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EXAMPLES OF SUSTAINABLE CONSUMPTION:

Review, Classification and Analysis

NTNU
Program for industriell økologi
Rapport nr: 5/2004

Reports and Communications from

Norwegian University of Science and Technology (NTNU)
Industrial Ecology Programme (IndEcol)

Report no.5/2004
ISSN 1501-6153
ISBN 82-7948-037-4 (trykt)
ISBN 82-7948-038-2 (pdf)

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Price: NOK 50,-

Final Report
to Mitsubishi Research Inc. and
the Society for Non-Traditional Technology, Japan

Examples of Sustainable Consumption: Review, Classification and Analysis

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10 April 2003

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Report 5/2004


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Abstract

In this report, we gather what could be seen as examples of sustainable consumption. The intention of the report is to help policy makers identify promising policy measures and strategies to reduce environmental and social impacts. We also would like to point to promising research directed at developing policies, tools, and evaluation methods for sustainable consumption. In order to fruitfully organize and present sustainable consumption examples, we group and classify these examples. A number of prior issues have to be addressed, most urgently the definition of sustainable consumption. We define sustainable consumption through a framework that can be used to analyse the social and environmental impacts of household consumption. In this framework, measures directed toward consumption are distinguished from those targeting production.

A more in-depth study of examples of sustainable consumption could yield insights in how these examples work, how well they are accepted, and how/to what degree they can be replicated. In the appendix, we proposed a detailed study to develop social science methods to evaluate acceptance and take into account the rebound effect.

Examples of Sustainable Consumption
Review, Classification and Analysis

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Introduction

Sustainable consumption is a term shaped by the international policy community and events such as the United Nations Conference for Environment and Development (Rio de Janeiro, 1992) and the World Summit on Sustainable Development (Johannesburg, 2002). The *Agenda 21*, developed at the Rio Earth Summit, includes following objectives:

- "To promote patterns of consumption and production that reduce environmental stress and will meet the basic needs of humanity;
- To develop a better understanding of the role of consumption and how to bring about more sustainable consumption patterns" (United Nations General Assembly 1992, § 4.7).

At the World Summit for Sustainable Development (WSSD), world leaders recognized that it is necessary to "chang[e] unsustainable patterns of consumption and production". In the "Plan of Implementation", the main document to emerge from the WSSD, world leaders call for "fundamental changes in the way societies produce and consume" (United Nations General Assembly 2002, §13). They resolve to "encourage and promote the development of a 10-year framework of programmes in support of regional and national initiatives to accelerate the shift towards sustainable consumption and production […]" (§ 14).

The development and implementation of future sustainable consumption policies depend on an understanding of the possibilities and limits of sustainable consumption as an approach to reduce environmental and social impacts. It can benefit from the experiences that have been made with trying to implement sustainable consumption before, both from past successes and failures. In this report we collect, organise and evaluate information on initiatives, measures, and activities that can be seen as examples of sustainable consumption. Because our intention is to evaluate examples, we focus on sustainable consumption measures, not on levels or patterns of sustainable consumption. The latter is of course closely related to the former, and we need to refer to patterns and levels when we define sustainable consumption. We review examples in the areas of mobility, housing, clothing, and nutrition. We include appliances as a cross-cutting category and lifestyles as an aggregate that encompasses all functions but is more than the sum of its parts. The examples are categorized (i) according to whether

they increase eco-efficiency or affect lifestyles, and (ii) according to the mechanism by which they work. Examples that did not fit in this report are documented in an attached Excel Table. Finally, we discuss different frameworks describing the driving forces of consumption used by the OECD (Geyer-Allély et al. 2002). We find that habits and other factors producing inertia are not properly taken into account in any of these frameworks. We hence propose a framework that allows for path-dependent development. Based on what we have learned from reviewing the examples and on our framework, we derive suggestions for sustainable consumption policies that aim to influence these development trajectories. Special consideration has been given to examples, analysis and discussion presented at the AIST/IIASA/UNEP workshop on "Lifecycle Approaches to Sustainable Consumption," which was held in Laxenburg on 22 November 2002. We cite the respective papers where appropriate in this report, but do not dedicate a special section to the workshop. More information can be gained from the workshop proceedings (Hertwich 2002a) and a summary posted on the internet.

The attached Excel table contains a list of examples and documentation of examples that we have collected. In many cases, a description of the example is available on the internet, and the appropriate URL is provided. In some cases, the reference is to a book, report or article. The table contains a short summary of each example. We have also attempted to find out whether a reduction in CO_2 emissions has been quantified and whether the acceptability has been evaluated. In some cases, this may have been conducted, but not documented. We were not able to contact the project leaders in person, so we could not identify such cases. In some cases, reductions in energy consumption have been quantified or total energy consumption was quantified. In these cases, we indicate that a limited quantification has conducted (L). Acceptance was in some cases not investigated as such, but considerations of attractiveness to consumers, or market potential and barriers have been made. These can serve as a proxy.

Defining Sustainable Consumption

Production vs. Consumption

Sustainable consumption patterns are patterns of consumption that satisfy basic needs, offer humans the freedom to realize themselves, and are replicable across the whole globe without compromising the Earth's carrying capacity. In most industrialized countries, current consumption patterns are unsustainable because they require too many resources, cause too many emissions, and produce social impacts in developing countries that are unacceptable. In many developing countries, consumption patterns are unsustainable because the consumption is insufficient to meet basic needs and allow humans a freedom from want (Sen 1998). They may also be unsustainable because they are based on resource exploitation or cause adverse side effects, such as soil erosion and salinisation. From our perspective, sustainable consumption refers to measures to achieve a more equitable distribution of consumption around the world and reduce the overall environmental impact. Not all measures that reduce the footprint of a person count as sustainable consumption, however. Such a definition would be too broad to be useful. We therefore derive our definition from a framework for analysing the impacts

related to household consumption. For practical purposes, we will focus here on the "middle class" or "consumer class," i.e. that part of the global population characterized by a high resource use and high direct and/or indirect emissions.

In economists' view, the purpose of production is consumption. An evaluation of the environmental and social impacts of households needs to account for both the direct impacts of the household, such as emissions arising from fuel combustion in a household, and indirect impacts caused during the production of the goods and delivery of the services to the household, such a pesticide exposure during agricultural production or emissions from landfills.

If all the impacts that arise during the production of goods and the delivery of services are also allocated to consumption, in addition to the impacts that arise during the process of consumption, will sustainable consumption be all-encompassing? This would be impractical. While production and consumption are two sides of the same coin, we think it is still sensible to distinguish between sustainable production and sustainable consumption.

We distinguish between measures or actions that address production and those that address consumption. Clearly, the household environmental and social impact can be reduced through production-side measures alone. If, for example, the CO2 emissions of all production processes are cut in half, all other things being equal, the indirect CO2 emissions of a household will also be reduced by half. If new cars, equipped with catalytic converters, replace older cars without a catalyst, the emissions of CO, NOx and VOCs by the consumer will be reduced. The first example is one of production processes becoming more sustainable, while in the second example the product itself is improved. None of these examples requires any change on part of the consumers. Of course there may be a rebound effect, as the price of the products may change, affecting the quantity of the specific products purchased, as well as the overall budget of the consumer. Changes in the eco-efficiency of products or services provided to the consumer belong to sustainable production, even if they reduce the direct impacts of households. The impacts should, in any case, be evaluated on a life-cycle basis.

Sustainable consumption consists of measures to reduce impacts that affect the behaviour of the consumer or require her actions. If in cold climates the room temperature is reduced, if consumers are encouraged to cycle instead of driving or to use dishwashers instead of running hot water, we have examples of sustainable consumption.

Changes in consumer activities and use behaviour are clearly examples of sustainable consumption. Changes in purchasing behaviour, however, are in a grey zone because they also concern production. We argue that a change in a diet to have more locally grown, seasonal food or less meat is an example of sustainable consumption. The selection of a highly efficient hybrid vehicle over a gasoline-guzzling sports utility vehicle, however, is a similar change. In cases where the consumer takes a decision about buying a green product over a conventional one, we talk about sustainable consumption. The production of these goods is sustainable production, so that we have an overlap of the two. Sustainable consumption can be highly voluntaristic, as the preference for garment certified not to be produced in sweatshops, or encouraged through public policy measures, such as car-pooling to avoid road tolls and get access to less congested car-pool lanes on highways.

Tracking and Modelling the Impacts

Our definition of sustainable consumption requires that environmental and social impacts are limited. It is advantageous to be able to quantify these impacts, so that the contribution of different countries, population groups, or consumer activities can be evaluated. The ability to measure impacts is also critical for the identification of measures that contribute to reducing impacts, for signalling consumers which products to choose, and for tracking the progress of society towards sustainable consumption. The quantification of impacts is not always easy, however, and may sometimes be impossible.

In general, methods to quantify environmental impacts are better developed than methods to quantify social impacts. Risk assessment, life-cycle assessment and cost-benefit analysis have developed various methods to quantify the impact of or express the relative level of concern with emissions. For abiotic resource use, it is hard to define a direct impact and the consumption level as such may be used as an indicator. For land use or transformation and for biotic resource extraction, the issue is even more complicated and proxy indicators can be used. For social issues, it may be possible to quantify some issues, such as whether workers received a "living wage" or less, or how many hours of child labour were used. For some issues, it may not be sensible to quantify the impact in a manner that can be expressed as impact per unit product. For example, customers may require that none of the work was forced labour or conducted under sweatshop conditions. They may not want to buy "blood diamonds" from conflict regions or tuna fish caught by methods that unnecessarily kill dolphins. We therefore distinguish between cases where impacts can be expressed on a functional unit basis and those where impacts can be expressed in a simple yes/no fashion. We note that there are impacts that cannot be simply quantified and expressed. For some of these impacts, methods are not yet available, for others it may simply be impossible to measure impacts or relate them to a product.

After clarifying these preliminary issues, we would like to introduce an analytical framework for modelling sustainable consumption. This analytical framework takes into account a large set of variables that range from demography through consumer economics to production patterns and resource intensities. It builds on the IPAT identity, developed in the 1970s by Ehrlich and Holdren (1971) and Commoner (1972) to discuss the relative importance of technological change and population growth in causing resource consumption and environmental impact. IPAT has been used prominently, but also discussed controversially (Chertow 2000). It has resurfaced recently in the climate change debate, where it is know as Kaya identity (Kaya 1990). In the original version, it is expressed like this:

$$\text{Impact}=\text{Polulation}\times\text{Affluence}\times\text{Technology} \qquad (0.1)$$

where population expresses the number of people, affluence commonly expresses the gross domestic product (GDP) per person, and technology is the amount of emissions or energy use per unit GDP. T here is simply a collection of everything not captured in the two other terms and is calculated as I/(PA). This is the reason why this equation is referred to as an identity: it is true by definition. Various investigations have used this general form to look at the change of the various factors over time. A further

decomposition of technology is common. For example, the Kaya identity is written like this

$$CO_2 emission = P \cdot \frac{GDP}{P} \cdot \frac{E}{GDP} \cdot \frac{CO_2}{E} \tag{0.2}$$

where E represents energy use. The unit of analysis is typically a country or group of countries. Waggoner and Ausubel (2002) generalize the Kaya identity and insist that the third term refers to the "intensity of use" (for which the consumers are responsible) while the last term refers to efficiency, determine by the producers. We find this line of reasoning simplistic and inadequate for studying sustainable consumption and production. Instead, we suggest a more disaggregated approach which is able to model different population groups, industries, products and insults (Hertwich 2002b). In this approach, we replace above single factors by vectors and matrices. We argue that there are several types of impacts:

$$I \rightarrow \begin{pmatrix} I_1 \\ ... \\ I_k \end{pmatrix}$$

We suggest the use of impact indicators that have been developed for life-cycle assessment. At the same time, we propose to look at *n* different population groups.

$$P \rightarrow \begin{pmatrix} P_1 \\ ... \\ P_n \end{pmatrix}$$

P_i can represent the population living in a specific household type, grouped by demographic or lifestyle characteristics. With this, demographic modelling as suggested by Büttner and Grübler (1995) can be integrated in the analysis. Here, affluence is replaced by the consumer expenditure patterns of the different households, as they are described on a regular basis by consumer expenditure surveys.

$$A \rightarrow \begin{pmatrix} H_{11} & \cdots & H_{1n} \\ \vdots & \ddots & \vdots \\ H_{m1} & \cdots & H_{mn} \end{pmatrix}$$

Now, the real innovation occurs in the replacement of the technology variable. We suggest a description of the impact intensity of different "products" (as defined in the national accounts, i.e. product categories such as meat or passenger cars) using input-output or hybrid life cycle assessment. Process LCA can determine the impact intensity of single products. Input-output analysis and its adaptation to LCA can describe the impact intensity of product groups. This is done in at least three steps of analysis.[1]

$$T \rightarrow \mathbf{CS}\left(\mathbf{I} - \mathbf{A}\right)^{-1}$$

[1] If we use the framework of make and use tables, which are now the common statistical basis for economic input-output tables, additional steps are necessary (Hertwich et al. 2002).

1. The Leontief inverse of the economic input-output matrix, $\mathbf{(I-A)^{-1}}$, describes the requirements of input from different industries for producing one unit of output from an industry. It therefore is able to describe the industrial activity required to produce one unit of product.
2. A stressor matrix **S** describes the emissions, resource use or social stress produced per unit of activity (turn-over) of an industry sector.
3. A set of characterisation factors **C** describes the contribution of different stressors to different problems. This is really an optional transformation which simplifies the description of the overall impacts. C would, for example, include the global warming potentials for the greenhouse gases, aggregating greenhouse gas emissions to CO2-equivalents.

The result of the multiplication is a matrix that expresses the environmental (and social) impacts per product category, where different aggregate indicators are used, one for each impact category (e.g. global warming, human toxicity).

$$\mathbf{I} = \mathbf{CS}\left(\mathbf{I} - \mathbf{A}\right)^{-1}\mathbf{HP} \tag{0.3}$$

If we take a simple case two household types purchasing goods from three different industry sectors, which emit two different pollutants, each of which contributes to two different environmental problems, the analysis looks like this.[2]

$$\begin{pmatrix} I_1 \\ I_2 \end{pmatrix} = \begin{pmatrix} C_{11} & C_{12} \\ C_{21} & C_{22} \end{pmatrix} \begin{pmatrix} S_{11} & S_{12}\ S_{13} \\ S_{21} & S_{22}\ S_{23} \end{pmatrix} \begin{pmatrix} 1-a_{11} & -a_{12} & -a_{13} \\ -a_{21} & 1-a_{22} & -a_{23} \\ -a_{31} & -a_{32} & 1-a_{33} \end{pmatrix}^{-1} \begin{pmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \\ h_{31} & h_{32} \end{pmatrix} \begin{pmatrix} P_1 \\ P_2 \end{pmatrix} \tag{0.4}$$

As the approach is written now, it can account for indirect impacts of households, i.e. those that are connected with the production of goods and the delivery of services. If life-cycle evaluation of products is possible, there is no reason not to also describe the insults or impacts produced during the use phase in the same manner, per unit product sold.[3] Alternatively, the household expenditure matrix can be expanded to a household activity matrix, describing also the level of important activities that cause impacts. The Leontief inverse can also be of mixed units, including for example energy in MJ or kg

[2] The framework suggested by Norris and Segal (2002) links environmental impacts to needs fulfillment. This is one of several ways in which quality of life can be addressed. The needs perspective (Segal 1998) is very interesting and investigations will hopefully be fruitful. We believe that there are other ways to address quality of life or life fulfillment that are equally promising (Nussbaum and Sen 1993; Kahneman et al. 1999).

[3] Some impacts can be derived just from the purchases alone, such as CO2 emissions from fossil fuels. Other impacts depend on the technology or other factors in the household, such as NOx emissions from combustion. Other impacts may be largely independent of purchases, such as land use. While NOx emissions can be estimated based on emissions factors of standard household technologies, not all land use change affected by households can be derived from consumer expenditure information.

oil. Our approach is, in fact, a generalization of the approach used for household energy analysis (Vringer and Blok 1995; Munksgaard et al. 2000; Wier et al. 2001).

There are several advantages to this approach:

1. The influence of different population groups or household types can be investigated. In fact, single households can be evaluated and compared to average households. This allows us to evaluate social innovation and evolution. This modelling approach thus delivers an impact quantification method that can be used in connection with empirical social science research.
2. The impacts of households are measured in the same manner as the impacts of countries, products, or industries. When normalized on a per unit product value (per unit value added for industries), then the different items can easily be compared and evaluated their relative importance. This offers us the opportunity to develop benchmarks for industries, products, activities, and life functions. It allows us to evaluate substitutions and innovations and target areas for improvement.
3. Evaluations are based on consumption, not on the production activity of a country. This allows for a fairer cross-country comparison of environmental impacts that is no longer determined by the international division of labour, but by the production activities that individual consumers demand. Imports are either treated as produced in the country or, better, production in other countries is explicitly modelled (Goedkoop et al. 2002; Hertwich et al. 2002; Munksgaard et al. 2002).
4. The approach can be used for structural decomposition analysis (Casler and Rose 1998; Farla and Blok 2000; Hoekstra and van den Bergh 2002; Munksgaard et al. 2002). In this case, changes over time are evaluated and related to different factors. Structural decomposition allows us to attribute changes in emissions to changes in absolute levels of activities, changes in the composition, and changes in the efficiency. With this, we can see for example that population affects the impact not only through the absolute population size, but also because the number of single households is increasing as a fraction of the whole.[4] We can capture and evaluate changes in the pattern of consumption. Similarly, replacements of goods by services are evaluated correctly. The rebound effect is endogenously taken into account. Changes in the structure of production can be separated from direct efficiency gains.
5. Various models can be used to model different elements in the equation, such as economic interactions, household consumption, emissions, and demographic changes. These can then provide scenarios, which can be evaluated for their environmental and social impacts with above equation. It would also be natural to integrate the modelling of production and consumption in a single framework, through a social accounting matrix (Duchin 1998).[5]

[4] Single households have higher per capita emissions and energy use than larger households.
[5] This would allow us to more ssystematically model the financial interactions between production and consumption, e.g. effects of changes in the production system on changes in the household income.

Changing the level of impact

With the help of equation(0.3), we can now identify different changes that affect impacts. Amazingly, the identified changes fit into the four categories identified by Keyfitz (1998). We evaluate whether the changes can be classified as sustainable consumption or production.

1. Pollution control: A change in **S**, which results in a reduction of the stressor produced per unit turn-over through technical measures or changes in operating practices etc. This includes classical end-of-pipe solutions, but also pollution prevention. This falls under sustainable production.
2. Increases in the efficiency of production:
    a. Change in $\mathbf{(I-A)^{-1}}$: Increases in the efficiency of production, e.g. through reduction of the overall inputs required or substitution of polluting inputs through less-polluting inputs, e.g. reduction of energy use. These fall into the category of sustainable production.
    b. Technical changes in the products that are produced so that less resource input is required or fewer emissions occur during their operation. These changes affect **H** and **S**. If, for example, cars become more fuel efficient, consumers will most likely require less fuel (even if they, due to a rebound effect, drive more). This reduces the expenditure for fuel. More complicated are substitutions, e.g. when an oil furnace for heating is replaced by a district heating system. Here, the emissions shift from the consumer to the producer; they may or may not be of similar magnitude. We think that sustainable production is responsible to minimize impacts on a life-cycle basis, hence we count these changes as sustainable production if they are initiated by the producer or the government. If it is the consumer, however, who consciously replaces a polluting good with a non-polluting one, we would count this under sustainable consumption. We think there is an area of overlap. Organic food, for example, requires less polluting production methods but also a willingness on part of the consumer to pay more for the food, i.e. to select organic products over conventional ones.
3. Changes in use efficiency:
    a. Behavioural changes of the consumer with regard to the way products are used. This again affects **H**. When, for example, the room temperature is reduced or passive driving replaces aggressive driving behaviour, the result will be reduced impacts. This is clearly part of sustainable consumption.
    b. Changes in how functions are fulfilled, e.g. shifts in diet or mobility behaviour. In this case, specific functions are fulfilled in a different way, leading to a different composition of the household expenditure pattern and in the demand for different products to satisfy the same need – nutrition. Such changes also belong to sustainable consumption.

4. Lifestyle
    a. Substitution of goods or services in the household, so that a function is now fulfilled in a different manner. For example, a dish washer replaces dish washing in the sink, or a laundry services replaces the laundry machine, or delivered food replaces home-cooking. These substitutions, changing **H**, clearly belong to consumption. These substitutions are possible only if the corresponding, newly introduced products or services exist, i.e. they may require innovation in the production system, but we still see them as part of consumption (if not necessarily sustainable).
    b. Changes in life organization, e.g. increasing number of single households in industrialized countries or urbanization. These shifts invariably affect consumption, travel and time use patterns.

Sustainable consumption policy addresses the household expenditure patterns **H** and the social demographic distribution of the population P. Sustainable production policy addresses the structure of production **A** and the environmental and social stressor intensity of production **S**. There is both overlap and interaction between those two connected sets of policy. Sustainable consumption depends on the availability of less polluting, less impacting alternative products and services. The industry structure will respond to changes in demand. Sustainable production depends on a market for innovative products and services.

Analyzing Consumption

When analysing sustainable consumption measures, it is useful to understand how they contribute to reduced impacts. Keyfitz' classification of sustainable consumption and production into four different levels can be useful for this purpose. UNEP has recently suggested using the life 'functions' nutrition, mobility, housing, clothing, health and education as a way to organize its work on sustainable consumption and production (UNEP 2002). This is an alternative way to investigate sustainable consumption and production. Functions can be seen as components of lifestyles. Functions are fulfilled by different products and services. The concept of a function relates to the analysis of needs. Needs comprise both fundamental bodily requirements, such as the provision with calories and water, as well as the goods and services required to fulfil a 'normal' life. According to Segal (1998), needs have changed. For example, in many US cities, towns and suburbs, parents need to have a car to bring their children to

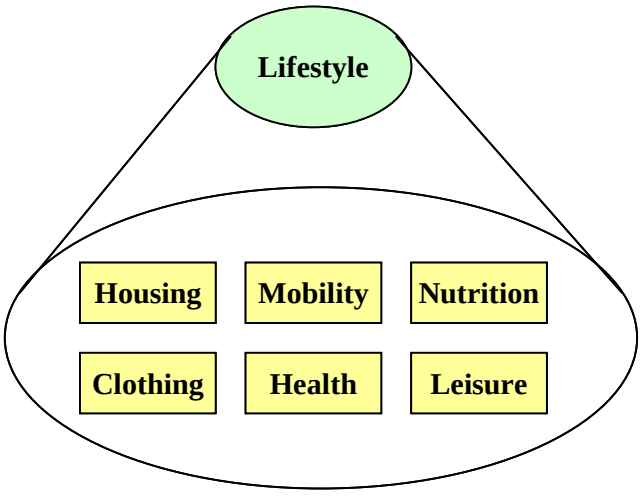

Figure 1: Functions and their relation to lifestyle.

school and leisure activities, because public transport is no longer available and/or socially acceptable. We think that functions are a useful basis for organizing the analysis of sustainable consumption and production. The environmental impacts of different alternatives of fulfilling a function can be analysed, and the popularity, time and financial cost of the alternatives can be evaluated. There is an interaction between the different functions, however, as one way of fulfilling a specific function may produce additional needs, related to a different function, or increase the overall time and money budget available to the household, leading to a rebound effect. A higher level of analysis, addressing entire lifestyles or consumption patterns, is therefore required. We therefore organize our review using the functions suggested by UNEP. We will not review education and health and only touch on leisure. But we will also include lifestyles as such.

Economists see obtaining utility as the purpose of consumption, even if utility usually remains undefined in economics. Significantly, however, two recent Nobel laureates in economics have worked on defining and operationalizing concepts of well-being or Quality of Life (Nussbaum and Sen 1993; Sen 1998; Kahneman et al. 1999). The sustainable consumption literature often contains references to well-being (Ryan and et al. 2002), but the concept is mostly discussed in the abstract. If consumption changes that reduce the social and environmental impacts keep well-being constant or even increase it, these changes should be in the interest of the consumer. The acceptability of both technical and policy measures should hence depend on well-being. An analysis of well-being could complement lifestyle analysis and assist the evaluation of sustainable consumption measures. The analysis of well-being could guide the selection of sustainable consumption measures that policy promotes. Information on well-being could also strengthen consumer interest in specific measures. Unfortunately, we are not able to address issues of well-being in this report, as no information is available about our examples.

Mobility

Transportation shows the highest growth of greenhouse gas emissions. It is the most important source of urban smog and ground-level ozone. Transportation also imposes a significant burden on land use, dividing a landscape and thereby drastically affecting biodiversity. The noise and visual impact of roads is significant, leading to substantial health effects. In fact, external cost calculations show that the noise impacts of transportation onto residential areas may be as large as those of pollution. Finally, road traffic causes many accidents. For these reasons, mobility has been a focus of sustainable consumption. When we refer to mobility, we do not address the transport of goods or business travel, both which belong to production. We focus on day-to-day trips, such as those between homes, schools, places of work, recreation, and shopping.

A persistent trend in personal transport is an increase in the distance travelled at constant travel time (Vilhelmson 1999). An increase in the speed of the average trip is caused by a shift in the mode of transportation from walking to biking and public transport, on to cars and finally airplanes. At the same time, the technical means of transportation increase their individual speed. The faster transportation modes usually cause a higher energy use and a higher level of pollution. Related to this shift in the modal split is a reduction of the exercise level and hence fitness in the population,

which leads to significant health effects related to overweight. The EU expects an increase both in the number of trips and the distances travelled, so that the kilometres travelled per person are expected to double by 2025 if present trends continue (ZEUS 2002).

We have reviewed a significant number of documents describing examples for sustainable consumption in the area of mobility. These documents include reports and web pages, as many examples are not described in the academic literature. The attachment of this report consists of an Excel file which lists the sources and provides a short description of the content of the documents. Where available, we have chosen summary reports and portal pages that are themselves directories to several examples. The home page of the European car sharing (ecs) organization, for example, describes car sharing and provides information on the car sharing organizations in different countries. It also contains a literature list. In this main report, we do not reproduce the entire content of the Excel file. Instead, we provide selected examples and then evaluate the entire literature.

The examples also include a short discussion of the elements of consumption. According to the Terms of References, the elements influencing consumer behaviour include opportunities, drivers, infrastructure and policies. We would like to include consumer awareness and intention/acceptance as further elements. These elements are, of course, interrelated. Policy provide infrastructure, such as bicycle paths, which creates an opportunity for more sustainable behaviour, i.e. biking instead of driving. Consumers will change their behaviour, however, only when they are aware of the opportunities and evaluate them positively.

Examples of sustainable consumption measures targeting mobility

Odense – Denmark's National Cycle City

Odense is a Danish city with 185,000 inhabitants. Over the last decade it has established a well-developed network of bike paths. Due to the fact that further investments in infrastructure will yield only limited results, Odense started a broad bicycle promotion campaign in 1999, which focuses on the fact that it is the individual who chooses his/her transport mode. Moreover, Odense now functions as a show case for bicycle traffic planning. New soft and hard policies are tested and evaluated in Odense (Andersen; Jensen et al. 2000). Because of changes in infrastructure and bicycle promotion, the percentage of bicycle use in the modal split lies at 24%. The percentage of car use, however, is unexpectedly high and amounts to 57% (Dijkstra et al. 1998).

In this case, policy provided for both bicycle paths (infrastructure) and awareness of this infrastructure. This led to a remarkable level of biking. It may, however, have impacted attention given to public transport. Both biking and driving are individual modes of transport that provide the person with a sense of control that is not provided by public transport. It may be individualistic attitude created that contributes to the low level of public transport.

ZEUS – Zero and Low Emission Vehicles in Urban Society

In this project eight European cities collaborate (London, Stockholm, Helsinki, Copenhagen, Bremen, Luxembourg, Athens, Palermo) in order to achieve positive ecological effects in the transport sector. The various measures in the participating cities are divided into 4 areas: vehicles, fuels, system & equipment and city planning & infrastructure. The main focus, however, lies on the elimination of market obstacles that hinder the widespread use of zero and low emission vehicles. In this project, many of these vehicles were purchased through a common procurement process. Petrol savings and the reduction of CO_2 have been documented by the European Commission (2000)

This project aimed primarily at creating a new opportunity, i.e. making alternatively fuelled cars available. This was achieved by policy actions that include the purchase of such cars (green purchasing) by public agencies and the development of a rudimentary refuelling infrastructure.

New mobility at the new place of residence

In an experiment, the traffic authority of the larger Stuttgart region sent out information packages about access to public transport in a neighbourhood and a free ticket to randomly selected people who had recently moved. These people were part of a three-phase panel investigation on mobility behaviour conducted by the University of Stuttgart. The investigation showed that the group who received this information used public transport more than the control group that did not receive the information. Because of the sample size, differences in car use were not statistically significant (Rölle et al. 2002).

This example illustrates the importance of awareness of and familiarity with opportunities for sustainable behaviour, provided in this case by a public transport infrastructure. People who were informed about public transport used it more.

Nordlicht – Climate protection to join in[6]

Northern lights (nordlicht) is a public campaign for climate protection by energy saving and traffic reduction. The strategy of Participative Social Marketing stimulates citizen activities to reduce greenhouse gas emissions in various participating countries. The concept is based on social psychology and works mainly with multipliers. In the year 2001 the campaign focused on traffic reduction und provided a “7-Steps-Manual”. According to the latest available interim results, the sum of saved kilometres was ca. 300.000 km per month, which accounts for an estimated reduction of 66 tons of CO_2 emitted (University of Kiel).

The social marketing includes awareness raising, i.e. informing participants of the availability of sustainable solutions and providing instructions of how to use this opportunity. The campaign, however, may also have created a sense of responsibility and obligation to act, both through the personal interaction and the appeal to the individual's responsibility for the public good.

[6] "Die Klimaschutzaktion zum Mitmachen"

Coalition of bike-friendly towns in North Rhine-Westphalia[7]

This action group of bicycle friendly cities and communities in North Rhine-Westphalia consists of 30 communities that foster the bicycle traffic according to an "Action Plan on Promoting the Bicycle Use". This action plan contains measures covering the development of infrastructure, bicycle and tourism, bicycle parking utilities, communication and awareness campaigns, etc. The action group was founded 1993 and already presented interim results. For example in Troisdorf, a participating city with 72.000 inhabitants, the CO_2-emission could be reduced by an estimated 2.700 tons per year due to an increase in bicycle use from 16% in 1988 to at about 21% today (Planerbuero Suedstadt / Planungsgemeinschaft Verkehr 2000).

This example addresses a broader set of policies that are implemented by communities to enable and promote biking. These policies address both the provision of the appropriate infrastructure and the use of awareness raising and promotion campaigns.

Växjö – the Fossil Fuel Free City

This project started in 1996 and is embedded in the Local Agenda 21 process. This project has two main goals: (1) Emissions of carbon dioxide from fossil fuels in the whole municipality shall be reduced by 50 percent per capita by the year 2010 compared with 1993, and (2) the Municipality of Växjö shall stop using fossil fuels. The reduction, as agreed upon in Agenda 21 roundtables with stakeholders, is to be achieved by efforts towards changes in behaviour patterns, energy efficiency and primarily to use bio-fuels to a considerably larger extent than today. The measures reached from car sharing and cycle campaigns to the promotion of a 50 % RME mixture as fuel for city buses. An evaluation of the project in the year 2000 showed, that the total CO_2-Emissions decreased by 21.5%, the CO_2-Emissions of the transport sector, however, increased by 21% (Växjö kommun).

The set of policies of the town introduce both new technical opportunities for reducing CO_2 emissions, such as providing biofuels, and an awareness at least of the importance of reduced emission.

The Sustainable Transport Modes Strategy in San Sebastian

This project started in 1990 and had the goal to promote more sustainable methods of transport and to win back public space. The activities concentrated on establishing a cycle route and pedestrian network and a further development of the routes for public transport. In addition to these hard policies various soft policies were applied, e.g. the creation of a permanent channel for public participation. The results of this project are: the number of passengers using public transport has increased by 10%, cycling accounts for over 1% in the modal breakdown of the city (there was practically no bicycle traffic in the past), and 120,000m^2 space could be won back from the motorized traffic (The Together Foundation and UNHCS 2002).

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[7] "Aktion Fahrradfreundlicher Staedte und Gemeinden in NRW"

This example is interesting because it not only provides opportunities and incentives for more sustainable behaviour, it also takes away opportunities for car driving. Both is achieved through a change in infrastructure. Again, awareness rising is included. Part of the success seems to be that the policies are planned in conjunction with the community, providing a channel for input and hence a higher level of acceptance.

Car-free housing project Vienna-Floridsdorf

This apartment complex includes 244 flats of different sizes (50-130 m^2) and was opened in the year 1999 as a demonstration project for car-free housing on the periphery of Vienna (GEWOG 2000). The apartment complex includes garages only for bikes and for car-sharing. The money saved from not providing one parking space per flat was invested in common areas, such as social rooms and a playground. The project includes an office for teleworkers and free-lancers, a fitness room, and a distribution/storage room for organic food. Solar energy is used for hot water heating. The apartment building is located near the old and the new Danube has therefore easy access to recreational areas. Access to the city is available through a nearby subway station.

This example makes it easier for inhabitants to forego car-ownership by providing easy access to car sharing and less hassle with storing bicycles. But if probably also works through the example that the inhabitants provide for each other, making it socially desirable to walk, bike and take public transportation. In such a situation, not owning a car is not seen as deprivation, but as liberation. Other measures at the housing project provide the technical infrastructure in the house or services – opportunities for sustainable consumption.

Discussion of the examples

Sustainable consumption measures in the area of mobility can have four aims:

1. Reducing the demand for mobility, or limiting its growth. These are measures that reduce the need for mobility by reducing the distances between home, work place, schools, recreational areas etc. This falls primarily under the area of city planning and is connected to limiting urban sprawl, the growth of suburbs. The question is whether, on a smaller scale, individual apartment buildings like the car-free housing project in Vienna can provide infrastructure and opportunity for socializing sufficient to reduce the demand for mobility.
2. Influencing the modal split. Most of the examples we found try to influence the type of mobility, i.e. the means of transport chosen. This can be done by reducing the areas accessible to cars, such as in Donostia, by reducing the availability of parking, and by promoting environmentally friendly transportation such as biking and public transportation.
3. Influencing the technology choice: The ZEUS project, for example, aims at encouraging the choice of environmentally friendly or energy efficient cars or providing for renewable fuels. It is the general aim of European energy policy to discourage high fuel consumption, because this increases the vulnerability to the

oil price. Measures in place include fuel taxes and registration fees depending on fuel consumption or motor strength.

4. Increasing the occupancy (load factor): Mobility centres and car-pools aim to reduce the number of cars on the road by increasing the occupancy of cars. The idea is that either for individual, longer car trips (mobility centre) or for regular commutes, the driver picks up additional persons who have to go the same direction.

Given these different policy targets, there are different types of policy measures, including infrastructure, zoning, public service availability, and so-called soft policies (information etc.). The majority of the examples reviewed indicate that soft policies, e.g. awareness campaigns and active participation of the residents, are crucial for success. This can be observed especially in the cases Langenlois, North Rhine-Westphalia, and nordlicht. Multiplier effects may play an important role.

Not all of these examples are success stories, however. Odense failed to realize an ideal modal split with a low car use rate. The high level of bicycle use is accompanied with a low level of walking and public transport use. This may be due to the absence of so-called push measures, like restrictions on car use and parking. Or it may be caused by the individualism that is promoted by both biking and driving. Mobility management therefore should combine pull- and push-measures, and they should probably not focus on a single environmentally friendly alternative.

The city Växjö failed in reducing the CO_2-Emissions caused by transport. Like in the case of Odense, this may be due to the fact that no push measures, with restrictions on car use, have been realized or even planned.

This means that a concentration on pull measures (incentives) without taking into account push measures (restrictions) may work if

- the potential of environmental friendly modes of transport has not been addressed yet (Langenlois)
- people are addressed directly via multipliers (nordlicht)

The case “Donostia” is a good example of combining push- and pull- strategies. The case “ZEUS” indicates that a strategy that focuses mainly on technological improvements can contribute significantly to the reduction of greenhouse gases.

Housing

Housing here is an umbrella term for a number of functions that are located in a modern OECD home. This includes shelter (including climatisation and lighting), hygiene (washing/toilette), and some leisure (TV, stereo etc). In principle, one could also consider domestic appliance use such as white goods, as these are also increasingly a feature of homes. We treat these aspects under a separate heading. Energy use for heating, cooling and warm water is responsible for a significant fraction of a households direct energy use and associated greenhouse gas emissions. This is strongly dependent on climate, culture, and technology, but in cold climates of Europe 60% of household

energy use is typically due to this category. Factors that influence the energy use for heating are climate, the insulation level of a building, the heating technology, the use of passive solar heat, the temperature, and the area heated per person. Warm water consumption is more strongly influenced by behavioural factors, such as the preference for showers or baths, the cleaning frequency, temperature preference and water use per shower. Low-flow shower heads are a fairly effective means of reducing the amount of water that needs to be heated. For lighting and the use of TVs, stereos, and ICT equipment, technology and behavioural factors interact. Energy efficiency efforts have focused on the technology of gadgets (energy efficient lamps and luminaries, operating and stand-by losses of appliances), as well as the interaction between gadgets and users.

There are other impacts of housing that are not related to energy use: material use and construction waste, land use and its impact on biodiversity, water use, and the use of home pesticides. Looking at these impacts, one realises that the function of a house is poorly described by the term shelter. A home is as much about representation and identity as a car is. Cultural factors are important (Wilhite et al. 1996). Apartments usually have low energy and pollution intensities compared to other consumption items. This may be in part related to the value of the land (which is not produced by any industry but may be responsible for a large fraction of the cost). Otherwise, building materials are not necessarily ecologically benign. Concrete and steel have high CO2 intensities, wood is scarce in some areas, and the PVC in pipes and window frames is highly controversial.

Sustainable consumption research has shown that the impact of individuals living in urban areas is somewhat lower than that of individuals in rural areas (in the same income group) (Vringer and Blok 1995; Vringer and Blok 2000). This is not only related to transport, but also to the flat area per person. The availability of gas and district heating is usually higher in urban areas and flats in larger buildings have fewer outer walls. Single-family buildings can therefore rarely be seen as "sustainable" and the trend towards suburbanisation and urban sprawl is a reason for concern.

Besides the type of settlement, sustainable consumption measures in the area of housing frequently address the building as a technological artefact. Technical measures are available to substantially reduce the energy demand for heating and cooling, using insulation, proper architecture with respect to the utilisation of sunlight as a source of heat and light (or the avoidance of heating in warm climates), the thermal mass of buildings and heat exchangers to reduce ventilation losses. In Europe, low and zero energy buildings are increasingly popular and affordable, where 'zero energy' refers to heat. The buildings are basically heated by the energy used by appliances. These buildings commonly include air exchangers and forced ventilation, but also electronic controls. As a result, use aspects have become important (Rohracher 2001; Rohracher and Ornetzeder 2002). Investigations in Austria have shown that individuals who live in detached houses with low-energy technologies are commonly satisfied and accept the technological constraints, such as not being allowed to open the window during winter. Individuals in apartment buildings with these features are less satisfied. This may be in part because the technological solution is more difficult and glitches are more likely, in part because tenants in flats are less enthusiastic technology adaptors. Individuals who build or buy detached houses with low-energy features consciously choose the technologies and are often technology enthusiasts. Individuals who rent choose an apartment for many reasons other than technology.

Technology can also be used to enable residents to control their energy consumption. For example, 'smart house' technology allows the user to programme room temperatures according to when a room is occupied and may react to external factors, such as sunshine, by controlling window shades (Trines and van Geet 2001). Such technologies also allow utilities to regulate the load, e.g. turning off a hot water heater during short periods of excess demand. Even in a wealthy country like Norway, such technologies are used as often to increase comfort as they are to reduce energy consumption. There is hence a substantial 'rebound' effect (Aune 2001).

Examples of sustainable consumption measures targeting housing

The New Home Energy Efficient Scheme

This British project was founded in 2000 and combines social and environmental matters. The target group are the so-called fuel poor; these are people who cannot afford quality heating in their homes and resultantly suffer from respiratory illnesses, strokes and heart attacks, poor living conditions and a reduced life expectancy. The heating costs of the fuel-poor amount up to £1,400 yearly, compared to £600 for average households. The difference is caused by the fact that low-income households use inefficient and expensive heating systems and lack insulation. The project will provide grants up to £2,000 per household to at about 460,000 households. Moreover it will provide packages consisting of insulation and heating improvements including the provision of efficient central heating systems. Most of the money and CO2 saved will be compensated by an increase in comfort, but a reduction in CO2 emissions by 0.7t per household per year is expected (G8 2000).

This example shows the importance of financing for realizing existing technical opportunities of sustainable consumption. Financing can make a solution affordable, but it is also an incentive to pursue such a solution, because the opportunity may go away, and it is always good to "get something back" from the government.

Sustainable Model Residential Area Freiburg-Vauban[8]

This project started in 1993 and will proceed until 2006. A new district will arise at a former barracks area and will provide housing for at about 5000 residents. The civic participation is a key element of the project. The following features contribute to the sustainable character of the district: all new buildings meet low or passive house standard, solar energy power plants and wood heating facilities provide the heating energy, the traffic concept fosters car-free housing, the infrastructure is walking- and bicycle friendly and restricts car use, and many social initiatives, like workshops, have been initiated (Sperling 2002).

Concerning the ecological effects, CO2-savings, compared with a reference district, amount to 3.400t per year in the field of heating and 1.000t per year in measures

[8] “Nachhaltiger Modellstadtteil Freiburg-Vauban” in German

targeting mobility. The overall CO2-savings amount to 5.000t per year, which is equivalent to 43% compared to a reference district (Brohmann et al. 2002)

The expansion of flat size per person and the trend towards "greener" surroundings are important drivers for impacts connected to housing and mobility. Planned new districts such as this one can provide a counterbalance by using technology that requires less esources, and by providing attractive surroundings through environmental planning. This may make it more attractive to not use the car and live more densely. The example affects the build infrastructure, which again has an influence on behaviour.

District Heating from Wood Waste in Vitry le Fraçois sur Marne

In 1985 a heating plant was converted from oil to wood. By the means of a 10km long heating network the heat is delivered to 13.000 residents or 65% of the population. The heating plant burns wood and wood waste – branches, forestry residues, barks, sawing dust, etc. Per year, 30,000 megawatt-hours of heat are produced, due to this at about 3 million litres of oil and the corresponding CO2 emissions are saved. Moreover, the heating plant operates so economical that the price of heating in the connected residential areas could be lowered (ICLEI - The International Council for Local Environmental Initiatives 1996). This is a technical solution that creates an infrastructure that provides heating from a CO_2-free energy source to houses.

Energy Efficient Buildings in Schiedam

This Dutch project started in 1980 and aimed at saving fuel and reducing air pollution through lower energy consumption. Moreover it intended to improve the living conditions in residential housing. The specific objectives can be described as: limiting pollution, reducing heat loss, improving heat storage and heat recovery, increasing the energy efficiency of water and space heating appliances and making use of solar energy. The first phase, from 1980 to 1985, involved the retrofitting of existing houses. In the second phase, from 1985 to 1990, refurbishments and new buildings were targeted for heat recovery units, solar water heaters, etc. The third phase dealt with building programmes and voluntary agreements with building and design firms. As a result, the saving from 1,500 houses refurbished in the first phase amount to about 1,5 million m^3 natural gas per year. The newly built houses use only 700m^3 natural gas per year per single-family dwelling, compared with 1,500m^3 for the average Dutch single-family dwelling. As a whole, all phases of the programme achieved savings of at about 6,825.000m^3 gas (Webb 1998).

This example again concerns technical solutions to the built infrastructure. Decisions targeted are not daily consumption decisions, but household and building company investment decisions.

Factor 10 House

This exceptional passive house is made of concrete and wood of the region (waste products from the regional forestry). In the design of this house, all relevant direct and indirect energy use was considered. Compared to the life expectancy of this building, the material input is minimal - the energy needed for the thermal insulation can be saved in during half a heating period. The energy for heating the building amounts only to 8 kWh per m^2 and year. Moreover, this house can be purchased at a reasonable price and is available in different modules. Due to this modularly system, it is also possible to combine such houses to terrace buildings (Tscharf 1999). Like the previous example, this one offers a technical solution.

RAL Eco-Label

This label is awarded to the planning and building of houses that comply with specified low energy or passive house standards. The energy efficiency of new buildings is assessed and certified by a third party. This label serves as information for building owners or purchasers and sets requirements in the fields of thermal insulation, sealing, heating, service water, and ventilation. For low energy houses, the energy loss due to transmission must be 30% lower than the current standard (Gütegemeinschaft Niedrigenergie-Häuser e.V. 2003).

This eco-label provides information to the prospective purchaser or renter about the low energy consumption of a building. This serves to identify an opportunity. The aim is also to create a market for low-energy consuming houses, i.e. it represents an incentive for building companies.

Discussion of the examples targeting housing

Space heating is a prominent target of energy policy, because the potential efficiency gains are large and in theory inexpensive compared to other measures. Problems that occur are the financing for measures that target tenant buildings (because the incentives of owners and tenants are in conflict) and spreading the knowledge in the fractured building industry. There is substantial uncertainty for the customer as to how qualified his building contractors are and what results savings will have. Measures should therefore target both the building industry and the financing. Demonstration projects, standards, and certification of planners or contractors are options to increase the competency of the building industry. There are also examples which target the use of buildings, often in connection with the introduction of new technologies. Different forms of residency, such as co-housing and communes, have the potential to reduce environmental impact through a sharing of certain facilities. These have been experimented with in the 1970s and on, but the success has been mixed and these forms of housing no longer appeal to the population.

Clothing

For clothing, production, maintenance and disposal are relevant concerns. Production causes substantial land-use concerns and agricultural pollution (eutrophication, pesticide use) when natural fibres are used. Treatment and dyeing can cause substantial water pollution. There are also concerns about the labour and health conditions of workers in the mass production of cloth, an issue important to civic groups such as the Clean Clothes campaign (http://www.cleanclothes.org/). Sweatshop and child labour is often used to produce apparel and shoes (Fung et al. 2001). Environmental attention has, however, focused on the washing or cleaning of clothes. The environmental effects of dry cleaning have received significant attention because the leakage of solvents such as tetrachloroethen (PER) has lead to ground water pollution and occupational health effects. Washing uses substantial amounts of energy, water, and detergents. Traditionally, phosphate-based water softeners have been responsible for the eutrophication of surface waters.

Sustainable consumption measures to influence production focus often on labour and health conditions. Attempts with introducing green clothing by manufacturer have focused on dyeing, chemical treatment, and the use of 'organic' cotton. To some degree, recycled fibre is used, most prominently PET bottles for fleece production.

From the perspective of climate change, the energy use during washing and drying is of highest concern. Transport from the manufacturer to the shop can also be significant, especially if air transport is involved. Energy use depends on the design of the washing machine, the amount of water that is used, the temperature, and the effectiveness of the detergent. It also depends on whether clothes are dried in a tumble drier or on a clothes line. The amount of spinning in connection with tumble drying is important, because spinning reduces the amount of water that needs to be evaporated.

Sustainable consumption measures in clothes maintenance are often focused on the appliances, washing machines and tumble driers. Energy-labelling, voluntary agreements and efficiency standards for washing machines have achieved significant efficiency gains (Bertoldi et al. 2001). In the European Union, the average electricity use of new washing machines for a standard 60^{o}C cotton cycle has been reduced from 0.286 kWh/cycle/kg 1994 to 0.228 kWh/cycle/kg in 1999. A further reduction to 0.165 kWh/cycle/kg is possible (Bertoldi et al. 2001). Sustainable consumption possibilities related to washing, however, arise also in the use of the washing machine: the frequency with which clothes is washed, the load factor of the washing machine, and the temperature chosen. In addition, cotton requires more water and allows higher temperatures than synthetic fibres, so that the choice of fabric is important. We note the importance of the choice of the washing machine/drier combination here; however, we address the purchase of these appliances as a cross-cutting issue together with other appliances in a later section.

Examples of Sustainable consumption measures targeting clothing

Green Cotton Label

This label is awarded to textiles that are produced in an environmentally friendly way and without human toxicants. The whole lifecycle of the product is considered from the cradle to the grave. The following requirements have to be met: at least 10% of the cotton originates from organic farming, no defoliants are used, the cotton is hand harvested and does not contain any residues of pesticides, the dyeing has to be environmentally friendly, colours must not contain any toxic metals, the bleaching has to be performed without chlorine, formaldehydes and chemical cleaning have to be avoided, waste water must be treated inside the company and measures in the fields of noise, waste prevention and energy efficiency have to be taken. The awarding rules are transparent and the awarding process is well documented (Verbraucher Initiative e.V. 2003c). Labelling is further discussed later.

Eco-Express – Ecological Laundrettes

This company was founded in 1997. It offers a prototype for a utility-orientated product service system and aims at overcoming the negative image attached to laundrettes. The company runs at about 38 self-service laundrettes in 21 German cities and more than 50 joint use washing facilities in tenant buildings. The customers are mainly students, but also self-employed. This means that the customers belong mostly to the young and low-income segments of society. Concerning the motivation of the clients, ecological matters play an insignificant role. The reasons for using the laundrettes are a lack of space in the dwellings and the purchase costs of washing machines. Regarding the joint use washing facilities in apartment buildings, the company showed that it is possible to profitably run such services. This is the opposite of the experiences of corporate building societies (ecom. AG - Buero Wuppertal 2000).

With regard to the ecological effects, by the means of using laundrettes the primary energy use can be reduced by at about 56% compared to the average residential washing machine. The amount of detergents can also be reduced significantly. Nonetheless, there exist important rebound effects: customers tend to use driers instead of using clotheslines, which counterbalances the positive ecological effects of laundrettes. In addition, the mode of transport to the laundrette is essential: a ride with the car to the laundrette (3km) compensates the ecological effects of two washings (60°C) completely (ecom. AG - Buero Wuppertal 2000).

Under certain circumstances – depending on the character of housing units and the transportation infrastructure, laundrettes and joint-use washing facilities reduce the environmental impact of washing. They represent an opportunity. Household dilution is a driver which increases the potential customer base, because singles are less likely to have space and be able to afford a washing machine. A countervailing driver is increasing wealth, which makes individual washing machines more available.

The "WashRight" campaign

The International Association for Soaps, Detergents and Maintenance Products (AISE) conducts a campaign that attempts, among other things, to reduce the washing temperature (to 30 and 40°C) and encourage a fully loaded laundry machine (www.washright.com). The campaign also attempts to reduce the detergent consumption and the packaging material. The campaign uses TV advertisements and leaflets. WashRight is a voluntary industry initiative based on a code of conduct. In some way, it only strengthens an ongoing trend. Average wash temperatures in Europe have dropped from 65 to 48°C over the last decade (Uitdenbogerd 2001). This trend has been enabled by better detergents and by easy-care fabrics such as new synthetics. The temperature leads to substantial energy savings. For a 1996 reference washing machine, electricity use was 2.32 kWh/cycle for 90°C, 1.45 for 60°C, 0.76 for 40°C and 0.44 for 30°C. A continuation of the trend towards lower temperatures, together with an increase in laundry machine efficiency, can bring a substantial reduction of electricity used for washing.[9]

Better detergents (and washing machines) created an opportunity for energy savings because the same quality wash can now be achieved at lower temperatures. To realise these gains, individuals have to relearn their washing routines. For this purpose, awareness rising is used.

Leasing Services for Washable Diapers

This project started in 1999 and its goal is to reduce the amount of waste due to throw-away diapers (nappies). Originally it was planned to provide a pick-up, wash and delivery service, but this turned out to be impracticable because of the inability to cover the running costs. Due to this the service was restricted to a leasing contract. The leasing costs are partly paid by the government of Styria (36 Euro), the local communities and waste managing associations. Advice about the proper use of reusable diapers is also part of the leasing contract. As a result, the communities save every year more than 100 EUR in waste disposal costs. Moreover, the resource use, the need for transport and indirect energy consumption are reduced (Municipia).

The diaper service makes it easier for consumers to choose a potentially more environmental alternative. It can also be seen as creation of an opportunity, supported by the solid waste policies.

Natur und Co.

This company was created in 1980 and manufactures clothes of natural wool, linen and organic cotton. Due to ecological and sanitary considerations, formaldehydes, carcinogenic and allergenic colours are avoided. In order to reduce volume of transport, clothes are produced locally. Concerning the inputs, wool and linen are produced locally

[9] Unfortunately, the trend in cloth drying is the opposite, shifting from the clothesline to the tumble drier, which is now often integrated in the laundry machine. "Household dilution" may also lead to more partially full washes. This is a rebound effect that negates the gains made in the washing itself.

and the organic cotton originates from Turkey. The energy for the production of the clothes is provided by solar energy, wind- and hydropower. Solar collectors and a cogeneration facility generate the energy for heating and warm water. However, Natur und Co. (2001) not only produces clothing, it is also engaged in research and promotion of sustainability.

Natur and Co is an example of a company that offers more sustainable products at a higher price. It provides an opportunity for individuals to lower their input through purchasing choices. A driver in support of such a development is the desire by individuals to create a unique identity, a trend which is supported by increasing wealth.

Fair Utilization of Used Clothes

This umbrella organisation with 150 members was founded in 1994 by several Catholic organisations in order to develop social and environmentally friendly concepts related to the treatment of used clothes. Main focus is to avoid commercial exports of clothes to developing countries that harm the textile industry there. This umbrella organisation does not collect used clothes itself, but provides guidelines and principles for collecting organisations. Those complying with these guidelines are awarded with a label. The guidelines are the following: non-profit status of the organisation; information about the further treatment of the clothes is provided; partner companies of the collectors are reviewed by external auditors; the impact on third world countries is assessed; a part of the profit has to be spent for developing projects. Moreover, the second hand commercialisation of clothes in Germany is fostered with awareness campaigns and projects (Dachverband FairWertung e.V. 2003).

This effort at organizing the reuse of clothes could be seen as an example of sustainable production, where the consumer influence is limited to the choice of organisation which to give the clothes to. This works like a label. The position of recycling and especially reuse is somewhat special.

Hemp for Textiles

This project started in 1994 and involves the private, public and academic sectors. It has, among others, the goal to compare various processing techniques and evaluate the best way to establish a UK hemp textile industry. The ecological advantage of hemp is based on the fact that this multiple use crop can be grown easily under organic cultivation, which is difficult in the cases of flax and cotton. Concerning the market niche, a small but growing market for environmental-friendly products, especially jeans and sportswear, in both 100% hemp fabric and blends with cotton, linen, wool or synthetics, seems to be promising. Although the project found out that there are some technical difficulties to overcome, it should be possible to initiate a revival of hemp industries (Riddlestone).

This is an example of a more sustainable product. Putting it on the market provides the consumer with the opportunity to reduce the upstream environmental impacts, and the advertisement connected with products provides "awareness."

Multi-generation orthopaedic shoes for kids

This eco-designed shoe for children is made of high-quality materials and is considered that several children can use it. This is possible due to an exchangeable inner sole. Moreover, this shoe is designed according to orthopaedic criteria. Concerning the environmental effects, using these shoes by several children results in an increase of resource productivity by a factor 2.4 (Mooss 2002). This is again an example for a more sustainable product.

Nutrition

Numerous studies have investigated the environmental impacts of nutrition (Jungbluth 1999; Geyer-Allély 2001). These impacts usually make a substantial fraction of the overall household environmental impact, more than the corresponding share of household expenditure (Goedkoop et al. 2002). The scope for reducing environmental impacts is also substantial, because there are significant differences in the impact of different foodstuff and of different diets. Relevant environmental issues include land use, effects on biodiversity, greenhouse gas emissions, eco-toxicity, human toxicity, eutrophication and acidification. Newer concerns include the effects of genetically modified organisms and hormonally active substances, as well as the use of antibiotics in animal husbandry. The sustainability of food production is of special concern for fish and game meat, but also for agriculture in areas with high erosion or irrigation (salt deposition). Life-cycle studies have focused on land use and greenhouse gas emissions. Using a modular LCA approach to food production, Jungbluth (2000) considers the greenhouse vs. open-air production, transport distances, meat vs. plant material, and organic or conventional food. He also considers preservation types and food preparation. Food production conditions vary with climate, fertility, diets and technology, so that general statements have limited validity. We address diets in this section. Refrigeration and cooking devices are addressed in the section on appliances.

From current Western and Northern European studies, following general features emerge:

- Energetic considerations show that animals are not very efficient in converting feed to meat, eggs, and milk. Animal-based food has hence higher land-use requirements than beans, grains, and many vegetables (Gerbens-Leenes and Nonhebel 2002). They also require higher inputs in terms of fuels and chemicals (Jungbluth 2000). Vegetarian diets are therefore usually more environmentally friendly than meat-based ones (Taylor 2000). There are significant differences between different meats, as well. In terms of land use and greenhouse gases, beef has the highest impacts, and poultry the lowest.
- There are also substantial differences between different fruits and vegetables in the environmental pressure they cause. In general, fats and oils require a large area, and proteins require more land than carbohydrates.
- Greenhouses cause a substantial impact on emissions and should therefore be avoided.

- Seasonal food is generally better than non-seasonal food, because it is connected to lower resource inputs and lower travel distances. In many cases, locally grown food is better.
- The contribution of preservation and preparation to the overall impact can be substantial, especially when refrigeration is involved. The contribution of packaging is usually insubstantial except for single prepared portions (TV-dinner).
- The case of organic agriculture is more difficult to evaluate, because organic food requires a larger area and sometimes more energy inputs due to lower yields, but less chemicals and therefore lower toxic emissions (van den Broek et al. 2001). From an LCA perspective, there has been insufficient attention to chemical and hormonal effects, so that recommendations regarding organic food are based on a poor characterization of the relevant impacts.

Various studies indicate that animal products, produce from greenhouses, and products transported over large distances cause high environmental impact, whereas locally grown food, basic carbohydrate sources (grains, rice, and potatoes), some vegetables and fruits have low impacts. Transport can be an important component, but in many cases the transport from the grocery store home is more important than that from the producer to the grocery store. None of the evaluations of seafood we have seen has properly taken into account the unsustainable harvesting levels of many current fisheries.

A sustainable nutrition is hence one that is mostly vegetarian, with a high content of local and seasonal food and low content of certain high-impact fruits and vegetables. Of course, the nutritional needs in terms of a balanced diet need to be appropriately considered. Following our definition of sustainable consumption, examples of sustainable nutrition are those of initiatives and measure to achieve reduced environmental and social impacts.

Examples of sustainable consumption measures in nutrition

Fair trade products

The social and occupational health impacts of the production of tea, coffee, bananas and certain other products in developing countries are a major concern. Fair trade labels indicate products that have been produced under specified conditions, often with reduced use of pesticides, and which provide workers or growers with a living income. There is a substantial number of fair trade labels in Europe, and increasing number of products is available also in regular supermarkets. Fair trade products are usually more expensive, resulting in something of a negative rebound effect, i.e. reducing the overall amount of products bought by the consumer. This also has a positive environmental effect. One example of a fair trade label is that of the fair trade foundation in the UK (www.fairtrade.org.uk). This is an example of a label, in this case connected with a more sustainable product line. It creates the opportunity to engage in more responsible consumer behaviour.

Organic label

Like fair trade labels, organic labels transmit information about the conditions of production to the consumer and thus allow the consumer to make decisions that are in accordance with the consumers' values and preferences. Organic products are usually also more expensive. An example for sustainable consumption with respect to organic food is the British supermarket chain Iceland. It converted its entire frozen vegetable line to organics, at no extra cost to consumers. Its initiative, which removed at a stroke the principal consumer objection to organic food, that it costs a lot more, put the rest of Britain's supermarket chains, many of which sell organics at very high mark-ups, on the defensive and under pressure to follow suit. Nonetheless, 6 months later the company abandoned the six-month-old plan to sell only organic "own-brand" frozen products, after an unexpected slump of 1.5 per cent in sales.

The vegetable box

This is a delivery service for organic cultivated food in the region of Darmstadt (Germany). Consumers are provided with meat, cheese and seasonal vegetables and fruits, mainly from regional farmers. The delivery takes place on a weekly basis or every other week. Multi-way boxes figure as package. The products can be reviewed at the company's homepage. Similar services exist in a number of European cities and towns. By providing locally grown, seasonal food, the environmental impact is lower. In addition, the vegetable box has the function of raising the awareness of consumers to the production of food.[10] A similar effect is achieved by various gardening and self-harvesting initiatives listed in our database. The creation of this product-service combination provides an opportunity to consume more sustainable.

Environmental impact calculator

An environmental impact calculator for foods was developed based on the data derived by Jungbluth (2000) and some related Masters Projects. It calculates the environmental impacts of different choices of vegetables and meat given various places of origin and preservation/preparation methods. It also includes a test for weekly diets. The aim is to give users a feeling for the magnitude and relative importance of different food items and thus influence the dietary preferences. It is unclear how effective the calculator is in actually influencing nutritional preferences.[11] There is certainly some secondary impact through reporting in the media about the general issues covered by the calculator.

The impact calculator aims at creating awareness about the environmental impacts connected to the consumption of food and at transmitting knowledge about how to reduce those impacts. It addresses the range of opportunities already available to Swiss and other central European consumers. No policies are required.

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[10] Kuhndt and Garcia (2002) provide a similar example from the Netherlands.

[11] Some of the feedback in an online questionnaire indicates that individuals accept the seasonal production and also the recommendation of a vegetarian diet. (Adrian Epp, Adrian.epp@schweiz.org, personal information).

Appliances: A Cross-Cutting Issue in Sustainable Consumption

Modern households are characterized by a wide range of appliances that simplify household chores or provide comfort and entertainment. The market penetration with major appliances is already very high in OECD countries, but the number still keep increasing because new appliances come on the market all the time and the number of households is increasing. Some appliances offer reductions in energy and pollution per service delivered, such as washing machines and dish washers, but there is a strong rebound effect. The customer's focus on initial cost implies that in a free market most of the available appliances are highly inefficient. There are large differences in the energy use of appliances, and significant efficiency gains can be achieved with programmes targeting appliances. Market transformation initiatives focus on replacing inefficient appliances on the market with efficient models through market incentives. There are also programmes that focus on use aspects, as we have already seen in the case of the WashRight campaign. What we have not found are examples that challenge the necessity of some of the services offer, such as American-size refrigerators that are used to store food that is better kept at room temperature, such as apples and tomatoes.

Examples of sustainable consumption measures targeting appliances

Energy Label (washing machines)

This EU-wide applied label is obligatory. It provides data on the energy use of household appliances. Information concerning other relevant ecological matters, like recyclability, is not considered. The energy efficiency is classified through 6 levels, from A (high efficiency) to G (low efficiency). Moreover, it assesses the noise level and the maximum quantity of clothes that can be dried through one drying process. Nonetheless, it is difficult to identify the most efficient appliances on the market using this label, because the top category is too wide, containing a substantial fraction of the entire product spectrum. In the A-level, e.g., appliances that consume only 20% of the average energy consumption can be found as well as appliances that consume more than 50% of average energy use (Verbraucher Initiative e.V. 2003b). The elements and working mechanism of labels is discussed further below.

Blue Angel (tumble driers)

This eco-label is based on ambitious criteria relating to energy consumption, life cycle, noise and recyclability. The following requirements have to be met, among others: extended warranty or the providing of spare parts for 12 years from ceasing manufacturing, disused appliances have to be taken back, and synthetics have to be classified and must not contain toxic ingredients. This label is very credible, especially due to the transparent and extensive documentation of the awarding. Since the tumble driers on the market are very different concerning their life cycle and noise emissions, this label provides important and relevant information for the decision of purchase (Verbraucher Initiative e.V. 2003a).

RWE's KesS Rebate Programme for Efficient Residential Appliances

This project started in 1992 and was finished in 1995. This demand-side management (DSM) programme offered 100 DM to any of its customers who bought energy-efficient domestic appliances from the white goods market. This programme was very successful from the clients' and society's point of view: 450GWh of energy, 300.000 tons of CO2 emissions and 3 million m3 of water could be saved. The savings in electricity costs were in most cases much higher than the extra costs of energy-efficient appliances. From the utility perspective, however, this programme was not cost-efficient. This may be due to high free-rider fractions; in this case, free riders are customers who would have bought an efficient appliance without the programme, but receive rebates. This indicates that the rebate level and/or the share of eligible models should be reduced for further appliance-orientated DSM-programmes (Thomas 1995).This is one of many DSM programmes that worked via a financial support mechanism for a customer. It thus created a direct incentive and made an opportunity to introduce energy efficiency in the household more accessible. Public policy is relevant in that it needs to encourage and allow such programmes. There have been less now since the liberalisation of the electricity markets.

FUNSERVE – Functional Service Contracts for White Goods

This project started in 1999 and has the aim to develop and field-test in the EU member states Austria, Germany, Sweden and the UK the approach to offer customers the services that they need instead of the products that provide these services. Three electric utilities in Germany and Austria and the appliances manufacturer Electrolux cooperate in leasing highly efficient appliances to the customer. The leasing scheme includes free delivery and installation with instructions on the optimal use, free repairs and a service hotline, and the removal of the appliance after the agreed period. The targets of this project are, among others, to assess the benefits and the costs for the participants and the environmental and market potential, and to test the market acceptance. The customer surveys have provided promising perspectives; also the retail trade has shown a high interest in participating. Concerning the environmental effects, a 10% market share of the appliances would reduce the energy consumption by at about 7TWh, which corresponds to a saving of CO2 emissions of at about 3 million tons per year. Moreover, 50 million m^3 water and 26.000 tons of detergents could be saved each year (Dudda et al. 2001).

This example of a product-service system creates a new opportunity to be more sustainable. It is equivalent in environmental impact to buying a more expensive, efficient washing machine. Due to the financial arrangement, it is more accessible to customers. It is also an opportunity for electricity companies to diversify their products. The infrastructure that needs to be in place is really a service infrastructure that includes the delivery, servicing and removal of the appliances. This is also a barrier, as it is costly for companies and requires a certain customer density.

Sustainable Lifestyles

While academics and policy analysts are hesitant about addressing the issue of lifestyles, politicians are less so. When the WSSD Plan for Implementation clearly points to unsustainable patterns of consumption, it refers to the combination of the level and the composition of consumption, without being specific about it. The Austrian government, in its sustainability strategy, talks about a "zukunftsfähiger Lebensstil" (future-enabling lifestyle). In our analysis, lifestyles are reflected by consumption patterns but encompass also other elements, such as time use, social identity, education, employment, family status, and cohort. The problem with looking at isolated functions or other elements (such as appliance use) is twofold: (1) the social analysis is incomplete and partial, and (2) rebound effects in other areas/functions are neglected.

The first issue is easy to understand. When looking at the entire life of a person or a household, time and budget constraints become relevant variables that can be addressed (Schipper et al. 1989; Jalas 2002; Perrels 2002). This is the more appropriate level at which to observe 'household dilution' (i.e. the decreasing average size of families) and population aging. It is also the more appropriate level to understand social dynamics and wealth accumulation. Cohort effects can then be evaluated and related back to individual issues (Büttner and Grübler 1995; O'Neill and Chen 2001). The second issue addresses the possibility of shifting consumption from one area to another. For example, if one moves from a rural area to a city and thereby reduces the need for mobility, what will the money saved be spent on? What is the emissions intensity of this new expenditure, compared to the previous one? What about the time rebound?

At the AIST/IIASA/UNEP workshop, many analysts in fact addressed the whole consumption of households. The method of input-output and hybrid assessments of household environmental impacts are commonly applied to the entire household expenditure (Goedkoop et al. 2002; Hertwich et al. 2002; Moll and Noorman 2002; Munksgaard et al. 2002). Perrels (2002) suggested using household time use and skill level to address the level of services derived by a household from consumption. In this case, household level concepts are used to understand shifts in function fulfilment. Norris and Segal (2002) proposed an alternative perspective that relates a household's overall consumption and environmental impacts to the household's needs, which are shaped by infrastructure, as well as social and cultural factors. Hubacek and Sun (2002) lifted the analysis up to the macro level and projected water demand in China based on expected changes in demographics, distribution of household types, and household income. In her commentary, Faye Duchin emphasised the importance of social life cycles. She identified the transition of an individual from one stage to the next in a human lifecycle, such as going from being a student to starting a family, as an important opportunity for influencing lifestyles. We have not seen any examples of interventions at this point. It is also important for the modelling of future household consumption and its environmental impacts.

The assessment and study of lifestyles is increasingly popular. Targeted activities to change entire lifestyles are less frequent than those addressing single functions or products, such as mobility or organic food. Activities that target single functions do

often have rebound effects, i.e. they lead to changed consumption in other areas. There are also spill-over effects, which mean that sustainable behaviour in one area leads to more sustainable behaviour in other areas (Thøgersen 1999). Some of the examples in the section housing could be counted as examples for sustainable lifestyles more broadly, because they do not only address the shelter as such, but the broader organization of life. Alternative living projects, however, are not always successful in sustaining themselves or in lowering impacts substantially (Lundgren 1999).

Sustainable consumption measures targeting lifestyles

Action at Home

"Action at Home" is a so-called social marketing campaign operated by the Global Action Plan in the United Kingdom.[12] Participants receive a questionnaire to establish a baseline of household environmental impact called Greenscore, which is measured again at the end of the programme. A monthly information pack provides step-by-step suggestions for making small changes to their practices. Packs cover waste, water, transport, shopping and energy, as well as 'next steps.' Over 30000 households have taken part in Action at Home. Unfortunately, the return of questionnaires has been low, so that the Global Action Plan cannot judge the impact of the campaign (Hobson 2002). For the "Sustainable Lifestyle Campaign" in the United States, the Global Action Plan claims savings of 9-17% of the household energy use, 16-20% of transportation fuel, and even larger amounts of water and garbage. This results in savings of USD 200-400 per year in utility costs. It is not clear, however, how representative and reproducible these number are. Hobson (2002) reports that only half of the UK participants that she interviewed have changed their behaviour and that most changes were minor and could be done with no cost and little effort, such as turning off the tap when brushing teeth. She criticizes the focus of Action at Home on "rationalizing lifestyles" and instead suggests a focus on social action and fairness.

Elements of this example are discussed in more detail in the analysis section further below.

Footprint Lifestyle Test

This interactive website by WWF Switzerland provides an online test that assesses the ecological footprint related to the user's lifestyle. The calculation is based on data inputs concerning housing (building, equipment), shopping-, mobility- and leisure behaviour and nutrition. In addition to the result, suggestions of how to reduce the footprint are provided. Moreover, the websites contains links and texts that explain the footprint concept and related issues. Participation is encouraged through prizes (WWF).

The main effect of the calculator is awareness rising. It does not impact infrastructure or policy, nor does it create new opportunities. It may, however, lead persons taking the

[12] http://www.globalactionplan.org.uk/aboutus/athome.htm. The Global Action Plan and its "Sustainable Lifestyle Campaign" started in the United States (http://www.globalactionplan.org). Similar activities also exist in Canada (http://www.toolsofchange.com).

test to identify existing opportunities to reduce impacts as such or create a motivation to pursue these opportunities.

Personal CO2 Calculator

The ECO2 calculator (www.novatlantis.ch > 2000 Watt Society) is the best of many personal CO2 emissions calculators we have reviewed. The idea of the calculator is similar to the footprint test: to show individuals where in their lives they cause major CO2 emissions. With this comes an indication of the changes the individual can make to reduce CO2 emissions. The calculator was originally developed as part of an integrated impact assessment project (Schlumpf et al. 1999). The calculator is based on an assessment of typical households in Switzerland and includes both direct and indirect emissions. It adjusts calculations based on information, e.g. about mobility and heating fuel purchases, provided by the test person. Unfortunately, it applies only in Switzerland. The same elements apply as to the footprint calculator.

Local Exchange Trading Systems

Local Exchange Trading Systems (LETS) have the goal to reduce the dependency on the official money and to foster regional and local production and distribution of goods and services. Every member has an official account, where the local forms of currency are credited or written off. These initiatives make use of modern computer and information technology. Transparency and democratic structures are key elements of LETS (Tischner 1997). According to the UK LETS and Complementary Currencies Development Agency, in the United Kingdom there are at least 450 LETS schemes with more than 40.000 participants (Letslink UK). Local exchanges reduce transport distances and are more oriented towards repair, service, and shared gadgets. Nonetheless, no evaluations of the ecological effects of LETS could be found. A social study found out that members feel educated about ecological issues and believe membership helps reducing pollution. Moreover, LETS members tend to reject the idea that future environmental problems could be solved through technological solutions. However, there was no single, dominant understanding of environmental problems among participants (Barry and Proops 1998).

LETS have multiple effects on society that are not easy to describe and classify. A LETS is a social, "soft" infrastructure, in the same way as law or markets. They are usually not part of official policy. The very idea is to create an opportunity for local exchange and value creation, something that shortens the transport pathways. In some way LETS is a form of resistance against a common driver of growth, the monetisation of economic relationship, but it is also a form of that.

Classification of Sustainable Consumption

In this paper, we have already introduced two types of classifications for examples of sustainable consumption. The first classification is the classification according to lifestyles and functions. This follows essentially UNEP's proposal to use functions but adds lifestyle more broadly to indicate that the whole is bigger than the parts (Classification I in **Error! Reference source not found.**). The classification according

to functions and lifestyle was used to structure the description of the examples. The second classification was introduced in connection with the analysis framework (Classification II in **Error! Reference source not found.**). It groups examples into those increasing eco-efficiency and those addressing lifestyles. With regard to eco-efficiency, there are measure that address production methods and product efficiencies, assuming otherwise identical products, and those that allow a shift in how a function is fulfilled, for example from product to service. With regard to lifestyles, there are those changes that affect the consumption pattern, shifting from one consumption area to another and those changes that affect the overall level of consumption.

We initially intended to classify sustainable consumption examples according to whether they created new opportunities for more sustainable consumption (e.g. organic food), whether they changed the infrastructure and thereby influenced the choice (e.g. reduce parking space and build bike lanes), whether they work by providing information/changing images (e.g. eco-labels), or whether they address policies (e.g. tax breaks for home ownership). The question behind this initial idea for a classification was how the examples work, their mechanism of action. Information is almost always part of a policy measure, so that we did not want to list this as a separate category item. The third classification in **Error! Reference source not found.** attempts to categorise examples according to the mechanism. The first category addresses situations in which several factors change. By moving the United States to Japan, for example, the emissions and resource consumption of a person is very likely to go down significantly. Both per capita energy consumption and material use are significantly lower (Grübler 1998; Matthews et al. 2002). A similar effect can occur within a country. Moving from a city to the suburbs will increase the environmental impacts. The second category addresses infrastructure. The third category addresses changes in behaviour through changes in preferences and cultural perceptions or changes in habits and routines. There is of course a connection, because one way for changes in preferences to be effective is by their impact on habits. The fourth category addresses the availability and access to environmentally friendly technologies, products, and services. They can reduce impacts either during production, delivery and disposal, or during use. Availability can be increased either by putting something on the market or by lowering the price or other financial entry barriers (investment costs). Indicating an existing activity as preferable, as it is done through labelling, also increases the access to sustainable products. The fifth category addresses the intensified use of products, which is in principle one option of greening a product; we have identified it separately here because it influence the use pattern. As last item, we list "life choices," like family size, number of children, choice of job. There are choices that have a large influence on the environmental impact, but are rarely or never seen from an environmental perspective. The increasing number of single person households adversely affects the environmental impact per capita. Reduced fertility is likely to have a positive overall effect. We have not found many examples for this category.

In Table 2, we present a classification of all the examples listed in this report according to all three classification systems. Across the classifications, there is a clustering. For example, measures that affect lifestyle in category II belong either to the category infrastructure or the category behaviour change, or both. Things that are classified in the category "availability"(III) are usually measures of eco-efficiency.

Table 1: Different options to classify sustainable consumption

I. Classification according to functions
1. Lifestyle
2. Functions
    a. Housing
    b. Mobility
    c. Nutrition
    d. Clothing
    e. Leisure
    f. Education
    g. Health

II. Classification according to analysis
1. Ecoefficiency
    a. Production methods and product characteristics
    b. Mode of service provision assuming functional equivalence
2. Lifestyle
    a. Consumption pattern (Shift between different types of services)
    b. Total level of consumption

III. Classification of examples according to observed mechanism
1. Locating person in a more sustainable set-up (e.g. move from a suburb to a city)
2. Changes in infrastructure (e.g. subways instead of roads)
3. Changing behaviour
    a. habits and routines
    b. preferences, values, cultural perspectives
4. Availability of and access to sustainable products and services
    a. affecting impact during production and disposal
    b. affecting impact during use
5. Intensifying the use of products (use less products)
    a. longer life cycles (durability, reuse, repair)
    b. more users (sharing)
6. Shaping careers[13]

[13] Choice of job; living single, in a group or a core family; number of kids; friendship circle etc.

Table 2: Examples discussed in this report and their classification. The classification systems and codes are listed in Table 1.

Example	Country	Classification	
		II	III
Mobility			
Odense – Denmark's National Cycle City	Denmark	2a	2, 3b,a
ZEUS – Zero and Low Emission Vehicles in Urban Society	EU	1a	4b
New mobility at the new place of residence	Germany	2a	3a, 3b
nordlicht – Climate protection to join in	Germany	2a	3b, 3a
Coalition of bike-friendly towns in North Rhine-Westphalia	Germany	2a	2, 3a
Växjö – the Fossil Fuel Free City	Sweden	2a	3a, 3b
The Sustainable Transport Modes Strategy in San Sebastian	Spain	1b	3a, 3b
Car-free housing project Vienna-Floridsdorf	Austria	2a	1
Housing			
The New Home Energy Efficient Scheme	UK	1a	4b
Sustainable Model Residential Area Freiburg-Vauban	Germany	2a, 2b	2
District Heating from Wood Waste in Vitry	France	1a	4b
Energy Efficient Buildings in Schiedam	Netherlands	1a	4b
Factor 10 House	Austria	1a	3b, 4a,b
RAL Eco-Label	Germany	1a	4b
Clothing			
Green Cotton Label	Denmark	1a	4a
Eco-Express – Ecological Laundrettes	Germany	1a, 1b	4a,b, 5b
The "WashRight" campaign	EU	1a	3a
Leasing Services for Washable Diapers	Austria	1b	5a, 4a
Natur und Co.	Germany	1a	4a
Fair Utilization of Used Clothes	Germany	1a	5a
Hemp for Textiles	UK	1a	4a
Multi-generation orthopaedic shoes for kids	Austria	1a, 2b	4a, 5a,b
Nutrition			
Fair trade products		1a, 2a	4a
Organic label		1a	4a
The vegetable box	Germany	1a, 1b	4a
Environmental impact calculator	Switzerland	2a	3a
Appliances			
Energy Label (washing machines)	EU	1a	4b
Blue Angel (tumble driers)	Germany	1a	4b,a
RWE's KesS Rebate Programme for Residential Appliances	Germany	1a	4b
FUNSERVE – Functional Service Contracts	EU	1a	4b
Sustainable Lifestyles			
Action at Home	UK	2b	3a
Footprint Lifestyle Test	Switzerland	2a, 2b	3b
Personal CO2 Calculator	Switzerland	2a, 2b	3b
Local Exchange Trading Systems		2b	6

Analysis of Examples of Sustainable Consumption

We would like to discuss some of the examples in more detail to understand how they contribute to reducing environmental or social impacts. We want to use this to highlight different elements, such as opportunities, drivers, infrastructure, policies, and culture. We have chosen the examples to discuss in detail so each example can serve as an archetype for a larger group of examples. After discussing the examples in sequence, we will draw some more general conclusions.

Action at home

The 'sustainable lifestyle campaign' is very interesting. There are at least three mechanisms that are in place:

1. Awareness rising: The participant learns something about where in the household environmental problems are produced. The greenscore, calculated from the questionnaire, will give an indication of the relative importance of different consumption items. The awareness raising is repeated again at the end of the exercise.
2. Produce the practical knowledge about what to do, leading to behavioural change, especially in day-to-day household routines that affect water and energy use, garbage etc. The idea is here to change habits and avoid the waste of resources.
3. Influencing of product choice and home improvement investments. Here is where the marketing comes in. 'Green products' are promoted, and this pays in part for the campaign. Small investments may also be necessary, such as installing low-flow showerheads.

What is interesting about this exercise is that it does not remain at the abstract awareness raising level, as CO2 emission calculators or the footprint web page do. Instead it gives specific suggestions and instructions of how to reduce the environmental

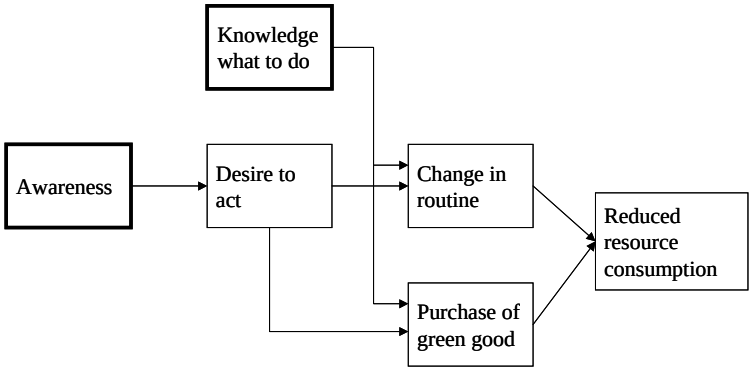

Figure 2: Mechanism of the sustainable lifestyles campaign.

impact. People can act on their new-won awareness. These actions are as simple as turning off the faucet while brushing your teeth. The mechanism of action of this

example is simplified in Figure 1, leading from awareness and practical knowledge (about behavioural change and alternative products) to reduced resource consumption.

Hobson (2002) argues that Action at Home is not as successful as it claims, because it uses the wrong language to advertise sustainability (rationalisation of lifestyles instead of equity and fairness). It is precisely the simplicity of the actions, connected with conservation (do with less, save) that puts people off. She points to a negotiation process that goes on between the individual and the workbook. It would be interesting to see how this negotiation process plays out in the United States, where the same campaign uses group meetings lead by volunteers. We believe that such a negotiation process is necessary. It is clear that people will not blindly follow a manual and change their habits without questioning the reasoning and effect. It may be that here Action at Home could do a better job in presenting the material, producing a more positive image that connects the behavioural change to more positive, fun themes than frugality.

It is the connection between awareness raising and behavioural changes that is of interest to us. The group dynamics, mutual encouragement and interaction as it comes with the social marketing approach in the US may, however, be a crucial ingredient. A more systematic evaluation of the effectiveness, already in the design phase of the program, will be necessary. The message and the communication mechanism probably need to be adjusted to each new cultural setting.

Organic food: Ja Natuerlich, Iceland plc, and the vegetable box

An organic food line in a supermarket works through two mechanisms.

1. Availability: It makes a sustainable product available. With this, consumers now have the choice between more or less sustainable products. This has feedbacks to production, of course. With more organic products consumed, the conventional farmers may rethink their practices; shift at least to integrated pest management. In cases of crisis, like to various food scares in Europe (BSE, antibiotics in pigs, poisoned fodder etc), organic functions as a positive example that indicates that the excesses of industrial agriculture are not unavoidable.
2. Eco-label: Organic food is labelled, and an organic food line works like an eco-label. The idea is to give consumers a signal, to provide them with information about a product attribute which they could not identify in any other manner.

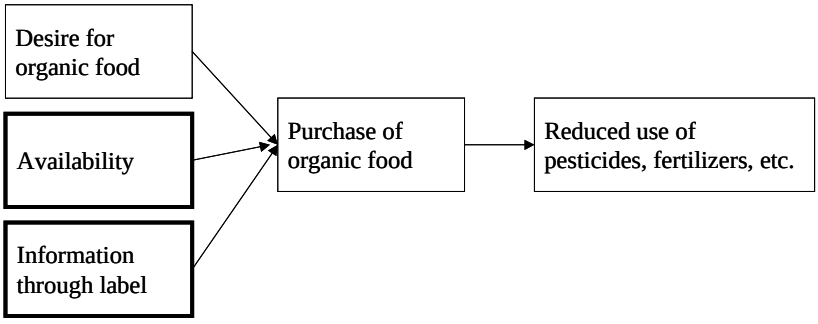

Figure 3: Mechanism of action for organic food line.

Organic food lines may have more or less success. Commercially, they can either attract wealthy customer to a retail chain by giving it a boutique flavour, as it was the case for Ja Natuerlich in Austria (IIASA-LUC 2001), or lead to reduced sales by scaring away the cost-conscious market segment, as in the case of Iceland plc in the UK.

While sometimes eco-labels can lead to a market transformation, as it was the case with toilet paper in Sweden (Stø and Strandbakken 2002), this is not expected for organic food. Instead, organic food works because customers want to signal that they are health-conscious, care for the environment and are worth high quality food. While the fraction of customers in Austria has increased steadily and may continue to do so, organic food works because it signals an identity.

The vegetable box is an interesting case, because it offers a different distribution route. It is dependent on the customer whether this is more or less environmentally friendly and more or less convenient than organic food in the supermarket. The significant difference is, however, that this food is often locally produced and seasonal, reducing the environmental load connected with long-distance transport or long-term storage.

Funserve and car sharing

Both funserve and car sharing are product-service systems in the wider sense. They work through changing incentives and helping customers understand the costs better. In both cases, investment costs are converted to operating costs. In the case of funserve,

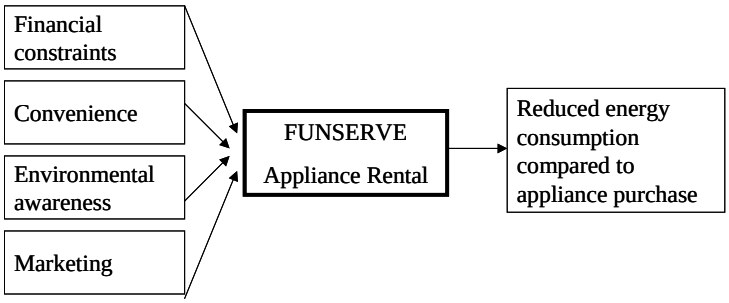

Figure 4: Mechanism of action for the FUNSERVE model of product-service delivery.

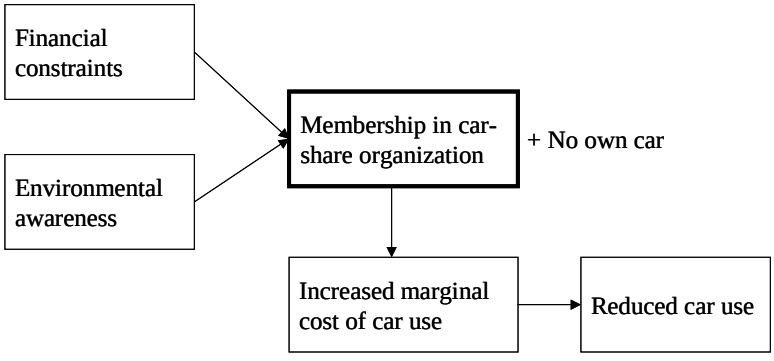

Figure 5: Mechanism of action for car-sharing compared to car ownership.

customers are encouraged to opt for more efficient, more expensive appliances, because the savings in utility costs are higher than the additional capital cost. The program is attractive because customers can save up-front costs, but also because the appliances are taken back by the utility after their useful life, removing the worries about correct disposal from the consumer. Car sharing shows the customers the real cost, leading to a change in mobility behaviour. Customers have the convenience of having a car available, but will use it only when it is indeed more attractive than public transport or biking.

There are some differences. Mobility behaviour is largely habitual, which the purchase of white goods is not. Car sharing affects how other activities in life are organized and has hence effects on time use and budget, while funserve has a minor effect on the budget. Car sharing increases the intensity of use of a gadget, similar to laundrettes or laundry services. This will, supposedly, create an incentive to buy a more efficient, longer-lasting car and reduce the need for buying so many cars, thereby reducing the material flow and impacts connected with the production and disposal phases. Funserve may also create an incentive for more durable appliances and for appliances that can be recycled or easily repaired and reused, but the connection is less clear.

Discussion

What we see is that different examples of sustainable consumption work according to different mechanisms. A mechanism (of action) is the sequence of events that will eventually lead to a reduced environmental or social impact. These mechanisms are sometimes mechanisms imagined or implied by those implementing a sustainable consumption measures. Some of the measures we have examined intervene at a single point. The footprint website provides information about which actions in a person's life produce high environmental impacts. This may lead to reduced impacts if the person, based on this awareness, identifies action opportunities and implements them. But the link is very tenuous. Action at home provides, in addition to awareness, also instructions for what to do and a feedback mechanism through the final questionnaire. But this is a lot more effort, and success is limited. Introducing the availability of a more sustainable alternative and providing information or at least a signal about it may or may not work; its success can be easily detected in sales figures. Changing financial incentives works where decisions are taken predominantly according to cost criteria, such as in the case of appliances. For many, however, cars are goods of symbolic value. For individual who purchase identity, not convenient transportation, car sharing will work only if the desired identity is that of a modern post-materialist, i.e. only in exceptional cases.

Most of the examples identified in this report address only one in a sequence of events that is necessary to reduce the environmental and social impacts of consumption. Other conditions need to fall in place for the desired effect to materialise. Those measures that include several actions at the same time, for example the combination of building bike paths, offering bicycle services and promoting non-motorised transport are more likely to succeed than those that are based on only one of those elements. The scope of most measures examined is limited, however, and the impact of the measures has often not been systematically evaluated.

Drivers of Consumption and Models of Change

In its exploratory work on sustainable consumption during the period 1999-2001, the OECD identified four different conceptual frameworks describing the driving forces of consumption (Geyer-Allély et al. 2002). These frameworks are founded in alternative theories about consumer behaviour, ranging from microeconomics to psychology. The frameworks are:

1. **The economic framework of consumer decision making**: This theory is based on the rational decision maker who reacts to price signals in a way as to maximise her utility. Consumer preferences are consistent, stable over time, and immune to external influences. The propensity to consume when income or wealth increases is of key interest, as well as the price elasticities for different goods, the income elasticities, and the elasticities of substitution. This theory is well suited to model the effects of product taxes, subsidies, and price changes with technological improvement. Using an econometric model, Kletzan et al. (2002) have investigated the pollution reduction that would result from carbon taxes, road fees, and planning measures in the areas of mobility and heating because consumers adapt to changes in prices and availability of transport opportunities.
2. **Socially contingent consumption**: Follows broadly economic theories of consumption, but is based on a more realistic model of preference formation. This model considers the influence of other people's opinions and behaviour and acknowledges that individual reasoning is typically based on multiple and contradictory goals and motives. It sees pro-environmental behaviour as something that emerges out of a sense of obligation towards public or common goods, depending on the values held by a person. Individuals are satisfied if they contribute what they see as a "fair share" towards the common good. Biel (2002) has investigated the effectiveness of positive and negative labels depending on social and individual values held by a test person.
3. **Systems of provision model of consumption**: Sees consumption as a set of social practices that are carried out by applying sets of rules and shared norms. Consumption is an active process, with actors seeking certain lifestyles and constructing their identity by selective consumption and practices. Consumers are co-actors together with producers in a system of provision, where the co-actors interact and are shaped by each other. This framework points to the necessity of addressing the entire system, that is, both producers and consumers.
4. **The Needs-Opportunities-Abilities model of consumer behaviour**. People consume to satisfy needs, such as comfort, pleasure, health, and justice. To consume, they require an opportunity. The need satisfaction depends on and individual's abilities, including the ability to afford a good and to understand how it is used. Needs, opportunities and ability depend on technology, the economy, demography, institutions and culture (Gatersleben and Vlek 1998). The framework, as displayed in Figure 6, describes qualitatively how these factors lead to consumer behaviour, which has consequences for both the quality

of life and of the environment. This framework is a modification of an earlier model of consumer behaviour that emphasises motivations instead of needs. Kuhndt and Garcia (2002) apply essentially the same framework, using the terms of provision (structures for the creation, delivery, utility, disposal and information for products and services) for opportunity, and access (factors that include or exclude consumers from participation in the market) for abilities. Using the term provision, they intentionally draw a connection to the *systems of provision* model described under point 3.

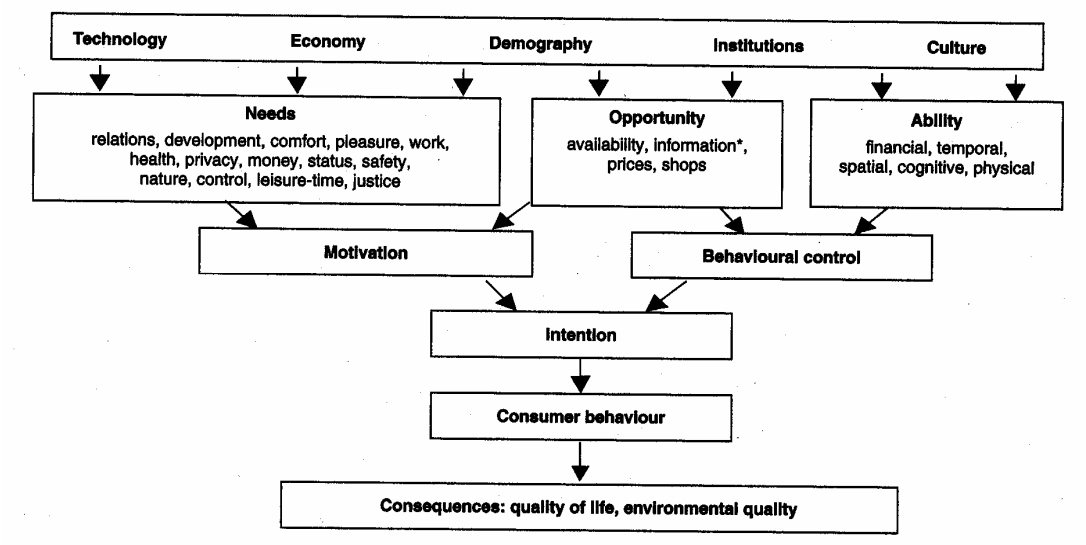

Figure 6: Needs, Opportunity, Ability (NOA) framework of consumer behaviour. From (Gatersleben and Vlek 1998).

There are two problems with these four frameworks. The first problem is that the frameworks are based on competing theories about consumption. Not all can apply (or be correct) at the same time. The second problem is that they do not lead to satisfactory models of change which accord with the mechanisms of action we have observed in our examples.

The different frameworks for the driving forces of consumption are based on competing theories of consumer behaviour. While the OECD team presents them as complementary (Geyer-Allély et al. 2002), from a scientific perspective not all of them can be correct, otherwise consumer behaviour would be overdetermined. Intuitively, however, each of the frameworks seems to capture valid aspects. If the frameworks are indeed used only as framing devices, as perspectives, and not as explanatory theories, we could accept the usefulness of several complementary frameworks. They would be equivalent to looking at the same building from different angles. This implies that we do not accord them explanatory power. At least the first two frameworks, however, are based on theories that claim to have explanatory power. One approach would be to integrate the theories where they are not mutually exclusive, or to weaken the explanatory claims so that each theory offers some degree of explanation for some behaviour, depending on situation. This, of course, begs the question of which theory

applies to which situation. We will offer a solution along those lines after addressing the second issue.

The second problem with the frameworks is the models of change that they suggest. At least three of the frameworks predict an immediate change in consumer behaviour as a result of changes in underlying factors. There is no place for inertia and hysteresis effects. We think that the constancy of individual behaviour is most remarkable. In a panel study on organic food purchases, Thøgersen and Ölander (2002b; 2002a) have shown that past behaviour is the most powerful predictor of current behaviour. Individuals who buy organic food once are more likely to hold a favorable view of organic products later and hence to repeat this behavior. There is also a positive feedback between attitudes and behaviour, which strengthens this trend but, from a scientific view, obscures the causal connection between different factors. We would claim that habits and routines in fact determine most of our behaviour. While transaction cost economics has gained prominence, we think that transaction costs are not sufficient to explain habituation, because in many cases the economic actor would be better of paying the transaction costs. Models of "statisfycing" going back to the idea of bounded rationality (Simon 1957) may be more appropriate. Bounded rationality emerges because humans economise decision making effort. They are satisfied when they have arrived at an acceptable solution and in thus do not continue the search for an optimal solution (Kleindorfer et al. 1993). We want to go further to say that in most cases; decisions are made by default, so that no effort is extended. The default is the habit, is what always has been done. A substantial change is necessary for the individual to even engage in a search process for alternative courses of action and to evaluate alternative choices. The occasion for such a search process can be a crisis, an epiphany, a substantial change in circumstances, or the shift from one stage in the personal life cycle to another. We have sketched this model of consumer decision making in Fig 7.

The economic framework suggests change in consumer behaviour occurs only in

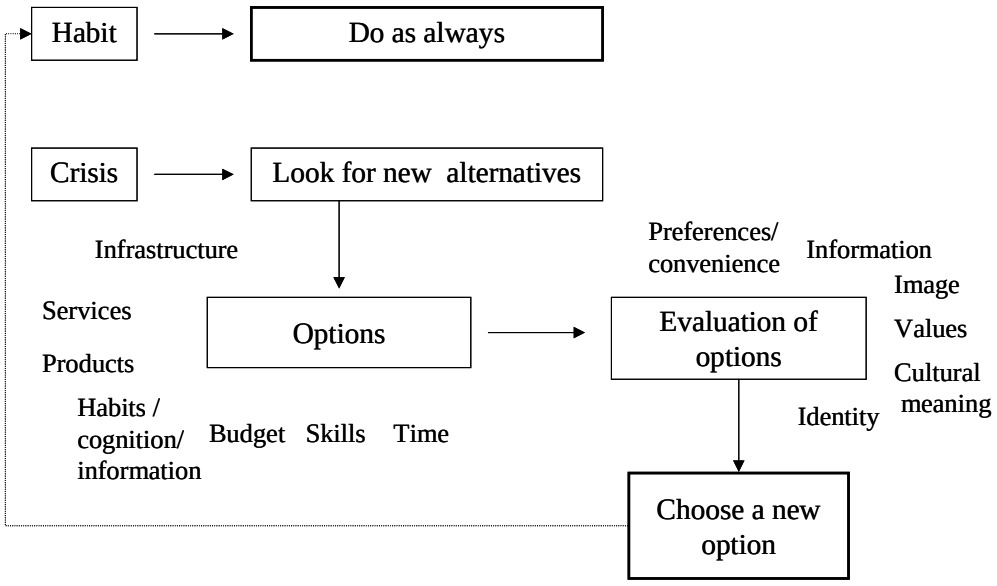

Figure 7: An alternative model for consumer (in)action.

response to (1) a change of relative prices, or (2) the introduction of new products or product-service systems that offer superior performance. The problem with this theory is that it does not have a place for "awareness raising" or the effect of eco-labels. In the field of energy efficiency, engineering economics studies have identified many energy efficiency measures both in households and in companies that are profitable according to the rate of return commonly applied by these actors to appraise investments, but that are not taken. This has resulted in a debate about the 'efficiency gap' (Sanstad and Howarth 1994). Some economists deny that such a gap in fact exists, pointing to the transaction costs, which are not accounted for in engineering economic analysis. Our alternative model explains the energy efficiency gap as a product of inertia, as a result of the absence of a decision making process. A documentation of opportunities to reduce pollution at zero to negative cost can also be found in the clean production literature (Panayotou and Zinnes 1994), and we suggest it also exists for consumption. In order to capture these opportunities for 'free lunches,' a search process needs to be initiated and information (or solutions) needs to be offered as to minimise the 'transaction costs.'

Inertia in the system is introduced not only through habits, but also through infrastructure, goods and services offered and advertised/promoted, as well as culture. Infrastructure makes available services in itself, determining what goods the consumer needs to buy, and it shapes the access to institutions, thus determining how the consumer will travel. Infrastructure is long-lived and hard to change once in place (Grübler 1998). Goods and services offered on the one hand have an enabling function. Garden care services, for example, make it more attractive to have large gardens because one does not have to do the work oneself. A bicycle repair service, together with the infrastructure of bike lanes, increases the attractiveness of biking. Goods and services on the other hand have the nature to perpetuate themselves, creating additional demand through advertising. Culture shapes consumption by creating the norms and social rules that we use to evaluate situations and choices (Wilhite et al. 1996; Wilk 2002). Wilk points to the processes naturalization and cultivation which shape what he calls the "habitus" of individuals. With Wilhite and colleagues (2000), we *"take the escalation of energy demand and the evolution of consumer expectations as a problem to be explained and understood in social, cultural and collective, rather than individualistic, terms*." Figure 6 indicates the importance of habits, culture, and infrastructure in decision making, but it does not explain the formation of culture or the shaping of infrastructures. It shows, however, that constant factors such as infrastructure and culture have an important influence on the identification and evaluation of options, thus creating inertia even in situations not ruled by habit.

The importance of infrastructure and culture can possibly explain the path-dependent development of resource consumption and environmental pollution in different countries. Figure shows that the energy intensity of the United States is significantly higher than that of Japan at the same point of GDP per capita. Japan is on a less energy-intensive development path.

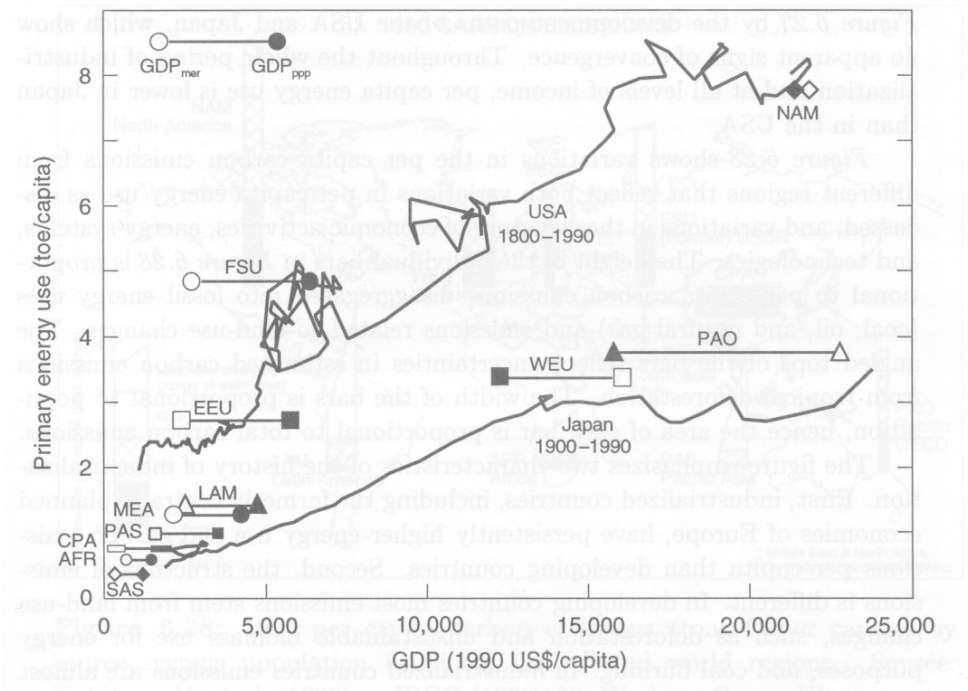

Figure 8: Trajectories of energy intensity for Japan and the United States show a path-dependent development. From (Grübler 1998).

Going back to the specific examples, we can now evaluate how they work. Awareness raising efforts try to stimulate the initiation of a search process, essentially replacing the "crisis" box in Figure 6. After awareness rising, Action at Home provides information about specific options. Of course, awareness raising efforts may not be as effective as a crisis, leading individuals to question both the message and the messenger when accepting the message requires additional effort on part of the messenger. Organic food or other labelled products (fair trade, Blue Angel) work only if consumers already look for such alternatives. External crises, such as BSE or dioxin-tainted milk from Belgium, often help existing options to be considered real alternative choices. Sometimes labels are also connected to campaigns and advertising efforts which try to raise awareness. Funserve and car sharing both work by offering a new option, a new way of obtaining a service. Car sharing is adopted either by households who cannot afford to own a car or by households who do not want to have a car but want to have the option to occasionally use it. Our model would suggest that only in rare cases do households who already own a car shift to car sharing, because it would require a new mobility pattern. We think that car sharing, eco-labels and organic food all target a fairly small group of environmentally concerned, interested customers who are already in the search mode for greener alternatives. While the sustainable consumption program needs to work with these customers, it also needs to address broader segments of society.

Reviewing the examples in light of the discussion about the frameworks of consumer action, we would like to suggest following lessons.

- Inertia is a powerful force rooted in habit, cultural perspectives and perceptions, infrastructure, and market dynamics. Change is likely to be slow. A sustainable

consumption programme should target habit formation, cultural perspectives and infrastructure. This requires a better understanding of how habits and culture shape consumption.

- Activities should be targeted at situations of change. In their successful experiment in Stuttgart, Rölle and colleagues (2002) addressed people who had just moved with targeted information on public transport, thus increasing its utilisation. The necessity to reorganise daily routines created a window of opportunity. Similar situations occur when individuals move away from their parents, find a common household with a partner, get kids, and retire. A better understanding of the habit formation and susceptibility to different types of intervention during the life cycle of individuals would yield promising models of intervention.
- The availability of green alternatives is an important precondition to sustainable consumption, but it does not by itself lead to a widespread adoption. Alternatives can be created for and sustained by the interested and dedicated segment of the population. They are then available in situations of crisis where a wider adoption is more likely. Diffusion of environmentally benign behaviour is sometimes slow, but can still result in an appreciable market share, as the example of organic food in Austria has shown. Sustainable consumption is not necessarily a luxury good. One should not neglect the role of different population groups, including disadvantaged persons as potential customers. The case of laundrettes and car sharing shows that sustainable consumption options can also help to increase well-being and social inclusion.
- The inclusion of 'soft policy' measures, especially information and image campaigns, can dramatically increase the acceptance of new, more sustainable alternatives that become attractive through new infrastructure (biking) or available as new products on the market.
- For all measures, we recommend that the effectiveness and acceptance is tested before measures are implemented on a broad level and that they are evaluated once implemented.

Conclusions

We have collected a large number of examples of sustainable consumption in Europe. The examples are listed in an Excel Table provided as an annex to this report. Some examples are also described in the report. These examples include energy labels for appliances, efforts to promote biking and public transport, an information campaign to reduce the clothes washing temperature, and the sustainable lifestyle campaign. Some of these efforts may already have an impact on the overall level of energy and resource use resulting from consumption and the production of the consumed goods, while others are merely kernels for the potential of reduced impact in the future. We have identified the availability of sustainable alternatives, habits, infrastructure, and cultural perceptions as important elements for sustainable consumption. These elements should be addressed in a work programme on sustainable consumption. We have not addressed the continued existence of products that are clearly not sustainable. Minimum efficiency standards,

taxes, and negative labelling (Biel 2002) may be effective policy measures, if they are politically acceptable. Habits, infrastructure, and cultural perceptions are very stable, so that a change in consumption patterns is likely to be slow. Sustainable consumption policy should especially focus on situations where habits and cultural perceptions are formed or reshaped.

Most of the examples of sustainable consumption we found are fairly narrow, focusing on a singe issue such as mobility or product choice. The need to understand why emissions and resource use keep increasing and to address this increase on a societal and per-household level (Wilhite et al. 2000) cannot be addressed by such narrowly focused measures. One can study the examples to understand the 'rebound effect' and the wider repercussions on the lifestyle. For us, those examples addressing several issues or the lifestyle as such, and best use more than one mechanism, are the most promising candidates for further study and implementation.

References

Andersen, T. The National Cycle City of Denmark. www.cyclecity.dk/english.asp. 15-Aug-2003.

Aune, M. 2001. Energy Technology and Everyday Life - the Domestication of the Ebox in Norwegian Households. Further than ever from Kyoto? Rethinking energy efficiency can get us there. 2001 Summer study proceedings, Mandelieu, France, European council for an energy efficient economy. 5-16.

Barry, J. and J. Proops. 1998. Local Employment and Trading Systems: Linking Citizenship and Sustainability? http://www.sussex.ac.uk/Units/gec/pubs/briefing/brief-18.htm. February 17.

Bertoldi, P., P. Waide and B. Lebot. 2001. Assessing the Market Transformation for Domestic Appliances Resulting from EU Policies. Further than ever from Kyoto? Rethinking energy efficiency can get us there. 2001 Summer study proceedings, Mandelieu, France, European council for an energy efficient economy. 191-202.

Biel, A. 2002. Values as Determinants of Environmental Behaviour. Life-cycle Approaches to Sustainable Consumption -- Workshop Proceedings, Laxenburg, Austria, International Institute for Applied Systems Analysis. 4-10.

Brohmann, R., U. Fritsche, S. Hartard, M. Schmied, C. Schmitt, C. Schoenfelder, N. Schuett, W. Roos, H. Stahl, et al. 2002. Sustainable Districts on Urban Areas: Material Flow Analyses as an Instrument for Evaluation - End Report (German). Darmstadt, Freiburg, Berlin: Oeko-Institut (Institute for Applied Ecology e.V.). http://www.oeko.de/service/cities/files/endbericht_%20final_%202002.pdf.

Büttner, T. and A. Grübler. 1995. The Birth of a Green Generation - Generational Dynamics of Resource Consumption Patterns. *Technological Forecasting and Social Change* 50(2): 113-134.

Casler, S. D. and A. Rose. 1998. Carbon Dioxide Emissions in the U.S. Economy. *Environmental and Resource Economics* 11(3-4): 349-363.

Chertow, M. R. 2000. The IPAT Equation and Its Variants: Changing Views of Technology and Environmental Impact. *Journal of Industrial Ecology* 4(4): 13-30.

Commoner, B. 1972. The Environmental Cost of Economic Growth. In *Population, Resources and the Environment*, edited by R. G. Ridker. Washington DC: US Government Printing Office: 339-363.

Dachverband FairWertung e.V. 2003. http://www.fairwertung.de/. February 24.

Dijkstra, A., P. Levelt, J. Thomsen, O. Thorson, J. V. Severen, P. Vansevenant, P. K. Nilsson, E. Jorgensen, B. l. C. Lund, et al. 1998. *Best Practice to Promote Cycling and Walking, Adonis*. Copenhagen: Danish Road Directorate.

Duchin, F. 1998. *Structural Economics: Measuring Changes in Technology, Lifestyles, and the Environment*. Washington DC: Island Press.

Dudda, C., S. Thomas and K. Schuster. 2001. Functional Service Contracts for White Goods: Selling a Function Instead of a Product (Funserve). Further than ever from Kyoto? Rethinking energy efficiency can get us there. 2001 Summer study proceedings, Mandelieu, France, European council for an energy efficient economy. 32-39.

ecom. AG - Buero Wuppertal. 2000. Map for Sustainable Economy in North Rhine-Westphalia - End Report Part 2 - Examples of Companies. Wuppertal: ecom.AG - Buero Wuppertal. http://www.efanrw.de/efared/medien/EFA-Nachhaltigkeitsstudie-Landkarte-2.pdf.

Ehrlich, P. R. and J. P. Holdren. 1971. Impact of Population Growth. *Science* 171(3977): 1212-1217.

European Commission. 2000. General Report: Reducing Barriers to Zero and Low Emission Mobility. A Guide for Cities. Zeus Project Final Report. Stockholm: European Commission. http://www.zeus-europe.org/news.html.

Farla, J. C. M. and K. Blok. 2000. Energy Efficiency and Structural Change in the Netherlands, 1980-1995. *Journal of Industrial Ecology* 4(1): 93-117.

Fung, A., D. O'Rourke and C. Sabel. 2001. *Can We Put an End to Sweatshops? A New Democracy Form on Raising Global Labor Standards*. Boston: Beacon Press.

G8. 2000. G8 Environmental Futures Forum 2000 on "Domestic Best Practices Addressing Climate Change": The New Home Energy Efficiency Scheme. http://www.env.go.jp/earth/g8_2000/forum/g8bp/detail/uk/uk12.html. February 17.

Gatersleben, B. and C. Vlek. 1998. Household Consumption, Quality of Life and Environmental Impacts: A Psychological Perspective and Empirical Study. In *Green Households?*, edited by K. J. Noorman and T. S. Uiterkamp. London: Earthscan: 141-183.

Gerbens-Leenes, P. W. and S. Nonhebel. 2002. Consumption Patterns and Their Effects on Land Required for Food. *Ecological Economics* 42: 185-199.

GEWOG. 2000. Model Project Car-Free Housing - Project Information (German). Vienna: GEWOG Gemeinnützige Wohnungsbau GmbH.

Geyer-Allély, E. 2001. *Household Food Consumption: Trends, Environmental Impacts and Policy Responses*. Paris: OECD.

Geyer-Allély, E., A. Zacarías-Farah, P. Crist, D. Biller and J.-P. Barde. 2002. *Toward Sustainable Household Consumption? Trends and Policies in OECD Countries*. Paris: OECD.

Goedkoop, M. J., J. Madsen, D. S. Nijdam and H. C. Wilting. 2002. Environmental Load from Private Dutch Consumption. Life-cycle Approaches to Sustainable Consumption -- Workshop Proceedings, Laxenburg, Austria, International Institute for Applied Systems Analysis. 38-47.

Grübler, A. 1998. *Technology and Global Change*. Cambridge: Cambridge University Press.

Gütegemeinschaft Niedrigenergie-Häuser e.V. 2003. http://www.guetezeichen-neh.de/. February 24.

Hertwich, E. 2002a. Life-Cycle Approaches to Sustainable Consumption -- Workshop Proceedings, 22 November 2002. Interim Report, IR-02-073. Laxenburg, Austria: International Institute for Applied Systems Analysis.

Hertwich, E. G. 2002b. The Environmental Impacts of Consumption. SETAC Europe Annual Meeting, Vienna, Society of Environmental Toxicology and Chemistry.

Hertwich, E. G., K. Erlandsen, K. Sørensen, J. Aasness and K. Hubacek. 2002. Pollution Embodied in Norway's Import and Export and Its Relevance for the Environmental Profile of Households. Life-cycle Approaches to Sustainable Consumption -- Workshop Proceedings, Laxenburg, Austria, International Institute for Applied Systems Analysis. 63-72.

Hobson, K. 2002. Competing Discourses of Sustainable Consumption: Does the 'Rationalisation of Lifestyles' Make Sense? *Environmental Politics* 11(2): 95-120.

Hoekstra, R. and J. C. J. M. van den Bergh. 2002. Structural Decomposition Analysis of Physical Flows in the Economy. *Environmental and resource economics* 23: 357-378.

Hubacek, K. and L. Sun. 2002. Changes in China's Economy and Society and Its Effects on Water Use. Life-cycle Approaches to Sustainable Consumption -- Workshop Proceedings, Laxenburg, Austria, International Institute for Applied Systems Analysis. 87-100.

ICLEI - The International Council for Local Environmental Initiatives. 1996. District Heating from Wood Waste. http://www3.iclei.org/egpis/egpc-015.html. February 17.

IIASA-LUC. 2001. Organic Farming. http://www.iiasa.ac.at/Research/LUC/farmtour/index.html?sb=1. 28 Feb 2003: International Institute for Applied Systems Analysis -- Land use change project.

Jalas, M. 2002. A Time Use Perspective on the Materials Intensity of Consumption. *Ecological Economics* 41: 109-123.

Jensen, S. U., T. Andersen, W. Hansen, E. Kjaergaard, T. Krag, J. E. Larsen, B. l. C. Lund and P. Thost. 2000. *Collection of Cycle Concepts.* Copenhagen: Danish Road Directorate.

Jungbluth, N. 1999. Case Studies, Research Groups and Results of LCAs for Food Products. Zurich: Department of Environmental Sciences, Swiss Federal Institute of Technology.

Jungbluth, N. 2000. *Environmental Impact of Nutrition: Evaluation of Product Criteria Based on a Modularly Ecological Balance (German).* Berlin: dissertation.de.

Kahneman, D., E. Diener and N. Schwarz, Eds. 1999. *Well-Being -- the Foundation of Hedonic Psychology*. New York: Russell Sage Foundation.

Kaya, Y. 1990. Impact of Carbon Dioxide Emission Control on Gnp Growth: Interpretation of Proposed Scenarios, Paper presented at the IPCC Energy and Industry Subgroup, Response Strategies Working Group. Paris: International Panel on Climate Change.

Keyfitz, N. 1998. Consumption and Population. In *The Ethics of Consumption: Good Life, Justice, and Global Stewardship*, edited by D. A. Crocker and T. Linden. Lanham: Rowman & Littlefield: 476-500.

Kleindorfer, P. R., H. C. Kunreuther and P. G. H. Schoemaker. 1993. *Decision Sciences: An Integrative Perspective*. Cambridge: Cambridge University Press.

Kletzan, D., A. Köppl, K. Kratena and M. Wüger. 2002. Economic Modelling of Sustainable Consumption Patterns for Mobility and Heating. Life-cycle Approaches to Sustainable Consumption -- Workshop Proceedings, Laxenburg, Austria, International Institute for Applied Systems Analysis. 117-132.

Kuhndt, M. and R. Gracia. 2002. Sustainable Consumption and Factor X in the Food and Ict Sectors. Life-cycle Approaches to Sustainable Consumption -- Workshop Proceedings, Laxenburg, Austria, International Institute for Applied Systems Analysis. 104-116.

Letslink UK. Uk Lets and Complementary Currencies Development Agency. http://www.letslinkuk.net/Home/latest-news.htm. February 17.

Lundgren, L. J., Ed. 1999. *Changing Environmental Behavior*. Stockholm: Swedish Council for Building Research.

Matthews, E., C. Amann, S. Bringezu, M. Fischer-Kowalski, W. Hüttler, R. Kleijn, Y. Moriguchi, C. Ottke, E. Rodenburg, et al. 2002. *The Weight of Nations: Material Outflows from Industrial Economies*. Washington DC: World Resources Institute.

Moll, H. C. and K. J. Noorman. 2002. Towards Sustainable Development at City Level: Evaluating and Changing the Household Metabolism in Five European Cities. Life-cycle Approaches to Sustainable Consumption -- Workshop Proceedings, Laxenburg, Austria, International Institute for Applied Systems Analysis. 153-170.

Mooss, H. 2002. Multi-Generation Orthopedic Shoe for Children (German). http://www.ecodesign-beispiele.at/data/art/31_1.php. February 24.

Municipia. Leasing Service for Washable Diapers. http://e-taten.municipia.at/alle/o_Name/f0001084.html. February 14.

Munksgaard, J., K. A. Pedersen and M. Wier. 2000. Impact of Household Consumption on Co2 Emissions. *Energy Economics* 22(4): 423-440.

Munksgaard, J., M. Wier, M. Lenzen and C. Day. 2002. Indicators for the Environmental Pressure of Consumption. Life-cycle Approaches to Sustainable Consumption -- Workshop Proceedings, Laxenburg, Austria, International Institute for Applied Systems Analysis. 171-192.

Natur und Co. 2001. The Other Way: Nature and Co. - Natural Clothes and Ecological Culture (in German). http://www.natur-co.de. February 24.

Norris, G. A. and J. M. Segal. 2002. Life Cycle Sustainable Development: An Extension of the Product Life Cycle Assessment Framework to Address Questions of Sustainable Consumption and Development. Life-cycle Approaches to Sustainable Consumption -- Workshop Proceedings, Laxenburg, Austria, International Institute for Applied Systems Analysis. 193-205.

Nussbaum, M. C. and A. Sen. 1993. *The Quality of Life*. Oxford: Clarendon.

O'Neill, B. C. and B. Chen. 2002. Demographic Determinants of Household Energy Use in the United States. *Methods of Population-Environment Analysis, A Supplement to Population and Development Review* 28:53-88.

Panayotou, T. and C. Zinnes. 1994. Free-Lunch Economics for Industrial Ecologists. In *Industrial Ecology and Global Change*, edited by R. Socolow, C. Andrews, F. Berkhout and V. Thomas. Cambridge: Press Syndicate of the University of Cambridge: 383-397.

Perrels, A. 2002. Understanding Consumption Patterns - Including Time Use, Skills, and Market Failures. Life-cycle Approaches to Sustainable Consumption -- Workshop Proceedings, Laxenburg, Austria, International Institute for Applied Systems Analysis. 206-227.

Planerbuero Suedstadt / Planungsgemeinschaft Verkehr. 2000. Accompanying Research to the Coalition of Bike-Friendly Cities and Towns in North Rhine-Westphalia - Measures and Evaluation (German). Duesseldorf.

Riddlestone, S. The Potential for Locally Produced Organic Hemp Textiles. http://www.bioregional.com/text/text2.htm. February 24.

Rohracher, H. 2001. User Involvement in Technological Innovations: The Case of Balanced Ventilation Systems. Further than ever from Kyoto? Rethinking energy efficiency can get us there. 2001 Summer study proceedings, Mandelieu, France, european council for an energy efficient economy. 292-303.

Rohracher, H. and M. Ornetzeder. 2002. Contextualising Green Buildings: Improving Social Learning Processes between Users and Producers. *Built Environment* 28(73-84).

Rölle, D., C. Weber and S. Bamberg. 2002. Neue Mobilität Am Neuen Wohnort? Individuelle Informationen Nach Dem Umzug Als Beitrag Zu Einer Nachhaltigen Mobilität. In *Nachhaltiger Konsum: Auf Dem Weg Zur Gesellschaftlichen Verankerung*, edited by G. Scherhorn and C. Weber. Munich: ökonom verlag: 389-401.

Ryan, C. and et al. 2002. *Sustainable Consumption: A Global Status Report*. Paris: UNEP.

Sanstad, A. H. and R. B. Howarth. 1994. Normal Markets, Market Imperfections and Energy Efficiency. *Energy Policy* 22(10): 811-818.

Schipper, L., S. Bartlett, D. Hawk and E. Vine. 1989. Linking Life-Styles and Energy Use: A Matter of Time? *Annual Review of Energy* 14: 273-320.

Schlumpf, C., J. Behringer, G. Dürrenberger and C. Pahl-Wostl. 1999. The Personal Co2-Calculator: A Modeling Tool for Participatory Integrated Assessment Methods. *Environmental Modelling & Assessment* 4(1).

Segal, J. M. 1998. Consumer Expenditures and the Growth of Need-Required Income. In *The Ethics of Consumption: Good Life, Justice, and Global Stewardship*, edited by D. A. Crocker and T. Linden. Lanham: Rowman & Littlefield: 176-197.

Sen, A. 1998. The Living Standard. In *The Ethics of Consumption: Good Life, Justice, and Global Stewardship*, edited by D. A. Crocker and T. Linden. Lanham: Rowman & Littlefield: 287-311.

Simon, H. A. 1957. *Models of Man*. New York: John Wiley.

Sperling, C. 2002. The Project "Sustainable Model District Freiburg-Vauban" - Facts and Background Information (German). http://www.forum-vauban.de/dubai-award.shtml. February 17.

Stø, E. and P. Strandbakken. 2002. Advantages and Limitations of Eco-Labels as Consumer and Environmental Policy Instruments. Life-cycle Approaches to Sustainable Consumption -- Workshop Proceedings, Laxenburg, Austria, International Institute for Applied Systems Analysis. 246-267.

Taylor, C. 2000. Ecological Evaluation of Diets by Means of Selected Indicators. (German). Agrarwissenschaften, Ökotrophologie und Umweltmanagement. Giessen: Justus-Liebig-Universität. http://bibd.uni-giessen.de/gdoc/2000/uni/d000074.pdf.

The Together Foundation and UNHCS. 2002. The Sustainable Transport Modes Strategy in Donostia-San Sebastian. http://www.bestpractices.org/cgi-bin/bp98.cgi?cmd=detail&id=20058&key=rpybfkbfe. 15-Jan-2003.

Thøgersen, J. 1999. Spillover Processes in the Development of a Sustainable Consumption Pattern. *Journal of Economic Psychology* 20(1): 53-81.

Thøgersen, J. and F. Ölander. 2002a. Human Values and the Emergence of a Sustainable Consumption Pattern: A Panel Study. *Journal of Economic Psychology* 23(5): 605-630.

Thøgersen, J. and F. Ölander. 2002b. The Interaction between Environmental Norms and Behaviour: A Panel Study of Organic Food Consumption. Life-cycle Approaches to Sustainable Consumption -- Workshop Proceedings, Laxenburg, Austria, International Institute for Applied Systems Analysis. 268-269.

Thomas, S. 1995. Evaluation of Rwe's Kess Rebate Programme for Efficient Residential Appliances. http://www.eceee.org/library_links/proceedings/1995/pdf95/951027.PDF. February 18.

Tischner, U. 1997. Eco-Intelligent Consumption (German). In *Eco-Intelligent Production and Consumption (German)*, edited by F. Schmidt-Bleek, T. Merten and U. Tischner. Berlin, Basel, Boston: Birkhaeuser Verlag: 82-104.

Trines, R. and C. van Geet. 2001. Smart Technology for Homes -- an Integrated Approach to Sustainable Development. Further than ever from Kyoto? Rethinking energy efficiency can get us there. 2001 Summer study proceedings, Mandelieu, France, european council for an energy efficient economy. 158-167.

Tscharf, D. 1999. Velox Factor 10+ ... The First Passive House without Heating from Carinthia. (German). http://www.faktor10plus.at. February 17.

Uitdenbogerd, D. 2001. Appliance Labelling from a Consumer's Perspective: Priorities in Cloth Washing. Further than ever from Kyoto? Rethinking energy efficiency can get us there. 2001 Summer study proceedings, Mandelieu, France, European council for an energy efficient economy. 171-181.

UNEP. 2002. Unep Contribution to Framework on Promoting Sustainable Consumption and Production Patterns. Draft working paper. Paris: United Nations Environment Program, Division for Technology, Industry and Economics.

United Nations General Assembly. 1992. Agenda 21. Rio de Jainero: United Nations Division for Sustainable Development. www.un.org/esa/sustdev/agenda21text.htm (accessed 20 jan 03).

United Nations General Assembly. 2002. World Summit on Sustainable Development: Plan of Implementation. Johannesburg: United Nations Division for Sustainable Development. www.johannesburgsummit.org (accessed 20 jan 03).

University of Kiel. Northern Light - Climate Protection to Join in (German). http://www.nordlicht.uni-kiel.de/nordlihp.htm. 15-Jan-2003: University of Kiel, Department of Psychology.

van den Broek, R., D.-J. Treffers, M. Meeusen, A. van Wijk, E. Nieuwlaar and W. C. Turkenburg. 2001. Green Energy or Organic Food? A Life-Cycle Assessment Comparing Two Uses of Set-Aside Land. *Journal of Industrial Ecology* 5(3): 65-87.

Växjö kommun. Fossil Fuel Free Växjö. http://www.vaxjo.se/agenda21/environmentalinfo/engfff.html. 15-Jan-2003.

Verbraucher Initiative e.V. 2003a. Blue Angel Ral-Uz 98 (Tumble Drier). (German). http://www.label-online.de/index.php/cat/3/lid/287. February 24.

Verbraucher Initiative e.V. 2003b. Eu-Energy Label (Washing Machine) (German). http://www.label-online.de/index.php/cat/3/lid/268. February 24.

Verbraucher Initiative e.V. 2003c. Green Cotton. http://www.label-online.de/index.php/cat/3/lid/158. February 20.

Vilhelmson, B. 1999. Daily Travel: Trends, Limits, Susceptibility to Influence. In *Changing Environmental Behavior*, edited by L. J. Lundgren. Stockholm: Swedish Council for Building Research: 91-104.

Vringer, K. and K. Blok. 1995. The Direct and Indirect Energy Requirements of Households in the Netherlands. *Energy Policy* 23(10): 893-910.

Vringer, K. and K. Blok. 2000. Long-Term Trends in Direct and Indirect Household Energy Intensities: A Factor in Dematerialization? *Energy Policy* 28: 713-727.

Waggoner, P. E. and J. H. Ausubel. 2002. A Framework for Sustainability Scince: A Renovated Ipat Identity. *Proceedings of the National Academy of Sciences* 99(12): 7860-7865.

Webb, A. 1998. Energy Efficient Building, Schiedam. http://www.sustainability.org.uk/info/casestudies/schiedam_energy_efficient_building.htm. February 17.

Wier, M., M. Lenzen, J. Munksgaard and S. Smed. 2001. Effects of Household Consumption Patterns on Co2 Requirements. *Economic Systems Research* 13(3): 259-274.

Wilhite, H., H. Nakagami, T. Masuda, Y. Yamaga and H. Haneda. 1996. A Cross-Cultural Analysis of Household Energy Use Behaviour in Japan and Norway. *Energy Policy* 24(9): 795-803.

Wilhite, H., E. Shove, L. Lutzenhiser and W. Kempton. 2000. The Legacy of Twenty Years of Energy Demand Management: We Know More About Individual Behaviour but Next to Nothing About Demand. In *Society, Behaviour, and Climate Change Mitigation*, edited by E. Jochem, J. Sathaye and D. Bouille. Dortrecht: Kluwer. 8: 109-126.

Wilk, R. 2002. Consumption, Human Needs, and Global Environmental Change. *Global Environmental Change* 12(1): 5-13.

WWF. Footprint. www.footprint.ch. February 20.

ZEUS. 2002. Reducing Barriers to Zero and Low Emissions Mobility. www.zeus-europe.org/files/ZEUS-summary.pdf. 17 Jan: Environmental and Health Protection Administration of Stockholm.

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ISSN 1501-6153
ISBN: 82-7948-037-4 (trykt)
ISBN: 82-7948-038-2 (pdf)