparent from these findings, however, is that appropriate social structures are required when designing new product-service systems. They consist of infrastructure, human structures and organisational layout, and are needed for the establishment and effective functioning of product-service systems.
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1. Introduction

This report builds upon the result of the study sponsored by the Swedish Waste Research Council at the Swedish Environmental Protection Agency. It presents an overview and practical examples of conducted and on-going projects by research institutions and activities by companies from Europe, America and Japan.

Sustainable production and consumption is an issue that is raising international interest. Many different concepts have been developed to address environmental problems that society faces at the turn of the millennium, such as cleaner production and cleaner technologies, waste minimisation and recycling approaches, eco-design and design for sustainability. However, a new initiative is required concerning production and consumption patterns, which can lead to the sustainability of an ever-growing population and levels of pollution. It is estimated that by the middle of the next century, resource productivity will be improved by a Factor 10. "Rising levels of consumption by the rich and doubling of the world's populating over the next 40-50 years would require a factor 4 increase in food production, a factor 6 increase in energy use and at least a factor of 8 of growth income."

This can be done by reducing the population, lowering the level of consumption or changing technology. The first option, lowering the human population, does not appear feasible in the short term. Decreasing consumption levels do not provide an option either because we might need to increase wealth on a massive scale just to provide basic amenities to a population of around 10 billion. Technological solutions are usually incremental in nature and tend to lead to even higher levels of pollution during the entire life cycle. The only answer is to create products and services that provide consumers with the same level of performance and that have a much more dematerialised life cycle and thus, a lower environmental burden.

Many authors and institutions proposed the concept of product-service systems as a possible answer to sustainability challenges. However, so far, little attention has been given to that concept at a policy level as well as at the operational level. Against this background, the aim of this report is to provide information about the concept, its benefits and drawbacks, to supply a number of examples of international and national projects, to present companies’ efforts to develop such systems and integrate them into daily routines, and to stimulate debate about the sufficiency of these efforts for increasing eco-efficiency of society and for minimising the anthropogenic environmental load.

This report is divided into seven chapters. Chapter 1 is the introduction. Chapter 2 outlines three critical trends that characterise the unsustainability of the current global situation. The sustainability concept is explored in Chapter 3, which also describes strategies towards sustainability, analyses the efficiency of approaches developed to address sustainability from the product, production and consumption side and presents scenarios of sustainable systems. Chapter 4 provides a theoretical background to the concept of a functional economy and analyses a product-service system as a conceptual, analytical and practical approach to minimise the environmental burden of the present patterns of production and consumption. Chapter 5 gives examples of the projects on theoretical development and practical applications of the product-service systems at research institutions, companies and communities. In Chapter 6, some observations and conclusions are presented and finally, Chapter 7 provides further directions of research in the area of moving from products to product-service systems.

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http://www.baltic-region.net/science/factor10.htm
2. Roots of unsustainability – trends in modern society

The idea of sustainability is inspired by the late discoveries of anthropogenic impacts on the natural environment and the conclusion that current patterns of human activity cannot be sustained indefinitely. Sustainability (further discussed in Chapter 0) is the ultimate future goal. However, the current global situation is in a condition of unsustainability that can be characterised by three critical trends:

- Overpopulation and continuing population growth, especially in developing countries
- Accelerating resource exploitation and increasing pollution levels, primarily by the developed countries, but increasingly also in different countries in transition
- Over-consumption, especially in developed countries

These trends will be presented separately below.

2.1 Overpopulation

It is estimated that the world population will almost double from the present six billion to around eight to ten billion inhabitants in 2025 and, as a consequence, it will increase the demand for resources and environmental impacts related to human activities. Since the earth is a closed ecosystem, it will not be possible to support such an exponentially increasing population within the actual growth-oriented economic systems.

The need to reduce poverty and to improve living standards in the underdeveloped countries has the potential to make the situation even worse. The developing countries are trying to reach the same levels of living standards enjoyed by more developed countries, but there is a risk that their resource consumption will rise dramatically, leading to even more pressure and abuse of environmental and natural earth systems. Taking into account the growing population of these countries, as well as China, India and Bangladesh, the natural system may not be able to support the pressures, culminating in a world catastrophe. The goal here should be to achieve comparable quality of life for the people of all countries. This is necessary because in poorer countries in particular, an excessively steep decline in health and prosperity has been shown to foster a willingness to accept ecological degradation in exchange for a small and short increase in economic and personal well-being. It is quite understandable that developing countries would take the opportunities and make all necessary efforts in order to change the present unbalance more in their favour, further speeding up the destructive competition for resources.

This implies that solutions, which demand only efforts from developing countries to reduce their present population growth, will be ignored unless they are accompanied by similar actions in more developed countries. People from poorer countries should feel that they have a realistic expectation of an immediate improvement of their life quality and at the same time, that more strict demands are placed on the people of developed nations. Similarly, any demands resulting in lowering of the quality of the life of population will be confronted in both rich and poor countries. Thus, taking a fair share of responsibility, more developed countries need to find ways of improving quality of life for many more people than those currently enjoying high standards of living. Thus overpopulation is still an open question.

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2.2 Resource exploitation and increasing pollution

The global primary fuel consumption has risen 20-fold and today over 90% of useful energy is generated from fossil fuel and wood-fuel sources. This, in turn, has given rise to profound social changes, from the globalisation of much of agriculture, manufacturing and financial service industries to the rapid development of industrialised societies dominated by high levels of consumption and mobility. Along with unprecedented industrial development, pollution and resource exploitation has risen to unprecedented levels. These were spurred by the extremely low efficiency of the industrial system. According to Robert Ayres, about 94 percent of materials extracted for use in the manufacture of durable products became waste before the product was even completed. More waste is generated in production than in any other stage, and most of that is lost unless the product is reused or recycled. Even material and energy efficiency in America, as the most developed country, is no more than 1 or 2 percent. In other words, American industry uses as much as 100 times more material and energy than theoretically required to deliver consumer services. This is so partially because during the last hundred years, the theories of human productivity dominated our society, giving no consideration to natural productivity.

However, resource depletion is not currently the most pressing problem due to the new discoveries of resources, prospects of technological development, and the possibility for substitution. Now we have reached the stage that is being brought about by powerful feedback loops from nature, and information from the destructive activities is finally being incorporated into the system in terms of tons of emissions, discharges and solid wastes. Environmental movement concerns were centred on the belief that economic growth was inherently limited by the finite nature of fossil fuels and other non-renewable resources, but environmental issues have now shifted to other potentially limiting factors. Both local and global environmental problems are due to persistent pollution in terms of the accumulation of waste and emissions in the environment, global warming, ozone depletion, and loss of biodiversity. These environmental issues are very serious and put short-term economic gratification in direct conflict with long-term survival of the planet. Many approaches, such as those controlling pollution levels (end-of-pipe technologies) and those that improve efficiency were developed and employed to address these problems. However, they do not look into the root of a problem, but rather offer quick fix solutions. For example, even if all companies in the developed world were to achieve zero emissions by the year 2000, the earth would still be stressed beyond its carrying capacity. Thus, pollution is still, to a large extent, an unsolved problem.

2.3 Over-consumption

Meadows et al. showed that, if the Brundtland report was still influenced by the necessity of an exponential growth of 5-6% in developing and 3-4% in industrialised countries, it has become evident that nature may not be able to sustain such a growth. Critics of the Brundtland forecast state explicitly that the study overestimated the preserving effects of environmental technologies. Innovative and economical technologies to preserve resources and sustain the

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4 This “zero-growth” position has been largely discredited on the grounds that it failed to give due weight to the ability of markets to stimulate technological substitutes as scarcities emerge as stated in Matthews, E. (1995) Towards Patterns of Sustainable Consumption. Proceeding of the Conference on Environment: the New Business Challenge. Turin. 2 December.
6 Meadows, Donella H., Meadows, Dennis L. and Jørgen Randers (1992) Beyond the Limits: Global Collapse or A Sustainable Future. London Earthscan
environment are simply not enough. Moreover, the critics recommend the need to supplement the technical potentials for conservation and reduction of material with the substitution of technical products with services, adequate economic conditions and social innovations. Indeed, huge investments made in end-of-pipe equipment and cleaner technologies to minimise environmental pollution and increase resource productivity did not really lead to drastic minimisation of overall environmental impacts because they were outweighed by increased consumption that is driven by economies of scale and by the emergence of completely new, "revolutionary" products, environmental characteristics of which were not analysed when these products were produced (PVCs).

A classic example of these two points is a car. Firstly, an average car today, in comparison to a car from the mid 70s, is lighter, "smarter", more fuel efficient, emits less per kilometre travelled, is more safe, comfortable, and functional, but the total number of cars has increased so that it outbalances all technical achievements and, as a consequence, transport is responsible for up to 70% of all CO₂ emissions. Secondly, when the car was designed it was perceived to be a solution to the problem of horses in cities, which resulted in much manure and odours. However, the level of pollution brought by cars was neither expected nor accounted for.

This example shows that to reach sustainability we need to increase the efficiency of current patterns of consumption or minimise consumption. But there is a need to distinguish between the environmental damage in developing countries caused by poverty and the “over-consumption” of the industrialised nations. The prevalent ideas of wealth, life style and personal development as well as economic prosperity are built upon an excessive use of non renewable energy and natural resources and cannot be applied globally. Different demands should be set onto developing and developed countries (see Chapter 0).

For developed countries, there is a need to separate economic prosperity and the number of products sold on the market. Presently our economic system and economies of scale lead to an ever-increasing number of products sold and new products offered on the market. Pantzar showed that the flow of new products in Finland is in the order of 6-7% annually. This means that one new product appears on the shelf every day, and that one product is removed from the mix every three days. Also, because of the non-linear function between capital employed and revenue generated, companies are doing anything to maximise profits. They than spend their profits on developing new products and on installing cleaner technologies to clean up pollution from production. In order to unlink economic growth and environmental impact we need to look at the discrepancies between business goals and societal goals, and the very essence of customers' needs and wants and recognise that value for the customer can be created not only through immense material and product flows.

A product is made in response to a certain need that is expressed by customers or perceived by producers. On the one hand, continuous change in consumers needs and wants serves as a constant driver for technical, economic and environmental innovation. On the other hand, practical realisation of consumers' needs and its environmental performance, to a great extent, depends on the producer. An indicative study of the correlation between some household consumption habits and associated environmental impacts was conducted from 1975 to 1997 in the County of Valencia, Spain. The study showed that during the studied period of 22 years, mass consumption patterns increased the environmental burden and social costs leaving the capacity of meeting consumers' needs basically the same. On the one hand, modern mass consumption requires more power, produces more waste, and exerts a greater pressure upon the

natural environment. On the other hand, the growing portion of household expenses goes not on increasing consumption, but on financing and insuring it. Lastly, the situation of those less favoured by the model becomes more and more difficult. Thus the increasing levels of consumption are not justified by consumer preferences and therefore, the problem of ever increasing consumption is an unresolved issue.

The three problems presented in this Chapter are still unsolved. Many concepts were recently developed in order to address these issues. Some suggest dematerialisation of present economies (see Chapter 0) and eco-efficiency, others advocate more naturalistic approaches, and yet others propose a concept of a functional economy, which is the focus of this study and will be further analysed in the report. However, in order to suggest a new concept, one should understand the essence of the sustainability challenge and analyse existing policies and approaches that are employed to answer that challenge. Chapter 0 will address these issues.

### 3. Sustainability

The work of the World Commission on Environment and Development headed by Gro H. Brundtland resulted in the report "Our Common Future", which for the first time underlined the necessity to achieve a new economic paradigm. The report defined sustainable development as "Development that meets the needs of the present generation without compromising the needs of future generations". The Brundtland Commission, which examined the long-term environmental strategies, argued that economic development and environmental protection in fact could be made compatible, but that this would require radical changes in economic practices throughout the world. Sustainable development is made up of three closely connected issues:

- **Environment**: The environment must be valued as an integral part of the economic process and not be treated as a free good. The environmental stock has to be protected and this means minimal use of non-renewable resources and minimal emissions of pollutants. Ecosystem needs to be protected so that the loss of plant and animal species is avoided.

- **Equity**: A higher degree of equity should be reached between developed and developing countries, and the issue of poverty has to be addressed.

- **Futurity**: Sustainable development requires that society, businesses and individuals give equal weight in the decisions to the future as well as the present.

#### 3.1 What is sustainability?

The sustainable development concept presented by the WCED stressed the role of industry and new production patterns in reaching a stable status of sustainable development; “many essential human needs can be met only through goods and services provided by industry, ...”. Later the concept of sustainable development was further developed to include the need of new consumption patterns and to discuss the role of consumers. The assumption that the transition towards sustainability also requires a change in consumption patterns was officially presented at the United Nation Conference on Environment and Development, the Rio Earth Summit held...
in June 1992. Agenda 21, the final document of the conference, stated that “the major cause of continued degradation of the global environment is the unsustainable pattern of consumption and production, particularly in industrialised countries …”. Later, the idea of sustainable consumption re-emerged as a serious concern in several public reports. For instance the 5th Environmental Action Plan of the European Union states that consumption and behavioural patterns in society should be modified. Furthermore, UNEP’s paper Elements for Policies for Sustainable Consumption shifts the question away from making current products in an environmentally responsible ways to promoting new ways to satisfy public demand. This outlines that the sustainability concept is actually viewed, in its broad meaning, from both the demand side and the production side of the economy.

Such perspectives of sustainability means a drastic increase in the “eco-efficiency” of the system and a considerable decrease in the consumption of environmental resources, which should, as calculated, lead to a reduction of 90% of resource consumption per unit of given service. Sustainability implies, therefore, a deep transformation of production and consumption activities that lead to economically, environmentally, and socially justified solutions. In order to reach the triple-bottom line of sustainability, production and consumption systems should give more attention to values, elementary human needs, resource property, product and service functions, and local conditions, in both developed and developing countries.

What are the characteristics of sustainability and sustainable development that make it so distinct in line with other policies that address many of the aforementioned issues?

- The primary feature is the system thinking that underlines the importance of interconnections, relationships, consequences, and feedback loops in analysing any problem from an economic, environmental and social point of view.
- The second feature is that sustainable development is not seen as a fixed state of harmony but rather as a process of change involving the reform of economy, technology and social organisation.
- The third feature is that the human and the non-human actors and issues are equally taken into consideration.
- The fourth feature is that sustainable development places high value on learning and innovation as a response to problems.

3.2 Concepts to reach sustainability

In order to reach sustainability we need to develop new approaches to satisfying the needs and wants of the population at the same (developed countries) or higher (developing countries) standards of living as those that currently exist, but with much reduced levels of resource consumption, pollution output and consumption patterns. However, new products and services will still be needed to satisfy our needs. We can try to reduce the resource intensity of products and services by employing the following approaches and strategies:

- Reducing the amount of materials in products and services (dematerialisation)
- Extending the product life

• Eco-efficiency
• Recycling and claiming the product material back
• Reducing requirement for product
• Increasing efficiency of the product usage phase

Clearly, suggested approaches can be divided into three categories: strategies that improve environmental profile of a product per se, its production activities and consumption patterns. Below are strategies to reach sustainable development that address different components of a product life cycle. Table 1 presents the boundaries of each component. Chapters 0, 0, and 0 look at approaches to improve each of the components of product life cycle to minimise the environmental impacts associated with each of them.

<table>
<thead>
<tr>
<th>Life cycle stages</th>
<th>Product</th>
<th>Production</th>
<th>Consumption</th>
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<tbody>
<tr>
<td>1 Product design and development</td>
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<td>2 Process planning and development</td>
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<td>3 Purchasing</td>
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<td>4 Production</td>
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<td>5 Control and test</td>
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<td>6 Control and treatment of non-conforming products</td>
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<td>7 Handling, storage, packaging and delivery</td>
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<td>8 Marketing and market research</td>
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<td>9 Selling/leasing</td>
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<td>10 Use</td>
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<td>11 Maintenance</td>
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<td>12 Refurbishment/upgrading</td>
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<td>13 Take back</td>
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<td>14 Reuse</td>
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<td>15 Recycling</td>
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<td>16 Final utilisation</td>
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3.2.1 Dematerialisation

Dematerialisation is the concept developed at the Wuppertal Institute for Climate, Environment and Energy. Dematerialisation aims to reduce the environmental impact per unit of economic activity. The baseline is that we need to produce more (to feed the growing population) with less natural resources. Dematerialisation describes a technological shift away from economies based on enormous and increasing consumption of raw materials. Herman et al. states that from an environmental point of view, dematerialisation should perhaps be defined as the change in the amount of waste generated per unit of industrial product. Herman, R., Ardekani, S. A. and J. H. Ausubel (1989) Technology and Environment. National Academy Press. Washington, DC. pp. 50-69 Schmidt-Bleek defines the environmental impact potential of goods as the weighted cradle-to-grave materials inputs per units of services (MIPS) obtainable from a product. It also includes energy inputs either directly or indirectly. Schmidt-Bleek, F. (1993) Fresenius Environmental Bulletin. Vol. 2 No. 8. pp. 407-412 In order to achieve both economic and ecological progress in a sustainable way, as
Welfens states, it would be necessary to sharply reduce the material intensity per unit of service. Schmidt-Bleek states that for a 50% reduction of the global material flows, future infrastructures, installations, product and services have to dematerialise by a factor of 10 compared with current western standards.

The methodology is based on calculating material flows, the quantity of which can be a rough indicator of anthropogenic influence. The methodology for material input accounting puts into practice Daly’s concept that the scale of the economy is a central determining factor for ecological sustainability. The methodology is used for calculating material throughput (in terms of energy and materials) of companies, regions, and entire economies. The methodology is a preventative methodology as it focuses on inputs of materials and energy. The amount of resources that flows through the economy and intensity of their use adds up to environmental degradation. Minimisation of these flows and intensities is a dematerialisation; “that is a reduction of the material flows set in motion by human intervention into the ecological system”.

The material throughput is quantified by using the material intensity per unit of service (MIPS) concept. The calculation of MIPS is based on accounting for all material and energy flows that are activated along a life cycle of a product, which fulfils a particular service by calculating all the material movements activated for the provision of any kind of service from the extraction until the disposal of a product providing this service. The material flows are divided into water, air, soils, abiotic and biotic raw material. MIPS is finally calculated by relating the total material input to the units of service provided by the product. It is difficult to compare products per se, but it is much easier to compare them based on the common ground, which is being the function they fulfil and the units of service provided by them.

This concept is usually criticised for not taking into consideration the quality side of material flows such as the toxicity of substances constituting them. But propagators of the MIPS methodology usually argue that it is very difficult to predict the total anthropogenic impact and effects resulting from inter-reactions of the inputs. LCA methodology that tries to transfer quantities of wastes and emissions into environmental impact categories constantly faces the valuation problem (which of the wastes and emissions are the most significant and to what environmental impacts do they actually lead to). Reducing scale of resource consumption and economy throughput reduces the potential environmental impacts of economic activity, which is an important prerequisite of economic sustainability.

The dematerialisation concept was accepted by many companies because of economic benefits (less resources used ➔ less resources bought ➔ less money spent ➔ less waste generated ➔ less paid for pollution and for final disposal). There are numerous examples of dematerialised products. One of them is the example of a CD-rom with a software, which will be analysed from an economic point of view. The cost price of an empty CD-rom is 10 krona, while with software,

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the market price starts from 100 to up to several thousand kronor. Thus wealth created exceeds
the material input by at least 10 times. In the US situation, out of the $15 that music CDs cost in
shops, only about $1.20 is paid for labour and raw materials. The rest goes to taxes
(governmental services) and for developing, designing, transporting, marketing, and selling it.
Each of these stages has an environmental impact.

Dematerialisation, MIPS, and methodologies for calculating material flows in society are
important, but not sufficient to make the economy sustainable. Therefore, more approaches will
be evaluated further.

3.2.2 Eco-efficiency and resource productivity

The concept of eco-efficiency was first coined in 1992 by the WBCSD in its report Changing
Course25. Eco-efficiency was further defined at the first Antwerpen Workshop on Eco-efficiency
held in November 1993 as being “Reached by the delivery of competitively priced goods and
services that satisfy human needs and bring quality of life, while progressively reducing ecological
impacts and resource intensity throughout the life cycle, to a level at least in line with the earth’s
estimated carrying capacity.”

Eco-efficiency provides a conceptual and operational framework for increasing the resource and
energy productivity of specific transport products and services. By focusing on increasing the
knowledge and service intensity of transport activity, firms and governments can significantly
reduce unit- and/or service-specific environmental impacts.

The WBCSD has defined seven success factors for eco-efficiency: 26

- Reduce the material intensity of goods and services
- Reduce the energy intensity of goods and services
- Reduce toxic dispersion
- Enhance material recyclability
- Maximise sustainable use of renewable resources
- Extend product durability
- Increase the service intensity of goods and services

These elements are based on, and extend further, the successful United Nations cleaner
production initiatives towards sustainable production and consumption patterns.27 The term eco-
efficiency aims at running a business more efficiently in both economic and ecological terms.
The WBCSD sees eco-efficiency as an integrated part in the path towards sustainable
development, along with consumer sustainable consumption, and the business of cleaner
production. The driver behind the eco-efficiency concept is making the challenge of
sustainability a business opportunity. WBCSD suggests that business can implement eco-
efficiency on four levels:

- Eco-efficient processes: Saving resources and minimising environmental impacts of processes
  allows companies to reduce the costs of production.
- Exchange of by-products: Exchange of by-products and wastes may lead to cost benefits.
- Developing better products: Developing products and services, according to the principles of
  eco-design.
- Eco-efficient markets: It has been claimed that eco-efficiency may de-link economic growth

25 http://www.wbcsd.ch
26 http://www.wbcsd.ch/ecoeff1.htm#top
http://www.wbcsd.ch/prodoc/prodoc.html
from the exploitation of nature. Companies can identify opportunities for producing and providing products and services that allow more efficient use of resources and closing material loops. "Selling services that directly deliver the function of a product to the customer, i.e. with add-on services, with leasing, or though functional offerings is often highly profitable and businesses and can continue to grow, while reducing use of resources and environmental impact." 28

Eco-efficiency reflects the firms’ internal ecological and economic efficiency. It does not, however, include the environmental effects of the product after the product has left the firm. In order to assess the product over the lifetime of the product, one must use a life cycle assessment. Another drawback of eco-efficiency is that measuring resource consumption does not necessarily indicate the level of environmental impact associated with that resource consumption. Moreover, environmental impact varies depending on the specific local conditions where production and consumption occur. Thus, measuring resource intensity is not necessarily the most accurate way to measure environmental impact. Agenda 21 states that "achieving the goals of environmental quality and sustainable development will require efficiencies in production and changes in consumption patterns". Eco-efficiency addresses the challenge of making production more efficient, but it leaves out consumption patterns from the consumer point of view. As was shown before, there is the possibility that the environmental benefits of efficient production may be negated if consumption levels continue to rise. Therefore, eco-efficiency answers just half of the sustainability challenges. It must be accompanied by concepts and approaches dealing with fundamental changes in consumption patterns before sustainability can be achieved. As Michael Braungart put it "If you make the wrong system efficient, it’s even more deadly". 29

3.2.3 Concept of environmental space

The concept of environmental space, which was developed by the Institute of Climate, Environment and Energy in Wuppertal, tries to operationalise the sustainability challenge in terms of a more equal distribution of space. 30 Environmental space is a measure of the quantity of natural resources and of the usage of the environment per capita, which must not be exceeded in order to not jeopardise sustainable development. It is built on the current levels of production and consumption in industrialised countries. The environmental space identifies the point of departure to sustainable development (state of the art) and points of technical and organisational optimisation as well as changes of values, consumption and lifestyles. While technical and organisational optimisation are covered by the “revolution of efficiency”, changes of values, consumption and lifestyles are embraced by “revolution of sufficiency”. The ultimate goal of both revolutions is an increase in productivity of resources, both natural and human. 31

The organisational component of “revolution of efficiency” is concerned with the selling of services instead of products and with the environmentally sound optimisation of logistics, and distribution. The technical component deals with the optimisation of products and processes. It focuses on product innovation based on less use of resources, on the possibilities for recycling, on prolonging product lives and reparability, based on eco-design, energy conservation, minimising the use of raw materials and toxic emissions in production processes, consumption and use. Sufficiency revolution calls for “dematerialised” use and consumption, which is “to

28 http://www.wbcsd.ch/ecoeff1.htm
have a utility instead of ownership”.

Furthermore, quantitative utilisation needs to be kept on a level as low as possible.

### 3.2.4 Innovative framework

"Incremental moves will get you nowhere in the race to the future. Innovation that breaks industry rules and creates new space will." So what is innovation and why should it be considered seriously? We live in a market economy, orchestrated by the rules of competition. While conventional competition takes place within the boundary set by products and services offered on the market, the success of many companies depends on their ability to break through the traditional boundaries of competition and create new customer offers, if not entire new industries. Sustainability challenges us to cross the boundaries of traditional concepts in order to reach the Factor 10 goal. Recent examples show that extending production line, fixing leaks or improving product design, so called incremental technical improvements, may fulfil Factor 4 goal. But in order to move to the Factor 10 goal we need to innovate on a system level; we need to rethink the very basis of offers to the market. What is needed at a company level is not only improvement of products and services, but completely different solutions - leaps in value.

At the company level conventional strategies differ from innovative logic along the five dimensions of strategy: industry assumptions, strategic focus, product and service offerings, customers, and assets and capabilities.

**Industry assumptions:** Often companies take their industry conditions as a given and develop their strategies accordingly. For example Compaq Computer does not develop different products and services. The company is striving to provide its customers with total chain solutions. They are trying to fulfil entire set of consumers’ wants across the entire chain, even if it takes them into a new business area.

**Strategic focus:** Often companies take their competitors' parameters of performance as the best and set their strategic goals to compete at the margin for incremental share. Innovators instead set ambitions to dominate the market and fulfil this by providing completely new, revolutionary offerings; leaps in value for consumers.

**Product and service offerings:** Product and service offerings define the boundaries within which the competition takes place. Innovators cross these boundaries and come up with new product and service solutions that fulfil consumers needs.

**Customers:** Innovations provide customers with such a leap in value that greater customisation and segmentation (incremental improvement in value) are not necessary.

**Assets and capabilities:** Existing assets and capabilities often restrain new development of companies. Innovators never leverage their existing assets and capabilities, and never let them govern arising business opportunities.

Beside better competitive position, more satisfied customers and a brighter future, innovative companies will make a better profit. An interesting study of 100 newly launched companies showed that 86% of all launches were line extensions (incremental improvements), which accounted for 62% of total revenues and 39% of total profit. The remaining 14% of launches (innovations) generated 38% of total revenue and 61% of total profit. Figures speak for themselves.

Thus, companies' success on the market depends on breaking through traditional boundaries to create new product and service offerings and new industries (Chapter 0 provides background for such leapfrogs).

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3.3 **Product side of reaching sustainability**

3.3.1 **Features of current product system**

Market economy is the basis of our society. An immense amount of products is produced and services offered in order to satisfy our ever growing demands. Recently we realised that products and services are not stand alone offerings; they are created, produced, used and disposed of within a system. These numerous systems also exist in a societal system that defines them from economic, technical, environmental, and social points of view. Indeed, economy defines product cost (carefully leaving out externalities); technology defines material manifestation of the product or service idea and processes that take part in the creation of the product; environment also defines material manifestation of the product by providing certain materials, and also takes back all by-products of production processes and all pollution that is generated throughout the product life cycle; social dimension defines product appearance and marketing mechanism for its promotion on the market.

However, existing product systems were designed in order to suit the goals of an economy based on fordist mass production, average quality and short life span of products. Thus, in modern economy growth, the profitability depends on increasingly rapid consumption of durable goods. But producers are not interested in making long-lasting products because their profit comes from selling as much as possible. Sometimes it leads to a discrepancy between the life span of products and the life span of their components that are usually produced by other producer. For instance, the life span or time to failure of some electronic components is 200 000 hours and yet they may be a part of short-life consumer products. The results from this are waste of natural resources and explosion of volume of wastes. Beside boosted profitability, manufacturers face a problem of time lag; the time necessary to develop a new product has become longer than the time of the product in the market. Thus, new products with incremental changes are advertised and sold as revolutionary innovative products. Thus, even an average in performaning product could be sold on the market due to highly educated marketing professionals and aggressive marketing strategies.

The environmental considerations are not usually taken into account in product design, nor in product price, as the entire financial system sends wrong signals about the true price (the entire unsolved problem of externalities). However, more and more companies are taking them into consideration as they see that in the near future a questions about the necessity of their product on the market can be posed. What companies are doing in order to stay competitive and gain profit by involving environmental considerations into their strategies will be shown in the next chapter.

One should not forget that successful products combine and take into account all four aspects that influence their success on the market. Often, environmentally advanced products are too expensive for the market and they fail.

3.3.2 **Strategies to reach sustainability by improving products**

There are numerous design practices associated with environmentally improved design that have a common name eco-design or, often design for X, by X meant different product characteristics that are considered to improve the product's environmental performance. The following are examples of some of eco-design strategies:\footnote{based on Fiksel, Joseph (ed.). (1996) Design for Environment: Creating Eco-Efficient Products And Processes. New York, N.Y. McGraw-Hill., p. 513}

- **Material substitution** - replacing product constituents with substitute materials that are superior in terms of increased recyclability, reduced energy content, etc.
- **Waste source reduction** - reducing the mass of a product or its packaging, thus reducing the resulting waste matter per product unit.
Substance use reduction - reducing or eliminating undesirable substances that are either incorporated into a product or used in its manufacturing process.

Energy use reduction - reducing the energy required to produce, transport, store, maintain, use, recycle, or dispose of a product and its packaging.

Life extension - prolonging a product or its components' useful life, thus reducing the associated waste.

Design for disassembly - simplifying product disassembly and material recovery using techniques such as snap fastening components and colour-coded plastics.

Design for recyclability - ensuring both high recycled content in product materials and maximum recycling at end-of-life.

Design for disposability - assuring that non-recyclable materials and components can be disposed of safely and efficiently.

Design for reusability - enabling components of a product to be recovered, refurbished and re-used.

Design for energy recovery - extraction of energy from waste materials.

Modular design - designs a product in modules enabling quick repair or change of one module in case of failure. The discrepancy between long life span of components and shortening life of products lead to the emergence of the modular design and design of components for commonalty principle35.

The ultimate goal of each is to create such product innovation that contributes to improvement of several features of product environmental performance. For example, dematerialisation of a product (reducing the mass of a product) can reduce energy use and transportation, which decreases resource consumption, and reduces pollution.

Many of the aforementioned designs for X improve the products' environmental performance during a product usage phase or at the end of life. This is determined by the fact that most consumer products have their highest environmental impact during these stages (life cycle analyses are usually employed to identify life cycle stages with the highest environmental burden). Kerr showed the significance of the usage phase in the entire environmental burden of a product (copier).36 Many other customer products have the highest environmental impact during the usage phase, therefore substantial efforts in eco-design were directed to reduce this burden.

A particular problem is inherent to all these types of eco-design. So far these types do not include customers as one of the main influencing factors for minimising environmental impact of usage phase. Thus, even a product designed in the most smart and innovative way, can be used so that it creates the highest impact. This problem is not a problem of only eco-design, but of the entire modern system of production and consumption. Usually, there is no input from customers that could make changes and induce even more impressive improvements in the product's environmental quality. Thus we need, together with design for X (remanufacturing, disassembly, etc.) a design for customers accompanied by customers' design (the education of customers on most efficient ways of using products so that to minimise their life cycle impact). Both proposed types will be discussed and analysed further (Chapter 0).

3.3.3 Evaluation of existing strategies

1. Presented approaches of eco-design do not address the design of the entire product system, which leads to the situation when improvements of some features of a product or product

35 Component commonalty principle refers to the situation in which one component may be used consecutively in different products. Thus, life span of a component is no longer linked to the life span of a single product. Instead components are standardised to suit many products.

system jeopardise the efficient and harmonious functioning of the entire system.

2. Eco-design has a possibility to improve the product's environmental performance to a certain level, this being usually incremental. In order to fulfil the Factor 10 goal improvement or changes in the entire system are needed.

3. Focus on designing for particular results (reusability, recyclability) misses the picture of the product system function. Instead, the product, or in the best cases, its function is analysed. However, the prerequisites of the system (current system of production and consumption) serve as a starting point and often as a restraint to innovative solutions (see Chapter 0).

4. System innovation requires certain changes that are needed in the first place to overcome the traditional inertia of all stakeholders in accepting, adopting and using new products and services. Of course it is much easier to change a product than a system, therefore, we often see inefficient products just because our present system does not have the necessary infrastructure or awareness to accept a better one. Thus instead of improving the system, we are making products that suit a very inefficient current system. The opposite is true as well; we create the entire system around one product. For example, the car has become the dominant mode of transport, and the entire societal infrastructure was created to suit this only product.

5. As was pointed out before, consumers are not a part of the design process. Partially, producers involve them through numerous consumer surveys, but in the end, producers are the ones that promote the product on the market in the shape and form that they decide would better suit the function the customer wants. This tendency came from the times when companies considered their processes extremely secret and there was little dialogue between companies and stakeholders. Now we are witnessing the era of transparency so the logical next step would be to involve the customers. The problem of separating producers from customers lies also in the structure of industry where retailers are usually placed between these two stakeholders. They serve as a buffer for the information coming from consumers and market, and often play with the information so that it is best suits them. The UK’s structure of product chains is dominated by the retailers who have the power and knowledge and dominate the entire product chain.

6. There is little incentive for the producer to improve the product design because the responsibility for the product is transferred to a customer at the point and moment of sale. In particular, the producer is not interested in improving the efficiency of the product during its usage phase because it is the consumer who pays for the electricity to power the product, not the producer. Theoretical justification of this point is presented by the Salter Cycle. Economies of scale minimise prices, which leads to increased demand for products. Companies are working on cost reduction and price minimisation, increase of sales and maximising profits through increased outputs and capacities. Thus producers are not interested in long life products (because the sooner a product will be broken, the sooner the consumer will buy another one); or low maintenance costs (because consumers are responsible for maintaining the products they own); or in repair of the products (because it is easier to make a new product than to repair the old one). Raising consumer awareness leads to increased demands for improved performance during usage phase. But until producers are interested financially in the improvement, little will be done in this respect.

7. Strategies of designs for X (usually, disassembly, reuse, refurbishment) are directed towards increasing product life span or, in other words, slowing product cycles. Prolongation of the

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37 Based on the discussion held at the seminar by Steven Reardon for Ph.D. students at the IIIEE at Lund University in September 1999.

product life span provides the opportunity to improve existing products, and to gain time in order to improve quality and to work on innovative new solutions. Providing less new products but more innovative ones is justified economically and ecologically. There might be a problem with social or societal justification, but technical, economical and ecological expediency together with understanding the real consumers' wants, reinforced by educational campaigns, might solve this problem.

### 3.3.4 Intelligent Product System

An alternative approach to eco-design is the Intelligent Product System created by Michael Braungart of the EPEA (founder of the Environmental Protection Encouragement Agency) in Hamburg, Germany. The system recognises three types of products: consumables, durables, unsalables.

The first are **consumables**, products whose waste becomes food for other living systems. Presently, many products that should be "consumables" are not, such as cotton cloth that contains many different chemicals, defoliants, and dyes that make them impossible for living organisms to use; shoes that are tanned with chromium and soles containing lead; silk blouses that contain zinc, tin, and toxic dye. Much of what is recycled today is toxic by-products that consume more energy in the recycling process than is saved by recycling. An alternative design needs to be developed; a design for decomposition so that used products should become fertiliser or food for other living systems.

The second category is **durables**; products that should not be sold, but leased, rented, or hired. Sophisticated products that, by definition, cannot be consumables, like cars and refrigerators, should always be owned by their manufacturer, so they would be made, used, and returned within a closed-loop system. Extended Producer Responsibility (EPR) is a facet of an environmental policy that promotes the take back of products by their primary manufacturer. However, it does not go further to show the drawbacks of ownership transfer. EPR is widely applied in counties of Western Europe and Japan, especially in particular industry sectors such as electronic and electric equipment and cars. This leads to a producers' initiative in design for disassembly.

Lastly, there are **unsalables** (toxins, chemicals, and heavy metals); products that cannot be broken down by living systems. Such products, therefore, should be totally accountable for by the manufacturer and should be either detoxified or stored in a proper manner until technology allows for their safe decomposition. Examples are found at Interface Inc. and the methods of handling radioactive wastes. However, such products should be developed with great caution.

Thus, all durable goods in an Intelligent Product System are owned and maintained by service providers and, therefore, they are productive assets and are to be used efficiently and maintained properly. The Intelligent Product System although not focusing on product design, suggests a new system of responsibility and in this way serves as a first step towards product-service systems that will be discussed in Chapter 0.

### 3.4 Production side of reaching sustainability

#### 3.4.1 Features of current production

Mass production is the main characteristics of the current production system. It is based on the creation of wealth through a flux of resources and goods due to economic activities, independent of the fact whether it is an addition of products, their replacement or repair and clean-up. In the

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current production system emphasis is still on process optimisation. In this situation, the short life of products is a prerequisite for economic success. New products with incremental improvements are sold on the market and justified with arguments of progress in technology or safety, changes in fashion and others. Our production system is extremely efficient thanks to global specialisation. But in the pursuit of highly efficient processes, robotisation and constant influx of new products, the economy forgot about utilisation (functional) value for consumer. What we see is that the system needed to satisfy the needs and wants is boosted in some countries, while the actual level of wants and needs stayed the same. At the same time, the environmental performance of the production system, despite all end-of-pipe and preventative measures, is becoming more and more environmentally harmful. Why do more efficient production processes lead to environmental degradation? More efficient processes provide us with products that satisfy our needs and in many respects our lives are better (at least in industrialised countries). In reality, our production system is highly inefficient (in USA 98% of extracted resources is wasted). So it depends on what is the starting point to our measurements of efficiency). Besides, that improvement in quality of life has been gained through a massively inefficient use of natural resources. Moreover, society developed a highly efficient financial system that masks all inefficiencies and provides improper information to the society about the efficiency of its system.

Why and how that happened? The very assumptions about the production systems were incorrect. Human productivity was overemphasised instead of resource productivity. So now the population is growing, while natural resources are declining. But even with the present level of efficiency of human resources we are dependent on material and energy flows. And as the ultimate goal of economic system is the increase of sales and thus, increase of production and consumption, and thus, exploitation of natural resources, of which we have less and less. The other design deficiency of our production and economic system is that natural capital is transformed into financial capital at an increasingly accelerated rate, and that is the fastest way to make a profit.

3.4.2 Strategies to reach sustainability by improving production

There are numerous methods of improving existing production processes and strategies that are being developed to minimise environmental impacts of these stages of the product's life cycle, such as pollution prevention and cleaner production, cleaner technologies and end-of-pipe technologies. These strategies include both technological innovations and organisational management-based approaches. All these strategies focus on in-house improvements. They are well known and have been implemented since the early 1970s, and therefore, will be outside the scope of this study. Several strategies that are currently being introduced into policies and industry sectors, however, will be scrutinised. They are mostly concerned with the post-user phases of handling products at the end of their conditional life spans and assume the extended producer responsibility for products in these phases.

Reverse logistics and Information Technology will be considered here, first being a strategy towards closing material and energy life cycles, the second one - being an innovation in the society that also increases efficiency of current production and has a potential to change the modern system of producing products and services.

Reverse logistics

In the broadest sense, reverse logistics stands for all operations related to the reuse of products and materials. Reverse logistics refers to all logistic activities to collect, disassemble and process used products, product parts, and/or materials in order to ensure an environmentally benign recovery. Traditionally, manufacturers did not feel responsible for their products after consumer

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41 Ibid. 10
use. The bulk of used products were dumped or incinerated with considerable damage to the environment. Today, consumers and authorities expect manufacturers to reduce the waste generated by their products. Therefore waste management has received increasing attention. Lately, due to new waste management legislation, the emphasis has been shifting towards recovery and especially remanufacturing (but not recycling\footnote{Recycling is criticised that it is not economically viable because of used electricity and materials, as well as limits to the recycling rates for many products.}), due to the high costs and environmental burdens of disposal. Firms become more and more responsible for collecting, dismantling and upgrading of used products and packaging materials.

The main reasons for companies to practice reverse logistics are:

- The environmental laws that force firms to take back their products and take care of further treatment,
- The economic benefits of using returned products in the production process instead of paying high disposal costs, and
- The growing environmental consciousness of consumers.

Remanufacturing is a new approach of reverse logistics and will be considered here in more details. Remanufacturing is the process of restoring used products to a ‘like new’ condition. Remanufacturing can extend the lifespan of a product or the product’s components that can be used as spare parts or combined with each other or with new components to create remanufactured products.\footnote{Ijomah, Winifred, Bennett, Jan & Jim Pearch (1999) Remanufacturing: Evidence of Environmentally Conscious Business Practice in the UK. in Proceedings of the IEEE International Symposium on Environmentally Conscious Design and Inverse Manufacturing, Japan, February, p. 192} In the remanufacturing process, all parts are restored to a "like new" condition, while during repair, only broken parts are changed and fixed, and during recycling, parts are broken down into raw materials. Remanufacturing process includes collection of end of life products, disassembly, cleaning, sorting, reconditioning or repair, and re-assembly. The goal of remanufacturing is to create products that fulfil the same function and are of the same quality as new products. There are many large companies that "are looking to remanufacturing as a premier way to hold costs down and keep products out of landfills", states The New York Times.\footnote{The New York Times (1999) 8th of November} Some major corporations have reported to be fearful that remanufactured versions of their products would cut into sales of new ones. To combat this, they sometimes use independent remanufacturers to keep small remanufacturing companies out of their market.

Examples of automotive parts remanufacturers include BMW, Germany; Ford Motor Company, USA; and Euro Motoren, the Netherlands. The Saturn Division of General Motors is working with the University of Tennessee to develop a software programme that tracks the energy and environmental impact of every part of a car, from manufacture to disposal to make parts easier to remanufacture or recycle. The software will also determine design changes that will make certain parts easier to recycle or reuse.

- Cameras: Eastman Kodak is remanufacturing its single use cameras.
- Toners, print cartridges: Xerox, Océ
- Photocopiers: Xerox, Eastman Kodak recently replaced some plastic parts in its high-speed copiers with more expensive, but reusable, stainless steel.
- Cellular phones: BT, UK; Sony Europe & Japan
- Carpets: Interface Inc., BASF, USA
- Weapons and military equipment: United States Department of Defence. The United States military is described as "the largest remanufacturer in the world since it routinely
uses remanufactured parts in vehicles and weapons”.45

- Office furniture: Davies Office Refurbishing, USA
- Chips: IBM is retrieving chips from its old machines
- Switching equipment: Lucent Technologies

Already in 1996 the US remanufacturing industry was a US $50 billion industry of over 70,000 small and medium-sized companies that employ nearly half a million people. The report of the remanufacturing industry shows that in 1996 there were 47 different types of products remanufactured, and at least 40 more were likely to become subjects of remanufacturing.46

**Information Technology**

It is difficult to imagine the current production system without information technology. The ratio of non-renewable resource consumption to output has been steadily declining in the developed countries, and this trend is likely to accelerate as the application of information technology increases the value added to materials in manufacturing.47 The economic value of national output consists to an increasing degree of the value added by information relative to the value of the material and energy inputs. Employment of multimedia services is growing in conjunction with rapid development of computer technologies and equipment innovation.

IT, not being the main characteristic of the production, is re-shaping our society and production methods. It, however, falls in being both product and production. At first, it seems that as a product, it is immaterial. But if the entire IT system is considered, than the IT product becomes much more material, consisting of cables, computers, printers, etc. An immaterial network is created, based on a number of interconnected information flows that is added to the existing network of physical flows. As any other product, IT followed the same type of development that is inherent to the current production, and society already experiences the excessiveness of information flow provided by Internet and information technologies - information pollution.

![Figure 1 Multi-layer networks in the information sector](image)

As a process, it has a huge potential to substitute some more environmentally burdening processes and activities, such as transportation, that can be substituted by tele- or video-conferencing. While in these cases it does substitute processes with less damaging ones, it still has a considerable influence on using resources (paperless office that in reality turned out to be more paper consuming, than before the introduction of information technologies). However, the IT industry made a significant progress in using dematerialised products to provide the service (computers become lighter and smaller, as well as telephones, diskettes, and printers).

One example from the IT industry concerns long distance transmission cables. Eighty years ago each telephone call from London to Liverpool needed over 80,000g of copper per kilometre of cable. There have been considerable improvements in efficiency over the years, to a point where the latest fibre optic technology has the capacity to transmit over 30,000 calls along a single glass fibre, with each call needing less than 0.001g of glass per kilometre of cable. The same cable ca

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now be used to provide a great variety of services, such as video, audio and software that will be supplied on demand, down the telephone line, replacing not only video cassettes and CDs, but also entire distribution networks.

Shopping, travel arrangements and information services will all be 'on line', replacing the need for paper publications - including telephone directories and environmental reports (many companies already have their environmental reports on the internet, e.g., BT). IT has a huge potential in increasing efficiency and speed of bank activities. It is also influencing our everyday life, affecting our homes the way we work. It helps to partially to solve environmental problems, but it also creates new ones as well.

Teleworking is now considered to be one possibility to solve congestion problems - one of the main environmental problems in urban cities. Reducing traffic by stimulating part-time teleworking requires new concepts at home (telework-places and connectivity with the home office), as well as at the office itself (flexible workspaces). Several companies are working hard to make this possible, not only in order to reduce environmental impacts, but also because of the economic incentive. It shows that ecology and economy can go hand in hand.

Information technologies can even make telecare possible. Telecare is the provision of health and support services over the new high-speed digital telecommunications infrastructure. The types of activities, which could be supported, include routine diagnostics, monitoring, screening, basic counselling and advice. Telecare offers a variety of benefits to users who can receive routine treatment almost immediately without travelling to, and waiting for doctors; they can participate in monitoring and diagnostics, which is less intrusive than traditional forms; or they can be assisted in routine treatments, including reminders about taking medication.

Still, there is a need to more thoroughly analyse the environmental impacts of the IT offerings and compare them with other options of the service provision. Additional analysis of the life cycle methodologies should be conducted in order to adapt it for IT applications (particularities arise with system boundaries, for instance).

3.4.3 Evaluation of existing strategies and some solutions

Mass production produces cheaper products with higher quality and contributes to wealth creation. But, constraints and limitations imposed by natural resource availability, energy supplies and absorbing capacity of the nature have led to the obvious problem of making, using, and disposing of an increasing number of products. In additions to these environmental limitations, social limitations are also evident, as are limitations of markets to accept increasing number of mass-produced products. Competition among those with an increasing productive capacity for markets with a decreasing absorptive capacity can lead to trade frictions and the difficulties they generate. Human capabilities of absorbing high-tech products also have limitations. To fundamentally combat these problems, we need to reconsider the current mass production paradigm and to pursue a new one. The new production paradigm should reduce the number of produced products to a manageable size (for consumers to understand the product's characteristics and necessity, and for producers to take care of the products at the end of their service life). Some call for a Post Mass Production Paradigm, which is a new manufacturing paradigm for decoupling economic growth from resource and energy consumption and waste generation. This means reduction of production and consumption to adequate and manageable levels while maintaining and even improving quality of life, including social issues.

The Post Mass Production Paradigm (PMPP) is based on the life cycle concept and allocates attention to crucial activities for closing the loop, such as refurbishment, reuse, remanufacturing, and recycling. The main goal of the PMPP is to decrease the total amount of products produced while maintaining the quality of life. The advocates of the PMPP consider the imaginary
situation with a closed loop economy and analyse how reduction of the production volume could be achieved. They propose two strategies. One strategy suggests the increase of the speed of the loop (circle flows and cyclic moves) circulation to match the demand. This will lead to shorter life spans of products, but total production would stay the same because of the closed system. Another strategy aims at the introduction of more expensive products with a longer life span. This will lead to the reduced production volume and material consumption.

If we look at the current linear system of production, in which anything entering system is consumed, and at a certain point of time discarded, then the second strategy is suitable for products with long life spans. In the present situation, second-hand use can actually improve the reuse. Recycling could also be promoted; production failures should be zero, thus eliminating production waste recycling. Post-consumer products could be recycled, if other approaches of closing life cycle loops are not possible, at the producer facility or, as a second option, in another company. Production by-products should also enter the system of products - by-products exchange. This, however, creates environmental impact through transportation, which is now the biggest emitter of CO₂. This leads us to an assumption that local production will be more sustainable, as opposed to globalisation. 49

Another aspect of current production to consider is the services supporting it. Presently the services extend from the marketing of the product to its maintenance. However, industry gradually provides service for later stages of the product life cycle (Table 1), such as those comprising reverse logistics, reuse, recycling, and final disposal. Consequently, for many producers the new areas of value creation and profit generation will be in operation, maintenance, recovery, etc. phases of the product's life.

Dematerialisation to decouple economic growth from the consumption of energy and resources means a shift to service contents provided by products. Thus products become a means to deliver services through product-based activities. The intensification of services requires an intensive use of accumulated knowledge about the function, the product, the services, associated externalities, processes and other product systems.

An open question still exists with respect to excessiveness of current production. Due to competition and rules of market economy, products are still manufactured in more than sufficient quantities. A big contribution is awaited from information technology in reducing production volumes. There are already some examples of such services provided, for example, video-on-demand, and publishing of books after they were asked for. Some new production practices such as Just-in-Time also leads to more reasonable amounts of products and materials purchased.

Closed systems of production and consumption assume that product quality does not depreciate with time. IT can help the producers to monitor the quality through software. The possibility arises than that the quality and functionality of products will be expandable through the software applications. Thus, multi-functionality will not be something built in from the beginning and unchanged, but instead functions would be added and products would be upgraded within a maintenance service provided by producers.

3.5 Consumption side of reaching sustainability

3.5.1 Features of current consumption system

Today, industrial output on a global level is about 20 times higher than it was in the early years of the 20th century. The population during the same period has tripled. 50 How this affected consumption patterns?


50 Ibid. 6 p.131
General mass consumption pattern. The transition to a developed industrialised society is usually accompanied by establishment of the mass consumption model with these main features:

- Markets are increasingly dominated by large corporations, which use massive production and advocate massive consumption through massive advertising. At the same time there is a change in material welfare and the development of "optional" consumption (purchasing of products and services that are not important for survival, that is, wants). However, these wants are gradually shifting into modern needs.
- Diet is increasingly based on animal protein and products imported from far-away countries, with a strong presence of highly processed and packaged food and beverage. However, food consumption has increased at a slower pace.
- Mobility and transport systems based on private cars. The infrastructure of housing, working, shopping, and leisure is built around the use of a car.
- Trends for suburban sprawl and growing energy use in housing;
- "Use-and-dump" culture, defined by short life of the products and high levels of production of waste. For example, only 20 years ago, self-repair of clothing was a common practice, while today it is, to a large extent, much reduced.
- Raising consumers’ awareness. The consumers’ environmental awareness has grown considerably during the past decade. However, in reality they still have very little knowledge about the links between their consumption choices and environmental consequences. The existing pricing mechanisms do not facilitate purchase of more environmentally oriented products and services. Instead, most of the environmentally benign products are more expensive.
- Transfer of ownership to consumers. The current consumption system transfers the ownership of a product to consumers at the point of product sale. Through the transfer of ownership consumers are made responsible for products and their environmental impacts during usage and disposal phase. Clearly, this is than, why there is an immense volume of waste in our society. The consumers, however, cannot be held responsible because they are so different and spread out, have little knowledge about environmental issues and little power in the product chain.
- So far there have been little or no policies or regulatory instruments to tackle consumption patterns. Developing any standards in consumption was considered as restriction of the choice of a consumer. It was not possible to force the customer to choose the environmentally friendlier alternative or dictate how it should be used in order to pollute less. However, the choice of information about the environmental performance of the products and their alternatives was not there.

3.5.2 Strategies to reach sustainability by minimising consumption

Cutting down on consumption sounds heretical. Not many people from industrialised countries are willing to minimise the consumption level they enjoy today. There is a need to bring consumption to a qualitatively new level. Instead of quantities, society should seek qualities that along with fulfilling customers' needs and wants will allow for environmental quality of the offerings on the market. The sufficiency revolution calls for “dematerialised” consumption, which is “to have a utility instead of ownership”. As Stahel proposes, in this respect the "point-of-sale" should become a "point-of-service". However, the main question "How we can

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51 Ibid. 10
52 Ibid. 9
53 Ibid. 32
minimise consumption without decreasing the standard of living? is still unanswered. We are reaching the point when we need to define what are the criteria for a high standard of living. Why do we need a high standard of living?

Sharing and pooling are strategies that have recently been promoted in order to minimise the consumption of certain products. This means that one product is used by several people. The positive ecological effect results from reducing the number of products, using industry-like appliances that are environmentally less damaging, and from the fact that the most efficient product can be selected from the pool. In addition, the increased use reduces the depreciation rate of the product. Consequently, products can be replaced faster by more efficient ones. The difference between sharing and pooling comes from different pattern of the product use - simultaneous or sequential. Examples include car sharing and car-pooling, and launderettes. Confusion exists about the use of these terms and often they are used interchangeably. American versus English definitions of these terms are actually opposite and thus, Americans use pooling when they talk about several people using the same car together.

This study uses English definitions, and therefore, car sharing means simultaneous usage, while car pooling means sequential use. There is also a difference between car sharing and car-pooling in ownership structure. While car sharing presumes that the consumer owns the car and shares it with others, an organised car-pooling assumes that the car is owned by a community, group of people that use it, or a commercial supplier. Car sharing is especially popular for people needing a car once in a while. The car sharing systems are set up by small entrepreneurs, providing evidence that sustainable concepts are not only developed by big companies.

There are other important considerations, which are further discussed in Chapter 0.

Leasing

Leasing is the long or middle term rental of mobile or immobile goods. During the leasing period the lessor remains the owner of the product being leased. Leasing arrangements that do not have a purchasing option seem to have more ecological advantages if the lessor embraces the concept of reuse and recycling. Such leasing arrangements are called eco-leasing. Leasing and renting are environmentally advantageous if the product at the end of the leasing contract is returned to the lessor in an agreed condition and at an agreed place. Thus, leasing arrangements include the reuse and recycling goals and serve to ensure the return of leased products.

Leasing rates paid by customers cover the amortisation of the leased products, thus an incentive is created to prolong the products' life span. This makes maintenance easy, and thus saves resources and minimises waste, which leads to lowered operation costs. The inefficient use of goods can be prevented and the entire use phase can be prolonged if, after the contract, the goods can be repaired and sold as refurbished second-hand goods to customers with lower demands and budgets.

The most cited example of leasing is that of copy machines. Two leading companies in the

55 There are more than 40 organisations in Germany that promote car-sharing (for example, Stattauto, Berlin – the oldest in Germany system); AutoTeilen and Autonative, Austria; Zurigo Sharecom and AutoTeilet, Switzerland; Coopauto, France; Kamsteeg AutoRental, Buurt Auto Service (BAS) and AutoDelen, the Netherlands; auto-sharing companies in Bergen, Oslo, Trondheim, Norway; Car Sharing at Cranfield University (Bedfordshire), England. These schemes are not only developing in Europe but in other parts of the world as well: C.A.N. Co-operative Auto Network (Vancouver), Autoshare (Toronto), Autocom (Québec City), Canada; Transportation Options (Washington State), Car Sharing Portland (Portland), National Station Car Association, USA; and Singapore CarSharing Coop, Singapore.

copier business, Océ and Rank Xerox, have changed their attitude towards environmental issues enormously throughout the last decades. Previously, their core business was to sell products, now it is to sell the function of the copier. As a result, their strategy is to lease their products. Therefore, producer responsibility is seen as a fundamental new way of dealing with environmental problems.

BMW is another example of the leasing arrangements becoming a part of the business strategy. BMW signed a contract with Digital-kienzle Leasing GmbH, Villingen-Schwenningen (Digital-Kienzle Leasing GmbH 78048 Villingen-Schwenningen) to support its take-back service, recycling or leasing solutions. There are many other leasing schemes for BMW vehicles in other countries, such as Canada, Italy, USA, and Austria.

Leasing can sometimes be a way to present specific products on the market, thus creating an opening for a market opportunity. For example, Black & Decker GmbH offers a leasing service for a relatively expensive professional series of mechanical saws, creating the possibility even for the private handyman to use them. General Motors leased electric vehicles instead of selling them when they first emerged on the market in 1996. The leasing is not only concerned with the cars, but with charging systems as well. General Motors understood that changing technology of EVs might cause customer concern over resale value and technology advances. Leasing the vehicle rather than selling it may alleviate some of these problems.

**Renting**

Renting means that a certain product is given out for an agreed period in return for a rental fee. The customer that rents the product is obliged to pay the agreed rent and to return the product in a proper state at the end of the rental period. The renting period is usually shorter in the case of renting than leasing. The temporary use of the product leads to a more intensive use of the product opposed to single owner usage, especially if she uses the product rarely. In general, renting reduces the purchase and production of specific goods that are usually quite expensive, considering the frequency of their use.

However, the environmental load of transporting the products every time they are needed has to be taken into account. The environmental potential of renting is mostly utilised if renting offices are situated close to the customer so that there is no long-distance driving involved. Examples of the commercial renting of products include car rentals, and the rental of copy machines, video recorders or recreational equipment. The renting side is interested in the production (or buying) of products with a long life span, which are easy to maintain, upgrade, refurbish, and to dispose of.

### 3.5.3 Inefficiencies of the proposed strategies

Eco-leasing creates possibilities for intra-organisational co-operation within the product-service life cycle. An Integrated Chain Management (ICM) analyses the possibility to minimise the

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58 http://www.dwnnblmw.com/PS.LeaseFinance.cfm
59 http://www.bmw.it/Prodotto/Finanziario/Leasing_data.html
60 http://www.ncbmw.com/finance.html
61 http://www.bmw.at/bmw/bank/leasing.htm
environmental impact of a product within its life cycle by involving actors. A producer, in order to establish a take back system, might need to co-operate with shops, recycling facilities, and consumers, etc. This, however, has its own limitations and drawbacks, such as the need for the transparency of product characteristics, the problem of strong and weak actors and possible conflicts of interest.

Eco-leasing has a built-in conflict between lessor and customer interests. Eco-leasing facilitates the monitoring of products and their performance during the use phase, their return and final disposal by the lessor. However, leased products tend to age faster than those owned by a private customer, due to the irresponsible use of the product by the lessee that increases wear. It is in the lessor’s interest, however, to prolong the product’s life span and to produce durable products that can be easily repaired, refurbished, upgraded, reused and recycled.

Leasing should be analysed very carefully as a means of reducing consumption because there is a tendency to accelerate the replacement of products, which leads to increased material flow and an increase in the intensity of product use, which leads to higher pollution if the products have considerable environmental effects during their use phase. On the other hand, customers might want to change products more often, which can stimulate the product development process so that more and more advanced and environmentally benign product-services are used.

Renting may lead to a reduction in the total amount of purchased products, as having the possibility to rent may lead to a decision not to purchase. On the one hand, renting might allow the use of more expensive products with a higher environmental performance that are not otherwise affordable (e.g., skiing and diving equipment). On the other hand, the demand for more expensive products might mean that more precious, rare or composite materials are used for their production, thus depleting resources and producing pollution that is difficult to clean up. Also the size of more expensive products might be larger, meaning that more resources are used in their production. Renting, as leasing, often decreases the responsibility from the consumer side, but improved maintenance and intensified use from the other side.

This short analysis shows that renting and leasing are not unequivocal means of minimizing consumption, but if employed in a system together with other methods, could be quite useful.

3.6 Features of sustainable systems

Utilisation over ownership Future consumption systems should be more focused on utilisation and functionality rather than physical or material value. Changing this focus will affect the design of products and will hopefully lead to the design of product systems where proper attention is given to service intensity. By orienting thinking towards function rather than product ownership, a change in the way products are designed and offered can be brought about. Some companies are already practising this by selling function. These include Electrolux, Interface Inc., Xerox and IBM (See more information about these examples in Chapter 0).

Increased service intensity It is an all embracing idea and James proposes six significant ways of achieving it. Some of them were presented as a separate strategies or types of eco-design before.

- Product substitution - for example, video on demand, where cassettes, as a product that provides movie function, are substituted with the transmission of the movie through wire.
- Life extension - through modular design and making products more durable.
- Use intensity - increased use of a single product and collective use of one product.
- Product augmentation - involves addition of new features to product in order to facilitate a

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63 Sustainable systems here include product, production and consumption systems.

service.

- Multi-functionality - product meets several different needs.
- Product integration - products meeting different functional needs can be integrated with each other to optimise their environmental and sometimes functional performance (temperature management in a house comprises insulation system, heating, and ventilation; making sure that these products do not conflict in their functioning).

Scenarios of sustainable services were presented by Ezio Manzini, among several others. However, many examples of these scenarios already exist in current society, and are implemented based on economic expedieny.

1. Immaterial services aims to substitute the material, tangible core of a product with a service component and thus, minimise the environmental impact. This is a typical case of the dematerialisation of products and services in which function was analysed and more environmentally benign ways of fulfilling it were found. As was discussed in Chapter 0, it is not yet possible to fully dematerialise a product, and thus, the goal should be the manifestation of continuous dematerialisation of function. Information and communications technology employment has been recognised as one of the promising ways of society dematerialisation (different IT applications were discussed in Chapter 0). Increased service intensity, through product augmentation, multi-functionality and product integration, plays an important role in operationalising this scenario.

2. Eco-efficient services increase resource productivity by fulfilling a function. Different schemes of a shared product use lead to minimised resource consumption per unit of a service fulfilled. This scenario corresponds to the aforementioned increased "use intensity" through the collective use of one product.

3. Community services further develop the previous scenario of shared use and aim for the reduction of individualism and a better balance in community development. Chapter 0 presents examples of cohousing and eco-villages that are based on the community services and decreased individualism.

Interactions between products, services and users Future production system should include the social innovation driven mainly by information technologies and by the increased possibilities to manage more and more complex systems of interactions between products, services and users. Even today we see the emergence of agile enterprises. The concept of "agile enterprise" is relatively new. Being agile implies being able to respond as quickly as possible to customers' demands, and to adjust to a rapidly changing market environment. Large agile enterprises will concentrate on their core activities and subcontract the remaining functions to other service firms.

The key firms will thus establish project-specific links with a network of subcontractors. These links will be active only for the time of a single project. "In this environment, organisations become 'virtual', and anything that is not the core function becomes a candidate for outsourcing". The agile enterprise concept proposes a radical change in the way production is organised. This change requires fast and reliable services linking many units inside and outside the organisation. There are entire new forms of organisations emerging, such as flexible networks of companies and employees (teleworking).

The challenge with future sustainable systems emerges not when we brainstorm possible future scenarios (that are to a large extent based on the current proactive innovative examples), but when we try to design sustainable future system, based on principles of economic and technological feasibility, environmental friendliness and social equity. Only practical implementation will provide us with answers about balancing four dimensions of sustainability.

The analysis of existing prerequisites for future systems in today's society, their characteristics,

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and design questions will be tackled in the next chapter that concerns product-service systems - the future sustainable systems of our society.

4. Functional economy and product-service system

4.1 Functional economy

During the last two centuries, the path of economic development led us from a dependence on agricultural production, through a period of rapid growth of manufacturing industries, to a post-industrial era in which service industries account for the dominant shares of output and employment. Thus, at the turn of the millennium we are witnessing the blooming of service economies with society experiencing a transition from mass-production to flexible production. A service economy is defined as one in which more than half of the total labour force is employed by the service sector. In the words of Schmidt-Bleek "the structure of demand is moving towards services. In industrialised countries, the share of manufacturing in business has already dwindled to 20-25 percent". Approximately 78% of all US workers are employed in industries commonly thought of as services; communications, transportation, health care, wholesale and retail redistribution, and financial services.

In a service economy, a gradual shift to the service sector comes in addition to a technology upgrade. The general shift to services reflects the genesis and expansion of entirely new industries e.g., computer software and cellular telephony, and rapid real growth in a variety of individual service industries (e.g., business services, wholesale and retail trade, air transportation, and communications). This new, more service-oriented model of manufacturing growth has key competitive factors such as the capability for continuous innovation, improved design and quality and customised goods, rather than the production of large volumes of standardised products.

What are the drivers of such structural change in our society? Some of the shifts in composition of output and employment depend, of course, on demographic factors. For example, urbanisation created the demand for sanitation and police; the ageing of the population has increased the demand for health care; a reduction in the working day has increased the demand for leisure services; women's liberation and a greater share in the workforce has extended the market demand for household services.

However, the most important forces are not usually realised. The industrial revolution, which was seen as the saviour of all human problems, and which shaped the development of the 20th century worked by its own rules, contrary to those of the natural world. It was deficient by nature; resources seemed inexhaustible and technological advances were viewed as something to be the answer for all the problems. Recently, however, the troubling symptoms of environmental decline have emerged and the dilemma about the direction of human development has been


67 Schmidt-Bleek, F. (1997) Into Productivity Hyperdrive. You think increasing resource productivity by a factor of four is a tough assignment? Try a factor 10. Tomorrow, Vol. 7 No. 4 p. 32
raised. There was less hindrance to the development of services, because services were generally perceived as less environmentally polluting than products (for a discussion on this issue, see Chapter 0).

Services have also developed in the manufacturing industry. The traditional boundary between manufacturing and services is becoming more and more blurred. Of the employees that are working in traditional manufacturing industries, 65 to 75% perform service tasks ranging from production-related activities like research, logistics (transportation), planning, and maintenance, as well as product and process design, to all supportive services existing at any company (e.g., accounting, financing, law services and personnel functions). Thus, more than 80% of all labour force is employed in services in industrialised countries.

The role of services in providing value is ever more important. Not long ago, most of a product's added value came from the production processes that transformed raw materials into products. Now there is added value from technological improvements, intellectual property, product image and name brands, aesthetic design and styling that only services can create. These help producers to differentiate and diversify their products to better respond to customers' demands; the so called move from mass production to the customised production or mass customisation. Therefore, there is an increased interest among manufacturing industries in putting less emphasis on producing products and more interest in adding value to a customer through the provision of a service that helps them to extend the spectrum of their products. Thus the environmental footprint of services extends into each product and every industry since they are an intrinsic part of the value chain. Therefore, early hopes for an environmentally clean service economy were overly optimistic.

The development of technology makes it possible to substitute products with innovative services, which is often referred to as functional economy. The idea of functional economy rests upon the notion that function is the key to customers' satisfaction, not products per se, thus in a functional economy customers are buying mobility instead of cars, cleaning services instead of washing powders and movies instead of videocassettes.68,69 Functional economy has the potential to be more environmentally benign than service economy because it questions the current levels of consumption and suggests options that provide services to customers without minimising their level of welfare. In a functional economy, the role of the manufacturer is shifted towards provision of services.71 Stahel notes that functional economy "optimises the use (or function) of goods and services and thus the management of existing wealth (goods, knowledge, and nature). The economic objective of the functional economy is to create the highest possible use value for the longest possible time while consuming as few material resources and energy as possible".72 In the functional economy, material products are treated as capital assets rather than as consumables, thus increasing value-added services to prolong the product's life and minimise loss of resources. Therefore, functional economy reduces capital depreciation.

Similar terms that are used most closely to functional economy are weightless economy, knowledge-based economy and zero-emissions economy.73 Weightless and knowledge-based economies embrace the

69 Ibid. 9
73 Ibid. 71 pp. 366-367
idea that creating knowledge produces economic value, while innovative technologies and a service provision are the main focus of the zero-emissions economy. Adding value and creating wealth in a weightless economy is not just a matter of building bigger houses or faster cars and making consumers buy them; it is also about emphasising the demand-side in order to appreciate the utility afforded in the new products and services. This will be discussed further in Chapter 0. Below is the classification of terms used in this study.

A literature search showed that there is a great variety of terms, and that often service economy has a double meaning; an economy with prevailing traditional service industries and an economy that has products reinforced by services, substituted by services and products with different schemes of product use. We, therefore, decided to use the following terms:

- The "traditional service industry" term for the economy with prevalent service industries in creation of a GDP.
- The "service economy" term is used to define an economy with products reinforced by services and with different concepts of product use (a lot of such examples presently exist).

![Figure 2 Services classification](image-url)

- The "functional economy" with product-service systems consisting of products that are substituted by services (Of course, it is not yet possible to substitute products with 100% immaterial services, but there is a possibility to substitute products with less environmentally problematic services based on more advanced products. Because we talk about product-service systems, these also include products reinforced by services and with alternative concepts of product use.) The main difference between functional economy from the service economy is that in the former an entire product-service system is designed, rather than only a product, as is the case in a service economy (the design of PSSs will be further explored in Chapter 0).

The present economies are mostly service economies saturated with products reinforced by services and some examples of alternative systems of product use. Empirical studies have indicated that even in industrialised countries with an expected higher level of product-service systems, penetration of new products and services are more complementary, rather than being substitutes.\(^4\) A functional economy is a more environmentally friendly economy only when the rate of economic growth is less than the efficiency gains of global resources. Global resources efficiency is the result of:

- the reduction of life cycle environmental impact of an average product (measured by MIPS), and

• the substitution of resource-intensive products with service-rich offerings (see Figure 3).

The first condition is dealt with under the auspices of eco-design and eco-efficiency and (Chapters 0 and 0), a product-service system design addresses the second condition. Below an environmental impact range is presented, depending on the level of intangibility of different products and services. It shows the distribution and also that there are not services without any environmental impact. Thus, we cannot exclude services from product-service systems as being environmentally innocent.

The environmental attributes of a service are quite tangible characteristics that could be measured, communicated and taken into account. The more tangible the service is, the easier it is to measure the environmental impacts.

The product-service system per se and its design particularities will be analysed further.

4.2 What is a product-service system?

Among the emerging concepts of how to achieve substantial reductions in the overall environmental impact of consumption and production activities, servicisation (or this study uses the name product-service systems (PSS) and moves towards PSSs) plays a prominent role. Society of product-service systems means the change from a focus on producing and consuming products to a society where the service components are increasingly replacing the more traditional material intensive ways of product manifestation, that provides individuals and organisations with the possibility to fulfil needs through the provision of more dematerialised system solutions.

The concept of the product-service system has its own history that reflects the development of our understanding of the production systems of our society; the society went from focusing on production systems to products. The next stage was the discovery of the entire system of surrounding factors, such as other products and services, drivers, stakeholders, factors that influence a product's performance, friendliness to the customer and environment, price, reparability, and all other parameters of the product's life cycle. The latest finding was that customers actually buy services instead of products, and that the service plays a very important

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75 Figure 3 is developed on the basis of the picture from Shostack, G. L. (1977) Breaking Free from Product Marketing. Journal of Marketing, Vol. 41, No. 2, April, pp. 73-80
role in customer satisfaction and again in product performance.
Extending producer responsibility helped realise the boundaries of producers' abilities to take care of the product, and to distinguish between consumption and production boundaries and the consumers responsibility in decreasing environmental impact of a product.

Stahel came up with the concept of service society as a means of reaching sustainable development. He advocated the need to distinguish between industrial economy and service-oriented economy. Industrial economy places the central value on the value of the exchange on the products that are sold. On the contrary, service economy recognises the value of utilisation, a performance driven orientation where the consumer pays for utilisation of the product. Thus in the latter, both product and technology are mere modes of providing function. Stahel argues that within the paradigm of the service economy, an intrinsic force towards efficiency is available, since the income is generated on the basis of performance costs with a responsibility of supply.

Manzini proposed the strategic product system, including product, service and communication, as a mode for companies to actively take part in society developments and on the market. Jansen and Vergragt have been working on the concept of sustainable product systems that cross company boundaries and include all stakeholders in the process. Many other approaches have been suggested:

- the sale of the use of the product instead of the product itself,
- the change towards a "leasing society",
- the pursuit of services instead of material flows,
- substitution of goods by means of service machines,
- a repair-society instead of a throw-away society,
- the change in consumer habits from sales to service orientation or the implementation of sale of services instead of products.

These concepts which are rather heterogeneous, are based on the common idea that the distribution of ownership of goods have considerable influence on the volume and speed of the material flow in an economy and therefore of importance in ecological terms.

The sale of products does not encourage a closed cycle economy because at the point-of-sale the responsibility for the user phase and the disposal is transferred to the customer; it is the customer who decides what is to happen to the product after use. The sale provides no incentive for the manufacturer to supply goods, which have a long life or are reusable.

Many research institutions are working on developing these and similar concepts, and on

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collecting and analysing existing examples of such concepts in companies and communities. They will be presented later in Chapter 0.

This study defines a product-service system as follows:

A product-service system (PSS) is
- a pre-designed combination of products and services in a market that can fulfil consumers' needs; and
- a dematerialised solution to consumer needs and preferences;
- a result of rethinking of the product value chain and ways of delivering utility to customers that will have a smaller environmental impact than separate products and services outside the system.

For consumers, product-service systems mean a shift from buying products to buying services and system solutions that will minimise the environmental impacts of consumer needs and wants, and this requires a higher level of involvement and awareness.

For producers and service providers, product-service systems mean a higher degree of responsibility for the product's full life cycle, the early involvement of consumers in the design of the product-service system, and design of the service system for the product (PSS design will be further discussed in Chapter 0). This utility-based consumption is finding increased application in professional markets where companies are looking less for prestige and status from the products they buy (as is the case with private customers), and more for cost effectiveness and functionality.

For both consumers and producers, product-service systems might sometimes involve a change in property rights. In general, product-service systems give more attention to the usage phase of the product's life cycle (consumer stage), than other methods of environmental policy and management, except for eco-labelling the ultimate goal of which is to provide information and advice on environmental characteristics of products.

Unlike eco-labelling, the paramount goal of product-service systems is to minimise environmental impact of consumption by:
- reducing consumption through alternative schemes of product use;
- increasing overall resource productivity and dematerialisation of product-service systems.

The concept of a product-service system has already been applied by some companies and has been driven mainly by business considerations, rather than environmental. The Extended Producer Responsibility concept places responsibility for the entire product's life cycle on the producer. The product-service system might be seen as a preventative approach to minimise costs of such responsibility:
- if there is a possibility to internalise use and disposal costs;
- if the product still has a high value at the disposal stage;
- when the provision of a product becomes a cost rather than a profit (see cases on chemical management services).

The concept responds to existing trends in industrialised lifestyles including shortened product lifetime, increased individualisation, and property orientation (ownership) by finding solutions for the extension of product lifetime, increased collective/shared use, and using, not owning a product. However, it is difficult to deal with different scenarios of alternative product use because they are often situated (on a theoretical representation of a product life cycle) between production and consumption. Thus, when designing a product (production), future users should be involved. At the same time the social system or infrastructure that would accept the suggested product scenario should be found. If such a system does not exist, a completely new

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infrastructure/social system should be designed that can support the environmentally benign performance of the product. However, such a cross point in the production and consumption system makes it difficult to design such a system because several stakeholders should be involved in designing both the product and the service system.

4.3 Why a product-service system?

4.3.1 Benefits

The concept of a product-service system is not new in itself, what is new is the recognition that this system has the potential role to bring about changes in production and consumption patterns that will accelerate the shift towards more sustainable practices and societies. The concept to be implemented needs to be adjusted towards strategic goals of companies. However, in this case, the concept goes beyond the companies' goals of increasing the total amount of products sold to support profit maximisation by offering function fulfilment, and aims to minimise environmental impacts at the same time. But the concept is promising not only for commercial companies; the concept of a product-service system is promising for governments, companies and customers.

For governments:

PSS addresses the issues of more cleaner or sustainable production, as well as consumption. This part of our society is not well investigated and even less regulated. Governments need an understanding of PSSs in order to formulate policies that promote sustainable patterns of consumption and sustainable lifestyles.

For companies:

Understanding PSSs for companies provides the opportunity to see strategic new market opportunities, market trends and developments, and to go beyond the habitual perceptions and routines of a company. The concept of a product-service system facilitates innovation at a more than incremental level, diversifies the PSSs offered to customers, and finally, leads to financial benefits. Whereas a manufacturer's interest is oriented towards selling as many goods as possible, the sales objectives of a supplier of services is the use or the result of the use. This can lead to ecological incentives for companies to save resources and prevent waste. Since the companies remain the owners of the products, economic objectives of profit maximisation are realised much more quickly if a product can be used as long and as intensively as possible.

Some companies are pursuing the product-service concept as a natural continuation of extending their offerings to the customers. Others see it as a survival strategy (e.g., Xerox, IBM84) where the application of a PSS is seen as the centre of a new business plan. Usually these companies are forerunners and see the lost opportunity of being first on the market as a threat to survival. Yet another group of companies reassessed their day-to-day business and found product-service systems as a way to strive towards sustainable development (e.g., Interface, Inc.).85

There are different benefits to developing a PSS for a manufacturing and service companies.

For manufacturing companies: a service component adds and allows:

• The possibility to attach additional value to a product; paying schemes or refurbishing or upgrading, etc.
• The possibility to base a growth strategy on innovation in a mature industry.
• The improvement of relationships with customers because of increased contact and constant flow of information about customers' preferences.
• The improvement of the total value for the customer because of increased servicing and

84 Ibid 83 pp. 85-88, 95-97
service components so that product-service package is sold. Servicing includes activities that make the existing product last longer and function properly without changing its projected characteristics, such as maintenance. Servicisation includes activities and schemes that make the existing product last longer, extends its function (upgrading and refurbishment), and makes the product useful after finishing its life cycle (recycling and reuse of parts or entire product).

- Anticipation of future take-back legislation, which can be turned it into a competitive advantage and financial gains by re-using end-life cycle products.

**For service companies:** product components:

- Extends and diversifies service.
- Safeguards market share by bringing component that is not so easy to copy.
- Facilitates communicating product-service package information, as it is easier to communicate information about more tangible products than intangible services.86
- Safeguards a certain level of quality that is difficult to change (product quality).

**For customers:**

Customers benefit from the product-service system because they get a greater variety of offers on the market, maintenance and repair services, payment schemes, and the proposal of different schemes of product use that suit them best in terms of ownership responsibilities. Customers get added value through more customised offers of higher quality, which comes as a higher quality of product/service per se and a higher quality of delivery/provision.

The service component, being flexible by nature, induces new combinations of products and services, creating new functions to better suit the customers' needs.

**For the environment:**

A PSS that looks at how product-service packages are delivered to customers and to what extent the function is fulfilled, has the potential of decreasing the total amount of products by introducing sharing/renting/leasing schemes for customers.

In employing PS systems, a producer becomes more responsible for her products-services because the material component has to come back to the producer or supplier, thus material cycles are closed, passing over the waste stage. Producers are taking back their products, upgrading them, refurbishing and selling them again (see section on Xerox activities on remanufacturing). In the end, less waste is incinerated or landfilled.

The product-service approach changes the price cost systems of the present economy because consumers do not pay for material goods but for intangible services. With the development of technology, less and less material will be used in the product, but more services will be added. Thus, the decoupling of economic and environmental development will be possible. If we look at the latest developments in this direction, decoupling is already an on-going process.87

It is expected that the orientation towards services will open new markets and potentials for value creation beyond production and sale. Evidence of this is the increasingly smaller margins in "the pure sale of products". The sale of services offers an opportunity to escape the pressures and gain economic success by having a higher turnover of goods, which includes large material flows. At the same time, it is expected that the promotion of added services or supplant products and alternative schemes of product-services use would assist in the creation of new jobs. This is substantiated by the belief that competition would increase and that more job intensive value creation chains will be realised than with mass production. Services are generally closely tied to

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86 This was showed in Schneider, Åsa (1999) Environmental Declarations as a Communication Tool for IT-Services: The Case of Telia. Masters Thesis, IIIEE

87 Ibid. 24 p. 9
location since the demand arises from more local circumstances, and they therefore contribute to the strengthening of the regional economy. In view of the trend towards globalisation, this is a factor of considerable importance.

For the society:

The functional economy is inherently more labour-intensive than an economy based on mass production and throwaway patterns of consumption. More jobs per unit of material product is created because of such labour-intensive services such as take back systems, repair, refurbishment, or disassembly. These services are less able to become large-scale operations, and therefore they are not standardised, as material products and processes. On the other hand, services minimise labour productivity (If we measure it with the indicators we use to measure labour productivity of economies of scale. Labour productivity in a functional economy might include customer satisfaction, which might shift the common understanding of the term per se.)

4.3.2 Drivers

The growth of product-service systems can be perceived as a demonstration of an economic transition away from standardised and mass production towards flexibility and customisation of product offerings. The fordist understanding of management, that is, how to make more goods more efficiently, gained currency a century ago with the success of such giants as Ford, Coca-Cola and Sears. Too many companies, in a rush towards low costs, neglected the fact that every customer is unique. This concept gained momentum when companies discovered segmentation in the 1950s and niche marketing in the 1980s. The rise of mass customisation in the 1990s has been both a response to, and the impetus behind, the not so commonplace notion of segments of one; every customer has her own market segment with specific requirements that must be fulfilled.

Lately, competing companies shifted to outsourcing, supply chain management, organisational learning and agility in order to supply their customers with additional values. Core competencies, rather than physical assets increasingly define leadership of companies on the market. Companies are increasingly comfortable involving several stakeholders in the decision making process and identifying strategic directions, as well as buying services and skills from outside their gates.

Product-service systems more appropriately respond to the demands of today than existing systems of mass production. From the corporate point of view, purchasing a service instead of a product is driven by outsourcing activities when it is more beneficial for companies to buy than to keep all the necessary services and competencies in a company. In the same way, leasing allows companies to keep away from maintenance costs. Outsourcing also means that production itself can be outsourced as in case of computers, which are mostly made in Asia. However, in order to sell a product-service, what is needed is knowledge of local context and infrastructure. Thus product-services can be used in order to achieve product differentiation and finally market advantage.

Improved competitiveness through improved environmental performance is also named among the drivers of the shift from product to services. Others include legislative threats (although no explicit demands have ever been placed on producers to introduce services into their product), developing or supporting image, and customers wishes. Some companies started thinking about expanding the offer to customers through services to increase their competitive dominance. Other companies are doing this in response to legislation that looks at servicing products with significant environmental impacts during the use phase. The most important external driver for a company, however, is supplier development. This consideration also sets a basis for supply chain

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management and integrated chain management approaches, which have already formed the foundation of environmental policies in some countries (e.g., the National Environmental Policy Plan, the Netherlands).

### 4.4 Classification of PSS

#### 4.4.1 Definitions in PSSs

The possibility for misinterpretation of terms used by academicians and company representatives in the area of product-service systems was noted during the preparation of this report. Therefore, in order to avoid misunderstanding, the list of terms and definitions used in this report is presented in this chapter.

A **product** is a tangible object produced to fulfil consumer's needs.

A **service** is heterogeneous, mainly an immaterial and perishable activity or process offered by a company or an institution and consumed at the same time as it is produced.  

A **system** is any assemblage of things forming a regular and connected whole.

A **product system** is a system of products and services that fulfils one function, which satisfies consumers' need. Product system development includes product design and design of the service system that minimises the product's environmental impact, as well as analysis of existing infrastructure and social arrangements that help with a more environmentally benign performance of the product throughout its life cycle. For instance, the design of diskettes should also include an analysis of the existent, or design of a new, system of their utilisation at the end of its life.

A **product-service mix** is the extension of the service component around the product for business activities that are traditionally product-oriented; the introduction of a new service component marketed as a product for business activities that are usually service-oriented. A product-service combination has the same meaning as product-service mix.

A **product-substituting service** is a service that enables needs fulfilment in such a way that it brings a significant decrease in the materials needed for the fulfilment of the customers' needs. For example, a telephone company may substitute an answering machine with an answering service. There are definitely, however, certain limitations to what extent products can be substituted by services.

#### 4.4.2 PSSs dichotomy

When analysing literature and talking to experts and researchers working with PSS, a clear lack of common definition and classification was observed. Below, several classifications will be presented to show similarities and differences that will help to identify the level of advancement of the research of PSSs. Some critical comments about proposed classifications will be presented.

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Based on Manzini's definition, Meijkamp proposed following classifications:

- **Product-life extension services** extend guarantees, repair, and maintenance; disposal is included as well.
- **Product-use services** offer a service of using products without owning them. The environmental benefits come from the more intense use of products, which are better maintained, such as call-a-car service.

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89 Mont, O. (1999) Strategic Alliance Between Products And Services. World Service Congress '99, Atlanta, Georgia, USA


Demand services fulfil consumers' needs in an innovative way. PSS is a replacement of a tangible product with an intangible service (not 100%), such as videoconferencing, teleworking, teleshopping, etc.

Product-life extension services are reflected as activities associated with the production side. However, the best product-life extension service is a smart product design. Demand services call for 100% substitution of a tangible product with an intangible service, which is not possible at the present levels of technology development.

Another dichotomy of eco-services was seen in the project on Eco-services for sustainable development in the European Union (Figure 4). Primary services are services that do not have a material component. An example of such a service is a hairdresser. However, a hairdresser needs material products, such as a comb, hairspray, a mirror and many others, to be able to offer a service. Secondary services include services, in addition to products, such as repair and maintenance, and services, substituting products. Services-substitutors are divided into two categories: result oriented (a result of a product performance is marketed, not the product per se, because the consumer is interested in a service associated with the product, not in using the product itself. An example can be hailing a taxi,) and use oriented services, that are divided into individual use (leasing, renting, and hire) and joint use (sharing and pooling).

The latter classification distinguishes between use-oriented and result-oriented services as categories of services-substituting products. Use-oriented services cannot be called a service-substituting product because there is no product substitution that occurs as in the case of result-oriented services with the introduction of new innovative services (through technical development of new products). Use-oriented services are delivered to the customer in a different way to result-oriented services; they give the option of choosing the way a product will be used. They are similar to result-oriented services, however, in that they provide a consumer with a service of using a product without owning it.

![Figure 4 Framework of eco-services](image)

The third classification of "services" was proposed by White et. al. All services were divided into non-material services and material, or product-based, services. Non-material services are delivered via a supporting infrastructure and goods that are owned by the service provider. Non-material services include hair salons and insurance and banking, thus the entire range of what we called traditional service industries are included.

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93 Ibid. 83 p. 18
Figure 2). Non-material services include, as a sub-category, dematerialised services that are based on highly dematerialised products per unit of service delivered (centralised voice mail instead of answering machines). Material, or product-based services use a physical product as the mode for delivering services related to the product for customers. They incorporate both product extension and product function services.

![Services diagram]

**Figure 5 A taxonomy of services**

Demand services (Meijkamp's classification) and result-oriented services (classification in the project on eco-services) partially capture the essence of the product-service system. The elements of PSS come from dematerialised service in White's classification. Different ways of delivering service of a product, such as sharing, pooling, leasing (product extension services) are mechanisms for only one stage of a product-service system. They definitely complement environmental benefits that can be gained through the provision of a product-service system, but are not the core of environmental gains in such system. The broken line shows this contribution in Figure 5. The systematisation used in this study is presented in Figure 6.

![Functional and service economy diagram]

**Figure 6 Components of product-service system**

Products reinforced by services include offers associated with the purchasing of a product. They begin with consultation and include maintenance and the take back of the appliance. Certain positive ecological effects may from using the appliances more energy efficiently due to proper handling, proper functionality and a longer life span of the appliances. The right to use the products

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94 Ibid. 83 p. 18
remains solely with the owner.

Different concepts of product use consists of two categories:

- The category of shared use of product where a product is moved to a customer (sharing scheme that includes all schemes of renting, leasing, private or collective use, sharing, pooling).

- The category, in which the customer moves to the product, which stays in one place. The product stays in the centre of attention and is paid for with a flat fee. A well known example for this kind of service concept are the copy shops where the user is charged per copy that usually was made with a rented copy machine. The customer does not care how the service is rendered; she is foremost interested in a satisfactory result. The supplier, however, has a business that is more lucrative the more efficiently the service is provided. This could result in a new economic rationale: "The enterprise sees itself as a supplier of a system and not the producer of a certain good. If more efficient alternatives emerge in the market, the company can easily use those alternatives, since the company identifies with the service (goal) and not with the product (means to a goal). This leaves room for creative solutions which many companies do not presently consider."

Product-service systems include previous schemes of shared product use, employment of IT (central answering service instead of answering machine - as well a type of shared use) plus more environmentally adopted product-service system design, reuse and refurbishment, increased customer involvement and participation of product-service system design and operationalisation. System components will be elaborated in more detail in Chapter 0.

Products (to a larger extent) substituted by services are not yet known (the use of the power of the human brain to educate, such as when parents teach their children with their own behaviour and example).

4.5 Characteristics of PSS systems

4.5.1 The role of producers

The successful application of a product-service system requires that manufacturers and service providers extend their involvement and responsibility from products to phases in the life cycle, that are usually outside the traditional buyer-seller relationship (see Table 1), such as take back, recovery of products and materials, reuse and refurbishment and remanufacturing. The difference of the role of producers in product-service systems are that these activities are designed at the same time as the producer designs its product. A close co-operation between a producer of PSSs and the service provider solves the conflict of interest when profits do not depend on the volume of the product produced and sold that happens because of a profit gain during the service provision schemes (leasing, renting). The producer does not have the incentive to produce more because

- the price of the product is much lower than the price of its use, which goes to the service provider and
- there is no market for her products, as products are used more intensively by several people but not bought.

The co-operation also means that all information and economic benefits from the service provision stage (use/consumer stage) can be easily transferred to the manufacturing and design stage, thus the entire system becomes more flexible for changing market parameters.

Producers are playing the role of the co-ordinating actor in the product chain. Usual responsibilities for products are extended through an increased or deepened responsibility for service, including the responsibility for educating customers and increasing their awareness about efficient product use and for proper organisation of the take back arrangements and systems for reuse, remanufacturing and recycling. Reduced material flow also requires a stronger co-
operation with suppliers. Producers are called upon to use the latest innovations in technology and environmental sciences, and to cross boundaries of their own companies, when providing package solutions to their customers.

4.5.2 The role of customers

The relationship between the company and customer plays a key role if the product-service systems are to be designed and run in a more environmentally friendly way. Two types of customer involvement can be distinguished:

- design for customers, and
- customers' design.

The first type refers to the design of a product with characteristics that respond to customers' needs, wants and preferences. Customers' design refers to the design of a customer so that the company's efforts (to introduce, for instance, more environmentally preferable product or entire product-service system that requires a certain behavioural pattern from consumers) are understood, appreciated and supported. Table 2 depicts a product-service system showing to the customer's influence (bold areas). Thus, stage 1 and 6 are designed in accordance with the customer's influence. Stage 7 is the first one that provides a basis for the customer's design. In order for stages 8-13 to be successful, a certain level of customer awareness is required.

Table 2 Influence of consumers on a product-service system

<table>
<thead>
<tr>
<th>Life cycle stages</th>
<th>Product</th>
<th>Production</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Product design and development</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Process planning and development</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>3. Purchasing</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>4. Production</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>5. Control and test</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>6. Control and treatment of non-conforming products</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7. Handling, storage, packaging and delivery</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>8. Marketing and market research</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>9. Selling/leasing</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>10. Use</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>11. Maintenance</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>12. Refurbishment/ upgrading</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>13. Take back</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>14. Reuse</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>15. Recycling</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>16. Final utilisation</td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Proactive companies started working more closely with their customers, who depended on them for many types of environmental information. In turn, service or servicised companies often have early insights into consumer tastes, preferences and regional buying habits. Thus, such companies play a critical role in both satisfying and creating consumer preferences for goods and services, including their environmental dimensions. Customers of Wal-Mart's environmentally designed store in Kansas are informed directly and indirectly about the environmental impacts of products in the shop. Home Depot has instituted extensive efforts to provide "green products" to customers.95

The success of PSSs comes from acknowledging the properties of the product systems that are traded in the functional economy, and then exploiting these properties. However, the demand side (consumers, customers and users) should be informed of, and made excited by, the unconventional properties of product-services from the functional economy that is placed in their hands. The next step of the functional economy after the recognition of specific properties of products and services that satisfy consumers needs and selling them, will be free distribution of products and the selling functions associated with them. We now see this happening with mobile telephones that are given to a customer for free, and instead a contract is signed for the mobile phone use. Netscape gave away 40 million copies of its product and now even made its browser source code available to everyone. Money is made by extending the features and services of these freely distributed products that consumers already feel associated with. Therefore, value is added to the society too.

Social research, however, shows that there is a problem with regard to motives and orientation of values that contradict the rather global conjecture of consumption without ownership and of collective use. More precisely, they contradict the presumption that consumers are more interested in the use of goods than in their ownership, provided that such a viewpoint is taken into account at all. Frequently, the dispute about concepts of eco-efficient use is conducted from a microeconomics perspective. Or, the debate is aimed towards a critical discussion of the common economic terms and definitions, for example the value of a product or the term “services”. Bierter for example, talks about products that are primarily “equipment to fulfil a service”, that satisfy certain functions, and thus human needs. Hockerts and others question the connotation of value. According to them, considering ecological efficiency, the value of a product is not determined by its ownership, but by its use. Hence, an increase in capacity for use will increase the value of the product. Consequently, sustainable use and service concepts should increase the capacity of use for products. Efficiency of resources should not be achieved by a sacrifice on the consumers’ side, but by a more efficient use with a simultaneously unchanged service level.

According to a representative household survey conducted by the IHS (Institute for Advanced Studies) in Vienna, the main reason why people prefer to buy a product instead of using a leasing or service contract is based on the desire to own things as well as to have the opportunity to use them anytime. According to the aforementioned study, there are two main reasons, which serve as a primary rationale for collective use:

- Financial reasons (for example it does not pay to buy the product),
- The product is used infrequently or only for a short period of time (lastly also a financial reason).

These results were confirmed by a qualitative study of persons who rented the equipment for home improvement. They showed that “the decision to rent a tool is primarily based on considerations of price and frequency of use with equipment that is costly. Additional factors like limited duration of use, the option to select other products, facilitating work through rented

100 Ibid. 99 pp. 8-9
equipment and diminishing responsibilities of ownership add to the appeal of equipment for rent. Considerations of environmental protection do not come into play. Renting requires more organisation as well as more and recurring travel time. Both of which are seen as a major disadvantage of renting. Accordingly, interviewees desire more advertisement about and information of companies that rent equipment. These places should be easy to reach, have customer friendly business hours and provide more service in regard to the renting arrangement or options for delivery as well as better legal protection for customers.”¹⁰¹ And: “The interviewees point out two major advantages of ownership of tools: firstly, ownership provides the option to use the tool any time independent of other people or business hours of the renting store. Secondly, different tools can be used many different ways, if they are easily available.”¹⁰² Increased storage room is seen as the only disadvantage, in particular in city apartments.

Most surveys in the social sciences on collective use concentrate, as mentioned above, on individual motives, on utility and on advantages of collective use. Often, collective use is defined as use that takes place at different times and not as a simultaneous use. Processes within the groups are hardly ever considered. An explorative study on collective use of a sauna for women in Vienna shows that precisely such group processes play an important role in collective use.¹⁰³ Based on the data presented above, it is clear that customers’ research need to be considered more thoroughly and conducted not only by social researchers, but by economists and environmental experts to find ways of introducing more environmentally adopted products and services.

4.5.3 Organisational basis for PSSs

Organisations that are the basis for producing product-service systems also have their particular features, such as agility, focus on core competencies and outsourcing of all supporting functions. Companies that are pursuing the concept of product-service systems will face the necessity to change the traditional structure, depending on whether they are now manufacturing or service providing organisations. If the most expected transition from manufacturing company to the company based on PPS is considered, than several organisational changes emerge. Close cooperation with consumers leads to extended organisational function that deals with customers. Usually it affects the administrative department and the process optimising department. Information management plays an increasing role in improving organisational efficiency and relationships with the final user. Organisation with consumer relations being the core of the business, is likely to make considerable investments into human capital - employees, and thus, the importance of education is growing. As product-service shaping occurs during interaction with the consumer, the structure of decision making is more decentralised. Moreover, employees are receiving first-hand information from consumers and thus, again, decision making is more democratic.

The extended involvement of the organisation with other companies leads to intra-organisational changes that include performance indicators and the demand for human capital. These intra-organisational changes modify the relationships between the business functions within the company.

The inter-organisational changes such as closer interaction with other actors in the product-service chain and outsourcing create the demand for intermediates. Some new companies that are based on one or several principles of a functional economy, such as car-sharing companies, computer leasing companies, telecommunication services, and chemical services, were never

¹⁰² Ibid. ¹⁰¹ p. 65
production companies, however, they play an important role in a product-service system. Some see that they play the role of aggregators and middle-companies. However, concerns were raised over introducing yet another stage/step in the life cycle of a product, thus dissipating information flow that is very difficult to initiate and support.

The agility of emerging organisations leads to creation of different kinds of networks that can be used to develop product-service systems. These networks can be

- **Information sharing networks** developed to share information that is relevant for entire product chain or industry sector
- Research networks that can investigate market changes and consumer preferences
- Regional networks – industries located in the same region can organise a network to close loop by transferring
- A sectoral network – industries, representing the same sector can organise a network to exchange the best practices, set the sectoral level of performance, etc.

4.5.4 Design particularities

There are no existing examples of design projects/attempts where an entire product-service system would be designed. Usually there is a practice of designing a product that fits the existing production equipment and technologies because usually the same company is involved in both stages. Chapter 0 considers different strategies for minimising environmental impacts at different stages of a product life cycle and the product per se. To facilitate dematerialisation in product design the Wuppertal Institute has developed guidelines on ecological product design. They look at optimisation of design/production factors and operational/maintenance factors, such as: how can products be re-designed for multi-function (e.g., fax-telephone-copier) and multi-user (e.g., server-network system) utilisation. However, these are still only components of the entire product-service system. Design of the entire product-service system would include the following stages:

<table>
<thead>
<tr>
<th>Design/production factors</th>
<th>Operational/maintenance factors</th>
<th>Post-consumer factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced size</td>
<td>Multifunctionality</td>
<td>Take back</td>
</tr>
<tr>
<td>Easy to recycle</td>
<td>Multi-user/Multi-use</td>
<td>Reuse</td>
</tr>
<tr>
<td>Renewables first</td>
<td>Self-controlling/self-optimising</td>
<td>Refurbishment</td>
</tr>
<tr>
<td>Reduced land use</td>
<td>Improved quality</td>
<td>Remanufacturing</td>
</tr>
<tr>
<td>Reduced weight</td>
<td>Reduced weight</td>
<td>Recycling</td>
</tr>
<tr>
<td></td>
<td>Longevity</td>
<td>Disposal</td>
</tr>
</tbody>
</table>

**Figure 7 Design considerations of a product-service system**

- Designing a product-service system requires close integration of all actors within the life cycle of a product-service. Tight integration, especially between the service and manufacturing organisations, is more likely to permit clear the “transmission” of the economic incentives, allowing service activities to drive manufacturing or design changes.

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• The incorporation of information about customers’ needs into the products, so as to anticipate customer needs at each stage of the product life cycle, pre-emptively designing solutions for them; where feasible, design product modules and involve customers in the final product design (see example of Paris Miki, Japan).

• The product characteristics attuned to the existing level of production processes and equipment. Modular design should make the product upgradable with development of technology, but only separate modules, not the entire product.

• The schemes of taking back the products at the end of their life, as well as all necessary arrangements with business partners should be set in order to ensure maximum closing of the product flow (for reuse, refurbishment and remanufacturing in the locations where products are sold, in the case the primary producer is not situated in the vicinity and it is cheaper and environmentally more preferable to remanufacture close by to the consumers).

• The alternative scenarios of product use should be analysed and the range of these scenarios should be presented to the consumer, providing information on economic and environmental features.

• Marketing strategies should be developed in a way that teaches and promotes environmentally and socially more acceptable way of a function fulfilment.

• Marketing strategies could include communication campaigns during which the producer would educate consumers about alternative scenarios of product use in the most efficient way.

• Alternative scenarios of servicing the products should be given at the point of sale to ensure the proper product exploitation during the usage phase.

The presented design process would make producers justify the existence of the product on the market and analyse total costs and benefits of developing the product. This procedure would become a routine if the externalities were internalised.

4.5.5 Functional unit

A functional unit according to ISO 14040 should have a stringent definition, if possible, be quantitative, and be the same for all product-services activities fulfilling the same function. The problem raised here is that functional units depend on customers’ preferences, perceived qualities and values that are not easy to capture in quantities. When designing a new product-service system for fulfilling new functions, the basic functional unit must always be defined. Usually, the functional unit can be defined based on customers needs and wants. For example, in the designing of a new refrigerator, the basic functional unit will be energy consumption. If, however, one forgoes the technical approach and instead, focuses on the customers’ wants and needs, one will realise that what the customers want is fresh food. From a technological point of view, it is possible to have fresh food if it is kept from rotting. Private customers, however, may not need refrigerators at all if they can be supplied with fresh food every day. For that, big shopping malls will probably need methods of keeping food from rotting, but the resources that haven’t been used for producing private refrigerators might now be used for more sophisticated or expensive methods. Solar power may be used for cooling (which is probably not the only way of preserving food), if solar batteries are placed on the roofs of huge shopping malls.

Thus we see that functional units change with the changed system boundaries (a functional unit of electricity consumed by a refrigerator changes to the unit of preserved food). This is what happens when we design product-service systems instead of refrigerators.

In the same way as products are now being made multifunctional, product-service systems are

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106 Ibid. 12
even more flexible and the delivery of the final function depends on the service provided and design characteristics. A design of a multifunctional product-services system can programme the possibility for expending the functionality of a system depending on the customer preferences, level of education and willingness to learn about the efficient use of the particular system.

4.5.6 Time-scale of PSSs applicability

PSSs are recognised by the Dutch Policy Document on Environment and Economy as a promising approach towards sustainable development in the medium and long term. Short-term solutions bring about incremental changes in products and services, but PSSs aim at facilitating more lifestyle changing options that are based on principles of social and ethical justice. However, examples of separate parts of product-service system already exist. This means that in the short term combinations of more and more components of product-service systems could be expected.

4.5.7 Environmental profile

As was already noted in Chapter 0, our hopes for clean services are a little too optimistic. This does not mean that services are more environmentally problematic than manufacturing or mining industries, but in an economy in which they dominate and serve as some of the most dynamic drivers of change, it is important to examine them directly in search for opportunities to halt environmental degradation and to improve environmental quality.

Kerr\textsuperscript{108} showed the share of environmental impacts from the usage phase, in which product-service systems operate, in the overall environmental profile of a product-service system. Because the PSS is based on the assumption that the usage phase can considerably reduce the total environmental burden of a product-service (consumption stage), there is a need to analyse them versus production stage (including post-production activities like take-back, reuse and remanufacturing). Therefore, the potential to minimise the environmental impact of the usage phase and all non-usage phases of the PSS life cycle should be analysed and compared with the actual impact created.

What are the possibilities to reduce environmental burden in the usage phase? The environmental impacts of the usage phase comes from the efficiency of each unit of function delivered and the total amount of a service delivered. The design of product-service systems can provide an incentive to manufacturers to design products more efficiently for their use phase products only when the producer will be paying for the environmental effects and resource consumption during this phase, i.e., when the conditions of function provision internalise use-related environmental costs. This initiative is created in the case of chemical management services. The higher the costs of operating or using a product-service, the higher the stimuli for the manufacturer to improve the efficiency of the product-service to minimise these costs.

A number of ecological advantages can arise from the sale of services. For instance, it encourages the producers’ interest in the reuse and increase of the recyclability rate of products. The services could include new, used and refurbished products. Ideally, this could lead to completely closed product cycles under the responsibility of the manufacturers. The closing of the cycle would not only represent a cost factor, as it is mainly the case today, but would be an integral part of the economic system with reduced material, energy, and waste flow.

The substitution of energy and materials with efficiency services (Demand Side Management and Least Cost Planning) reduces overall resource consumption. In the case of energy-efficiency services this could, in the long run, prevent building of new power stations.

Increasing the intensity of use, if products are shared or used jointly, can minimise the total number of products produced and the capacity for use can be more fully realised resulting in greater resource efficiency and less impact on the environment. Moreover, higher intensity of use

\textsuperscript{108} Ibid. 36
leads to regular upgrading of the product, meaning that the most efficient products are used in the system.

If the operation of the product-service is a cost for the company that has internalised them, the producer might be interested in providing maintenance that helps to extend product life and, thus, reduce the quantity of the product required for delivering the service; less product per unit of services, less environmental burden.

What are the possibilities to reduce the environmental burden in the non-usage phase? The environmental impacts in the non-usage phase come from all stages of product-service life cycle except for the consumption (usage) phase. The main methods to reduce an associated environmental impact are to improve environmental performance of each stage and to reduce the throughput of products manufactured without reducing function/service delivered.

In order to assess the environmental performance of product-service systems there is a need to develop criteria that could include the lifespan of a product, efficiency of resource consumption, closed cycle efficiency and potential for improvement.

4.6 Barriers for PSSs

- Product-service systems require, from their producer, close co-operation with suppliers and service producers or final consumers. While relationships with suppliers are being addressed by ISO 14000-series standards and environmentally conscious purchasing practices, downstream practices are addressed by EPR and Product Stewardship concepts. Integrated Chain Management specifically addresses the issue of involving several actors in order to improve the environmental performance of products. However, problems associated with ICM are also going to be relevant for PSS as they have the same life cycle basis. These problems include trade-offs between co-operation and internal environmental management; the problem of choosing wrong actors who do not have the power to change or influence (however, in case of product-service systems the main actor is already chosen – the producer of a function fulfilling product and associated service); information sharing and transparency; barriers from material flows crossing borders and variety of regulatory frameworks in each country, although customised services are most efficient and consumer responsive if they are local and created taking into account local cultural and behavioural particularities.

- Although, ideally, ownerless consumption offers many advantages and hopes, it has its own problems. For instance, studies conducted so far show that the multiple use does not automatically lead to less impact on the environment. The environmental impact depends, to a large extent, on the circumstances, schemes and conditions of use. Leasing, for example, can lead to a much higher impact on the environment when it promotes use of products which otherwise would not be affordable for customers. Without the option of leasing, the purchase would have to be postponed to a later date, a less expensive version would be purchased (again, maybe less environmentally benign) or other alternative concepts of use would be applied. On the other hand, leasing can facilitate the return of old appliances since the duration of use is monitored and they are returned after the lease has run out, if the purchase option is not executed. This could strengthen the manufacturers' interest in their own products and would thus considerably improve the economic conditions for a closed cycle economy.

- Different systems and sources of gaining profit can deter producers from employing this concept, because profit partially comes from leasing and renting, partially from selling products and partially from sharing products with communities with whom producers might develop common schemes and alternative ways of using the products. Where point-of-sale becomes a point-of-service that operates over an extended period of time, traditional incentives can fail to reflect the real drivers of profit for the firm, and thus, a particular problem is the changeover from short-term profit realisation at point-of-sale to medium- and
long-term amortisation periods. Moreover, another characteristic of PSSs that affect the usual ways of gaining profits is the possibility to raise revenue and get profit not through sales but through efficiency (energy services; Demand Side Management (DSM) and Chemical Management Services (CMS). These cases, that is, when PSSs have the effect of decoupling product volume from profits, may become particularly problematic for companies.

- The resistance of companies to extend involvement with a product beyond point-of-sale and historical practice has been identified as a major barrier to increased manufacturer responsibility for environmental impacts of products.\(^{109}\) The extended involvement leads to intra-organisational and inter-organisational changes, such as closer interaction with other actors in the product-service chain. This happens partially due to inertia and fear of innovations.

- The reorientation of companies towards product-service systems requires a fundamental shift in corporate culture and market engagement, which, in turn, requires time and resources to facilitate the shift. Changing the orientation of the company from product to service sale means changing also the traditional marketing concepts. This is often met with psychological barriers in the larger companies. In addition, it is likely that risks, such as the lack of information and qualification, the faults and disturbances of new activities and processes, the costs involved in adaptation and adjustment, would hinder the readiness to change the services supplied.

- There is still a problem of quite narrow PSSs applications. More often PSSs work in the case of low utility range, seldom use, high cost to buy the product or to maintain, or when there is a need for special knowledge to maintain the product (e.g., in the case of computers, copy-machines). Moreover, purchase and ownership appears to provide the lowest cost alternative in the long-run compared to leasing that becomes more and more expensive.

- It is quite difficult to trace the shift in service or manufacturing industries because of differences in how services are reported in national and international statistics.\(^{110}\) In manufacturing companies there are service departments like human resources, canteens and medical care centres for workers. Basically, all products were developed and produced by a series of services added to resources.

- Adding environmental considerations to the product development cycle is often seen as lengthening the time to market. This is even more so if the entire product-service system should be designed with criteria of environmental efficiency in mind.

- The consumers are not very excited about the ownerless consumption. Numerous examples of practical applications of product-service ideas in the commercial sector did not facilitate operationalisation in the private market.\(^{111}\) The successful models such as car sharing are still limited to market niches.

- The customers' demands and purchasing behaviour turned out to be either much more complicated than expected or under-researched. The assumptions that the customer is more interested in use rather than the ownership\(^{112}\) or is looking for the use rather than the product itself does not exactly represent the reality. Apparently, availability and psychological factors with regard to ownership play a much larger role than does price, quality, functionality and

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\(^{110}\) This problem was recognised and discussed at the World Service Congress '99 with Ms. Gunnel Mohme, the Head of the Service Business Unit at Svenska Industriförbundet.

\(^{111}\) Ibid. 72 pp. 91-100

\(^{112}\) Ibid. 39 p. 36
5. Current research and practical activities

Current research and practical activities in the area of product-service systems are carried out at several levels: international projects of research institutions and consultancies, national projects of research institutions and consultancies, companies' projects and routine activities, sometimes together with academia and consultancies, and communities' initiatives.

Chapter 5 presents a cross section of activities at all the levels as of December 1999.

5.1 International research efforts

5.1.1 Fifth RTD Framework Program (1998-2002)

Eco-Services for Sustainable Development In The European Union\textsuperscript{113}

The project is run under the Fifth Framework Programme of the European Union. It began on April 1, 1998 and is planned to be finished on March 31, 2000. The central idea is that an intelligent distribution of rights of ownership and use creates an incentive to pursue strategies of increased durability, use, reuse and recycling of products which contribute to relieving environmental stress but have so far been mostly neglected.

Four research institutes, 16 enterprises and four consumer associations formed a partnership aimed at comparing and analysing experiences with eco-services and their ecological and economic potential in Germany, the Netherlands, Austria and Spain, and thus, their use and application in the EU. The projects analyses economic, legal, environmental, and social conditions for leasing, pooling and sharing concepts and how these concepts can contribute to the sustainable use of consumer goods.

Case studies are the basis of the analysis. The choice of product groups to which these concepts can be applied to make ecological, economic and social sense, is analysed. Based on the findings, scenarios shall be developed in order to demonstrate sustainable product use in the EU, and the consequent effects on the environment and employment. The development of suggestions for a further employment of eco-services in the EU and tools for supporting their application is the final expected outcome of the project.

Creating Eco-Efficient Producer Services

The project is run under the Fifth Framework Programme of the European Union.

The overall purpose of the project is to examine the characteristics and possibilities for, and barriers to, the development of eco-efficient services and provide practical tools for both large companies and SMEs to identify opportunities to introduce them. The main focus is on eco-efficient producer services, that is, the business-to-business-perspective. The project will develop a conceptual model of the key elements involved in the development of eco-efficient producer services, identify the drivers for their introduction, assess their impact on organisational competitiveness and employment, compare them with non-business eco-efficient services, identify corporate and policy level barriers, and develop practical tools, which can be used by organisations and entrepreneurs

\textsuperscript{113} Ibid. 92
Strategies Toward the Sustainable Household

The project was run under DGXII’s Environment and Climate Programme by Delft University of Technology and the Dutch Sustainable Technological Development Programme, involving five European nations. Its aim was to assess the possibilities for an alternative function fulfilment of various “household functions”, one of which was clothes washing. The Workshop on Sustainable Washing put forward four scenarios for washing; all were variations of multiple-household services. A tool for stimulating the conversion of unconventional ideas into a workable future (2026 and beyond) solutions was used.

The results predicted a three-fold reduction in water use in the shift from conventional aqueous washing in the home to aqueous service washing, and the corresponding factor 6 reduction in the detergent use. The consumer surveys found that people were unprepared to sacrifice ‘quality’ for the environment. The final workshop was intended to look at “concrete solutions and actions”. It was pointed out that aspects, such as consumer acceptance, lack of distribution facilities and cost of infrastructure, were the obstacles to provision of any type of multiple-household clothes washing. Future research on managerial aspects, new technologies, and the application of sustainable energy is needed for “more practical solutions” to be realised.

5.1.2 UN-WG-SPD

The United Nations Environmental Programme Working group on Sustainable Product Development has a research area on A Future Vision - Sustainable Product Development Towards 2050. The main focus of this group is on future scenarios and potentials of sustainable product design. However, not only products are in the scope of the research, but also services and systems that fulfil the needs in a sustainable way. There are seven ways the sustainable product is defined by the group. They include sustainable services (alternative scenarios), strategic design (holistic approach comprising impacts, logistics, and resource use planning), optimised design (modular, multi-functionality), dematerialisation, life cycle design, longevity (design for durability), and positive aspects for sustainable product design (design of products, environmental impact of which are outweighed by positive environmental effects).

5.1.3 European Foundation for the Improvement of Living and Working Conditions

The European Foundation for the Improvement of Living and Working Conditions is conducting a project on Design for Sustainable Development that aims at increasing the involvement of the social partners in the move towards policies that promote sustainable development. The research is developing information networks, tools and training to help decision-makers in implementing these types of policies as well as identifying practical examples of sustainable production and consumption.

5.2 Initiatives of national research institutions

5.2.1 The Netherlands


The project was commissioned by the Ministry of Environment and Ministry of Economic Affairs in the Netherlands, and continued from December 1997 until January 1999. The main goal was to estimate the potential of product-service combinations in environmental policy. The study showed that services can have both positive and negative environmental effects. The study proposed specific steps that help analyse product-service systems and employed graphical representation of the results to show whether or not the decoupling of economic from environmental development might occur. One of the study conclusions was the finding that due to usually faster development of services than products, PSSs can lead to environmental benefits more promptly. "The main conclusion of the research was that systemic integration of environmental load, business economics and client value design through PS systems is only found in a very few studies", such as the work of Meijkamp on car-sharing.116,117,118

**IVAM**

In addition to practical technical assistance to companies, IVAM Environmental Research is active in the development, evaluation and improvement of the methodologies used to achieve environmental improvements of industrial products and processes. The work on methodologies aims to result in practical tools that enable enterprises to organise their environmental activities and to identify, evaluate and implement environmental improvements in production chains and processes, products, and services.

Current efforts of IVAM Environmental Research are focused on Increased use of services.119 A current project at IVAM Environmental Research is on "Eco-services for sustainable development in the European Union" (see Chapter 0). The project is being conducted in close collaboration with research institutes from Germany, Austria, and Spain addresses the opportunities and constraints for eco-services, in particular those enabling use of durable goods (e.g. cars) by multiple users through leasing, pooling, renting and sharing.

**Delft University of Technology**

Delft University of Technology has a research programme called Design for Sustainability Program.120 One of two research sub-programs within the Design for Sustainability Program is programme on Eco-efficient Services & Systems.121 The programme aims at gaining scientific insight in the possibilities of eco-efficient alternatives for products, such as dematerialised services or changes in product-systems infrastructure. Theoretically, eco-efficient services and systems could contribute significantly to a more sustainable society, but these concepts are usually long-term oriented, urging new business and stakeholders coalitions and new industrial design methods.

Delft University of Technology also conducted two studies on washing services and car sharing.

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119 http://www.ivambv.uva.nl/IVAM/thema_i/about.html
120 http://www.io.tudelft.nl/research/dfs/research/researchset.html
121 For example, Function fulfilment versus selling of a product - Faculty of Industrial Design Engineering, The Netherlands, Meijkamp
Robert van den Hoed investigated whether it would make sense to centralise washing process since refrigerators and washing machines get more energy efficient in the future. The outcome of the research showed that home washing is still a preferable option, as transportation and the larger amount of heat needed in large washing facilities (disinfecting) may have a detrimental effect on energy use.

Reijn Meijkamp conducted also some studies of washing services\textsuperscript{122} and as well on car sharing.\textsuperscript{123} Kathalys Centre for Sustainable Product innovation TNO-TUD is an initiative of the Industrial Design Department of Delft University of Technology and TNO Institute of Industrial Technology. Kathalys develops long-term ideas for system-level environmental innovations and functional optimisation.

Syntens

Syntens Innovation Network for entrepreneurs, Amsterdam \textsuperscript{124} participated in the project Design Plus Service in 1997,\textsuperscript{125} and in the Eco-design II programme that showed that the option of introducing and expanding the service part of a product-service package in SMEs is often neglected.

The Eternally Yours Foundation

The Eternally Yours Foundation is a foundation that deals with problems of shortening life cycles of consumer products and seeks solutions for product life extension.\textsuperscript{126} It organises meetings and tink tanks to facilitate discussion among designers and engineers to find systemic solutions to the aforementioned problems. For example, in April 1997 the Eternally Yours Congress took place. The congress served to deepen the insights on extending product longevity, or improving product endurance.

So far Eternally Yours activities provided a list of concepts that need to be considered to increase product life spans, but no real designed systemic solutions. That is why Eternally Yours is planning to initiate several projects, in co-operation with the Netherlands Design Institute, to design product-service combinations, that include every aspect needed for enduring quality.

5.2.2 Germany

Wuppertal Institute

Besides having developed the dematerialisation approach and a methodology of calculating Material Inputs for Unit Service (MIPS), the Wuppertal Institute carried out some projects on servicisation.\textsuperscript{127}

124 \url{http://www.syntens.nl/} \\
127 See for example, Kranendonk, S. (1995) Rent-a-chemical as a strategy for resource reduction. Draft case-study.\end{flushright}
For example, the project Service Offers from Enterprises: "Selling Services Instead of Products". The project shows that the objective should be the design and sale of services, which have been dematerialised as far as possible. For this, it is necessary to develop intelligent enterprise concepts, which permit the firms to design a soft transition from pure producers to service companies. Naturally, not every firm can transfer its operation into providing services, but it can participate in the design and development of marketable and eco-efficient services within its product line. The claims made of the company organisation and product development are high: economically advantageous concepts for the entire product line require permanent communication between firms. High resource consumption with close proximity to the customer can be seen in the construction and housing industry. Therefore, preliminary concepts of eco-efficient services were mainly drawn up for the building and living area.

The Wuppertal Institute is also co-ordinating a project on eco-efficient services as part of the BMBF initiative «Services for the 21st Century». In co-operation with over 40 businesses, including companies from the housing and the motor industry, both general and specific recommendations for action on new markets of eco-efficient services are made. Both the Material Flows Division and the Energy Division are working on calculating the resource productivity of new services, together with marketing strategies and criteria for financial support, as well as the development of new concepts for energy services.

**Service 2000 plus**

This project was conducted by the Ruhr University of Bochum in co-operation with Fraunhofer Institute for Ergonomics and Organisation from 10.1995 to 10.1996. The goals of the project were to examine the development in the service sector and to develop future scenarios, as well as to develop action and research plans for further evaluation of the service sector competitiveness. The project resulted in publication.

**IÖW - Institut für Ökologische Wirtschaftsforschung**

The Institut für Ökologische Wirtschaftsforschung (IÖW) GmbH (Institute for Ecological Economy Research) has continued to take on new scientific challenges and to widen its range of subject areas over the past years, one of which is the sustainable consumption, that focuses on patterns and determinants of sustainable consumption, analysis of approaches to consumer information, consumer policy, evaluation of political tools influencing consumption, eco-strategies for retail trade, determinants of and changes in consumer behaviour.

In the framework of this research area, the IÖW carries out the project "New Concepts of Product Utilisation. Environmental Benefits, Implementation Barriers and development Options for Product Lifetime Extension and Product Use Intensification" aims at analysing new forms of product use, such as renting and sharing, as well as prolongation of a product useful life. The preliminary results identified the environmental benefits, associated with the employment of these strategies, and drivers and barriers for their application in the marketplace. The project started in October 1997 and is planned to be finished in January 2000.

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130 Staudt, E., War man, B., Muschik, C., and M. Nowicki (1996) Growth by Services? The materials can be obtained from Prof. Dr. Erich Staudt at tel: 971 17-0, fax: 971 17-20, iai@rz.ruhr university bochum.de, Bochum University, Working Group on Innovation and Quality Management or at BMBF: +49 228 593 037, fax: 601
The IÖW also participates in Creating Eco-efficient Producer Services, the project of the Fifth Framework Programme of European Union that started in March 1998 and is planned to be finished in March 2000.

The Institute for Future Studies and Technology (IZT\textsuperscript{131}), Berlin

The Institute for Future Studies and Technology currently participates in the project on Eco-services for Sustainable Development in the European Union.

Before the project on Advantages in Competition with Ecological Services was conducted at the institute. It run in 1998 and was co-ordinated by Mr. Siegfried Behrendt. The results were published in a book.\textsuperscript{132}

5.2.3 Switzerland

The Product-life Institute, Geneva

The main focus is to develop innovative strategies and policies to foster the move towards a more sustainable society, for both industry and government. The Product-life Institute conducts research that includes an analysis of the optimisation of the product life of goods or services, defining new policies and industrial strategies that focus on product-life from cradle to cradle, and related market research, economics of the use of resources, resource productivity and environmental impacts.

The Institute is involved in several research topics such as the impact of shortening (or lengthening) the life-time of products and production equipment on industrial competitiveness and sustainability.\textsuperscript{133} The move from products to services or service economy were the focus of the research activities of the Product-life Institute since late 1980s.\textsuperscript{134} Sustainability and innovation as concepts to be employed by environmental policies were also analysed.\textsuperscript{135}

Currently the Institute is involved multi-client study on The Shift from Products To Services in Europe, 1998 And 2010. The publication is expected at the end of the year 1999.\textsuperscript{136}

5.2.4 Italy

Domus Academy

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\textsuperscript{131} IZT - Institut für Zukunftsstudien und Technologiebewertung. \url{www.izt.de}
\textsuperscript{134} See, for example, Stahel, Walter R. (1998) From Products to Services: Selling performance instead of goods; ISSN 1025-9384
\textsuperscript{136} \url{http://www.product-life.org/sales.htm#MULTI-CLIENT STUDY}
DARC, the professional centre at Domus Academy, that works on strategic design and design research. It conducts design projects on various themes related to innovation in design strategies and product evolution.\textsuperscript{137}

The Director of the Domus Academy, Ezio Manzini, is known as a strategist and theorist in the area of sustainable services, product-service mixes and systemic discontinuity.

5.2.5 Austria

**Institute for Advanced Studies, Austria**

The Institute for Advanced Studies conducted a study on Eco-Efficient Services for Private Households. Looking At the Consumer’s Side.\textsuperscript{138} The project was conducted in cooperation with the Group for Adjusted Technology (GrAT) by an interdisciplinary research team (of sociologists from the IHS and technical scientists from GrAT). The study investigated the preconditions for using eco-efficient services and products by private users.

The study distinguished between borrowing, lending, sharing and renting. It showed that collective use is practised rarely and that the ways of use vary dependent on the domain.\textsuperscript{139} Based on the results, the research team formulated requirements regarding the offered products and services. The sociological part of the projects included a representative survey of households in Vienna and qualitative case studies of selected services (washing, hobby-working, cooling).

5.2.6 United States of America

**Tellus Institute**\textsuperscript{140}

The research programme on Restructuring the Supply Chain \textsuperscript{141} included a project on Environmental Impact of the "Servicising" Transition. Tellus, together with EPA, assembled seven case studies and presented the report, providing background information and analysing whether servicing can serve as a facilitating factor to Extended Product Responsibility. The study found that by "providing a dematerialised functionality rather than physical goods, servicing companies are shifting product responsibilities, and may profoundly alter the environmental impacts of products at all stages of their life cycle".\textsuperscript{142}

The programme The Chemical Strategies Partnership at the Tellus Institute is co-ordinated by the California Environmental Associates, Tellus Institute and The Pew Charitable Trusts. The aim of the programme is to redefine how chemicals are sold and used in terms of shifting from a volume and sales orientation to a service orientation, the so called service-based contracting, which can improve environmental performance through pollution prevention. The programme involves electronics manufacturing companies that are assisted in employing the new supplier-customer model in order to improve environmental performance, reduce costs and increase...

\textsuperscript{137} http://www.domusacademy.com/english.htm#there

\textsuperscript{138} Beate Littig, Institute for Advanced Studies, Stumpergasse 56, A-1060 Vienna Tel. ++43-1-59991-215, e-mail: littig@ihs.ac.at


\textsuperscript{140} http://www.tellus.org/

\textsuperscript{141} Ibid. 83

\textsuperscript{142} Ibid. 83
efficiency.143

5.2.7 United Kingdom

**Eco Innovations Group, Cranfield University**

A 3-year long research programme was initiated in October 1999, which studies life cycle design innovation with a focus on how designers could take a customer service viewpoint during the design process. The goals of the programme are to study how designers identify the service a customer receives from a product, whether using this service orientation will increase the designer's ability to design products with reduced environmental impact, and what effect the specification capture, writing and negotiations process has on the company's ability to take a service design viewpoint.

**5.3 Initiatives of different companies**

There is an increasing number of business ideas whose success is based on the capability of breaking the traditional relationships between products, producers and consumers. However, at the moment, it is difficult to say that they are a clear step towards sustainability. But, the fact that they exist proves that the change is possible. As was discussed and showed in this study, sustainability cannot be reached by a simple re-design of existing products. New, innovative approaches need to emerge based on understanding of interrelationship between products, services and consumers.

Today, product-service concept has been already applied by some companies and has been driven mainly by business considerations, rather then environmental. Most often the concept of PSSs is seen as one component of competitiveness.

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5.3.1 Demand side management (DSM) and Least-Cost Planning (LCP)

Currently, can see the development of demand-side management the central notion of which is value creation for the customer and provision of the function she wants, rather than product or commodity. A perfect example of demand-side management is the utility industry that was usually considered simply as an electricity supplier. Some companies changed the scope and perception of their branch and now sell packages of efficient use of energy and lighting, including information and education. Thus they sell efficiency which we now measure as a decrease in energy consumption and thus, an absence of energy is actually sold. This is an example of a so-called win-win solution when both producers-providers and customers are satisfied. If we think also that efficient use and decreased consumption leads, in the long run, to fewer power plants built and, thus, less resources extracted and used, it is also a win for the environment and future generations.\(^\text{144}\)

The main problem with DSM is that current institutional and regulatory regimes are often set up in a way, which actively discourages such innovation. Energy companies are usually regulated on the basis of their unit sales and unit price of energy. For energy efficiency measures to be cost effective to the company over the long-term, it is necessary to decouple the company’s profits from its unit sales, so that it can sell fewer units at a higher unit price, and to allow the savings to be shared between the customers and the company’s shareholders.\(^\text{145}\)

\(^\text{144}\) In the field of energy, the services to be provided are thermal comfort, lighting and cooking. These services can be provided with less primary energy input by the installation of energy-efficient devices, such as compact fluorescent light bulbs or insulating equipment to prevent heat losses. This increased energy efficiency can be sold in the form of ‘Negawatts’ (Lovins A.B. (1996) Twelve Transitions, Eight Improvements and One Distraction. Energy Policy Vol. 24 No. 4 pp. 331-343). The basic idea is that, in many cases, it is cheaper to save a unit of electricity than to generate that unit. The energy supplying companies can sell or supply energy efficiency measures to its customers. These energy efficiency measures will pay back for their investment over a short period in the form of reduced electricity bills. In theory, everybody benefits - the customer from cheaper bills, the company from avoidance of investment in expensive new generating plant, and the environment from reduced emissions due to more efficient use of energy. It can work in practice - for example, the Pacific Gas and Electric Company in Northern California was able to save over $300 million from a single year’s energy efficiency investments (von Weizsacker, E., Lovins A.B. and L.H. Lovins (1997) Factor Four: Doubling Wealth - Halving Resource Use. Earthscan, London).

\(^\text{145}\) What does the deregulation of energy market mean? In general terms the deregulation of energy market promotes competition between energy producers and suppliers that causes the prices levels to fall. Cheaper energy facilitates not only an increase in its use but also an increase in other goods consumption due to reduction of the general price index. Without adequate measures on the demand side the energy consumption increase that has detrimental effects on the environment. The positive social effects due to increased purchasing power might be overshadowed by the external social costs related to environmental degradation. An effort must be taken to change the consumption patterns along with the market liberalisation.

Some words about the importance of peak load energy management. The demand of electrical energy over a day is very uneven. There are periods when sharp increase in energy demand occur, for example early in the morning when the industry is starting or in the evenings when most of the households return home and use their household appliances and utility services. The electricity grids must compensate these electrical energy peak-loads by utilising flexible reserve capacities. The flexible energy production capacity is normally based on power stations powered by non-renewable energy sources such as gas, oil and coal. For example in Sweden, hydro and nuclear power stations running at almost constants production rates produce the bulk of electrical energy. The peak-loads are compensated purchasing foreign energy or firing fossil fuel power stations.

The use of these reserve production utilities puts a heavy burden on environment both in terms of use of natural resource and atmospheric pollution. One of the issues that could contribute to reduction of environmental impact from energy sector is the reduction of peak-load energy demand. Changing consummation patterns and improving energy consumption means can facilitate the reduction of this demand. Accordingly, the Demand Side Management and efficient technologies and equipment and the means facilitating this change.

In the field of Energy Policy in the European Union the issue of Demand Side Management (DSM) was clearly introduced in 1995 in a Directive dealing with Integrated Resource Planning (IRP). The essence of the Directive deals with the to protect the environment and to enhance energy saving by means of regulation.

There are four provisions in the Directive. While the first three provisions focus on legislative and regulatory
Least Cost Planning is a process that was developed by the electric utility industry. The utility industry set out to develop a process designed to maximise efficiency while lowering electrical costs to the customer. Energy conservation programs are an example of this. After a decade of development, least cost planning methodology is still changing and evolving in the utility industry.\textsuperscript{146} Least-cost planning is widely used not only in energy, but also in transportation sector. In transportation the LCP is viewed as a process of comparing direct and indirect costs and benefits of demand and supply options to meet transportation goals and/or policies where the intent of the process is to identify the most cost-effective mix of options. In other words, since more money won’t necessarily improve congested roadways, various alternatives need to be studied in managing congestion and giving people more transportation choices.\textsuperscript{147}

**Energy service companies**

Energy service companies in the United States, supply a package of services on a turn-key basis.\textsuperscript{148} The package includes supply of energy resources, identification and selection of measures to improve efficiency of electricity use, installation of equipment, operation, and maintenance of the energy supply.\textsuperscript{149} Thus, what they are selling are conservation and energy management, not electricity. Energy service companies comprise 3 types of companies depending on the financing scheme and these are energy services companies per se, performance contracting companies, and third party financing companies.

Energy Services Companies (ESCOs) are most often private companies that provide comprehensive energy efficiency or load reduction services to customers that own or operate facilities such as factories and buildings.

Performance contracting most often refers to the practice of providing energy savings to a customer for a fee, the level of which depends on the amount of energy saved.

Third party financing (TPF) is the funding of energy savings investments by an outside company, using energy savings to pay for the investment.

Besides North America, Europe is the other region with significant third party financing activity (third party financing is the common name for performance contracting in most of Europe). The market in Europe is less well developed than in the United States, with significant third party financing activity taking place in only a few European countries and other countries, namely UK, Spain, Belgium, Czech Republic, France, Germany, Luxembourg, Poland, Portugal, Netherlands (Energy Contract Partners), Switzerland, India, and Thailand.\textsuperscript{150}

**Sydney Water Least Cost Planning Study, Australia**

This project involves the development of a least cost planning end use model for all Sydney Water customer sectors (residential, commercial, industrial, government and others). The study frameworks as well as common rules for integrated resource planning, the fourth provision requires Member States to play their role in promoting affordable and efficient energy solutions for customers. It is up to the EU members to decide by which means and measures they will comply with the Directive.

(Along with the directive on IRP, another Directive was introduced in 1995 dealing with liberalisation of energy sector and promoting the competition. This Directive defined common rules to the internal market for electrical utilities and promotes competition in the electricity sector.) These two Directives seem to contradict each other, since the first one is for environmental protection and integrated planning and the other is in favour of strengthening market forces and economic growth.

\textsuperscript{146} \url{http://www.islandcounty.net/publicworks/}
\textsuperscript{147} \url{http://www.islandcounty.net/publicworks/}
\textsuperscript{148} \url{http://www.coned.com/athome/custnews/escolist.asp}
\textsuperscript{150} \url{http://www.wecia.org/esco/}
required in order to design a range of water efficiency programs which would assist Sydney Water to comply with licence requirements to reduce per capita water demand. A range of demand management options are modelled, including retrofitting, financial incentives, re-use, pricing and regulation. Particular attention is placed on reducing the impact of the Olympics tourist influx and social equity issues. Sydney Water has undertaken the initial implementation of several of the recommended programs involving all customer sectors.151

RMM Energy GmbH, Germany
RMM Energy GmbH offers a service package to its customers consisting of analysis of energy consumption and energy efficiency potential; recommendations for investments needed and energy management; guidance on project tender, execution and completion; assistance with grant applications and reviewing of delivery contracts. Since 1987 RMM Energy GmbH has completed more than 200 projects achieving an average of 35% saving on energy.152

DSM in Electricity, Water and District Heating, Denmark
In a small Danish town Kibæk of 1,200 households the electricity, water and heating utilities jointly decided to create a common remote reading and information system. The essence of the pilot project was an establishment of common administration and accounting office. This would account the use of utilities in a more flexible and precise way promoting change of consumption patterns as well as allow sharing capital and operational costs of the three systems. The system was built on a three-way energy tariff scheme, remote reading and display of consumption of electricity, cold water and district heat, with short response times.

The outcomes of the project showed that the customers did not reduce overall consumption of the utilities, however they acted according to the economic laws which say that you should consume when it is cheap.

DSM in Gas Sector, France
A local French gas distributor Gas de Bordeaux delivers more than 4TWh/year to nearly 200,000 customers of the Bordeaux region. Over years company's customers along with the concerns of fuel costs became more and more concerned with the equipment amortisation and maintenance integrating overall cost. In addition the community concerns about general improvement of environmental condition became increasingly evident. In 1993, the Gas de Bordeaux realised these changes and took several decisions that lead to another market opportunity. The new ideas in company's business were related to providing energy consulting and the maintenance of equipment. The company started least cost programming service providing the customers with individual plans of cheapest energy use options. The company performed a detailed analysis of current and future energy supply and came up with several local solutions of more efficient supply of gas and other alternative energy types such as geothermal energy. Also by analysing the structure and the nature of consumption sector by sector and taking into account the local variations the company made changes in the supply prices and tariff structure allowing more flexible payment scheme.

As a result, the company reduced its operational costs by increasing the efficiency of energy production and supply. The costs for customers were also reduced due to adoption of their consumption patterns to optimal payments schemes, utilisation of alternative energy sources as well as better equipment maintenance. This led to annual savings of about 10GWh equivalent to savings of 5,300,000 French Francs. Accordingly, the company in co-operation with finance houses offers a package integrating services and loans, tailored to the needs and means of their customers.

151 http://www.isf.uts.edu.au/water_proj.html#2
152 Ibid. 149
clients, and comparable to the lifetime of the equipment involved.

5.3.2 Chemical Management Services (CMS)

In the last few years, several manufacturers have developed a new model for chemical management services that redefine the way they purchase, manage, use, and dispose of chemicals at their facilities. They have designed new programmes for partnering with their suppliers that create incentives for cost and chemical-use reduction as well as improved chemical management efficiencies. The manufacturers, which are buying chemical management services, call this co-operation with service providers as the Chemical Strategies Partnership (CSP), while their partners provide Chemical Management Services (CMS). The basic idea of CMS is that chemical companies, very much as aforementioned energy providing service companies, provide the efficiency of the function rather than sale volumes: they provide the same function fulfilled by their chemicals but promise resources reduction and cost reduction for their customers. This approach helps companies realise what is costs financially and environmentally to bring into a facility. There is often a lot of waste because many manufacturers are more concerned with the smooth flow of their operations and processes.

Chemical Strategies Partnership even developed a manual, Tools for Optimising Chemical Management, that offers a decision-support framework to help companies quickly assess benefits of the Chemical Management Services and to provide step by step guidance to develop a CMS programme. Below, several examples of CMS providers are presented.

**Castrol Industrial North America, Inc., USA**

The company is a leading provider of professional lubricants and related services. A chemical management service is among the services provided since 14 years. Castrol Industrial North America markets itself as a lubrication service and expertise provider. "Our proposition to industry is performance lubricants expertise that goes beyond the lubricant" states the company. A typical set of lubricant service package includes lubrication needs assessment, site survey, analysing costs and productivity indicators, recommendation of product-service package, training and changes of equipment, where necessary, regular performance assessment and continuous identification of opportunities for reducing lubricant consumption. Castrol is working on improving efficiency of processes. The profit comes from cost savings delivered to the customer, rather than the volume of the chemicals sold.

**Ashland Chemical Co., USA**

The company has established a Chemical Management Service Program. Industrial chemical users see chemical use as a necessary but marginal aspect of their manufacturing processes, therefore, Ashland Chemical Co. proposes an entire service package for such companies, because it has necessary expertise and handling of chemicals can be a very expensive activity, especially at the end of the chemical life. Thus, procuring, training, testing, inventorying, regulatory compliance, point-of-use application, internal waste management, and disposal are some of the components of the company’s service.

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155 http://www.castrolindustrial.com

package, which is based on cost saving contractual arrangements with unit-pricing structures (e.g., per door panel coated) that reduce chemical use. Under these arrangements, both chemical supplier and user benefit from technological innovations that reduce operating costs. These arrangements shift ownership of the product back to the supplier, thereby creating incentives for improved materials management, maximum recovery and recycling, and minimum losses during handling, storage, and use.

**Quaker Chemical Management Services, USA**

Quaker Chemical Management Services offers a package of services to customers to reduce manufacturing costs, improve focus on the core business, solve problems, and reduce liabilities. These services are custom-designed for each customer. These services are provided to virtually all manufacturing industries including automotive, appliance, aerospace, metals production, and heavy equipment. When a company employs the chemical management concept to support its manufacturing processes, a number of functions are transferred to the Chemical Manager. This allows the customer to focus on the manufacturing process while retaining control of the decision-making regarding the chemicals used in the process.

**SafeChem, USA**

SafeChem, a 100% Dow subsidiary and official SAFETAINER logistics and service provider, deals with chlorinated solvents. The regulation regarding the use of CHC solvents, to limit evaporation and to make take-back obligatory for chemical manufacturers has decreased the market for these substances (from 180,000 tons in 1986 to 40,000 tons in 1995). SafeChem created a sophisticated closed-loop system in order to comply with the regulation. SafeChem is able to re-use and recycle chlorinated solvents more than hundred times. Environmental regulation in this case has helped the company to create an innovative distribution system with the result of a new niche market. Beside this, its activities include distribution of consulting services to their customers on how to change the equipment and to recycle the used solvent.

**5.3.3 Launderettes**

**Launder Bar & Café, USA**

A laundromat combined with a bar equipped with TV monitors of the washing room so it is possible to see the washing process. Other examples from USA comprise Just like at home, and Jazz launder Bar & Café.

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158 [http://www.quakerchem.com/cms/display_services.htm](http://www.quakerchem.com/cms/display_services.htm)


161 [http://www.safechem.de/](http://www.safechem.de/)

Wash n Tumble, Australia

Wash n Tumble is a new concept in Launceston with modern new laundrettes at Mowbray and Prospect, equipped to meet the challenges of the next century. Naturally you can wash and dry your clothes yourself or if you prefer our well trained service staff will do it for you and then fold and iron if you desire. Wash n Tumble do minor mending repairs and are also Dry Cleaning and Shoe Repair Agents.163

Chalet Coin Laundry, USA

Heavy duty, coin-operated washers and dryers. While doing laundry, shop at the liquor or convenience store. Waterslide complex, squash and racquetball, and scenic trails adjacent.164

Launderettes from Electrolux, Sweden

Electrolux provides washing services through promoting various supporting schemes for its washing equipment, the most known is Wascator. The Electrolux Professional appliances division is providing this service. The company assists initiators to start a new launderette or to upgrade an old one. Besides being equipped with the latest machines, these launderettes provide additional services, such as ironing and delivery.

Electrolux supplies systems solutions; the entire equipment for a launderette according to the customer preferences. Such solutions include equipment, installation, training, suggested layout of equipment location, support with environmental permits, market surveys, contracts for maintenance and repair, guarantees, and financial schemes. The financial assistance is made through an Electrolux’s internal bank that offers more attractive loans to entrepreneurs than a regular bank.

5.3.4 Car sharing schemes

StattAuto, Germany

StattAuto is a 10-employee, 4 000-member, 150-vehicle car-sharing company in Berlin. The company successfully runs the business and is thinking of expanding to other countries.

However, from the beginning the company had to deal with such problems as the predictable wish of most users to drive the vehicles on weekends and wasteful car surplus from Monday through At StattAuto, Carsten Petersen, the owner of the company, attacked these problems with an aggressive telemarketing campaign, promoting the fleet to the various private businesses, such as sales organisations and repair services that need extra cars during the workweek. By offering 20 percent corporate discounts Monday through Friday, StattAuto was able to attract 200 companies onto its membership rolls. By signing up these corporate customers, StattAuto was able to buy more cars and improve service to its traditional base of weekend drivers. At the same time, StattAuto has been making its booking and billing technology more customer-friendly. The company now has its own 24-hour dispatcher and offers child-safety seats, bike racks and roof carriers with its cars.165 StattAuto is planning a merger with a car-sharing business

164 http://www.discoverbanff.com/Shopping/Laundries/
165 An example of typical costs for a member of StattAuto (prices include gasoline and insurance): $550.00: Security deposit for individual members, which is returned if he or she drops out of the organisation. $110.00: A one-time, non-refundable access fee. $6.50: Monthly fee. $1.60: Cost per hour for a compact car from 8 a.m. to midnight.
in Hamburg and to open a branch in Rome.

**Mobility CarSharing, Switzerland**

The Mobility CarSharing is a big company in Switzerland that by November 1999 owns 1200 cars at 700 locations in 330 communities for 30000 customers. The system allows the users to chose an appropriate for the purpose of travel vehicle: a small car, a family car, a 7-seat van, a lorry or a convertible. There is a 24 hours telephone booking service and internet. The company calculated that if one drives less than 15000 km per year and combines Mobility CarSharing with public transportation, she can save up to CHF 250.- per month compared to driving own private car. The benefits of the system can also be expressed in environmental terms; up to 57% energy is saved and less strain is put on the infrastructure if people use the CarSharing system. Since Mobility CarSharing Switzerland is a founding member of the European umbrella association ECS, Mobility members can use vehicles in over 80 cities in Europe.

**Honda Motor Co., Japan**

Honda Motor Co. has designed an electric vehicle (EV) sharing system in Tokyo, Japan that uses cards for renting out four types of EVs available for use by multiple drivers. With the Intelligent Community Vehicle System (ICVS), users can choose from a range of EVs: a Raccoon pedal-assist bicycle, The Mon Pal single-occupant EV, the Step Deck single-occupant hybrid EV, and the City Pal two-occupant hybrid EV.

The goal of the system is to provide convenient transportation without the costs of ownership and maintenance. The EVs can be checked out at the parking lots most convenient for transit.166

5.3.5 Carpet leasing programmes

**Interface Inc., USA**

Interface Inc. operates a carpet-leasing program for its range of commercial carpet tiles. The leasing program is significant in that it applies the utilisation thinking to the carpet industry. The company offers the benefits or services, which the carpet offers rather than the carpet itself. The leasing service is called Evergreen and is based around a modular system of flooring. The producer maintains control of all stages of the product's life from production, through use and maintenance, to disposal and lead to the advantages:

- The condition of the floor covering can be carefully monitored and maintained. This leads to a greater life expectancy from the floor covering and should lead to lower costs to the customer. Due to the leasing contract, extending the life of the product is an important business incentive for the producer.
- Due to the modular nature of the covering, areas of the floor that have a higher wear rate can be replaced before others, at the producer's expense.
- When the floor covering is eventually replaced, the producer can recycle the product. It is part of a closed loop recycling system. In some cases the floor covering can be refurbished rather than recycled and this has the potential for cost savings and reduced environmental impact.
- New carpet, which can be made using recycled content, reduces resource consumption.

$0.50: Cost per hour from midnight to 8 a.m. $16.50: Cost for a 24-hour period. $0.12: Per-mile fee.

However, the company faces several problems, such as customers are generally reluctant to embrace the concept of a continual lease arrangement. Interface is considering extending the length of the lease period to ten years so that more of the product’s values are used up during the lease period. Despite these difficulties, the Interface is persevering with the concept with the aim of developing a sustainable floor covering business, which is able to reclaim and recycle its products and "never have to take another drop of oil from the earth".167

**MilliCare, USA**

MilliCare168 was originally created as a cleaning system for modular carpets when it was realised that traditional carpet cleaning methods do more damage than good, the dry system that MilliCare uses today was developed. The MilliCare System can double the like-new appearance of carpet over old cleaning methods. In 1996, MilliCare Environmental Services became an independent franchise, with providers across the U.S. and in Canada. They service mostly offices and other carpeted facilities. MilliCare’s dry system uses a moist powder that absorbs soil and stains from carpet fibres and is then vacuumed up leaving a clean carpet.

The product is made of tiny polymer particles, which have been thoroughly tested safe. It even improves indoor air quality. Beyond cleaning, MilliCare gives customers a "lifecycle" of maintenance services including Earth Square™ - a breakthrough carpet recycling program that saves waste and landfill costs by reconditioning, re-patterning and reinstalling old carpet for another useful service life.

**DuPont, USA**

DuPont is a manufacturer of carpet and fibres. The company introduced the DuPont Flooring Systems as a system product-service solution to satisfy customers’ needs. The company assists in selecting the right product for the customer. Moreover, the DuPont’s Carpet Leasing Options Programme provides opportunity to the customers to choose between buying and a two-to-five year leasing solution. DuPont provides a wide range of service solutions after the purchase was made or leasing contract signed. For example, DuPont provides installation service by using a simple technology to attach carpet to the floor. A special lift system was developed in order to facilitate carpet installation without considerable disturbance of customers. A maintenance service includes professional carpet cleaning, consultation, and recommendations for cleaning products. DuPont developed Carpet Maintenance Index, which assists managers in determining if current maintenance needs of a carpet are being appropriately met.169

DuPont recycles all old carpet through its Carpet Reclamation Program. The collected carpet becomes automotive parts, marine-grade boat materials, and building board.170

**BASF, Monsanto, Collins & Aikman, and Milliken Carpet**

Other fibre and carpet companies including BASF, Monsanto, Collins & Aikman, and Milliken

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167 Ibid. 85
170 [www.dupontflooring.com/](http://www.dupontflooring.com/)
Carpets have developed carpet recycling and/or refurbishing initiatives. BASF recycles commercial carpet made with Zeftron nylon 6 into new commercial carpet. Monsanto grinds up old nylon carpets and turns them into automotive parts and other goods. Collins & Aikman recycles used vinyl-backed carpet into parking-lot bumpers, industrial flooring, highway sound barriers, and marine bulkheads. Milliken recycles various types of carpet through DuPont's programme and through its Earthwise Innovations program that refurbishes older carpet. Earth Innovations (TM) or E2 renewable carpet program employs proprietary processes to clean, texture, and re-style company's previously used modular carpets for reuse. Dirt and debris are removed from carpet and the pile re-textured. Carpet is completely updated with new patterns and colours.

### 5.3.6 Tack back and remanufacturing of photocopiers and printers

#### Xerox Corporation, International

Xerox Corporation\(^{172}\) started as a photocopier manufacturer and already for several years has been turned into a document company, focussing on the whole commercial documentation process. Xerox producer goods and service for business and private use, from photocopiers to books "à la Carte" and translation services of documents while they are transmitted over a telephone line. Another programme introduced by the company is called Asset Management Programme; the products are leased or sold under a multi-year contract, which guarantees customer satisfaction through functioning machines as a fixed price per copy. The company has a long history of leasing; the first copiers were leased already in 1960 because of unfamiliarity of the users with the new process and for tax purposes.

A system design was required in order to keep leasing strategy successful; products and processes had to be designed for remanufacturing. The product design process was enhanced by applying the commonality principle to component design. A new Asset Recycling Programme was set up as soon as products started to come back from the market. These programmes demand more time in the conception and design phase of products and components. However, the possible losses due to the increased time-to-market and loss of economy of scale through region (re)-manufacturing are offset by considerable savings in raw material procurement and waste disposal.

A historical bias exists against remanufactured products, but Xerox has taken steps to overcome this by promoting the remanufacturing products as "proven workhorses".\(^{173}\) Moreover, Rank Xerox gives 3 years replacement guarantee on all products and provides a quality training to its suppliers. These programmes and commonality principle lead to a substantially longer and more intensive service life of products and components.

#### Océ, the Netherlands

172 Xerox Corporation: [http://www.xeroxmicr.com](http://www.xeroxmicr.com)
The company is known for its commitment to the environment and eco-design. The company has been working with the Institute of Industrial Technology, the Netherlands on various eco-design projects. The life cycle analysis is employed in each design project. Océ-manufactured products are designed for long lifetimes and high reliability. Moreover, the company organised a take back system for its products. Since 1990, Océ has been cleaning and dismantling machines returned from the marketplace. Many components and materials are reused, or recycled to make raw materials, keeping waste to a minimum. The same applies to used supplies.

**Hewlett Packard, USA**

Hewlett Packard's 850 series of inkjet printers were designed under an eco-design framework. All LaserJet printers, beginning in 1993, have a sleep mode to let unused printers consume less energy. These machines use 80% less energy than dot matrix printers. The environmentally benign features also included the use of post-consumer recycled plastic, modular design, ease of disassembly for repair and recycling. A system was developed in order to identify and mark by type all plastic parts that are heavier than 3 grams. 95% of the materials in every cartridge returned to HP is recycled through the Planet Partners toner cartridge recycling program.

5.3.7 Functional design and sales of appliances

**Electrolux AB, Sweden**

Electrolux is the world's largest producer of white goods. The idea of providing services instead of products came up during one of environment-oriented planning exercises at Electrolux Euroclean, which was a professional cleaning equipment division at Electrolux. A new service-oriented business model that could offer competitive advantages and reduced environmental impacts in the use phase of the product was proposed and developed. Its novelty was in selling product function, not the product itself.

The expanded service offer included end-of-life management, including reuse and recycling, provided by Electrolux. This expanded service is now marketed by the division of Professional Appliances as a concept of functional sales. Customers do not buy equipment, but pay a monthly fee for the function provided, that is rental of equipment, maintenance, and training of staff.

**Philips, the Netherlands**

Philips Consumer Electronics division of Royal Philips Electronics developed and is implementing the EcoDesign approach, which includes such goals as reduction of energy consumption, reduction of packaging and material consumption, reduction of environmentally relevant substances, and improved durability and recyclability.

The approach can be performed at different levels:

1. Environmental improvement of existing products
2. Radical redesign based on existing concepts
3. Green function innovation, for example, by application of a different physical principle

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175 Océ Nederland B.V. [http://www.oce.nl/index2.htm](http://www.oce.nl/index2.htm)
176 Ibid. 83 pp. 69-72
177 [http://www.electrolux.se/corporate/group.html](http://www.electrolux.se/corporate/group.html)
4. Green system innovation (selling the use of products instead of leasing)\textsuperscript{178}

The design procedure at all levels includes the green design matrix. The company claim that in order to go further not only industrial transformation is required, but also societal transformation.\textsuperscript{179} No practical results of the EcoDesign implementation were found in the literature.

5.3.8 Furniture services

**Coro, USA**

Coro is a subsidiary of Herman Miller, a manufacturer of furniture products for offices. Coro provides furniture services for large customers after purchasing, these are planning, managing and carrying out rearrangements of furniture and office space. The Coro's service is offered in several stages: co-ordination and scheduling of internal moves, moving furniture and office equipment, storing of surplus furniture.

The company is now do not provide an option of leasing, but is preparing it by organising a system of reverse logistics (see Chapter 0). The goal of Coro is to close the loop of its manufacturing processes.

**Wilkhahn, Germany**

**Wilkhahn** The company was knows for environmentally conscious design of many of its products. It established its environmental objectives by the late 1980s. These included the objective of making products greener and increasing their value to customers. Some of the products are designed for durability. The company tries to reduce the number of parts and the amount of materials used in its products. The products are made for easy repair, disassembly and reuse. For that no glue is used; all parts are mechanically joined, without glue. All plastic parts weighing more than 15 grams are marked for identification. The materials used are produced without CFCs; pigments do not contain heavy metals; the cloth covers are detachable for cleaning, repair or replacements Wilkhahn has developed a system for taking back the product and remanufacturing it after the initial use.\textsuperscript{180}

**Gispen, the Netherlands**

**Gispen** is a well-known Dutch producer of modern style furniture, and particularly office furnishing service.\textsuperscript{181} Gispen has set a goal to shift from production and sales, to providing a customised service. The aim is to realise best working conditions for the customers. To fulfil that goal, Gispen developed a new concept of furniture promotion; it is not sold, but leased. First, Gispen offers an expert consulting service specifying the furniture concept for a new customer, and at the same time receives information about customer's preferences and conditions in terms of office area, lighting and number of people working in each room. Secondly, the selected furniture is leased by the customer and delivered. During the furniture usage phase, Gispen assists in changing the configuration of furniture in the office and moving it.

5.3.9 Product to service


\textsuperscript{180} UNEP (1997) Ecodesign: A Promising Approach To Sustainable Production And Consumption.

\textsuperscript{181} Ibid. 88 pp. 57-60
The Body Shop International

The company since 1993 has started to reconsider selling shampoo by substituting selling pre-packaged shampoo by providing shampoo refill service. The company had some difficulties with establishing and proper run of the system, but the obstacles (such as in this case inconvenience and waiting time) are often easy to overcome to set up a system that is easy to use, hygienic, and spillage-free. The system however uses electricity for refilling, but it was claimed to be very small.182 The example shows that it is necessary to think through entire system of product-service. The Body Shop products are known for their more natural products. However, poorly developed system of delivering nice products can jeopardise the success on the market.

Volvo, Sweden

The biggest opportunities for efficiency come from substituting know-how and service for material products. Volvo has redefined its business as "transportation", not "combustion engine vehicles." It is now developing mass transportation systems for China and global positioning systems to get vehicles and shipments from place to place more directly.

5.3.10 Co-production of value

Co-production of value implies that the individual needs, wishes and preferences of the customer are predicted and taken into account during the service provision. The service shaping occurs in the process of communication with the customer. During the service development and finding a solution for the customer, a lot of interaction between service provider and the customer takes place.

Paris Miki, Japan

Paris Miki is an eyewear retailer that developed the Mikissimes Design System that eliminates the customer's need to review different choices of eyewear before choosing a pair of glasses.183 The system takes a digital picture of a customer, analyses its features and parameters together with preferences of the customer about the look that she desires. Than the types of glasses are digitally displayed on the image of the customer's face. When the suitable shape is found, the optician and customer collaborate to adjust thickness of lenses until the optimal solution is found. The same procedure is followed for choosing hinges, nose bridge, and arms. And, finally, a technician grinds the lenses and assembles the glasses in less than an hour.

Lutron Electronics Company, USA

The company developed a system to maximise productivity of light at the office or to change the light settings at home, following the moods of the owner.184 Lutron's Grafik Eye System connects various lights in a room and allow the user to program different light settings for different purposes, such as working mood, party mood, and reading mood. By using the program the customer can quickly find the necessary setting, thus saving electricity and reducing environmental impact.


184 Ibid. 183 p. 93
5.4 Community initiatives

5.4.1 Call-a-car

Since the big Swiss and German groups started in the late 1980s, an estimated 25,000 Germans and 20,000 Swiss have signed up. In the heavily congested Netherlands, where the government subsidises car-sharing programs, about 57,000 people participate in the call-a-car programmes. Networks are starting up in Austria, Scandinavia and Canada. Usually, a fleet of cars is owned by a membership organisation and subscribers pay fixed costs and per-kilometre/per hour fees. Cars are reserved on demand via a central reservation point.

CITYgogo, Belgium

City Gent is known as a historical centre. Few initiatives introducing more environmentally benign modes of transport were taken by private people and students since early 1990s. The city municipality announced a mobility plan to make the inner city car-free in 1997. Special taxi-cycles were proposed as an alternative mode to public transport and motorised taxi service. Currently, ten four-wheeled cycles ride in the centre of the city under the name of CITYgogo. These taxi-cycles are used by both citizens of Gent and tourists. The ordering system is established to provide the nearest taxi-cycle to a customer. The system enthusiasts are trying to extend the service provided to customers and therefore, all taxi-cycle "drivers" are trained as tourist guides. Lately the company decided to expand the area of the services and currently, fulfills the functions of distributing and collecting goods in the city centre, messages and medicine, flowers and cloth from dry cleaners, and provides courier services. The company even employed the renting concept, renting out vehicles without a driver.

Car sharing system in Leiden, The Netherlands

Car sharing initiatives can be considered as new forms of entrepreneurial activities promoting an alternative organisational structure for the car system. As an example, in the Netherlands, one of the most proactive European countries dealing with environmentally friendly experiences on mobility, there is the car sharing system developed in Leiden, under the name of “Huur-op-Maat”, where a group of car rental companies and car dealers is co-operating with the local government. Within the system, the “fleet manager” provides all its clients with a car whenever they need one. The local government supports the initiative in the field of communication and with parking facilities. Besides the financial advantages for people that travel less than 9000 Km per year, these kinds of initiatives give practical benefits, like no paperwork and no maintenance for the end user. Furthermore, they also present environmental benefits related to a reduction of car ownership among the participants and in mobility.

5.4.2 Housing Initiatives

CoHousing

CoHousing is a new way of living and sharing in a community. CoHousing is a collaborative housing that is characterised by private dwellings with their own kitchen, living-dining room etc, but also extensive common facilities. The common building may include a large dining room, kitchen, lounges, meeting rooms, recreation facilities, library, workshops, and childcare. Usually, CoHousing communities are designed and managed by the residents, and are intentional neighbourhoods; the people are consciously committed to living as a community; the physical

186 Ibid. 117
187 The CoHousing Network P.O.Box 2584 Berkeley, CA 94702. +1 510 486 2656

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design itself encourages and facilitates social contact.

CoHousing communities also provide societal benefits, such as greater resource efficiency, in terms of both materials and energy, and enhanced security for the community and surrounding neighbourhood. Furthermore, by taking advantage of the benefits of clustering dwellings, this type of development makes higher densities more attractive, an essential element in reducing transportation requirements and suburban sprawl.

Trudeslund CoHousing in Denmark

This type of housing began in Denmark in the late 1960s, and spread to North America in the late 1980s. There are now more than a hundred CoHousing communities completed or in development across the United States.

http://www.cohousing.org/whatis.html 1999-12-07

The CoHousing model incorporates ideas that have already proven very successful. Planned retirement communities often include shared dining and other common facilities. Resident involvement is recognised as a critical aspect in reducing long-term housing management costs. Yet, CoHousing communities are unique in combining a participatory planning process, neighbourhood design, shared facilities, and resident management to attract all ages and household types.
6. Observations and Conclusions

6.1 Product-service systems

The literature research and communication with experts in the area of product-service systems showed that few efforts have been made to understand the benefits of PSSs in practical implementation cases (Chapter 0). However, the most important conclusion is that there are many examples that illustrate parts of the solution (eco-design, optimisation of distribution, product customisation, added services, take-back systems, remanufacturing, and recycling), but there are no examples of complete product-service combinations that are based and designed on the life cycle basis in companies. This can be seen on the Figure 8 that summarises the efforts of the companies (case studies presented in Chapter 0), the case studies are matched with different stages of a theoretical life cycle. Stages 2, 4, 5, 6 are not considered here because they were the only tackled under the auspices of such approaches and strategies as Cleaner Production and Cleaner Technologies. The general trend of these stages is the diversion from a pure product development and manufacturing design. Recently, focus on production has diversified to include new approaches of vendor and materials management and approaches for forecasting, assessing and responding to changes in demand (reverse logistics, demand-side management, quick response manufacturing, JIT). Improving efficiency of production is considered to be a common sense strategy and, therefore, is left outside the scope of this study.

In analysing other stages and cases presented in this report, it is noticeable that no company addresses all stages when designing a product. More precisely, companies are reflecting on external demands and requirements, and are fixing problems identified by these external demands. The companies are lacking a system approach, which allows for improved system parameters and conditions, which provides a competitive advantage to companies and the allocation of resources more efficiently to where they are mostly needed at any particular moment.

What is the reason for such a limited application of product-service systems in companies? First of all, it is a new area and even at the academic level the product-service systems have not yet been studied and suited for practical applications. This is because product-service systems do not yet exist, as no information is available regarding the design of a PSS. Therefore, a number of uncertainties concerning the characteristics of the product-service systems still exist. These uncertainties can be combined into three main categories:

- Readiness to adopt the product-service systems into company’s strategic decisions. The shift from selling products to selling PSS entails substantial changes in the companies’ structure and organisational frameworks, production and marketing strategies, as well as their relationships with stakeholders. Few studies have evaluated the profitability of product-service systems for companies (e.g. Xerox), although present economic difficulties within some companies (e.g. Interface Inc.) serve as a counter-argument to the outcome of the evaluation.

- Readiness to accept the product-service systems by consumers. Little or no research has been conducted on evaluating the competitiveness of product-service systems and their profitability for consumers.

- Environmental characteristics of product-service systems are also not yet studied. A number of studies evaluated the environmental features of particular stages and activities, such as remanufacturing and take back as favourable. On the other hand, other studies showed that environmental characteristics of, for example, eco-services should be accounted for carefully, because they are not always preferable in comparison to products.
Figure 8 Companies’ initiatives undertaken at different life cycle stages

Some first steps towards designing product-service systems were made by Rens Meijkamp in
developing new product use routines\textsuperscript{188} and some interesting ideas were brainstormed during the Doors of Perception 3, "On Matter" meeting.\textsuperscript{189} The UNEP's Manual on Ecodesign refers to the improvement options identified during the design case of the Veromatic professional coffee machine, some of which include optimisation of the end-of-life system (initiation of take back system; design for disassembly, and reuse) and new concept developments (lease or rent). Otherwise, little has been done in the area of designing PSSs.\textsuperscript{190} Thus, there is a need to develop a methodology for designing product-service systems. One should start by analysing the possibilities, drivers and barriers of developing and employing such a methodology.

\textbf{6.2 Economic implications of the shift towards product-service systems}

Society's environmental problems are directly connected to its types and structures of economic activity - methods of production, patterns of consumption, and forms of economic organisation. The question of the excessiveness of current production still remains. Due to competition and rules of market economy, products are still manufactured in more than sufficient quantities in industrialised countries. The trend that characterises the current economic system is called the "rebound effect". The technological progress that was made a cornerstone of economy development always results in the generation of more products and services, and often it overcompensates for the original technological progress made, and essentially eliminates the potential for overall reduction in resource use. It is the very mechanism by which additional efficiency translates to an increase in people consuming more energy and resources.

A big contribution is awaited from information technology to reduce the production volumes of material products. There are already some examples of such services provided, for example, video-on-demand, and the publishing of books after they were asked for. Some new production practices, such as Just-in-Time, lead to more reasonable amounts of products and materials purchased. However, changing patterns of production and consumption demands parallel changes in environmental policy. In particular, policy makers must recognise service businesses, service functions in manufacturing industries, and new product-service systems as core economic activities and thus as an important focus for the next generation of environmental analysis and programmes.

Product-service systems provide a basis for the decoupling of wealth creation from natural resources consumption and pollution. Historically, economic growth was realised by increasing inputs (flows of materials into economy) that were substituted for human capital. Thus, labour productivity was a prerequisite and the success factor. An increasing population with decreasing resources demonstrates that what is needed at the moment is to drastically increase resource productivity. The shift towards services provides a possible alternative way of doing this. For example, new IT industries generate much higher growth than they use resources, use labour and create jobs. Thus, there is a need for new industries based on labour.

Another potential change is a closer interaction between the customer and the service-providing company. Many opportunities exist for the company to sell a package of related services, for example gas, electricity and water. The company could tailor its service provision to the specific needs of individual customers. This, in turn, could lead customers to think more deeply about what their service needs are and how they would like these to be met. This could prevent excessive production of goods that do not fulfil customers' expectations. Product-service provision could lead to a re-thinking of the appropriate scale for the provision of that service. In

\textsuperscript{188} Ibid. 122 http://www.io.tudelft.nl/research/mpo/nwsbrf/brief4.htm


\textsuperscript{190} Ibid. 180
combination with other related changes, such as ecological tax reform (moving from taxing labour to taxing pollution), services may be more effectively provided at a more local level, where additional, “old-fashioned” benefits such as personal service and community interaction can flourish. The tax reform should also reduce the use of raw materials and ease the change to a more labour intensive “repair society”.  

6.3 Environmental implications of the shift towards product-service systems

The diversity and complexity of PSSs must be reflected in an equally diverse set of environmental policies. There is no a single environmental policy tool to address PSS-related impacts and opportunities. It is especially true when factories are replaced by complex chains of production sites (outsourcing), transportation and information chains. Incentives and information are likely to become more effective as a regulatory strategy rather than command-and-control regime.

The environmental analytical community is just beginning to apply systems approaches to characterising the impact of product-service systems, and links between such analyses and policymaking do not yet exist. There are no indicators of PSS environmental performance and little is done about data collection systems. There is a fundamental problem with providing product-service systems. If services will be provided more efficiently in terms of resources and money, this will release money, which could then be used to buy increased services of the same or other types. This is so called the rebound effect; some of the savings from efficient services come back in the form of increased consumption. This is not a problem in cases where current service provision is inadequate, and its efficiency can provide an adequate level. However, in the case of a higher standard of living, higher consumption will lead to higher environmental burden. The extent of the rebound effect is a subject of many debates and can only be analysed on a case to case basis.

Figure 9 shows development steps towards sustainable development. On the vertical axis the reduction of the environmental impact is shown, expressed in factors of reduction with respect to the present level. On the horizontal axis is a time scale.

Figure 9 Levels of development towards sustainability

191 Ibid. 82
193 Kleijn, René (final ed.), Hansen, Eric; Huppes, Gjalt; McLaren, Jake; Pesonen, Hanna; Steevels, Ah; Vanakari, Evdokia; and Hans van der Wel (1999) Electronic Consumer Goods Case Report. (2nd Draft) CHAINET. March pp. 37-38
Currently our society is still in the lower left corner of this diagram, with the focus on improving the current conceptual stage and fixing immediate problems. This stage is more curative and still little is done in terms of considerable innovations. The realisation of such environmental concepts and approaches that would lead us to the higher levels on the graph depends on the ability of companies to communicate and collaborate beyond their gates. System innovation requires not only finding new ways of satisfying consumers' needs and increasing efficiency of products and processes, but also needs to improve the functionality of systems. Moreover, present state of the art methodology, for instance of LCA, still has some difficulties in describing the appropriate environmental performance of systems.

Both new and existing systems in society require investments; old systems for delivering functionality need to be upgraded and at the certain point changed, which will result in an additional environmental load.

### 6.4 Social implications of the shift towards product-service systems

There are several social implications resulting from the shift from selling products to providing services. Economists currently realise that there is a limit to the potential of labour productivity to generate economic growth. Previously, new jobs resulted from the newly created labour-intensive industries, such as cars, white goods, etc. However, there is emerging evidence that, for example, information technology creates jobs to a much lesser extent than it spurs growth. Thus, finding new employment opportunities is a great challenge for the next century. However, as services are usually more labour intensive than manufacturing, and value is created through direct communication with the customers, an opportunity exists for developing customised product-service solutions that will provide employment and satisfy the customers.

Social implications also concern consumers and their ability to utilise the purchasing power in order to affect different life cycle stages of a product or service offer. Basically all phases from the Figure 8 can be affected by consumers, through their purchasing decisions, who prefer a product or a service with lower impacts in resources and manufacturing, lower impacts in use, or properties that facilitate reuse or recycling. The use phase is affected if a consumer uses the product or the service efficiently, controlling energy and resource use and minimising waste creation. Disposal, to a large extent, depends solely on consumers.

Another social implication of introducing and employing PSS is based on the potential for consumers to make a change in their consumption patterns. To change the content of a consumption basket of goods and services requires significant changes in social structures. For instance, most of the direct environmental impacts result from the activities of established companies and institutions rather than consumer behaviour. Thus, the most important environmental decisions are not those that are made by consumers alone. Hence, changing consumers' purchasing habits also requires changing the social structures that determine these needs. The design of such structures is of fundamental importance in determining the type and composition of a consumption pattern. Products and services in turn should also be designed in accordance to the changed design of social structures. The social structures consist of infrastructure, human structures and organisational layout, and are summarised as follows:

- **Infrastructure** includes all facilities, equipment, logistics, and technologies that assist in the process of making and distributing products and services. The type of infrastructure built in a society has a direct effect on individual consumption patterns and environmental impacts. The indirect effect includes infrastructure influence on employment and income. Present

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infrastructure can be characterised by urban sprawl and transportation systems built around a car use. Its main characteristic is resource management resulting in the perceived right to free access and use and resulting pollution, that requires greater consumption to mitigate. Existing media and advertising reinforce and promote present consumption patterns and unsustainable lifestyles.

- Human structures include individuals and their well-being, and structures that enhance human potential, importance and consciousness about society and its interrelationships with the environment in a broad sense. Moving satisfaction from material towards less tangible ground might help reduce overall environmental impact. This could be done by investing in education and training.

- Organisational layout reflects societal cultures, procedures and traditions. The organisational framework in any society influences consumption patterns. For example, economic associations direct how individuals understand the market and themselves, and act to improve their quality of life through utilising existing economic organisational structures. Political structures can allow for different levels of the public access to the decision-making process. Enhancing transparency and public participation can influence the final consumer choice.

Yet another challenge with the shift towards PSS is reducing consumption. Such a developmental scenario is however difficult to sell to consumers. Navid Hanif, vice chair of the Commission on Sustainable Development, stresses that "It is not about consuming less, but consuming differently". It is definitely about how consumers needs are satisfied and about switching from the current necessity of satisfying consumers needs by consuming products and services to alternative satisfiers that meet those needs.
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