Dematerialisation for urban waste reduction: Effectiveness and side-effects

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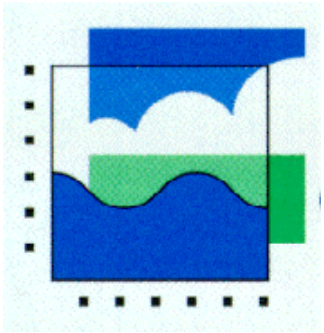

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Summary

Introduction

The Brussels Institute for Management of the Environment (BIME) is responsible for the formulation of strategic Waste Prevention and Waste Management Plans for the Brussels Region. Two of such plans, which have a 5 year horizon, have been issued and adopted in the past. A third one is being drafted now.

Waste volume reduction has been a goal in the two earlier Plans (BIME, 1992 and BIME, 1998). Many initiatives have been started to reduce waste by separate collection, recycling and prevention. Despite progress (BIME, 2000), some of the targets for 2002 will probably not be met (http://www.ibgebim.be/). The starting point for the upcoming third Waste Prevention and Waste Management Plan is, that in an urban area such as the Brussels region, a change in waste volume is very much linked to a change in consumer behaviour. Therefore, sustainable consumption will be a subject in this Plan. One of the developments that may lead to a more sustainable consumption is dematerialisation. The general idea behind the concept of dematerialisation is, that a reduction of the societal throughput of materials is possible while maintaining or even increasing welfare. Many attempts at dematerialisation focus on the reduction of water and energy use, since these are the main flows in terms of mass. Consumer related flows are relatively small. However, from a waste management perspective these consumer flows are the important flows, since they end up as household waste.

Dematerialisation applied to consumer flows focuses on the production, use and discarding of household products. Examples include lengthening of the life span, using lighter materials and sleeker design, recycling of waste materials at the plant, lighter packaging etc., but also a shift from products to services, electronic instead of paper information and tele-services to reduce shop or office space and transportation. Efforts like these may reduce the volume and change the composition of waste. The examples show that dematerialisation has potential. However, there is also some concern when looking at these isolated cases. While the examples may be illustrative for what can be achieved by aiming at dematerialisation, they may also lead to a shifting of problems on a different level. When considering specific measures aimed at dematerialisation it is important to keep an eye open for possible unintended side-effects. To identify possibilities to realise a “smart dematerialisation” is the subject of this report.

Dematerialisation

Dematerialisation is often mentioned as a strategy or as an indicator in the framework of sustainable development. Dematerialisation can be defined as the reduction of the throughput of materials in human societies. It can be measured on different geographical scale levels like nations, regions and cities but also on within different sectors of industry, households and in products (MIPS). One can distinguish *Absolute* (or strong) dematerialisation and *Relative* (or weak) dematerialisation. When the total amount of material inputs in a society is decreasing this is called absolute dematerialisation. When the amount is material input is going down per unit of GDP or per capita the term relative dematerialisation is used. Current trends show that on aggregate and in absolute terms both material inflows as outflows of industrialised societies are increasing. However, the material inputs and outputs per unit of GDP are decreasing, so relative dematerialisation actually takes place. A closer study of the figures and trends shows that both in the use of primary materials as in industrial production there are clear examples of dematerialisation per unit of product e.g. by material substitution, efficiency improvement and other economic factors. On the other hand however consumers tend to have increasing material wants which is of course closely connected to economic growth and increasing material wealth.

A very important phenomenon for dematerialisation may be the shift from matter to information. One trend that can be seen in industrialised societies is that information is gradually becoming more valued then matter. Some matter cannot be replaced by information, but what seems to be occurring is that for every object or service we develop or use, the information density and knowledge inherent in it is rising. Examples of this increasing information density are easily found when today's products are compared with there predecessors e.g.: a T-Ford compared to a smart, old carphones compared to modern cellular phones, LCD displays compared to CRT computer monitors etc.

In practice dematerialisation can be accomplished via different routes, for example:
- increasing the efficiency of material use (using less materials for a specific function)
- materials substitution (exchanging heavy materials with light materials)
- re-use / recycling of materials (using materials for multiple functions)
- sharing (use of products by more than one consumer)

In order to achieve the routes mentioned above different policy strategies can be used, for example:
- promote leasing (which creates incentives for producers to make their products easy to re-use, recycle, durable, easy to disassemble etc.)
- introduce extended producer responsibility (which creates similar incentives as leasing)
- ecodesign
- re-manufacturing

One option for dematerialisation is the transition from products to services, or “servicizing”. Servicizing focuses on the development of product-based services. Consumers no longer buy products but instead pay for services. This will increase the involvement of the producer with the product in its use phase. Buying and selling are replaced into different property rights options like producer take-back and leasing and pooling arrangements. Value is not created by creating a product with a certain value added but by the function that is provided by the producer, the product is just a means of delivering that function. According to White, Stoughton and Feng (1999) incentives to develop servicizing in a modern competitive market appear when 3 principles are in place:
- when the business arrangement serves to internalise use or disposal costs;
- when the product in question has significant value at end-of-life;
- when provision of the product is viewed as a cost, rather than a profit centre

This shift from products to services is the central issue of this report.

Although the shift to a dematerialised world is normally thought of as a step towards a sustainable world not all individual shifts are necessarily good from an environmental point of view. Unwanted side-effects can occur in specific situations for example:
- lighter materials are not necessarily more environmentally friendly than heavier materials;
- a shift in materials may cause side-effects due to reduction of life span, need for more transportation, tendency to throw away instead of repair, reduced recyclability etc.;
- lengthening of life span may lead to fossilisation of equipment: obsolete energy intensive equipment must be kept in use longer, reducing waste but also maintaining a high energy use;
- lengthening of life span may cause stockbuilding in society, which may lead to a “time bomb” of delayed waste generation;
- computerisation, instead of reducing material requirements, leads to new possibilities that may increase material flows and energy use (e.g., the quite considerable energy use of electronic networks);
- recovery and recycling may have unwanted side-effects due to extra transportation and energy use;

A specific type of side-effect is called the "rebound effect". One well-known example of that is related to the introduction of low-energy light bulbs. The introduction of these very efficient light bulbs with low energy costs gave people the idea that the energy use and costs were so low that

it did not matter if they would leave them switched on 24 hours a day. The introduction of new and eco-efficient products can thus cause counterproductive shifts in consumer behaviour. A similar example is the introduction of highly efficient heating systems which reduce the cost of energy to customers who respond by having higher standards of warmth and therefore, increased energy consumption. Rebound effects can also occur in a very indirect way e.g. consumers will spend the money which is saved by the use of these new heating systems and light bulbs for other purposes for example to buy flying tickets for an extra holiday.

An overview of dematerialisation initiatives in the category “shift from product to service”

Appendix 1 contains an extended list of examples of dematerialisation, as found in literature and on the internet. The examples in Appendix 1 refer to consumer products and services only, and can be described as different options to replace products by services. Most initiatives may be categorised as leasing, sharing, digitalisation and maintenance. Leasing instead of ownership may reduce waste during use by a more centralised and therefore better care during the life span of the product. It will be in the interest of the producer to reduce materials use and waste production. Sharing may reduce the total number of products required for a community: instead of a car, washing machine, carpet cleaner etc. per household a limited number of such products per neighbourhood will be sufficient. Digitalisation will reduce paper requirement. Repair services may lengthen the life span of products; professional instead of do-it-yourself maintenance of the house and garden may lead to a more efficient use of materials. Table 1 provides a summary of the initiatives, with references to the extended list in Appendix 1.

Three criteria were used to select examples of dematerialisation in the Brussels region, they must:

- be municipal waste oriented and focus on household and commercial waste
- be consumer oriented and thus focus on the power of citizens consumption to achieve dematerialisation
- address initiatives which are not developed yet in the Brussels region.

On the basis of these criteria the a number of categories were chosen out of the long list presented in Chapter 4 and Annex 1. From every category one, occasionally two, examples are selected.

Category	Example Products
products -> services	nappies, mobile dishwashing, house-to-house delivery
renting / leasing	carpets
promotion of new technology	e-services: advertisements / catalogues and telephone books
sharing	washing machines
take-back and repair / regenerate / re-use	electric and electronic equipment, re-usable packaging
stakeholder involvement	product panels
immaterial goods	immaterial gifts

Table 1 Examples of dematerialisation by shifting from products to services

category	description	type of waste reduced	Example in Appendix 1
information, digitising	The need to use traditional information carriers, like newspapers, magazines, books, photographs, paper mail, and account overviews etc. might be reduced by the present technology of digitising information.	paper, ink, roll of film, film chemicals	49, 50, 56, 57, 58, 59
information, reduce data carriers	The need to use data carriers, like videos, CD's, CD-ROMs, diskettes, smartcards et cetera, might reduce by the possibility to of download digital information directly from the internet and store information directly on the hard disk or even to a provider on a network.	video tapes, CD's, diskettes, smartcards	2, 48, 93
mobility, sharing	There are several examples of communities that share means of transportation , like cars, bikes, caravans et cetera. Sharing reduces the number of vehicles required and therefore reduces the amount of waste during production, use/maintenance and disposal of the vehicles.	waste during maintenance of vehicles, wrecks of bicycles, (car wrecks)	4, 5, 6, 7, 8
mobility, leasing	There are many examples of companies that lease vehicles instead of selling them. Because the leasing company has an extended product liability along the total product chain, from production until discarding, the incentive to reduce the use of materials in order to reduce costs might lead to less waste per product.	waste during maintenance of vehicles, wrecks of bicycles, (car wrecks)	9, 10, 11, 13, 14, 15
mobility, reducing	Tele-working leads to less transport-kilometres and therefore might indirectly lead to less waste.	waste during maintenance of vehicles, wrecks of bicycles, (car wrecks)	
shopping, improved logistics	Logistics in shops can be improved by information technology. Detailed information on the needs of customers makes it possible to fine-tune supply to demand. This leads to less storage, which in turn might lead to less waste from food that is outdated. The minimalising of storage possibly might lead to opportunities to reduce the use of packaging materials. Harmonisation of supply and demand also leads to less transport and therefore indirectly waste due to mobility might be reduced (see mobility).	outdated food, packaging materials during storage	57, 60
shopping, return packaging materials	In some shops and shopping centra it is possible to bring back packaging materials or to leave packaging materials in the shop. This central collection of packaging materials might lead to more re use of packaging. Also central collection gives better opportunities to collect materials more separately, which in turn might lead to better recycling possibilities.	packaging material	32, 35
tele-shopping	Tele-shopping means that customers can order their products by a tele- or internet service. The products are delivered to wherever the customer wants. As a service of tele-shopping the delivery of products might be combined with the take back of packaging materials. Tele-shopping also might lead to less vehicle kilometres and therefore indirectly reduce waste due to mobility (see mobility).	packaging material	18
	Direct tuning between consumers and farmers might lead to less over production. Also the use of packaging materials might be reduced.	outdated food, over produced food, packaging materials	87

reparation service	The lifetime of many products can be increased by repair of broken parts instead of buying a complete new product.	tools, apparatus, electronics, computers, ink cartridges	13, 21, 22, 39, 40
household and office goods, leasing and re-manufacturing	There are several examples of goods used in households and offices, which are leased instead of owned. Some examples are the leasing of furniture, carpets, copiers, laundry equipment, computers, baby goods, diapers, clothes, dishes, magazines. Leasing reduces the total amount of products used. Because the leasing company has an extended product liability along the total product chain, from production until discard, the incentive to reduce the use of materials in order to reduce costs might lead to less waste per product.		
		furniture	72, 73, 74, 75, 76, 77,78, 79, 80
		carpets	118, 119, 120, 121, 122
		copiers	94, 95, 96, 97
		laundry equipment	102, 103, 104, 105, 106, 107, 108, 109, 110
		baby goods, diapers	128, 37
		magazines, books	46, 47
		others	100, 123, 130
maintenance	The leasing instead of owning of equipment for large jobs in the house or garden leads to less demand for such equipment.	electronics, machines, tools	129
	A biological instead of chemical pest treatment service may reduce the use of pesticides.	pesticides	
	Many large jobs in the house probably can be done more effectively and with less produced waste by professionals.	remainders of paints and other chemicals, electronics, machines, tools	
packaging design	A smarter design of packaging materials might reduce the amount of packaging waste in shops and households. Redesigning might lead to less material, more mono-materials, which can be more easily recycled, and more reusable packaging materials.		36
other possibilities to reduce the amount of waste			
	increase of peoples involvement in their neighbourhood might help to reduce the amount of waste produced and/or materials consumed.		42
	The exchange of services between consumers (in a community) is a way of sharing goods.		124
	Information technology makes it possible to charge households for their produced amount of waste. This personalised levy may be an incentive for consumers to produce less waste / consume less materials. Another variant is the equivalent of the "negawatt" idea for energy consumption: a personalised bonus for using a less-than-average amount of materials or producing a less-than-average amount of waste, which can be called "negakilos"		52
contest for consumers	There are several examples of companies that have encouraged people to come forward with ideas to minimalise the use of materials and therefore reduce costs, the production of waste and emissions to the environment. This could also be attempted by a regional government for product-to-service initiatives.	municipal waste	28, 43, 44

The case studies

Diapers
The use of disposable nappies causes a large waste stream. Shifting to cotton diapers, either bought or rented from a nappy service, has a significant potential to reduce waste flows in the Brussels region. If all households would change to cotton, the reduction of total domestic waste would be about 5%. The overall environmental assessment of paper versus cotton nappies (private or service) is not apparent. Different studies draw different conclusions. However it is clear that the use of ecologically grown cotton – i.e. grown with less or no use of fertilisers and pesticides – will lead to an environmental preference for cotton nappies.
Cost calculations show that for a first child the difference between paper and cotton is small. However cotton becomes much cheaper for later babies. The user friendliness of cotton nappies is lower. Nappy services take away part of this disadvantage, but at a price: they are the most expensive alternative. In order to induce a significant number of households to make the change, a nappy service will have to rely on subsidies.

E-advertising and other forms of electronic information
E-information, instead of advertising on paper, may lead to a reduction of paper waste. If all households that have an internet connection, and all commerces participate the maximum reduction would be roughly 5% of the total amount of paper waste. A positive side-effect is the disappearance of the paper life-cycle and its impacts. A possible negative side-effect may be a larger consumption of energy. The costs for advertisers of the e-alternative are expected to be less. The efficiency of the measure depends on the willingness-to-send and the willingness-to-accept electronic information. There are no technical problems for implementation. In offices, e-mail may save paper mainly through the distribution of short notes and communications, which do not need to be printed. This may reduce total office paper waste by 3 – 5%.

Digitised telephone books
The introduction of digital telephone books may lead to a significant reduction of non-packaging paper waste. An internet service would lead to a reduction of 2% if all households that have an internet connection participate. The distribution of the information on CD-ROMs is more effective and would lead to a reduction of 6%, assuming that all households that own a computer would participate. A new waste stream of CD-ROMs will be generated of ca. 6 tonnes, very small compared to the avoided 3446 tonnes of paper waste. The costs for telephone companies to maintain an internet service or to distribute a CD-ROM are expected to be less than the traditional distribution of a paper telephone book. There are no technical problems for implementation. The efficiency of the measure again depends on the willingness-to-send and the willingness-to-accept electronic information.

Sharing of washing machines
Sharing of washing facilities – in apartment buildings or in laundrettes – may lead to a reduction of the waste of discarded washing machines by 25 – 67%, if all the households in the Brussels Region would switch over to sharing instead of private ownership. This represents 7 – 11% of electric and electronics waste, and 2 – 4% of large garbage. A possible positive side effects of more centralised washing is a more efficient use of water and detergents. Side effects for energy use are not clear. Private ownership and use of a washing machine is a factor 16 cheaper than the use of a laundrette and a factor 5 compared to renting a washing machine. The large-scale implementation of sharing of washing machines may encounter some problems. Not only for economic, but also for practical or hygienic reasons people may prefer to have their own washing machine. Sharing may be a more successful option if applied to large luxury goods such as campers and caravans, or to products such as newspapers or magazines. For washing machines, company-related options such as leasing or EPR may be more effective.

Repair of electric and electronic waste
Waste from electric and electronic appliances is a significant and growing waste stream. Repair instead of throwing away of broken equipment is a means to lengthen the life-span and therefore reducing the waste flow. Lengthening the life span also may have negative side-effects, mainly due to the fast developments in the electronics sector.
The establishment of repair shops may be a good idea for some appliances with more stable markets. A major difficulty is the cost of labour, making repair very expensive, often more so than the purchase of a new product. As long as this is the case, repair shops would have to rely on subsidies. For rapidly evolving products in the electronics sector, a form of extended producer responsibility (take-back after discarding, possibly linked to extended leasing options) seems to be more promising.

Re-usable packaging
The use of re-usable (plastic) containers instead of throw-away cardboard packaging may lead to a reduction of the waste of paper and cardboard. If all large electronics and furniture would be stored and transported in reusable containers the maximum reduction could amount to 3% of the total amount of packaging waste. The shift to re-usable plastic containers instead of single used cardboard packaging means a shift in the production and disposal from cardboard to plastics. The overall consequences for the environment considering the total product chain of the materials are not known, but will mainly depend on the trip rate of the re-usable plastic container. This also applies to the costs. The minimum trip rate for which such an option is economically or environmentally beneficial could be established and compared with estimates of the actual trip rate.

House-to-house delivery
House to house delivery services might lead to a reduction of throw away packaging materials, such as paper and plastic packaging for fresh foods. The effect is not quantified but is considered to be small, because only the packaging of fresh foods can be avoided. Theoretically, a complete shift to house-to-house delivery would lead to a reduction of transport. In practice, however, this effect will be dampened because households still will do shopping by themselves despite the fact that some products are delivered.

Mobile dishwashing
Public events in the city generate large quantities of waste from paper or plastic disposable cups, plates, spoons etc. An alternative is to use more-way crockery and cutlery, combined with mobile dishwashing. This will probably have a relatively small effect on the total amount of waste, but can indeed be an important signal to the local community that the public authorities take the waste problem seriously.
When a choice must be made between moreway plastic and “real” china and glassware, moreway plastic is most likely preferable both from an environmental and safety point of view.
In order to reduce the environmental side-effects of mobile dishwashing, the dishwashing process should be optimised and the behaviour of the public will have to be controlled either through direct control or via a deposit system.

Leasing of carpets
A certain waste reduction can be expected from a change from buying to leasing of carpets, mainly as a result from the concurrent recycling. Positive side-effects may be the possible changes in production processes and use of secondary materials by the manufacturers, to enable installation, repair, collection and processing of waste. Negative side-effects may occur as a result of a shortening of the life span. When leasing is linked to the possibility to buy after a number of years for a symbolic price, the advantage disappears since the producer is no longer responsible for the after-life treatment.
Leasing schemes as they exist for offices are not directly suitable for households. Moreover, leasing has special problems in the case of carpets due to the installation and the absence of a second hand market. In fact, for households leasing may be more appropriate for other product groups such as furniture and (electronic) equipment.

For reducing household carpet waste, a form of EPR may be most suitable. Consumers pay a certain amount of money at the purchase to ensure that the provider or manufacturer collects and disposes of the carpet after discarding.

Product panels
Product panels may be a good platform to discuss options for dematerialisation. They may be used to generate and especially to test new initiatives. Whether or not product panels may lead to a significant reduction of household waste, cannot be concluded. There is some scepticism about what such initiatives can accomplish. However, similar initiatives of stakeholder groups have had practical results in realising environmental benefits, at least on a small scale. Including stakeholders may even be a boundary condition for acceptance of changes, whatever these may be. This role could certainly be played by product panels.

Immaterial goods
The effectiveness as well as the side-effects of a shift from material to immaterial gifts is difficult to estimate. It may indeed prevent waste generation. Some of the alternatives require travel, are energy-intensive or lead to different waste streams. For others, the shift will be beneficial even including side-effects. Local governments may help to promote such a shift.

Conclusions and recommendations

Sharing
Sharing of goods may lead to a smaller number of products being used, and therefore a smaller stock requiring a smaller inflow of new products, and generating a smaller outflow of waste. The case study worked out in the above refers to washing machines. The conclusion was that washing machines may not be a good type of product for this option. Other products such as caravans, campers, expensive do-it-yourself tools etc. may be more appropriate to share. Another type of product suitable for sharing may be newspapers and magazines. For washing machines, collection and re-use or recycling – conform to EU policy – seems to be a better option. To generalise, sharing may be a suitable option for:

- Large, long-lived and not intensively used luxury goods. These goods are too expensive to buy for most people, while sharing may be much cheaper than renting if you want to use them regularly.
- Throw-away information carriers. These products are still perfectly good after use but once used they lose their value to the owner.

Leasing and Extended Producer Responsibility
Leasing instead of buying products may decrease household waste generation if applied properly and to the right type of product / user combination. The expected environmental benefits lie mainly in the resulting Extended Producer Responsibility: by making manufacturers responsible for production, maintenance and end-of-life treatment, the incentive to design for the environment, for disassembly or for setting up recycling processes increases, resulting in a longer life span or a larger recycling percentage. Leasing of carpets, one of the cases worked out in this report, may be very useful for offices. Application for households presently appears not very useful. Other types of products, such as furniture or electronic equipment, may be more suitable for household leasing as well as office leasing. The nappy service as discussed in Section 5.2 may also be regarded as a leasing scheme. For this case, the main benefit does not seem to result from leasing, but from the shift of materials (see below); the leasing option merely serves to take away some of the discomfort for the user.
In general, leasing can be a very good option for:

- Rather expensive intensively used durable goods. Leasing provides extra services, therefore all problems that arise in the use-phase will be solved in one way or another, which is worth the extra costs for the user. Moreover it is worth the extra trouble for the producer, who can adapt both production and waste treatment processes to make repair, reuse and recycling easier.

Shift of materials
Shifting from one material to another enables to phase out applications of a certain unwanted material. Although this may indeed be environmentally beneficial, one should be aware that a material shift nearly always results in problem shifting as well. The nappy case shows this quite clearly: the waste stream of paper nappies disappears, as well as its previous life-cycle impacts, but this is replaced by environmental problems due to fertiliser and pesticide use for the production of cotton. The only exception may be digitising of information. In principle, this could save a lot of paper without negative side-effects although in practice this effect is often dampened. Shifting from material to immaterial luxury goods may cause less waste but frequently involves using more energy. A shift from one-time cardboard packaging to re-usable plastic crates also reduces waste but involves other emissions, the environmental gain being dependent on the trip rate. In this case, too, the choice must be made on a case-by-case basis.
A shift of materials is therefore is beneficial in all cases that the new material is causing, per functional unit, clearly less environmental pressure throughout the life cycle than the old material. This will especially be the case for digitising information. In principle, there is no limitation regarding the groups or classes of products being suitable for this option.

Repair
Repair extends the life span of products, thereby reducing the throughput while keeping the stock intact, and therefore also reducing the waste flow. The longer the life span, the less waste is produced: doubling life span means halving waste generation. Side-effects may be expected especially in case the products involved are part of a rapidly developing and changing market, as is the case with electronic appliances. New products perform much more environmentally friendly than old ones. Keeping the old ones in use thus slows down the penetration of the environmentally friendlier alternatives. For other types of products repair may be more clearly environmentally beneficial. A major barrier is related to the cost of labour: repair is often more expensive than the purchase of a new product. The economic times are not good for repair.
From an environmental point of view, repair is a very good option for:
- Long-lived products having a stable market. Here, the life span lengthening will not cause problems with the penetration of newer and better designs.
- Relatively simple products. The repair of these products does not require great expertise and could be done by a general repair man.

Considerations for policy

All in all, dematerialisation as defined here appears to be feasible for a number of product (groups). In general, it may indeed lead to a reduction of waste streams. The examples treated in Section 5 show that sometimes a significant reduction of certain waste streams could be reached, if the change would be successful, i.e. a large fraction of the consumers will participate. Participation will be induced easier in some cases than in others. Environmental gain is just one of the considerations. For many people, user friendliness, costs and other private considerations are much more important. If there are no barriers in that way, the change will be made easier and on a larger scale. These aspects therefore need careful consideration when designing dematerialisation schemes.

Another issue to be aware of when promoting dematerialisation schemes, is the fact that in most cases there will be environmental side-effects, the extent of which is not necessarily limited. It is important that these will be specified before progressing with some or other initiative. In hardly any case it can be concluded beforehand that dematerialisation is automatically beneficial. The environmental soundness needs to be established on a case-by-case basis.

Considering all, the most promising options seem to be the ones linked to producers, either via a leasing option or via obligatory take-back as part of EPR demands. This lays responsibility at the manufacturers door, and therefore provides an incentive for design-for-recycling, as well as an

incentive to work out economically feasible solutions. Some very important waste streams cannot be avoided in this manner (packaging, organic waste), for some product (group)s therefore other options are indicated.

The role of regional governments in inducing a change in consumer behaviour or consumption patterns is not automatically clear, since most of the product or service chains operate on a national or even international level. Very little can be arranged by command-and-control or in permits. Still there are some distinct possibilities to influence developments, which emerge from the fact that the local governments are closest to the citizens. The local level seems most appropriate to influence behaviour and engage a discussion with citizens. Several options of promoting dematerialisation initiatives can be thought of:

1. Generation of information: initiating studies with respect to the feasibility and environmental benefits of specific options, and introducing the results in the relevant platforms (national and international policy making, deliberations with producers / companies, information campaigns for consumers etc.).
2. Stimulating and subsidising: if certain options for dematerialisation have been established as environmentally sound, regional governments could try to stimulate these by subsidies (for example in the case of a nappy service), or by giving the good example (carpet, furniture and office equipment leasing in government offices, the telephone book on CD-ROM).
3. Mediating: in some cases groups of stakeholders may be indicated to identify options and provide directions for sustainable production, for example the eco-teams or the product panels as mentioned in Chapter 5. Governments may play a role in establishing such groups and facilitating their functioning. The demand for environmental plans of companies may also fall within this category. Governments might emphasise the increased need to include aspects of chain management, EPR etc..
4. Initiating attractive pilot projects: an example is the case on mobile dishwashing at public events. The environmental gain may not be large in a direct sense, but it could provide an important signal to the local community. Such initiatives may pave the road towards other, more effective options.

1 Introduction

The Brussels Institute for Management of the Environment (BIME) is responsible for the formulation of strategic Waste Prevention and Waste Management Plans for the Brussels Region. Two of such plans, which have a 5 year horizon, have been issued and adopted in the past. A third one is being drafted now.

Waste volume reduction has been a goal in the two earlier Plans (BIME, 1992 and BIME, 1998). Various specific indicators linked to targets regarding total waste volume, prevention, recycling, composting and consumer behaviour have been formulated. Despite progress (BIME, 2000), some of the targets for 2002 will probably not be met (http://www.ibgebim.be/). The starting point for the upcoming third Waste Prevention and Waste Management Plan is, that in an urban area such as the Brussels region, a change in waste volume is very much linked to a change in consumer behaviour. Therefore, sustainable consumption will be a subject in this Plan. Activities to raise public awareness have already been started, treating subjects such as ecolabels, waste separation and composting.

One of the developments that may lead to a more sustainable consumption is dematerialisation. The general idea behind the concept of dematerialisation is, that a reduction of the societal throughput of materials is possible while maintaining or even increasing welfare. The assumption, questioned by some, is that a reduced throughput of materials also implies a reduced pressure on the environment. Dematerialisation is an issue on the scale of total national economies: in various studies the de-linking of economic growth and total materials throughput is studied. On a lower scale level there are some cities want to monitor their materials throughput (see for example Gorrée et al. (in press) for Amsterdam). Large flows are in all cases the flows of water, fossil fuels and building materials. Many attempts at dematerialisation therefore focus on the reduction of water and energy use. Consumer related flows are relatively small. However, from a waste management perspective these consumer flows are the important flows.

Dematerialisation applied to consumer flows focuses on the production, use and discarding of household products. Industries attempting to develop in a more sustainable direction adopt dematerialisation as one of the guidelines for the design of their products. A number of case studies describe how various products can be designed in such a manner that the use of energy and materials will be much lower (e.g. Von Weizsäcker et al., 1997; Global Futures website). Examples include lengthening of the life span, using lighter materials and sleeker design, recycling of waste materials at the plant, lighter packaging etc.. Some ideas for dematerialisation are more related to consumer behaviour, for example a shift from products to services, electronic instead of paper information and tele-services to reduce shop or office space and transportation. Efforts like these may reduce the volume and change the composition of waste. The examples show that dematerialisation has potential. However, there is also some concern when looking at these isolated cases. While the examples may be illustrative for what can be achieved by aiming at dematerialisation, they may also lead to a shifting of problems on a different level. When considering specific measures aimed at dematerialisation it is important to keep an eye open for possible unintended side-effects. To identify possibilities to realise a “smart dematerialisation” is the subject of this report.

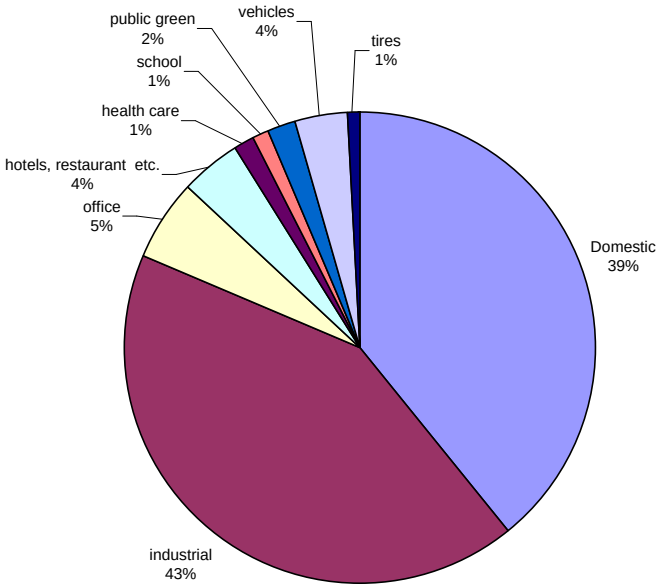
In Section 2, the Brussels situation regarding the produced municipal waste and the already existing policies and initiatives is described. This provides a focus for potential dematerialisation efforts. Section 3 is dedicated to a general treatment of dematerialisation and a narrowing down of the scope for this project. In Section 4, a list of existing examples and initiatives is provided. Some promising examples will be translated for the Brussels situation in Section 5, and a rough estimate will be made of their potential effectiveness and side-effects. Finally some recommendations for the Brussels region waste policy will be formulated in Section 6.

2 Waste generation and treatment in the Brussels region

2.1 Waste in Brussels: amount, composition and collection systems

In the Region Brussels yearly about 871 ktonnes waste is generated by households, industry and offices. Besides this also a yearly amount of sludge from dredging, sewer and waste water treatment is produced. Finally building and demolition activities yearly produce about 1233 ktonnes of Waste. In figure 2.1 the contribution of the different sectors to the waste in the Region Brussels is summarised (excl. sludge and building and demolition waste).

Figure 2.1. Waste from households, industry and offices in the Region Brussels in the year 1995 (total amount 871 ktonnes, excl. sludge and waste from building and demolition)
source: BIM, 1997



Both households and industry contribute most to the generation of waste in the Region Brussels. Their contribution to the total amount of waste generated (excl. sludge and waste from building and demolition) is about 40% each.

This study is focussed on the domestic waste generated by households in the region Brussels. In 1995 the amount of domestic waste was estimated to be about 340 ktonnes. In 1999 this amount was increased to 343 ktonnes. (see appendix for detailed figures).

Figure 2.2 illustrates the composition of the domestic waste generated in the Region Brussels in the year 1999. Remainings from food (kitchen waste) and paper waste have the largest contribution in the total amount of generated domestic waste, each about 20%. Other important types of waste are glass and waste from gardening, each about 9%. Plastics and large garbage (incl. electronics) have a contribution of about 7%.

In Brussels there are several systems to collect the domestic waste from households. Domestic waste is collected house-to-house using different types of litter bags. Besides this the waste is also collected by means of bulbs (glass), green spots (waste from gardens), container parks

(paper and textiles). Some of the waste is also collected by clubs (paper and textiles). There also is a separate collection of large garbage (furniture, electronics et cetera) and Domestic Chemical Waste. Figure 2.3 illustrates contribution (% of total weight) of the different types of systems in the collection of domestic waste in the Brussels Region.

Figure 2.2 Composition of Domestic Waste in the Brussels Region (year 1999; expressed in % of total weight, total amount 343 ktonnes)
Source: BIM, 2000

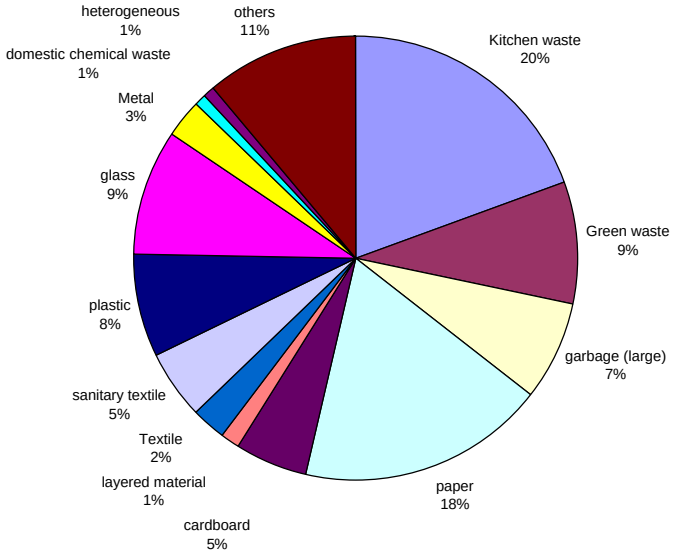
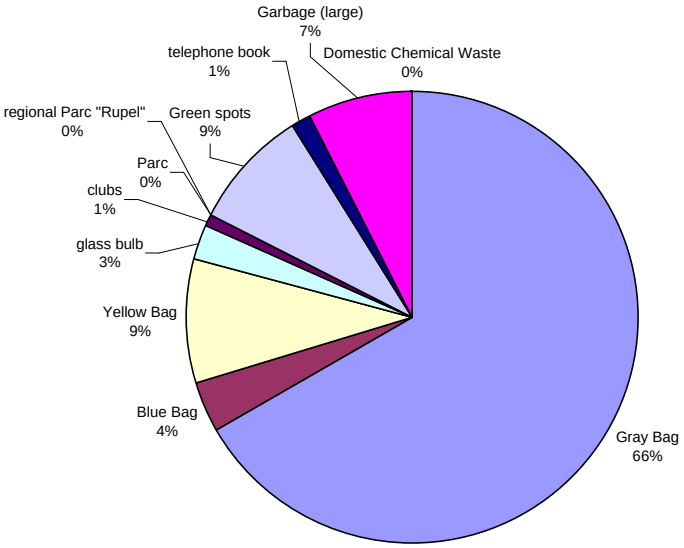


Figure 2.3 Contribution of systems to collect the Domestic Waste in the Brussels Region (year 1999, expressed in % of weight)
Source: BIM, 2000



Most of the waste in the Brussels Region is collected house-to-house using litter bags. About 80% of the total amount of domestic waste is collected this way. There are three types of litter bags; blue bags for packaging waste that can be recycled, yellow bags for paper waste and grey bags for remaining waste (not sorted).

By far the largest amount of domestic waste is not collected separately, as remaining waste, in the grey bags, about 228 ktonnes in 1999 that is 65% of the total amount of domestic waste.

About 12 ktonnes of waste is collected with the blue bags. This is 4 % of the total amount of domestic waste. The blue bags are destined for the collection of waste that can be recycled, like:

- metal: cans, boxes of white iron, aluminium foil et cetera;
- plastic: boxes and bottles;
- glass: bottles and jars;
- tetrabrik: boxes for milk, fruit juice et cetera.

With the yellow bags about 31 ktonnes of waste is collected. This is 9% of the total amount of domestic waste. The yellow bags are destined for the gathering of paper and cardboard, like news papers, magazines, books, advertisements et cetera.

Other types of waste that are collected separately are remains from gardening on green spots (9%), large garbage (incl. electronics) (7%) and glass voluntary delivered in glass bulbs (3%).

2.2 Present policies and realised actions to reduce the waste in the Brussels Region

The strategy and plans of the Brussels Region to reduce waste and its environmental effects is documented in the report “De preventie en het beheer van afvalstoffen in het Brussels Hoofdstedelijk Gewest. Plan 1998-2002”. (BIM, 1998). The plan covers the period between 1998 and 2002. The goals presented below are assumed to be defined over this period.

2.2.1 Strategy and objectives

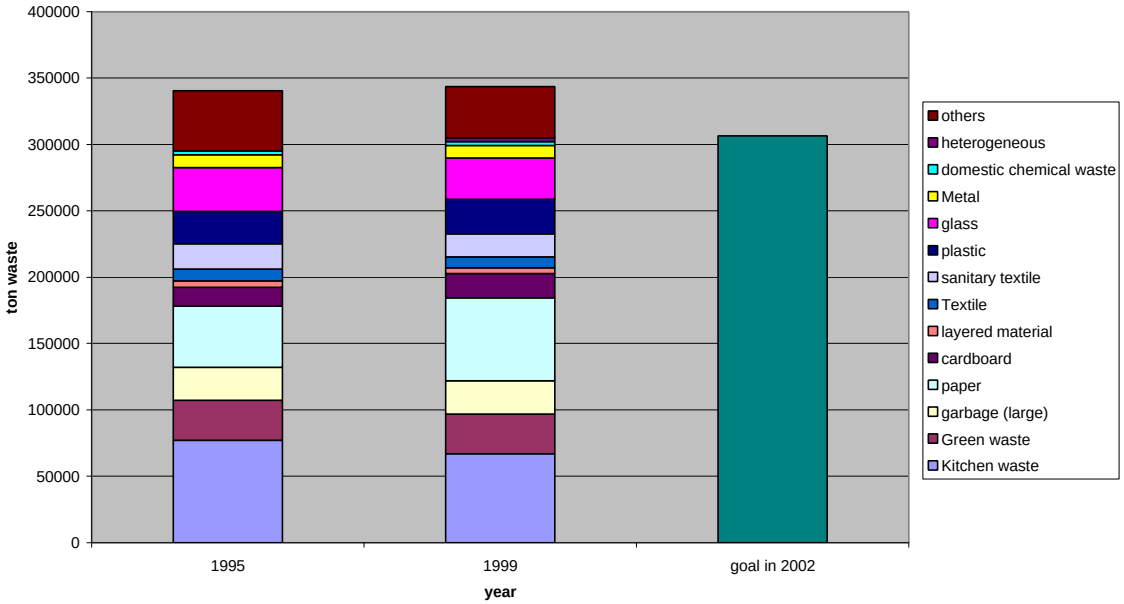
The Region of Brussels has in order of decreasing priority the following principles of waste management to prevent environmental effects of waste production and waste management:

- Prevention of the production of waste at the source and reduction or elimination of harmfulness of the waste for the environment. The Region of Brussels aims at a reduction of the production of waste at the source of 10% for all waste types and sectors together, for example by means of improved re use.
- Useful application of waste. The Region of Brussels forces the useful application of waste. The Region will try to accomplish its goals by the following means:
  a . Individual composting of high quality makes the useful application of the organic fraction of the waste (kitchen waste and gardening waste) possible with a minimum effect on the environment. The Region of Brussels aims at a number of 10000 households.
  b. Recycling of materials and organic processing. The Region of Brussels aims at a re-use or recycling of 33% of the domestic waste and 88% of the non domestic waste.
  c. Energy recovery: The Region of Brussels aims at a recovery of energy from waste that, for reasons of high economic, social or environmental costs, is not suitable for reuse or recycling.
- Final waste treatment
  a. waste incineration: The Region of Brussels wants to abolish the incineration of waste in installations without energy recovery.
  b. landfill: In the year 2002 the Region of Brussels wants to stop the landfill of non domestic waste that was not sorted at the source and/or was not pre-processed.

2.2.2 Actions to reduce the amount of produced waste

The Brussels Region government has taken a great number of actions to reach their targets. These actions include many different initiatives in the sphere of consumer awareness, producer responsibility, schemes for recycling, reuse, composting etc. etc. However, the targeted reduction of waste volume so far has not happened, as can be seen in Figure 2.4:

Figure 2.4 Domestic waste in the Brussels Region in the year 1995 and 1999 , confronted with a reduction goal of 10% waste reduction for 2002.
Source: BIM, 2000



3 Dematerialisation

Many of the environmental problems we are faced with today are related to the material basis of society. Emissions and waste flows of substances in the different stages of industrial production and consumption chain cause global warming, acidification, toxic effects etc. Dematerialisation is therefore often mentioned as a strategy or as an indicator in the framework of sustainable development.

3.1 What is dematerialisation?

In general one could define dematerialisation as the reduction of the input, use and output of materials in human societies. Dematerialisation can be measured on different geographical scale levels like nations, regions and cities but also on within different sectors of industry, households and in products (MIPS). One can distinguish *Absolute* (or strong) dematerialisation and *Relative* (or weak) dematerialisation. When the total amount of material inputs in a society is decreasing this is called absolute dematerialisation. When the amount is material input is going down per unit of GDP or per capita the term relative dematerialisation is used.

3.2 Is dematerialisation actually occurring?

Material Flows into and out of societies are nowadays monitored on a regular basis on the level of nations (e.g. Adriaanse et al. 1997, Matthews et al., 2000, Bringezu & Schütz, 2001). In these studies totally aggregated indicators like Direct Material Input (DMI) and Domestic Processed Outputs (DPO) are often used to observe trends in the material use in societies. Current trends show that on aggregate and in absolute terms both material inflows as outflows of industrialised societies are increasing. However, the material inputs and outputs per unit of GDP are decreasing. If one would accept GDP as a good measure for economic growth one could argue that the economy is growing faster than the material inputs and outputs. A closer study of the figures and trends shows that both in the use of primary materials as in industrial production there are clear examples of dematerialisation per unit of product e.g. by material substitution, efficiency improvement and other economic factors (Wernick et al., 1996). On the other hand however consumers tend to have increasing material wants which is of course closely connected to economic growth and increasing material wealth. On the output side there has been a shift from solid waste to emissions to the atmosphere, especially of CO_2. The solid waste production has remained more or less constant over the years.

3.3 What could be the "natural" causes of dematerialisation?

Bernardini and Galli (1996) mention a couple of possible general theories that could explain the causes of dematerialisation. The first one is that in the course of time old materials are substituted with new ones which would show improved physical properties per unit quantity thus leading to lower intensity of use. The second theory states that developing countries will benefit from the learning curves of developed countries and not just imitate the behaviour of the developed countries. This would mean that those countries will achieve the same per capita GDP value with less material intensity then their predecessors.

3.4 The relation between materials and information

Negroponte, the head of MIT Media Lab, describes the shift from matter to information as a shift from 'atoms to bits' (Negroponte, 1996). One trend that can be seen in industrialised societies is that information is gradually becoming more valued then matter. Negroponte notes: "The

information super highway is about the global movement of weightless bits at the speed of light. As one industry after another looks at itself in the mirror and asks about its future in a digital world, that future is driven almost 100 percent by the ability of that company's product or services to be rendered in digital form" and "This is, of course, hyperbole; since cars and catfish and cantaloupes will be needed for many decades and they are not likely to be rendered digital. What seems to be occurring though is that for every object or service we develop or use, the information density and knowledge inherent in it is rising". Examples of this increasing information density are easily found when today's products are compared with there predecessors e.g.: a T-Ford compared to a smart, old carphones compared to modern cellular phones, LCD displays compared to CRT computer monitors etc.

One realm where dematerialisation has proceeded to a large extend is the in the financial world. One could argue that the dematerialisation started when the concept of money was introduced and replaced barter. This was taken one step further with the introduction of paper money and finally by replacing physical money with information in the mainframes of the banks and on chipcards.

Other contributions to the literature in dematerialisation come from Danny Quah[1] who expresses his thoughts on the 'weightless economy' and the work of Manuel Castells[2] who discusses similar processes using different terminology.

3.5 Roads towards dematerialisation

In practice dematerialisation can be accomplished via different routes:
- increasing the efficiency of material use (using less materials for a specific function)
- materials substitution (exchanging heavy materials with light materials)
- re-use / recycling of materials (using materials for multiple functions)
- sharing (use of products by more than one consumer)
- p.m.

In order to achieve the routes mentioned above different policy strategies can be used:
- promote leasing (which creates incentives for producers to make their products easy to re-use, recycle, durable, easy to disassemble etc.)
- introduce extended producer responsibility (which creates similar incentives as leasing)
- ecodesign
- re-manufacturing
- p.m.

An interesting case is the development of lighter carpets: people tend to renew their interior every now and then for aesthetic reasons, regardless of its state. The potential life span of good quality carpets is much higher than required from this point of view. Lighter carpets with a reduced life span thus reduce materials use per m^2, without leading to more waste due to a reduced life span. The same idea is emerging in the design of office buildings: architects have realised that such buildings tend to be abandoned after some decades anyway, and go for light constructions instead of building for eternity. Another trend is to differentiate between interior and exterior. A modular design of buildings allows for a higher frequency renovation of the interior construction.

[1] http://econ.lse.ac.uk/staff/dquah/
[2] http://sociology.berkeley.edu/faculty/castells/

3.6 The contribution of a shift from products to services

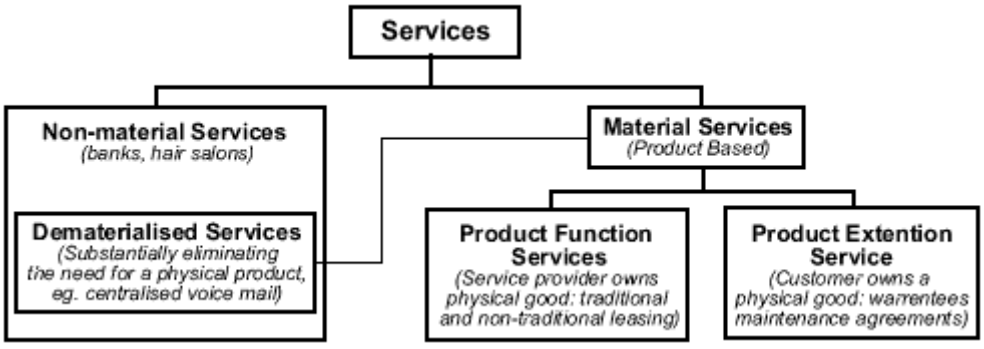
White, Stoughton and Feng (1999) outline the implications of the transition from products to services and for this they use the term servicizing. The servicizing principle applied within the business world, focuses on the added value that servicizing can bring both for the economic well-being of the organisation concerned, as well as the environmental impact of consumption.

Servicizing focuses on the development of product-based services. These product-based services change consumption patterns of the consumer from buying products, into buying services. When producers provide a service in stead of products this will increase the involvement of the producer with the product in its use phase, rather than just providing that product to the consumer. Buying and selling are replaced into different property rights options like producer take-back and leasing and pooling arrangements. Value is not created by creating a product with a certain value added but by the function that is provided by the producer, the product is just a means of delivering that function. The development of a functional economy is based upon the notion that providing a function is how to meet the consumer need, rather than providing a product per se (Stahel, 1997).

The transformation is outlined in the typologies of eco-efficient services of Hopkinson and James (2000):

- Activity management e.g. 'end of life' disposal of materials and products, or facilities management of energy provision of buildings
- Advice and consultancy e.g. energy or water efficiency
- Information e.g. provision of systems which make use of global positioning systems (GPS) to control tractor spraying of fertilisers or to support reverse logistics through better vehicle tracking
- Intermediation e.g. e-commerce portals which enable buyers to be found for unused capacity
- Product extension e.g. with maintenance, repair and other after-sale services
- Product result services e.g. where suppliers guarantee levels of performance and do all that is necessary to achieve this (demand-side management in energy)
- Product utility services e.g. when goods are hired or leased rather than sold
- Substitution e.g. when electronic services are substituted for physical processes (MP3-music, e-publications, pay-per view video etc.)

Services can also be distinguished on the basis of the extend of the transition from products to services:



Source: White, Stoughton and Feng, (1999)

Hockerts,1999 and Schrader, 1999 use a similar type of structuring:

1. **Product services** - offering additional services, mainly for the product sold (e.g. maintenance, guarantee, and take-back).
2. **Use services** - the provider no longer sells the product, but only its usage, e.g. leasing, renting, sharing and pooling. The expected eco-efficiency rating for these types of services is closely related to high use intensity, which brings about a reduction in the amount of products needed.
3. **Result services** - offers the consumers the opportunity to benefit from the use of material goods. The product is owned and run by the supplier, who therefore has an incentive to intensify and optimise the product's operation and increase its service life.

According to White, Stoughton and Feng (1999) incentives to develop servicizing in a modern competitive market appear when 3 principles are in place:

- when the business arrangement serves to internalise use or disposal costs;
- when the product in question has significant value at end-of-life;
- when provision of the product is viewed as a cost, rather than a profit centre

In this report we will focus on the shift from products to services. Examples of this shift are given in Chapter 4.

3.7 Side-effects

Although the shift to a dematerialised world is normally thought of as a step towards a sustainable world not all individual shifts are necessarily good from an environmental point of view. Unwanted side-effects can occur in specific situations for example (Herman et al. 1989):

- lighter materials are not necessarily more environmentally friendly than heavier materials;
- a shift in materials may cause side-effects due to reduction of life span, need for more transportation, tendency to throw away instead of repair, reduced recyclability etc.;
- lengthening of life span may lead to fossilisation of equipment: obsolete energy intensive equipment must be kept in use longer, reducing waste but also maintaining a high energy use;
- lengthening of life span may cause stockbuilding in society, which may lead to a “time bomb” of delayed waste generation;
- computerisation, instead of reducing material requirements, leads to new possibilities that may increase material flows and energy use (e.g., the quite considerable energy use of electronic networks);
- recovery and recycling may have unwanted side-effects due to extra transportation and energy use;

3.8 Rebound effects

The "rebound effect" is the environmentally negative second order effects which can sometimes arise from eco-efficient service inputs to customers. One of the most important examples is related to the introduction of low-energy light bulbs. The introduction of these very efficient light bulbs with low energy costs gave people the idea that the energy use and costs were so low that it did not matter if they would leave them switched on 24 hours a day. The introduction of new and eco-efficient products can thus cause counterproductive shifts in consumer behaviour. A similar example is the introduction of highly efficient heating systems which reduce the cost of energy to customers who respond by having higher standards of warmth and therefore, increased energy consumption. Rebound effects can also occur in a very indirect way e.g. consumers will spend the money which is saved by the use of these new heating systems and light bulbs for other purposes for example to buy flying tickets for an extra holiday.

4 An overview of dematerialisation initiatives

Appendix 1 contains an extended list of examples of dematerialisation, as found in literature and on the internet. Most examples found in literature refer to energy: less use of energy also means dematerialisation since the use of fossil fuels is reduced. Energy examples are not mentioned in Appendix 1, and neither are examples referring to reduction of the use of water, the use of building materials, or the design of products in large companies. The examples in Appendix 1 refer to consumer products and services only, and can be described as different options to replace products by services. Most initiatives may be categorised as leasing, sharing, digitalisation and maintenance. Leasing instead of ownership may reduce waste during use by a more centralised and therefore better care during the life span of the product. It will be in the interest of the producer to reduce materials use and waste production. Sharing may reduce the total number of products required for a community: instead of a car, washing machine, carpet cleaner etc. per household a limited number of such products per neighbourhood will be sufficient. Digitalisation will reduce paper requirement. Repair services may lengthen the life span of products; professional instead of do-it-yourself maintenance of the house and garden may lead to a more efficient use of materials. Table 4.1 provides a summary of the initiatives, with references to the extended list in Appendix 1.

All these types of dematerialisation may lead to specific types of problem shifting. This is not mentioned in Table 4.1 but will be treated in Section 5, where a limited number of initiatives is elaborated for the Brussels region.

Table 4.1 Examples of dematerialisation by shifting from products to services

category	description	type of waste reduced	Example in Appendix 1
information, digitising	The need to use traditional information carriers, like newspapers, magazines, books, photographs, paper mail, and account overviews etc. might be reduced by the present technology of digitising information.	paper, ink, roll of film, film chemicals	49, 50, 56, 57, 58, 59
information, reduce data carriers	The need to use data carriers, like videos, CD's, CD-ROMs, diskettes, smartcards et cetera, might reduce by the possibility to of download digital information directly from the internet and store information directly on the hard disk or even to a provider on a network.	video tapes, CD's, diskettes, smartcards	2, 48, 93
mobility, sharing	There are several examples of communities that share means of transportation , like cars, bikes, caravans et cetera. Sharing reduces the number of vehicles required and therefore reduces the amount of waste during production, use/maintenance and disposal of the vehicles.	waste during maintenance of vehicles, wrecks of bicycles, (car wrecks)	4, 5, 6, 7, 8
mobility, leasing	There are many examples of companies that lease vehicles instead of selling them. Because the leasing company has an extended product liability along the total product chain, from production until discarding, the incentive to reduce the use of materials in order to reduce costs might lead to less waste per product.	waste during maintenance of vehicles, wrecks of bicycles, (car wrecks)	9, 10, 11, 13, 14, 15
mobility, reducing	Tele-working leads to less transport-kilometres and therefore might indirectly lead to less waste.	waste during maintenance of vehicles, wrecks of bicycles, (car wrecks)	
shopping, improved logistics	Logistics in shops can be improved by information technology. Detailed information on the needs of customers makes it possible to fine-tune supply to demand. This leads to less storage, which in turn might lead to less waste from food that is outdated. The minimalising of storage possibly might lead to opportunities to reduce the use of packaging materials. Harmonisation of supply and demand also leads to less transport and therefore indirectly waste due to mobility might be reduced (see mobility).	outdated food, packaging materials during storage	57, 60
shopping, return packaging materials	In some shops and shopping centra it is possible to bring back packaging materials or to leave packaging materials in the shop. This central collection of packaging materials might lead to more re use of packaging. Also central collection gives better opportunities to collect materials more separately, which in turn might lead to better recycling possibilities.	packaging material	32, 35
tele-shopping	Tele-shopping means that customers can order their products by a tele- or internet service. The products are delivered to wherever the customer wants. As a service of tele-shopping the delivery of products might be combined with the take back of packaging materials. Tele-shopping also might lead to less vehicle kilometres and therefore indirectly reduce waste due to mobility (see mobility).	packaging material	18
	Direct tuning between consumers and farmers might lead to less over production. Also the use of packaging materials might be reduced.	outdated food, over produced food, packaging materials	87

reparation service	The lifetime of many products can be increased by repair of broken parts instead of buying a complete new product.	tools, apparatus, electronics, computers, ink cartridges	13, 21, 22, 39, 40
household and office goods, leasing and re-manufacturing	There are several examples of goods used in households and offices, which are leased instead of owned. Some examples are the leasing of furniture, carpets, copiers, laundry equipment, computers, baby goods, diapers, clothes, dishes, magazines. Leasing reduces the total amount of products used. Because the leasing company has an extended product liability along the total product chain, from production until discard, the incentive to reduce the use of materials in order to reduce costs might lead to less waste per product.		
		furniture	72, 73, 74, 75, 76, 77,78, 79, 80
		carpets	118, 119, 120, 121, 122
		copiers	94, 95, 96, 97
		laundry equipment	102, 103, 104, 105, 106, 107, 108, 109, 110
		baby goods, diapers	128, 37
		magazines, books	46, 47
		others	100, 123, 130
maintenance	The leasing instead of owning of equipment for large jobs in the house or garden leads to less demand for such equipment.	electronics, machines, tools	129
	A biological instead of chemical pest treatment service may reduce the use of pesticides.	pesticides	
	Many large jobs in the house probably can be done more effectively and with less produced waste by professionals.	remainders of paints and other chemicals, electronics, machines, tools	
packaging design	A smarter design of packaging materials might reduce the amount of packaging waste in shops and households. Redesigning might lead to less material, more mono-materials, which can be more easily recycled, and more reusable packaging materials.		36
other possibilities to reduce the amount of waste			
	increase of peoples involvement in their neighbourhood might help to reduce the amount of waste produced and/or materials consumed.		42
	The exchange of services between consumers (in a community) is a way of sharing goods.		124
	Information technology makes it possible to charge households for their produced amount of waste. This personalised levy may be an incentive for consumers to produce less waste / consume less materials. Another variant is the equivalent of the "negawatt" idea for energy consumption: a personalised bonus for using a less-than-average amount of materials or producing a less-than-average amount of waste, which can be called "negakilos"		52
contest for consumers	There are several examples of companies that have encouraged people to come forward with ideas to minimalise the use of materials and therefore reduce costs, the production of waste and emissions to the environment. This could also be attempted by a regional government for product-to-service initiatives.	municipal waste	28, 43, 44

5 Examples of dematerialisation

5.1 Selection of examples to be investigated

Three criteria were used to select examples of dematerialisation in the Brussels region, they must:

- be municipal waste oriented and focus on household and commercial waste
- be consumer oriented and thus focus on the power of citizens consumption to achieve dematerialisation
- address initiatives which are not developed yet in the Brussels region.

On the basis of these criteria the a number of categories were chosen out of the long list presented in Chapter 4 and Annex 1. From every category one, occasionally two, examples are selected.

Category	Example Products
products -> services	nappies, mobile dishwashing, house-to-house delivery
renting / leasing	carpets
promotion of new technology	e-services: advertisements / catalogues and telephone books
sharing	washing machines
take-back and repair / regenerate / re-use	electric and electronic equipment, re-usable packaging
stakeholder involvement	product panels
immaterial goods	immaterial gifts

The examples will be used in order to sketch the possibilities they offer to reduce the municipal waste flows in the Brussels region. Other issues that will be discussed are the costs of these options, their possible environmental side-effects and the role of the different actors involved. In the following sections, the examples will be grouped according to the waste flow(s) they influence. In § 5.2 we concentrate on non-packaging (including sanitary) paper, in § 5.3 on electric and electronic equipment, in § 5.4 we will treat the case studies regarding packaging waste, in § 5.5 household textile and finally in § 5.6 the two more general case studies of product panels and immaterial gifts.

5.2 Examples influencing the generation of non-packaging paper waste

In this section, three case studies are presented: diapers, e-advertising and telephone books. Diapers are the source of a relatively large waste stream in Brussels. There is an obvious alternative, namely washable cotton diapers. However the use of these cotton diapers is not without its drawbacks. Apart from health care considerations (nappy rash) it implies a lot of rather dirty work for households. For this reason, a nappy service has been established in a number of communities. In § 5.2.1, the advantages and drawbacks of the different options are sketched.

Two case studies in this chapter concern the use of electronic information, especially for advertising (§ 5.2.2) and telephone books (§ 5.2.3). The revolutionary developments in modern electronic information and communication technology are sometimes also described as an ecological revolution. Some people claim that modern technology will lead to a dematerialization of the society. Indirect, information technology would lead to more efficient processes, services and logistics, smaller ‘intelligent’ apparatus, better communication, less transport et cetera. Direct, the information technology makes it possible to substitute old information carriers, like videos, books, papers et cetera, by bytes (CD-ROM, DVD, internet, e-mail et cetera). Other people however argue that the revolution leads to the development and need of more new apparatus and a growing demand of electricity, which will lead to a larger demand of resources and a growing amount of, sometimes environmental hazardous, waste. Or even that ICT services add new services and functions to the market instead of

substituting materialised products, so even larger volumes of materials and energy are involved (Brezet *et al.,* 2000).

In this study for the Region of Brussels only the possibilities of the reduction of the domestic waste by substitution of old information carriers by bytes is worked out. The cases are focused on the substitution of paper advertisements by e-mail and telephone books by internet or CD-ROM in households. Also some, not quantified, attention is given to the use of e-mail versus paper in offices.

In theory every form of information now published on paper, like books, news papers, magazines, advertisements, letters and notes, can also be transmitted electronically on screen and/or hard disk, CD-ROM or DVD. Electronic publishing thus has a large potential to reduce the amount of paper consumed. Besides this electronically stored information might also be considered more convenient, because information from different sources can be more easily searched, compared, retrieved and processed.

A large fraction of the present domestic waste in the Brussels Region consists of paper. In 1999 about 59 ktonnes of non packaging paper waste was collected, which is 17% of the total amount of domestic waste (table 5.2.1).

Table 5.2.1 Non-packaging paper in domestic waste of the Brussels Region in 1999

Non-packaging paper	tonnes	% of total domestic waste
newspapers	16915	4.9
magazines	8249	2.4
advertisements	13597	4.0
bureau paper	6125	1.8
telephone books	4595	1.3
others	8952	2.6
mixed	516	0.2
total	58949	17.2

Source: B.I.M., 2000

Especially the information of advertisements and telephone books are suitable forms of paper information that can be easily dematerialised in the Brussels Region. Advertisements and telephone books both most likely represent regional information, which is offered by regional commerces and authorities, that probably can be influenced by the local authority of Brussels. The advertisements, including all kinds of catalogues, can be replaced by e-mail. Telephone books can be substituted by an internet service or digital telephone books on CD-ROM.

5.2.1 Diapers (or nappies)

Description of the case
The main alternative for paper throw-away nappies are cotton nappies which sometimes are offered via a nappy-laundering service. Although there are some minor differences between the various initiatives, the general idea of a nappy laundering service is very similar. Cotton nappies are either bought or rented by the parents and the laundry service company picks them up with intervals ranging from every day to once a week. This service is quite often promoted by local and national NGO's and in some cases sponsored by local governments[3]. Compared to cotton, the use of paper nappies causes a large waste stream as well as a squandering of resources. On the other hand, paper nappies are much easier to use. By offering a nappy service, the major disadvantage of the use of cotton nappies – they have to be laundered which is a lot of rather dirty work – is taken away from the household workload.

[3] http://www.wageningen.nl/aktueel/luier.html

In an increasing number of cities all over the world[4] nappy laundering is offered as a service for parents.

Effectiveness and side effects
With an annual average of 12-13 births per 1000 inhabitants around, a population of around one million and an average nappy time of three years the there will between 36000 and 39000 children using nappies in the Brussels region. If every baby produces around 500 kg of nappy waste per year[5] the total amount of diaper waste in the Brussels region would amount up to 18-20 ktonnes per year (equivalent to the amount of sanitary textile in the waste statistics). This is a little over 5% of the total 343 ktonnes of waste. The impact of introducing nappy services that will produce less waste thus has certainly potential to reduce waste flows in the Brussels region. The effectiveness is of course very much dependent on the number of households that is actually prepared to use cotton nappies.

It is clear that the use of cotton nappies, either individual or via a nappy service, strongly reduces the amount of waste produced. Moreover, the life cycle impacts of paper nappies are avoided. On the other hand, this is replaced by the life cycle impacts of cotton nappies. Their number will be less, but the production of cotton is notorious for its pesticide and fertiliser use. In the use phase, cotton nappies must be laundered which implies the use of water, electricity and detergents. A nappy service will increase the amount of transport needed. Moreover, nappies from a nappy service will be washed at higher temperatures due to hygiene demands, increasing the use of energy. Whether or not these side-effects outweigh the advantage of less waste production is not decided. In a study by the Dutch Consumentenbond, paper comes out slightly better than cotton, although the difference is so small that it is concluded that their environmental performance is more or less equal. They attribute this to the further development of paper nappies, making them lighter and more efficient. The nappy service is the worst alternative from a environmental point of view if life-cycle aspects are taken into account[6]. Other studies however point in exactly the opposite direction[7]. The Real Nappy Association calculated the environmental footprint of nappies. Here, the nappy service came out best and the paper nappies worst. This can be explained by the fact that the Ecological Footprint method does not consider toxic impacts, while these are considered very important in LCA studies. However in all cases it is clear that the use of ecologically grown cotton – i.e. grown with less or no use of fertilisers and pesticides – will strongly reduce the total environmental impact of cotton nappies.

Aspects of implementation
According to the Consumentenbond study, the costs of paper nappies range between € 270 to € 360 per year per baby. The costs of individual use of cotton nappies depend on the type of nappy (plain cloth or pre-modelled) and the frequency with which the nappies are changed and washed, and ranges between € 260 to € 500. Eco-cotton nappies are more expensive and will cost € 500 to € 600 per baby per year. A nappy service will cost are around € 500[8]. Squilbin (2001)[9] has made a calculation for the present Belgian situation and estimates for paper nappies an average cost of € 560 per baby per year, while the cost of cotton nappies depends on whether the baby is a first child or not. Cotton nappies for first babies would cost € 460, while for later babies this is € 160 since diapers do not have to be purchased again.

From an environmental point of view, eco-cotton nappies seem to be the best alternative. However this is also the most expensive alternative, although the costs may be much less if cost calculations would include the difference between first and later babies. Paper nappies certainly score better than cotton in the area of user-friendliness. A nappy service could take

[4] http://www.eco-babes.co.uk/, http://www.nappiewash.com.au/, http://www.kaatjekatoen.nl/, http://www.nappies.net/, http://www.naturwindeln.de/, http://www.mothernaturesdiapers.com/, http://www.cottonfresh.co.uk/
[5] http://www.ecoline.org/verde/infobladen/35luiers.shtml
[6] http://leden.tref.nl/~luyer/babyinfo/
[7] http://www.realnappy.com/
[8] http://leden.tref.nl/~luyer/babyinfo/
[9] Squilbin-Colpaert, C. (2001): Langes jetables ou en tissu? IBGE-BIM, internal memorandum.

away some of the disadvantages of the use of cotton diapers. Public authorities could, as some municipalities already do, lighten the financial burden by subsidising the use of cotton, especially of eco-cotton in order to make sure that environmental problem shifting from waste to pesticides and fertilisers is minimised. The nappy service business could also play a role in this and could demand from the producers of the cotton nappies that only eco-cotton should be used as a raw material.

Conclusions

- The use of cotton instead of paper diapers has a significant potential to reduce waste flows in the Brussels region. If all households would change to cotton, the maximum reduction of total domestic waste is about 5%.
- The overall environmental assessment of paper versus cotton nappies (private or service) is not clear. Different studies draw different conclusions. However it is clear that the use of ecologically grown cotton – i.e. grown with less or no use of fertilisers and pesticides – will lead to an environmental preference for cotton nappies.
- Cost calculations show that for a first child the difference between paper and cotton is small. However cotton becomes much cheaper for later babies. Nappy services are the most expensive. In order to induce a significant number of households to make the change, a nappy service will have to rely on subsidies.

5.2.2 E-advertising and office e-mail

Description of the case

The information of advertisements is a suitable form of paper information that can be dematerialised in the Brussels Region. Advertisements most likely represent regional information, which is offered by regional commerces and authorities, that probably can be influenced by the local authority of Brussels. The advertisements can be replaced by e-mail.

Effectiveness and side-effects

In order to be able to receive e-mail instead of paper advertisements a household needs a computer and a connection to the internet. In the beginning of the nineties about 10% of the Dutch households had a computer. In 1998 this percentage was already 60% and it is assumed that mid 2000 this percentage will be 75%. About 1/3 of the households has a connection to the internet. In the future without doubt this number will grow fast. (Trommelen, 2000). Let us assume that mid 2000 about 25% of the households in the Brussels Region have a computer with a connection to the internet.

The efficiency of the measure both depends on the percentage of households that is willing to accept electronic information and the percentage of commerces that is willing to send electronic information instead of paper (total willingness is the product of these two). In table 5.4.2 the effectiveness of the introduction of digital information instead of paper advertisements is given for different gradients of consumer and commerces willingness.

Table 5.2.2 Effectiveness of email as substitute of paper advertisements

	combined willingness of households and commerces to participate in E-information			
	100%	50%	25%	10%
tonnes reduced domestic waste	3399	1700	850	340
% of reduced paper waste	5.48	2.74	1.37	0.55

Table 5.2.2 shows that a significant reduction of paper waste can be achieved by switching to electronic advertisements. However some comments have to be made on this effectiveness.

In the calculations it is assumed that the electronically distributed information is not printed after all. For advertisements this seems a reasonable assumption. However in offices it is sometimes noticed that the paper consumption has grown explosively due to the power and speed of computers to handle graphics and documents and the cheapness of printing.

The mutual dependence of computer hardware and software and the increasing developments in information technology have lead to decreasing lifetimes of computers and devices. Vast quantities of perfectly functioning computers are dumped because the capacity of the computer no longer fulfils the requirements made by the developments in software and the demands of the consumer. The production of the computer requires large quantities of energy, water and toxic chemicals, like heavy metals, which may be released in the environment after disposal. The growing demand of faster more sophisticated computers of course can only be partly attributed to the use of e-mail.

The growing use of computers also means a growing consumption of energy. In the mid nineties the energy consumption by computers in Dutch households was 55 kWh a year (average use of the computer 4 hours a week). This is nearly as much as the use of a vacuum cleaner or 1/10 of the lighting in a house. The costs of this energy consumption is about € 0.65 each month. (Trommelen, 2000). However the use of computers in households is growing fast, also because of the growing use of the internet.

Calculations on the energy consumption of paper post versus e-mail have been made by the Institute for Advanced Industrial Design Engineering of the University of Technology in Delft[10]. All aspects of production, distribution and use were taken into account. The energy consumption by e-mail and paper post seemed to be equal for the sending of information (one A4) from Delft to Utrecht (about 50 km). For distances shorter than 50 km paper post costs less energy than e-mail[11]. A radius of 50 km serves a surface of 7850 km^2. The surface of the Brussels Region is 161 km^2. So, according to this study, from an energy point of view the sending of paper mail seems better than the sending of an e-mail. Other aspects however have not been taken into account, such as the environmental impacts of resource extraction, production and waste management of the materials (paper and ink).

In 1995 about 32 to 44 ktonnes of paper and cardboard waste was produced in offices. Of all this paper, only short internal memos are likely to be replaced by e-mail. Reports, concepts of reports, bills, contracts, large notes etc. will be printed even if they are sent by e-mail. It is not known how much of the paper waste comes from short internal notes (first guess, 3 – 5%) and how much of these short internal notes are already send by e-mail (first guess, nearly all). Discouraging the printing of short e-mails may be a first step to take.

Aspects of implementation
In the calculations of the effectiveness of e-advertising as presented above, an autonomous growth of the possession of computers in households is assumed. In the Netherlands the property of a computer at home is stimulated fiscally, primarily to stimulate tele-working.

To introduce e-advertising instead of paper advertising the local and regional commerces could be stimulated by the local authority to offer also electronic advertisements. Customers that wish to receive (certain types of) advertisements could be put on a mailing list. In the Brussels Region households can indicate their unwillingness to receive paper advertisements by a sticker on the mailbox. Many companies already make use of the internet to advertise their goods; some also offer the option to order by electronic mail. This may reduce some environmental pressure, although not much: the actual transport of the goods still must take place by aeroplanes, trains, trucks and cars. A more effective option to reduce the amount of paper waste might be a more intensive sharing of newspapers, magazines etc., for example between neighbours, at work or in the train.

[10] Klok *et al*. (1999). Energy efficiency of sending messages. Institute for Advanced Industrial Design Engineering. Technical University Delft, The Netherlands.
[11] Trommelen, J. (2000). Handboek Milieu. Tips voor milieuvriendelijk huishouden. De Volkskrant and J.M. Meulenhoff b.v., Amsterdam, The Netherlands.

Conclusions

- E-information, instead of advertising on paper, may lead to a reduction of paper waste. If all households that have an internet connection, and all commerces participate the maximum reduction would be about 1% of total domestic waste, or roughly 5% of the total amount of paper waste.
- A positive side-effect is the disappearance of the paper life-cycle and its impacts. A possible negative side-effect may be a larger consumption of energy. From an energy point of view, the sending of paper mail within a radius of about 50 km may be better than the sending of an e-mail.
- The costs for advertisers to send an e-advertisement instead of a paper advertisement are expected to be less. The efficiency of the measure of course depends on the willingness-to-send and the willingness-to-accept electronic information. There are no technical problems for implementation.
- In offices, e-mail may save paper mainly through the distribution of short notes and communications, which do not need to be printed. This may reduce total office paper waste by 3 – 5%.

5.2.3 Digitised telephone books

Description of the case

The information in telephone books is a suitable form of paper information that can be dematerialised in the Brussels Region. Telephone numbers represent regional information, which is offered by the (regional) telephone company that probably can be influenced by the local authority of Brussels. The telephone books can be replaced by an internet service or by distribution of CD-ROMs instead of books.

Effectiveness and side-effects

In order to be able to make use of the internet service a household needs a computer and a connection to the internet. We take the same estimate as in § 5.2.2: 75% of the households have a computer, and about 1/3 of these has a connection to the internet. It further is assumed that all computers have a CD-reader so 75% of the households are able to receive a telephone book on CD-ROM instead of paper. The efficiency of the measure also depends on the percentage of households that is willing to accept electronic instead of a paper telephone book. In table 5.2.3 the effectiveness of the introduction of digital information instead of a paper telephone book is given for different gradients of consumer willingness.

Table 5.2.3 Effectiveness of electronic information as substitute of telephone books on paper.

	willingness of households to participate in E-information			
	100%	50%	25%	10%
tonnes of reduced waste				
telephone book internet service	1149	574	287	115
telephone book on CD-ROM	3446	1723	862	345
% of domestic paper waste reduction				
telephone book internet service	1.85	0.92	0.46	0.18
telephone book on CD-ROM	5.54	2.77	1.38	0.55

Table 5.2.3 shows that a maximum reduction of paper waste of 6% can be achieved by switching to a digital telephone book. The effectiveness on paper waste reduction of the distribution of telephone books by CD-ROM compared to internet is much larger because it is assumed that all computers are equipped with a CD-reader, while only 1/3 of the computers are connected to the internet. A telephone book on CD-ROM generates a new waste stream of discarded CD-ROMs. This new waste stream could be limited if re-writable CDs are used. This waste stream will be much smaller: a first rough estimate leads to a maximum figure of

5.6 tonnes / year[12]. We have no information on the overall environmental life-cycle impact of information on paper compared to information on CD-ROM. This could be assessed by LCA.

Aspects of implementation
To reduce the number of paper copies of the telephone book, automatic distribution could be replaced by distribution only among households who have indicated that they are interested in a paper copy. There are several alternatives for the traditional telephone book on paper. An electronic telephone guide is already available on the internet[13]. Telephone books can also be distributed electronically by stimulating the telephone companies to distribute re-writable CD-ROMs. Another already existing service given by the telephone company is the inquiry of telephone numbers by telephone. To stimulate this telephonic inquiry service the costs of the service for the customer could be reduced.

Conclusions
- The introduction of digital telephone books may lead to a significant reduction of paper waste. An internet service would lead to a reduction of 2% if all households that have an internet connection participate. The distribution of CD-ROMs is more effective and would lead to a reduction of 6%, assuming that all households that own a computer would participate.
- If telephone books are replaced by CD-ROMs a small new waste stream will be generated: 5.6 tonnes compared to 3446 tonnes of paper waste. This waste stream could be limited even further by using re-writable CDs.
- We have no information to make a comparison between the two alternatives based on their life-cycle impacts. This should be assessed in an LCA study.
- The costs for telephone companies to maintain an internet service or to distribute a CD-ROM are expected to be less than the traditional distribution of a paper telephone book.
- There are no technical problems for implementation. The efficiency of the measure of course depends on the willingness-to-send and the willingness-to-accept electronic information.
- A third option to compare could be the already existing telephonic service for the inquiry of telephone numbers. This might be the most environmentally friendly option, although not the cheapest for the customer, and certainly not the easiest. If the public authorities want to stimulate this option, the costs of the service for the customer should be reduced.

5.3 Examples influencing the generation of electronics waste

This section contains two case studies: the sharing of washing machines (§ 5.3.1) and the repair and re-use of electric and electronic equipment. According to BIM[14] a number of 2.300.000 domestic appliances are discarded yearly, amounting to 16.000 kg or ca. 5% of total domestic waste. The largest fraction, ca. 70%, is formed by “white” appliances: kitchen stoves, washing and dishwashing machines, vacuum cleaners, mixers etc. “Brown” appliances like tv-sets, video recorders etc. contribute 20%, telecommunication devices 6% and PCs and printers 3%. The amount is expected to increase in future, especially of the last category. Reducing waste in this category contributes significantly to total waste reduction, and this will even be more in the future. In this section, two examples will be elaborated: the sharing of washing machines (§ 5.3.1), and the repair and re-use of electronics (§ 5.3.2). Sharing reduces the number of products in-use, and therefore also waste generation. Repair will lengthen the life-span of the product, and therefore also reduce waste generation. For both product groups, other options are possible as well and may even be more suitable depending on the nature of the product and its use. This will also be included in the discussion.

[12] 500,000 (no. of households) * 0.75 (fraction with computer) * 15 g (weight of 1 CD) = 5625 kg = 5.6 tonnes.
[13] www.telefoondiensten.be
[14] BIM – De Schriftjes van de Dienst Milieustatistiek – September 1997 “Het Brussels Afval in Cijfers”, no. 4: Productie van electrisch en electronisch afval.

5.3.1 Sharing of washing machines

Description of the case
Modern multi-apartment buildings in Northern Europe and the US tend to have central laundromats. In this way families are encouraged to use central washing facilities instead of using private washing machines in their own apartment[15]. At present in Britain and the Netherlands about 90% of the households own a private washing machine[16]. There are several options to facilitate central washing, such as laundrettes (commercial firms), laundry services (commercial firms, including collection and delivery service) and community washing facilities (tenants association, local authorities).

Effectiveness and side-effects
In the Brussels region the disposed washing machines are collected as large garbage. In 1999 the total amount of large garbage was 25198 ton, which was about 7% of the total amount of domestic waste. The fraction of the large garbage in Brussels that consists of discarded washing machines is not known. In Britain (58 million inhabitants) around 2 million washing machines are discarded each year (Cooper & Evans, in prep.). If this figure is transposed to the Brussels Region (0.95 million inhabitants) the amount of discarded washing machines is estimated to be 33000 pieces a year, which results in a waste flow to the large garbage of 2770 ton (17% of electric and electronics waste; 11% of the total amount of large garbage). A washing machine weighs about 80 to 90 kilo[17]. Washing machines typically comprise 45-60% steel, 20-30% concrete and 5-15% non-ferrous metals[21,18]. They contain environmentally dangerous substances, especially heavy metals, in their electronic components, plastics and wires.

Central facilities instead of a washing machine per household will reduce the number of washing machines in-use at one point in time. However it does not decrease the amount of waste automatically. More intensively used machines break down sooner, therefore the life span of a centrally used washing machine will be much shorter. In fact, the life span if a machine can be expressed in the number of cycles it is able to sustain. Therefore, if all else is the same, it will not reduce waste generation at all. However, all else need not be the same. The introduction of central washing facilities can be, and will probably be, accompanied by a shift to a the use of more durable products. In that case, the sharing of a central washing facility may lead to de-materialisation. Built for robustness, a laundromat machine typically lasts for 30.000 washing cycles. Household machines with similar life-cycle materials consumption last for only an average of 23.000 washing cycles[19]. In Goedkoop et al. (2000)[19] the lifetime of machines for laundrettes is estimated to be even 3 times higher than washing machines for household applications. If all households in the Brussels Region will shift to centralised washing facilities using more durable washing machines the amount of discarded washing machines might decrease to 2100 tonnes (= 23/30 * 2770 tonnes) or even 925 ton (= 10/30 * 2770 tonnes). Sharing of washing facilities instead of private washing machine ownership thus might maximally lead to a reduction of the large garbage of 650 ton to 1850 ton, which is 2% to 4% of the present amount of large garbage, and 7 – 11% of electric and electronics waste.

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[15] Weiszäcker, E. von, A.B. Lovins & L.H. Lovins. 1997. Factor Four, doubling wealth, halving resource use. The new report to the Club of Rome, Earthscan Publications London, United Kingdom.
[16] Cooper, T. & S. Evans (in prep.) Products to Services, A report for Friends of the Earth. The Centre for Sustainable Consumption, Sheffield Hallam University.
[17] Ansems, A., 1986. Zware metalen afkomstig van electrotechnische en electronische apparatuur. Afvalstoffen 35. Ministry of Housing, Physical Planning and Environment, The Hague, The Netherlands (in Dutch)
[18] Nordic Council, 1997
[19] Goedkoop, M.J., C.J.G. van Halen, H.R.M te Riele, P.J.M. Rommens (1999). Product Service Systems, Ecological and Economic Basics. Pre Consultants, Amersfoort, The Netherlands. Report downloaded from http://www.pre.nl/pss/default.htm

The shift from decentralised private washing to centralised washing also has consequences for the use of energy and water. The environmental benefits however are ambiguous. In Von Weizsäcker et al. (1997) laundrettes are claimed to be more energy efficient. The energy gains mainly come from the choice of the energy source. Privately owned machines almost always run on electricity. Laundromats, on the other hand, tend to use natural gas to heat the water (a far more efficient and cost effective method) and can partly reuse the hot water or recover the heat, thanks to a higher washing cycle frequency. Also the waste heat is available for reuse in tumble dryers. Goedkoop et al. (2000) also claim a more efficient use of water and energy in laundrettes compared to home washing. Furthermore they claim a more efficient use of detergents. Due to the fact that in laundrettes several washing machines are installed it is profitable to use a central ion exchanger. By removing calcium and magnesium from the water, less detergent is needed. On the other hand they argue that central washing, as in laundrettes or community washing facilities, may lead to more mobility and therefore a higher energy demand, in order to collect en redistribute the clothes.

Van den Hoed (in Cooper and Evans (in prep.)) argues that continuous washing in central laundry facilities makes recycling of water and detergents feasible. On the other hand, collective washing would require higher temperatures (in order to meet hygiene requirements), mechanical drying (for fast throughput), and some form of distribution to and from customers (which may involve packaging to protect clean clothes). This research concludes that energy demand in central washing facilities (large commercial laundries or small professional laundries within housing developments) is higher than in home washing due to the need to dry clothes, to wash at high temperatures and to transport clothes. The use of water would be substantially lower for large commercial laundries than for domestic washing or small neighbourhood laundries, due to filtering and cleaning of water for recycling. Detergent use would be significantly lower for central washing due to the better recycling technologies and expert dosing systems.

It can be concluded that sharing of washing facilities may lead to a reduction of the waste of discarded washing machines (maximum 2 – 4% reduction of waste category large garbage). The reduction might well be less if the possible increased need for mechanical tumble dryers is taken into account. The need to wash at higher temperatures may also lead to a quicker wear of the clothes. Possible beneficial side effects of centralised washing include a more efficient use of water and detergents. Benefits for energy use are not completely clear.

Aspects of implementation
In order to make an introduction of commercial laundries or collective washing facilities acceptable by the consumer, investments must be made to increase the durability of the more intensively used machines, reduce the environmental impact of machines and create a more pleasant, attractive, atmosphere. There are several initiatives of manufactures (Electrolux, Miele) and laundries (Öko-Express Washsalons in Germany, Launder Bar and Café in the USA) to improve the efficiency and attractiveness of collective washing places (Cooper and Evans, in prep.; Goedkoop et al., 2000).

Since 1988 Electrolux works on upgrading laundrettes in the Netherlands. Initiators are helped to start a new laundrette in attractive places (in shopping areas), or to upgrade old ones. Electrolux supplies “complete solutions for customer’s laundry requirements”. This approach includes equipment, installation, training, suggested layouts, support on environmental permits, market survey, service, guarantees, and financing. A modern Electrolux laundrette, called ‘Electrolux Wascator’, has on average six machines with six-kilogram capacity, one machine for 12 kilogram, three or four tumble-dryers for 14 kilograms. Such a laundrette is sufficient for an area of about 15000 people. To make a laundrette feasible it would be advisable to have some professional customers (shops, small hotel) within this area. The washing machines have a capacity from 6 to 32 kilograms and cost between € 450 and € 3600.

At present it is often to expensive to use a laundrette (around € 8 to wash and dry a 12 kg load) or rent a washing machine (around € 25 per month, which amounts to around € 2.5 to wash a 12 kg load). Purchasing of a washing machine is the most economically rational choice (price washing machine € 450, which amounts to around € 0.5 to wash a 12 kg load).

To make central sharing of washing facilities in neighbourhoods economically acceptable local authorities could consider subsidise non-profit sharing of washing machines. Local authorities are also involved in the hand out of environmental permits and the spatial planning of washing areas in residential areas.

There will be cultural barriers to solve as well for a successful introduction of collective washing facilities. People have become accustomed to owning washing machines, which gives them ability to wash clothes at whatever time they choose without having to consider opening hours and without queues. People may find collective washing not hygienic or are reluctant to leave their clothes behind in collective rooms. Laundrettes have a poor social image. Local authorities could, if they want, help to overcome these barriers by starting a campaign and initiate experimental projects.

In order to overcome the negative influences of transport of the clothes to the collective washing places the washing machines should be in the direct neighbourhood, preferably in the same building or block of houses. This seems to be in conflict with the above mentioned capacity of a laundry as designed by Electrolux, which is feasible for an area of 15000 people. Laundries below this capacity might loss their environmental benefits for water, energy and detergent use. Another possibility might be a clever, environmental friendly, collecting service, so not each household has to transport the clothes themselves.

All in all, sharing could reduce waste but might still not be the optimal solution if applied to washing machines. It might be a more effective option for (luxury) goods, which are used less intensively (campers, caravans, tools) or one-time use goods (magazines, newspapers). For example for tools, magazines and newspapers a network of neighbours could be set up, sharing the costs and use of the goods. For intensively used electronic apparatus such as washing machines, it may be more efficient to focus on collection and recycling. A (draft) EU Directive, WEEE[20], aims at promoting product designs that enable the ease of repair, upgrading and recycling, and thus reduce waste. If approved this would require washing machine producers to recycle or re-use 90% of all discarded items from 1 January 2004 onwards. Another option is to shift from buying to leasing. The end-of-life treatment then again is in the hands of the producer, who then has an incentive to develop recycling or waste treatment options for these products.

Conclusions

- Sharing of washing facilities may lead to a reduction of the waste of discarded washing machines by 25 – 67%, if all the households in the Brussels Region would switch over to sharing instead of private ownership. This represents 7 – 11% of electric and electronics waste, and 2 – 4% of large garbage.
- A possible positive side effects of more centralised washing is a more efficient use of water and detergents. Side effects for energy use are not clear.
- Purchasing of a washing machine is the most economically rational choice, being a factor 16 cheaper than the use of a laundrette and a factor 5 compared to renting a washing machine.
- The large-scale implementation of sharing of washing machines may encounter some problems. Not only for economical, but also for practical or hygienic reasons people may prefer to have there own washing machine.
- Sharing may be a more successful option if applied to large luxury goods such as campers and caravans, or to products such as newspapers or magazines.
- For washing machines, company-related options such as leasing or EPR may be more effective.

[20] Proposal for a Directive of the European Parliament and of the Council on Waste Electrical and Electronic Equipment; Proposal for a Directive of the European Parliament and of the Council on the restriction of the use of certain hazardous substances in electrical and electronic equipment. Final proposal, 13-6-2000, Document 500PC0347(02).

5.3.2 Electric and electronic equipment

Description of the case
The amount of electric and electronic appliances, such as coffee machines, mixers, vacuum cleaners, ironers, television sets, radios, video recorders, CD players, computers, mobile telephones etc. etc., is increasing in households. Stocks of such appliances in houses are growing, implying that the waste flow connected with the discarding of such products will grow as well.
One of the possibilities of reducing the waste flow is to lengthen the life span of these appliances. Repair instead of discarding is one option to do so. Repair of electric and electronic appliances is not always easy. Do-it-yourself repair is often not possible:

- repair of modern electronic equipment requires highly specialised knowledge,
- repair of simpler electric appliances is increasingly difficult because of their design (inbuilt plugs, inbuilt batteries, impossible to open etc.).

Repair by the manufacturer or by specialised repair shops is possible in most cases. A great many general or specialised repair service companies exist and can be found on the internet[21]. However, although possible repair is not always feasible:

- after the period of guarantee has extended, repair is often more expensive than the purchase of a new product
- repair sometimes takes a long period because the device, or the parts required for reparation, must be transported over great distances
- products may become obsolete very rapidly, implying that the production of parts is stopped very soon and repair is no longer possible.

These developments result in a very high turnover of products in this diverse category. Often, the products discarded only have small ailments, which means that they are repairable and could function very well for another number of years.

A new development in this direction is the emergence of internet systems or schemes for trouble shooting and tips for repair, aimed at professional repair service people but also at well-informed users[22]. This may increase possibilities for (professional) repair.

Possibilities to repair and extend the life span of products can be helped greatly by a product design allowing for that. Some companies have developed initiatives in that direction[23]. A link to a leasing scheme has further advantages: the manufacturer has to take care of

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[21] For example:

- repair services for electronics (all brands): http://www.anatekcorp.com/faq/applianc.htm, http://www.edri.com/ , http://avr-services.4mg.com/service.html , http://www.deltaelectronicsw-tx.com/, http://www.approvedaudioservice.com/,
- in the Netherlands: http://www.kooymans.nl/av%20reparatie.html (also sales of parts)
- repair and parts for Play Stations, Game Boys etc.: http://www.vdo-specialties.com/index.htm
- idem for photo camera's: http://www.midwestcamera.com/
- idem for camcorders and some other appliances: http://www.pro-cam-electronics.com/
- repair and sale of second hand electronics: http://avr-services.4mg.com/service.html
- idem in the Netherlands: http://www.indurep.nl/indurhol.html
- door to door repair service: http://members.tripod.com/~mondeo/snelservice.htm
- some repair addresses in the Netherlands and Belgium: http://www.zoeken.com/categorie/524500_1.htm
- "home management" including all kinds of repair services: http://www.myhomekey.com/, http://www.servicemagic.com/servlet/CategoryServlet;jsessionid=8606%3A3b938ac7%3Abc1ae8a1b047eed?catOID=-9205&link_id=255

[22] Website voor professional repair with repair tips: http://www.videotech.org/, http://www.repairworld.com/
Repair tips for professionals and informed users: http://www.repairfaq.org/, http://www.electronic-repair.com/tips1.htm, http://elmswood.guernsey.net/,
a possibility to pose questions and get answers related to the repair of electronics can be found at: http://www.electronix.com/

[23] for example: http://www.oce.com/about/environ/environ.asp#products, http://www.greenmarketing.com/articles/ama_Jan97.html

maintenance, including repair, and after-life treatment; therefore there is a clear incentive to design products in such a way that an effective management is possible and resources are not wasted.

Effectiveness and side effects
According to the Brussels region waste statistics, the production of domestic electric and electronic waste concerns 2.300.000 appliances, amounting to 16000 tonnes, in 1996[24]. This contributes almost 5% to the total amount of domestic waste[25]. In future, this waste flow may be expected to increase further, especially the electronic appliances.

As mentioned above, the idea behind repair is that the life span of the application will be lengthened, and therefore the waste flow will be reduced. It is difficult to estimate what life span increase can be gained by repair. For some applications this may be considerable. For others, it may not even be an option. For example personal computers will be able to function beyond a period of 5 years, but they become outdated so quickly that their continued use is not feasible. To get a rough idea of the gain of lengthening the life span: an average life span increase of 1 year would imply a waste flow reduction of 10%, assuming the life span of electric and electronic equipment averages around 10 years. For the domestic large garbage flow this would mean a reduction of 6%. For specific products this figure may be very different.

Increase of life span may also have some negative side-effects:
- Ageing of the equipment implies that the speed of renewal slows down. New generations of products are usually more efficient: they use less energy and materials and their performance is better. Especially when the manufacturer is committed to principles of ecodesign, design for the environment, sustainable production etc[26], renewal of equipment may have more environmental benefits than lengthening the life span of old appliances. Van Nes et al. (1999)[27] state that lengthening of life span is never *automatically* beneficial, except when the new product is identical in all aspects to the old one. In every other case, an individual assessment must be made. Logically, this side-effect will be stronger for product groups undergoing rapid changes, for example electronics such as computers, play stations, mobile telephones etc. For electric appliances, such as vacuum cleaners, ironers or coffee makers, the pace of renewal is lower and the benefit of life span increase therefore larger.
- Another side-effect, which also occurs especially for electronics, is the transport required for repair. In many cases, the required knowledge or parts for reparation is so specialised that the product has to be sent to (or replacement parts must come from) the manufacturer, who frequently resides at the other end of the world.
- A third but probably minor class of side-effects comes from the act of reparation itself: reparation requires energy and materials.

Aspects of implementation
As stated above, repair can be an option to increase the life span of products. A first question to be answered is, whether the benefits of increased life span outweigh the damage due to a slower penetration of new products with a better environmental performance. This would have

[24] BIM – De Schriftjes van de Dienst Milieustatistiek – September 1997 “Het Brussels Afval in Cijfers”, no. 4: Productie van electrisch en electronisch afval.
[25] We can double check this number by comparing it with EU level waste. According to Mastino et al. (1995) (in: Kleijn et al., in press) the EU waste from electonic and electric equipment amounted to 7000 ktonnes in 1995, of which 4700 ktonnes is household appliances. If we transpose this figure to the Brussels region, we arrive at (4700 / 375000000) * 950000 = 12 ktonnes. These estimates are in the same order of magnitude. The difference might be caused by different definitions, or perhaps the Brussels region as an urban region differs from the EU average.
[26] An example is the Philips eco-tv: http://www.environment.philips.com/EcoShop/tvset.html
[27] Nes, N. van, J. Cramer & A. Stevels (1999): a Practical Approach to the Ecological Lifetime Optimization of Electronic Products. Paper for First International Symposium on Environmentally Concious Design and Inverse Manufacturing, 1-3 February 1999, Tokyo, website http://www.computer.org/proceedings/ecodesign/0007/0007toc.htm

to be established. A regional government considering to develop initiatives in this direction may issue studies to get an answer to this question for some specific products. In general it might be possible that the balance is negative for rapidly changing electronic appliances, but positive for less complicated electric equipment. Repair shops may be a good option for relatively easy, standardised reparations on electric equipment.

For the establishment of repair shops, whether aimed at electric or electronic appliances, there are some major difficulties that must be overcome:

- In the first place, reparation is generally very expensive due to the high cost of labour. At present many repairs do not take place simply because it is cheaper to buy a new product. This can only be solved by some basic changes in the economic system (taxing materials instead of labour), or alternatively by subsidies from governments.
- In the second place, there should be a link to the production of these products. Products must be designed to enable repair (also referred to as Design for Disassembly). This implies modular design so parts can be replaced easily, the use of standardised parts which are not taken out of production, the use of simpler materials etc. etc.

Especially for expensive and complicated products it would seem that this is a case for extended producer responsibility (EPR) rather than specialised repair shops. Take-back of discarded products by distributors is also a part of (upcoming) EU legislation[28], and is already practised for some goods in various EU countries[29]. A combination with a leasing scheme could be a good idea as well. This provides an incentive for companies to design in order to enable repair, or an upgrade of rapidly ageing products.[30] At the same time it places the responsibility for after life treatment at the producer. Old parts still functioning can be reused and basic materials recycled more efficiently[31]. Leasing of relatively expensive office electronics, such as PC's, printers, copiers etc., is practised already. It could be a good idea to explore possibilities to develop leasing schemes for households as well for such appliances.

Conclusions

- Waste from electric and electronic appliances is a significant and growing waste stream. Repair instead of throwing away of broken equipment is a means to lengthen the life-span and therefore reducing the waste flow.
- Lengthening the life span also may have negative side-effects, mainly due to the fast developments in the electronics sector.
- The establishment of repair shops may be a good idea for some appliances with more stable markets. A major difficulty is the cost of labour, making repair very expensive, often more so than the purchase of a new product. As long as this is the case, repair shops have to rely on subsidies.
- For rapidly evolving products in the electronics sector, a form of extended producer responsibility (take-back after discarding, possibly linked to extended leasing options) seems to be more promising.

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[28] Proposal for a Directive of the European Parliament and of the Council on Waste Electrical and Electronic Equipment; Proposal for a Directive of the European Parliament and of the Council on the restriction of the use of certain hazardous substances in electrical and electronic equipment. Final proposal, 13-6-2000, Document 500PC0347(02).

[29] Nagel, C., J. Nilsson & C. Boks (1999): European End-of-Life Systems for Electrical and Electronic Equipment. Paper for the First International Symposium on Environmentally Concious Design and Inverse Manufacturing, 1-3 February 1999, Tokyo.

[30] For example Apple computers: the modular design not only enables repair and ungrades, but also makes after life treatment easier by increasing possibilities for recycling: http://a1936.g.akamai.net/7/1936/51/577d84239ab11c/www.apple.com/about/environment/design/case_study/powermac_g4.pdf

[31] A paper on some difficulties for re-use of old parts: Pötter, H., H. Griese, A. Middendorf, G. Fotheringham & H. Reichl (1999): Towards the Re-Use of Electronic Products – Quality Assurance for the Re-Use of Electronics. Paper for First International Symposium on Environmentally Concious Design and Inverse Manufacturing, 1-3 February 1999, Tokyo.

5.4 Examples influencing packaging and other throw-away materials waste

Packaging waste is a large waste stream. In Table 5.4.1, packaging waste in the Brussels region is quantified for the year 1999. The total amount is almost 70,000 tonnes per year, which is a little over 20% of total domestic waste. Any option that may successfully influence packaging waste therefore could contribute significantly to a reduction of the total domestic waste flow in the Brussels region.

A large amount of the waste is already collected for recycling (about 40%, as can be seen in Table 5.4.2). Instead of recycling of the materials (paper, cardboard, glass, iron etc.) it is also possible to reach an absolute reduction in the consumption of packaging goods by re-using the packaging product itself (box, bottle, can). An example of re-use of packaging is the re-usable milk bottle.

Table 5.4.1 Packaging materials in domestic waste of the Brussels Region (year 1999)

	tonnes	%
paper	2411	3
cardboard	15290	22
layered material	4530	7
Tetrabrik	2602	
other layered material	1928	
plastic	13445	19
bottles (PE, PET, PVC)	5928	
other (foil, PE other)	7517	
glass	26941	39
metals	6924	10
iron	5855	
aluminium	1069	
TOTAL	69541	100

Source: BIM, 2000.

Table 5.4.2 Collection percentages of packaging for recycling in 1999

	Realisation in 1999 (% selective collection)
Packaging total	41
Paper	10
Cardboard	38
Multicoated	24
Plastic	24
Glass	47
Metal, iron	87
Metal, aluminium	10

Source: BIM, 2000

In this section, three examples are treated: re-usable packaging, house-to-house delivery, and mobile dishwashing. Re-usable packaging will reduce packaging waste automatically. In § 5.4.1 the subject is mainly the conditions under which such an option may become effective, and the possible side-effects. House-to-house delivery (§ 5.4.2) may also reduce packaging, because if goods are delivered to the door some packaging may be avoided altogether. Mobile dishwashing aims at reducing waste from throw-away plastic or paper dishes, cups, cutlery etc. at public events. In § 5.4.3 some remarks are made on how this could be shaped into an effective option.

5.4.1 Re-usable packaging

Description of the case
Packaging materials are used to prevent damaging of the goods during storage and transport at the retailer and at households. For some goods however packaging material may not be necessary for the transport from the shop to the house (for example shoes, small electronics et cetera). In these cases the packaging material can be left at the shop. For large goods, which are most commonly delivered at the house by the retailer, the packaging may be taken back by the retailer for re-use (for example large electronics, furniture et cetera). Packaging materials are still necessary for transport from the factory to the shop and storage of the goods at the shop. For these cases however re-usable uniform packaging is possible using durable materials (for example plastic instead of cardboard boxes).

Effectiveness and side-effects
How much of the present cardboard in the domestic waste comes from packaging of these goods, like shoes, small and large electronics and furniture? No figures of the purchase of these goods in the Brussels Region are available. In Ansems (1986) some figures of the disposal of electronics and furniture are given for the Netherlands. Based on these figures a very rough estimate is made of the amount of goods that will be yearly purchased, assuming that the discarded goods will be replaced (table 5.4.3).

Table 5.4.3 Estimate of the yearly purchase of large electronics and furniture

	pieces / 10000 inhabitants.year	pieces in Brussels Region
refrigerator	405	38604
stove, furnace	275	26212
washing machine	272	25896
freezer	251	23933
tumble dryer	116	11021
dishwashers	87	8249
couch	920	87692
chairs	2550	243060
tables	1375	131062
large cupboards	600	57191
beds	850	81020
total		733939

For small goods and electronics (like shoes, electric shavers etc.) no data are found. Medium sized goods (small cupboards etc.) and electronics (like TV sets, audio sets and suchlike) are assumed to be transported by the customer, instead of delivered by the retailer. These products are assumed to be sold in the packaging that is not taken back for re-use by the retailer.

Under the assumption that the average weight of a cardboard packaging is about 3 kg, then the total weight of cardboard packaging material for large electronics and furniture is about 2200 tonnes, or about 3% of the total amount of packaging waste. This figure is of course only an indication of the maximum amount of waste that can be reduced if re-usable boxes are introduced in the Region of Brussels. In the calculation many assumptions are made and the avoided packaging only concerns large goods with a relatively long lifetime (10 years). The packaging of small goods was not taken into account. An example is the packaging of shoes in shoeboxes. Some stores already have shifted to reusable packaging: plastic containers of a number of pairs of shoes. The consumer takes the shoes home without the

container, and the packaging goes back to the factory to be filled again. Assuming every inhabitant buys 2 new pairs of shoes each year and 1 shoebox weighs 0,15 kg, an extra reduction of cardboard waste can be achieved of 285 tonnes per year (0.3% of packaging waste) when re-usable shoe boxes are introduced[32].

Although the amount of waste will be reduced by shifting to re-usable packaging, there are also some other environmental aspects to consider. The substitution of the single used cardboard packaging by re-usable plastic packaging will lead to an alternative plastic waste stream, since after a number of trips the re-usable plastic packaging will be discarded as well. The increase of the amount of plastic waste depends on the trip rate of the re-usable containers. The overall life-cycle consequences for the environment considering the total product chain of single used carton versus re-usable plastic packaging should be investigated further.

Aspects of implementation
In principle there are no barriers to implement re-usable packaging. However the influence of local authorities may be limited to local or regional companies and industries. The implementation of such a system of re-usable containers may be more of a national, if not international, affair.

Conclusions
- The use of re-usable (plastic) containers instead of cardboard packaging may lead to a reduction of the waste of paper and cardboard. If all large electronics and furniture would be stored and transported in reusable containers the maximum reduction could amount to 3% of the total amount of packaging waste.
- The shift to re-usable plastic containers instead of single used cardboard packaging means a shift in the production and disposal from cardboard to plastics. The overall consequences for the environment considering the total product chain of the materials are not known, but will mainly depend on the trip rate of the re-usable plastic container. This also applies to the costs. The minimum trip rate for which such an option is economically or environmentally beneficial could be established and compared with estimates of the actual trip rate.
- The implementation of a system of re-usable containers is a national, if not international, affair. The role of regional authorities in establishing such a change on a large scale will necessarily be limited.

5.4.2 House-to-house delivery

Description of the case
In the past it was very common that products were delivered house-to-house, and waste products were collected house-to-house by special delivery services like milkmen, coal and oil deliveries, bakeries, greengrocers, laundry services, waste food collectors, rag-and-bone men etc. During the last decades most of these services disappeared, largely because of the rising of the supermarkets, changes in social behaviour of the population and the increased mobility of population. Some of these services are however still operating. Examples are the SRV-men in the Netherlands, and occasionally local milkman and local greengrocers. However, with the increasing number of one-person households, couples with double income and the introduction of the internet, new house-to-house initiatives have started, especially in the grocery business[33]. In general these services make it possible to order groceries via the internet, which are subsequently delivered at your home address.

[32] 2 (pairs of shoes/year) * 0.15 (kg/shoebox) * 950,000 (inhabitants) = 285,000 kg
[33] http://www.dekruidenier.be/
http://ah-thuisservice.ah.nl/hss/shop
http://www.tesco.com/
http://www.peapod.com/fcgi-bin/gateway.fcg?006=1987
http://www.maxfoodmarket.nl/

Effectiveness and side effects
The relation between these initiatives and waste flows is not self-evident. One way in which waste flows could be influenced is by reducing the amount of throw-away packaging materials. The use of refillable packaging materials could be stimulated when the delivery services take back the packaging materials of the products they sell. At the moment this is not an issue within these services, but local authorities could stimulate this. The amount of plastic packing materials in the household waste is around 17 ktonnes, including plastic bags and bottles. This is around 5% of the total amount of waste in the Brussels region. Only part of this can be avoided via house to house delivery services. The use of refillable bottles is stimulated because the consumers don't have to return their empty bottles themselves. The use of packaging for vegetables and fruits can be reduced by delivering them in reusable crates or by using only one bag for the whole order. Furthermore, the use of plastic bags to carry the groceries can be abolished by the use of reusable crates. However there are all kinds of pre-packaged products like tinned groceries, frozen foods, pre-prepared foods etc; the packaging of these will be unaffected by house-to-house delivery.

Side effects can both be positive and negative: negative is the fact that a truck of the delivery service is driving around all day, positive is the fact that consumers don't have to drive their own car to the supermarkets anymore. The latter is only true if groceries would be the only reason that people drive their car to a shopping mall, in reality other shopping is often done at the same time.

Aspects of implementation
Home delivery services offer advantages as well as disadvantages for consumers. It is a clear advantage that consumers do not have to go shopping and carry their own groceries. Furthermore grocery lists can be automated and so-called impulse buying is reduced but on the other hand the fun of shopping is reduced too. A disadvantage is that consumers have to be at home at the time the service comes by. This is difficult for people working outdoors. However experiments are in progress with refrigerators which are placed next to the front door which can be opened by the supplier from one end and by the consumer from the other. Another disadvantage is that in some, although not all, cases home delivery services are more expensive than regular supermarkets. A last disadvantage is that the services which are available are not a one-stop-shopping point yet.

Conclusions
- House to house delivery services might lead to a minor reduction of throw away packaging materials, such as paper and plastic packaging for fresh foods. The effect is not quantified but is considered to be small, because only the packaging of fresh foods can be avoided.
- Theoretically, a complete shift to house-to-house delivery would lead to a reduction of transport. In practice, however, this effect will be dampened because households still will do shopping by themselves despite the fact that some products are delivered.

No costs were estimated; in general delivered products are more expensive but households may save on fuel and on time.

5.4.3 Mobile dishwashing

Description of the case
During large festivals, fairs and other events where food and drinks are supplied to a large number of participants, it is quite common to use disposable crockery, cutlery and cups. Although the number of these events is normally quite limited, the amount of disposables used in these events is high. An alternative for the use of disposables is of course the use of normal china, glassware and cutlery. This however needs some extra organisation. There have always been companies that provide a rental service for all materials needed with large events. Traditionally these companies focused on the market for business events, business parties and other events of more or less private nature and not on the market of public festivals. The main reason for this is that using “real” china and glassware is regarded as more luxurious but at the same time it is more vulnerable for accidents and misuse. It is also much more expensive than using throw-away plastic cups and plates. Moreover, many city

councils even prohibit the use of real glassware during these events for safety reasons. Nowadays, the use of mobile dishwashing machines is becoming more popular because of environmental reasons[34]. The problems connected to the use of "real" china and glassware mentioned above are sometimes avoided by the use of moreway plastic[35] instead of china and glass.

Effectiveness and side-effects
The amount of plastic waste caused by the use of disposable during festivities in the Brussels region is unknown. However, it is probably not a large part of the total amount of waste. Still, using alternatives for disposables during public events can give a very important signal to the local community that the government is taking the waste problems of the region very serious.

Although the magnitude is different the side-effects of introducing mobile dishwashing service in the city is similar for both types of alternatives: real china or moreway plastic. The side effects from an environmental point of view are:

1. the use of water and detergents in the process of dish washing;
2. the production of the china, glassware and plastic, since disposables are much lighter the amount of material needed in the production is much lower;
3. the transportation of the dishwasher and the china and glass to and from the location of the festivities.

There have been several studies comparing the environmental impacts of the use of throw-away plastic cups with the use of cups made of earthenware. One of the first studies (van Eijk et al., 1991)[36] compared stoneware cups with cups made from polystyrene and paper / cardboard. However, the study was not conclusive when polystyrene cups and china cups were compared. Regarding to water pollution the stoneware cup had an higher impact, independent of the number of times the cup could be reused. Regarding air emissions the cup should be used at least 1800 times before it is the better option. For energy use the number of cycles needed to beat the polystyrene cup was 640 and for waste disposal 125. However, a peer review study (van Duin & Blonk, 1992)[37] revealed that some of the assumptions and data used in the report were questionable and thus came to other conclusions. According to this peer review a stoneware cup would already be preferable after 200 cycles regarding to energy use, waste disposal and air emissions. Furthermore, it was concluded that for water emissions the stoneware cup could be equal to the plastic cup when detergents and sewer water treatment would be optimal. Since the number of cycles, in normal use, is much higher than 200, the stoneware cup was the clear winner in this study. A similar conclusion was reached in a study focusing on exergy as an environmental indicator (Cornelissen, 1997)[38] although the number of cycles needed to break-even with plastic was around 1500 in this study.

There are several reasons why the results of the studies in which coffee cups are compared cannot directly be used in the case of mobile dishwashing. First of all the case does not only consider crockery but also glassware and cutlery. Secondly transport to and from the location of the event is not included in these studies and finally the number of cycles of crockery used in festivities is probably much lower than during normal use. However a safe conclusion

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[34] http://www.capcon.de/agenda/isk/projekte/geschirrspuelmobil/index.html
http://www.geschirrmobil-verleih.de/
http://www.waca.de/de_default1.html
http://www.oekoservice.at/Geschirrmobil.htm
http://www.geschirr-mobil.de/tarife.htm
http://www.berg.net/region/wermelskirchen/freizeit/geschirr.htm
[35] e.g. http://www.waca.de/de_default1.html
[36] van Eijk, J., J.W. Nieuwenhuis, C.W. Post, J.H. de Zeeuw (1991). "Weggooien of afwassen?" een vergelijking van de milieubelasting van polystyrene, papier/karton en porselein. Publicatiereeks produktenbeleid nr. 1991/2. VROM/DGM, Den Haag.
[37] van Duin, R., H. Blonk (1992). Milieubewuster op de koffie; een levenscyclusanalyse getoetst. Bureau B&G, Rotterdam.
[38] Cornelissen R. (1997). "Thermodynamics and Sustainable Development". Proefschrift, Universiteit Twente.

would be that the number of cycles of the crockery would have to be between 200 and 1500 in order to be the better alternative from an environmental point of view. Whether this number is feasible depends very much on the nature of the event but for large outdoor public events it seems to be quite high.

The case for moreway plastic however looks a lot more promising for the mobile dishwashing option. The amount of material needed in moreway plastic glasses and china is roughly a factor ten higher than their disposable counterparts. This would mean that from a material point of view only ten cycles would be needed to reach a better environmental score. This seems quite feasible especially taking into account that the plastic items are less easily broken. However, the environmental score of the whole system is to a large extent determined by the dishwashing. This process should therefore be optimised in order to reach optimal environmental scores.

Aspects of implementation
The cost of using moreway plastic or stoneware can vary between € 1 and € 2 per set[39]. The rent of the dishwasher depends on its size (cheaper per person if bigger) and ranges from € 0.2 to € 2 per person per day[40]. Furthermore, the use of moreway plastic or earthenware also implies the need for personnel collecting empty glasses and china. The cheapest option of course is when this could be done by volunteers. An alternative for a system of control and discipline would be to introduce a deposit charge for the items used in order to stimulate people to return these items and take care of them. All in all a mobile dishwashing is certainly more expensive than using disposables. Furthermore, the use of moreway plastic needs some sort of control and/or discipline of the public in order to keep everything in one place and in one piece.

Conclusions
- Using mobile dishwashing during public events in the city will probably have a relatively small effect on the total amount of waste, but can be an important signal to the local community.
- When a choice must be made between moreway plastic and “real” china and glassware, moreway plastic is most likely preferable both from an environmental and safety point of view.
- in order to reduce the environmental side-effects of mobile dishwashing the dishwashing process should be optimised and the behaviour of the public will have to be controlled either through direct control or via a deposit system.

5.5 Examples influencing household textile waste

One example is elaborated in this section: leasing of carpets.

5.5.1 Leasing of carpets

Carpets from households probably contribute to the large garbage, which totals around 25,000 tonnes per year or 7% of the total domestic waste flow in the Brussels region. The amount of carpets ending up in the domestic waste of the Brussels region is not known. An estimate is made starting from two sides:

(1) The discarding of carpets after use causes a waste flow of 1,5 million tonnes/year in Europe[41]. If we downscale the European flow based on the number of inhabitants, taking

[39] http://www.berg.net/region/wermelskirchen/freizeit/geschirr.htm
http://www.heman.nl
[40] http://www.geschirr-mobil.de/tarife.htm
http://www.berg.net/region/wermelskirchen/freizeit/geschirr.htm

[41] http://www.tapijtnet.nl/milu/milu.html

"Europe" to be the European Union, it would be 950.000 / 375.000.000 * 1,5 million tonnes = 3800 tonnes / year for the Brussels region.

(2) In the Brussels region this waste flow is probably a part of the category "large garbage", which amounts to ca. 25000 tonnes/year. The composition of "large garbage" is not known. In the Dutch city of Amersfoort[42], 8% of the large garbage consists of "woningtextiel", which is probably mostly carpets. If we apply this percentage to the Brussels region, it would amount to 8% of 25000 tonnes = 2000 tonnes / year.
Although they are in the same order of magnitude, there is a difference between the two estimates. This may result from a number of causes, but could possibly be explained by stating that the larger figure, 3800 tonnes, includes discarded carpets from offices while the smaller figure, 2000 tonnes, does not. Discarded carpets from offices will probably be part of building and demolition waste, although this cannot be verified based on the Brussels waste statistics.

Leasing may be an interesting option, since the after-life treatment is placed in the hands of the producer. It is likely that producers will also make amendments to the earlier life-cycle stages, especially the production, in order to be able to treat discarded products more efficiently. The choice is made for carpets since leasing of carpets is an existing and viable option.

Description of the case
The carpet manufacturing industry has developed a number of initiatives to reduce the environmental pressure related to their products. Initially, improvements were made in production processes themselves, focusing on materials used for the products, the use of energy and water etc.[43]. Later, the attention has been shifting towards the other parts of the life cycle. In Europe, companies have contributed to the establishment of recycling processes for discarded carpets[44]. A large recycling plant in Germany now processes around 20 ktonnes per year[45]. Another development has been the shift from broadloom carpets to carpet tiles, making it possible to renew only the damaged parts of the floor covering. Another option is the refreshment instead of discarding of carpets[46]: if one is dissatisfied with the look of the old carpet, it can be cleaned and re-styled so it has a totally new look, without need for renewal and thus saving on waste production.

The large company Dupont was one of the first to introduce the concept of leasing instead of selling carpets[47]. The idea is that there is no demand for carpets, but for the service of floor covering, including installation, maintenance, renewal and disposal. This has had consequences for the production processes as well. The choice of materials, the development of a system for installation on all kinds of sub-floors, and the development of a recycling system for the discarded carpets are all part of this integrated floor covering system. Nowadays, other companies also have leasing schemes[48]. These schemes aim at offices, not households. Generally, there is a minimum (financial) size to the project which exceeds that of household applications. Sometimes a combination can be made with the leasing of office furniture and office equipment. In many cases there is a possibility to buy the leased carpet after a number of years of leasing at a symbolic price. If the carpet is still good, this implies some years of extra "free" use. However, in this case the disposal of the carpet will not be taken care of by the manufacturer.

[42] http://www.amersfoort.nl/intranet/amersfoort/ris/ris99/BWBS9902/b52372a.htm
[43] for example: http://www.milliken.com/environment/bargraphs.html
[44] http://www.gut-ev.de/
[45] http:/www.carpet-recycling-europe.de/
[46] http://www.millicare.com/services/earth_trash.html
[47] http://flooring.dupont.com/content/about_us/dfs01_02_03.shtml
[48] for example http://interfaceeurope.com/ , http://www.sunoffice.com/ , http://www.b2000lease.com , http://www.creativeoffice.com/environmental/green.html , http://4floors.com/services.html

In order to reduce domestic waste, the idea of leasing carpets (or floor covering in general) must be applied to households. This would imply developing new or adapted floor covering schemes that must be economically feasible on a smaller scale as well.

Effectiveness and side effects
When all households and offices would shift to leasing carpets instead of buying, the total waste flow influenced could amount to 3800 tonnes / year, and of domestic waste to 2000 tonnes / year, as very rough estimates. This does not mean that this carpet waste has disappeared. It means that instead of entering the municipal waste treatment systems, it goes back to the company. The real benefit of the measure thus depends on what the companies do with the waste carpets. Manufacturing companies have better possibilities for treating this waste, especially recycling, in-company or in carpet recycling plants. Therefore it may be expected that the leasing option will indeed reduce the amount of waste.
A positive side-effect will be that manufacturing companies, in order to streamline their services, will be inclined to avoid the use of complex materials (easier recycling) and develop more efficient installation schemes, which may result for example in less use of aggressive glues (easier collection).

A negative side-effect may be that, especially in offices, carpets will be discarded sooner. Leasing periods generally do not extend beyond a five year period. Once the leasing sum is an established part of office budgets, there is no incentive to maintain the carpet for a longer period.

If the decision is made to keep on using the carpet after the leasing period has ended, the ownership of the carpet is transferred from the manufacturer to the user. The manufacturer therefore will not collect and dispose of the carpet. Especially when such a leasing scheme is translated to households, this is likely to happen frequently. The carpets will still be usable for a number of years, that are more or less for free. The potential environmental advantage of leasing then will quickly disappear.

Aspects of implementation
For offices, the transfer from buying to leasing carpets may be both feasible and environmentally sound, provided that a large part of the carpets will be recycled. The trade-off with a possible reduction of life-span needs to be investigated further. The carpet manufacturing companies are the main actor in this case. They must provide the service and market it; there should be no need for subsidies or implementation costs for governments. The role of governmental institutions would indeed seem limited. One could think of a number of smaller options, such as

- giving the good example by shifting to leasing floor covering for governmental offices
- helping the companies promoting the idea among offices in the area
- establishing awards for waste management, such as the Waste Wise[49] and the WRAP[50] awards in the USA, which may be granted to companies offering environmentally beneficial leasing schemes. This may be an incentive for companies who want to style themselves as sustainable or caring for the environment.

For households, there appear to be some more difficulties. There are no possibilities for leasing carpets now. Leasing options would have to be designed specifically for households, with attention for a number of details, especially

- the reduced level of scale, implying further standardisation of the service
- the end-of-life treatment, which asks for much longer lease periods and – therefore – lower prices.

If these are not taken care of, leasing of carpets for households probably will not be a successful option from a waste reduction point of view. To develop household leasing schemes, companies would appear to be the principle actors again. For governmental agents a first thing to do could be to issue studies to establish the environmental benefits of leasing for households. If this seems a good idea, governments may provide incentives (taking the initiative to put this on the agenda of manufacturers, subsidies for the development of specific

[49] http://www.epa.gov/epaoswer/non-hw/reduce/wstewise/index.htm
[50] http://www.ciwmb.ca.gov/wrap/default.asp

schemes and suchlike). If not, it might be a better idea to develop collection-and-recycling schemes for waste carpets; for example to explore possibilities to establish collection by the distributor as a form of EPR, comparable to the existing scheme for washing machines: consumers have to pay a disposal fee at the purchase, in return the distributor collects the washing machine after discarding.

Leasing of carpets has specific difficulties compared to leasing of furniture and equipment. These difficulties lie in the installation and collection (much easier for furniture and equipment), but also in the possibilities of re-use. It will not be a problem to sell or lease second hand furniture[51], while it seems difficult to imagine a market for second hand floor covering. As is underpinned by the fact that leasing of furniture is possible for households[52] (aimed primarily at temporary residence), it may be that leasing schemes for other categories of goods can be established easier for households.

Conclusions

- A certain waste reduction can be expected from a change from buying to leasing of carpets. On the one hand, this is an administrative matter: household waste now is classified as industrial waste. On the other hand, there can be a real reduction of waste when leasing is followed by recycling.
- Positive side-effects may be the possible changes in production processes and use of secondary materials by the manufacturers, to enable installation, repair, collection. and processing of waste. Negative side-effects may occur as a result of a shortening of the life span. When leasing is linked to the possibility to buy after a number of years for a symbolic price, the advantage disappears since the producer is no longer responsible for the after-life treatment.
- Leasing schemes as they exist for offices are not directly suitable for households. Moreover, leasing has special problems in the case of carpets due to the installation and the absence of a second hand market. In fact, for households leasing may be more appropriate for other product groups such as furniture and (electronic) equipment.
- For reducing household carpet waste, a form of EPR may be most suitable. Consumers pay a certain amount of money at the purchase to ensure that the provider or manufacturer collects and disposes of the carpet after discarding.

5.6 More general initiatives for dematerialisation

In the previous sections, some specific cases have been treated. In this section, some initiatives on a more general level are discussed. These initiatives have nothing to do with specific waste flows or products, but may be relevant in a more general way in thinking about possibilities to reduce waste by dematerialisation. In § 5.6.1, the institution of product panels is discussed. In § 5.6.2, some remarks are made on the possibilities to dematerialise in the area of gifts and presents.

5.6.1 Product panels

Description of the case

This is not a case like the others presented in this Chapter, since it does not concern a specific waste flow, product (group) or service. Therefore, it is not possible to make estimates of the effectiveness or side-effects of such an initiative, nor of the costs and benefits.
The idea of establishing product panels is presented in the EU Green paper on Integrated Product Policy[53]. In this paper, a plea is made for the establishment of stakeholder groups to discuss product aspects. By involving other actors besides just the producers, a wider range of views and interests is represented and ideas may come up that would not occur to the producers themselves. In the EU green paper, a comparison is made to the stakeholder

[51] http://www.corporateoutfittersfurniture.com/used_furniture.htm
[52] http://www.rent-ifr.com/
[53] Commission of the European Communities: Green Paper on Integrated Product Policy. COM (2001) 68 final, Brussels, 7-2-2001.

groups participating in the Auto Oil II program[54]. This program was aimed at developing scenarios to reduce traffic emissions. The outcomes are the basis for EU legislation. Applied to product panels, the outcomes would have to lead to changes in production processes or in the design of products, or on other aspects of producer responsibility. This could be voluntary, but also as part of legislation. EU involvement in such product panels is indicated if the result could significantly contribute to EU environmental policy goals.

There are several other examples of (stakeholder) involvement, that have led to some result:

- Ecoteams: groups of consumers in a certain area, meeting regularly to create and implement ideas on sustainable life-styles. Main issues are energy and water saving, waste reduction, but also buying habits (eco-food, cotton diapers, second hand furniture and clothing, etc.). Ecoteams originate from an international initiative: the Household Eco Team Programme of the GAP (Global Action Plan)[55]. The GAP has national and regional chapters, through which people can get in contact with ecoteams in their neighbourhood. Results show that such groups do have an impact[56], although others are very sceptical about the potential on a larger scale level[57].
- Some companies involve their employees in generating ideas on how to improve the environmental performance of their plants or products. This seems to result in significant improvements[58]. The rationale behind this is that employers (1) are consumers themselves, and (2) have knowledge of the company and its processes. Companies can, and sometimes do, make this more interesting by establishing awards.

Whether or not such stakeholder groups will have tangible results is not clear beforehand. In the international research program SusHouse a methodology based on stakeholder participation is worked out. An analysis has yet to be made on the effectiveness, on three aspects: environmental performance, economic performance and acceptance[59]. A very important condition seems to be to put the right people together. In the EU Green paper it is also stressed that the goals of such groups should be clear and the tasks practical and well-described.

In the sphere of the examples presented in this report, one could imagine establishing groups to discuss leasing schemes for households. The existing schemes for offices could be a starting point, and the subject of discussion the translation to households. Consumers may identify possible difficulties and may provide insight in conditions to be met for leasing schemes to appeal to households. Manufacturers on the other hand have insight in the boundary conditions provided by production processes and economic feasibility. Distributors have specific difficulties regarding transport and collection which need to be solved. Governments could for example play a mediator role, or could issue studies on effectiveness and side-effects if called for during the groups' work.

Conclusions

Product panels may be a good platform to discuss options for dematerialisation. They may be used to generate and especially to test new initiatives. Whether or not product panels may lead to a significant reduction of household waste, cannot be concluded. There is some scepticism about what such initiatives can accomplish. However, similar initiatives of stakeholder groups have had practical results in realising environmental benefits, at least on a small scale. Including stakeholders may even be a boundary condition for acceptance of changes, whatever these may be. This role could certainly be played by product panels.

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[54] Communication from the Commission: a Review of the Auto-Oil II Program. COM (2000)626, 5-10-2000. To be found at http://europa.eu.int/eur-lex/en/com/cnc/2000/com2000_0626en01.pdf

[55] http://www2.tcd.ie/Natural_Resources/Agenda21/ng-gap.htm#int

[56] http://www.ecoteam.nl/home/body.htm, http://www.emis.vito.be/thuis/ecoteam/inleiding.htm, http://www.dse.nl/ecoteams/niebri/, http://www.awbury.org/ecoteam.html.

[57] http://www.nwo.nl/nwo/nieuws/onderzoekberichten/00maart10/content.html

[58] http://www.globalff.org/Library/Case_Studies/cat-dema.htm

[59] Quist, J.N., Ph.J. Vergragt & C.W. Young: Demand Side Innovations Towards Sustainability Using Stakeholder Workshops. Paper for 5th Int. ASEAT Conference: Demand, Markets, Users and Innovation: Sociological and Economic Approaches, 14-16 September 1999, Manchester. http://www.sushouse.tudelft.nl/wijzigen/paginas/publications.htm

5.6.2 Immaterial goods

Description of the case
Immaterial goods can be defined as goods in which the amount of material is very low compared to the price of the good. Often, such goods do not represent essential needs. These goods are either bought as presents (for oneself or someone else) or as a part of fun-shopping. The main categories of immaterial goods that fall in this definition are:

- knowledge
- entertainment
- personal care
- funding
- advice.

The category knowledge consists of goods like courses (language, patchwork, cooking, yoga, computer etc) and subscriptions to electronic journals, newspapers or other websites. In the category entertainment one can think of tickets (movies, theatre, concerts, fairs, zoo, dinners) but also downloadable software, games, video, music and books, lottery tickets, art (expensive in relation to the amount of material), e-cards, pay-tv etc. Personal care can be in the form of visits to the hairdresser, spa's, beauty centres etc. Funding may consist of donations to environmental and nature conservation organisations, human rights or aid funds etc. In the category advice one can think of clothing advisors, interior decorators, personal coaches etc. Other immaterial goods are for example pre-paid telephone card. A collection of even more items of an even less material nature like a "birdsong concert" can be found in the Consuminderkrant[60]

Effectiveness and side effects
The effectiveness of a shift to immaterial goods is difficult to quantify. The Dutch statistics indicate that in 1999 an average household spent around 18% of their income on luxury goods like cosmetics, electrical equipment, photo-camera's, clothing, house decorations, sports equipment etc. Only a part of this can be seen as the material goods that will be replaced by the immaterial goods as they are defined here. As a first rough guess, this will be in the order of 1 to 5 % of the income. A translation to the amount of materials involved and the amount of materials ending up in household waste is not attempted here. When we assume a relation between income and materials throughput, the same guess may apply here: 1 – 5% of the total waste flow.

The side effects of a shift from material to immaterial gifts will occur in the following areas:

- environmental impacts due to transport
- energy consumption
- waste and emissions on other locations
- rebound effects

In order to get to movie theatres, spa's, beauty centres, evening schools etc. people need to be transported to the locations where these events take place. For e-cards, e-journals and e-newspapers, pay-tv, etc energy is needed to feed the computers and tv-sets. During a visit to a theatre, school or zoo energy will be consumed in that location for heating, lighting and to drive the attractions. During their visit to a restaurant, movie-theatre, zoo etc. people will generate waste in these locations by eating and drinking and buying souvenirs. It is difficult to say whether or not these side-effects will outweigh the benefits of waste decrease. In some cases these side-effects will be considerable, in others negligible. How the balance will be, depends on the specific situation. If the "immaterial" alternative involves motorised travel or clearly is energy-intensive, the shift may not be beneficial. However there are many examples of immaterial goods or services not requiring travel. In these cases, the shift will not only decrease waste but also reduce energy and materials use due to the avoidance of the life-cycle of the material goods they replace.

[60] http://www.ddh.nl/nwd/2000/krant/
http://www.ddh.nl/nwd/2000/krant/pag03b.html

Aspects of implementation

The main issue related to implementation is the question how people can be motivated to spend their money on immaterial goods and gifts instead of things. This would require a shift of attitude. “Things” often imply a certain status. Especially among children, there is a large pressure to have certain fashionable things – clothes, games etc. – which is difficult to resist. In order to really make a difference, immaterial goods and services would need to be fashionable or even status symbols. A stimulus for such a change of attitude could be given by the promotion of such goods and products by the local government.

Conclusions

- The effectiveness of a shift from material to immaterial gifts is difficult to estimate. Such a shift certainly has potential to reduce waste, but it depends on the specifics how much.
- There also may be side-effects: many of the alternatives require energy and other waste streams may be generated. These side-effects are equally difficult to estimate. In general, they may be considerable in case the immaterial alternative requires motorised travel or is very energy-intensive. In other cases they will mostly be limited.
- A shift from material to immaterial goods required a shift in attitude. The local government could help by providing information and conducting campaigns.

6 Conclusions and recommendations

In the above, several options for dematerialisation are scanned on their potential for waste reduction. Together, these examples have provided a certain insight in the possibilities and also the difficulties to overcome when directing policy towards dematerialisation. In this section, some general conclusions are drawn and recommendations are made, based on the findings of the examples.

Sharing
Sharing of goods may lead to a smaller number of products being used, and therefore a smaller stock requiring a smaller inflow of new products, and generating a smaller outflow of waste. The case study worked out in the above refers to washing machines. The conclusion was that washing machines may not be a good type of product for this option. Other products such as caravans, campers, expensive do-it-yourself tools etc. may be more appropriate to share. Another type of product suitable for sharing may be newspapers and magazines. For washing machines, collection and re-use or recycling – conform to EU policy – seems to be a better option. To generalise, sharing may be a suitable option for:

- Large, long-lived and not intensively used luxury goods. These goods are too expensive to buy for most people, while sharing may be much cheaper than renting if you want to use them regularly.
- Throw-away information carriers. These products are still perfectly good after use but once used they lose their value to the owner.

Leasing and Extended Producer Responsibility
Leasing instead of buying products may decrease household waste generation if applied properly and to the right type of product / user combination. The expected environmental benefits lie mainly in the resulting Extended Producer Responsibility: by making manufacturers responsible for production, maintenance and end-of-life treatment, the incentive to design for the environment, for disassembly or for setting up recycling processes increases, resulting in a longer life span or a larger recycling percentage. Leasing of carpets, one of the cases worked out in this report, may be very useful for offices. Application for households presently appears not very useful. Other types of products, such as furniture or electronic equipment, may be more suitable for household leasing as well as office leasing. The nappy service as discussed in Section 5.2 may also be regarded as a leasing scheme. For this case, the main benefit does not seem to result from leasing, but from the shift of materials (see below); the leasing option merely serves to take away some of the discomfort for the user.
In general, leasing can be a very good option for:

- Rather expensive intensively used durable goods. Leasing provides extra services, therefore all problems that arise in the use-phase will be solved in one way or another, which is worth the extra costs for the user. Moreover it is worth the extra trouble for the producer, who can adapt both production and waste treatment processes to make repair, reuse and recycling easier.

Shift of materials
Shifting from one material to another enables to phase out applications of a certain unwanted material. Although this may indeed be environmentally beneficial, one should be aware that a material shift nearly always results in problem shifting as well. The nappy case shows this quite clearly: the waste stream of paper nappies disappears, as well as its previous life-cycle impacts, but this is replaced by environmental problems due to fertiliser and pesticide use for the production of cotton. The only exception may be digitising of information. In principle, this could save a lot of paper without negative side-effects although in practice this effect is often dampened. Shifting from material to immaterial luxury goods may cause less waste but frequently involves using more energy. A shift from one-time cardboard packaging to re-usable plastic crates also reduces waste but involves other emissions, the environmental gain being dependent on the trip rate. In this case, too, the choice must be made on a case-by-case basis. A shift of materials is therefore is beneficial:

- In all cases that the new material is causing, per functional unit, clearly less environmental pressure throughout the life cycle than the old material. This will especially

be the case for digitising information. In principle, there is no limitation regarding the groups or classes of products being suitable for this option.

Repair
Repair extends the life span of products, thereby reducing the throughput while keeping the stock intact, and therefore also reducing the waste flow. The longer the life span, the less waste is produced: doubling life span means halving waste generation. Side-effects may be expected especially in case the products involved are part of a rapidly developing and changing market, as is the case with electronic appliances. New products perform much more environmentally friendly than old ones. Keeping the old ones in use thus slows down the penetration of the environmentally friendlier alternatives. For other types of products repair may be more clearly environmentally beneficial. A major barrier is related to the cost of labour: repair is often more expensive than the purchase of a new product. The economic times are not good for repair.
From an environmental point of view, repair is a very good option for:

- Long-lived products with a stable market. Here, the life span lengthening will not cause problems with the penetration of newer and better designs.
- Relatively simple products. The repair of these products does not require great expertise and could be done by a general repair man.

Considerations for policy
All in all, dematerialisation as defined here appears to be feasible for a number of product (groups). In general, it may indeed lead to a reduction of waste streams. The examples treated in Section 5 show that sometimes a significant reduction of certain waste streams could be reached, if the change would be successful, i.e. a large fraction of the consumers will participate. Participation will be induced easier in some cases than in others. Environmental gain is just one of the considerations. For many people, user friendliness, costs and other private considerations are much more important. If there are no barriers in that way, the change will be made easier and on a larger scale. These aspects therefore need careful consideration when designing dematerialisation schemes.

Another issue to be aware of when promoting dematerialisation schemes, is the fact that in most cases there will be environmental side-effects, the extent of which is not necessarily limited. It is important that these will be specified before progressing with some or other initiative. In hardly any case it can be concluded beforehand that dematerialisation is automatically beneficial. The environmental soundness needs to be established on a case-by-case basis.

Considering all, the most promising options seem to be the ones linked to producers, either via a leasing option or via obligatory take-back as part of EPR demands. This lays responsibility at the manufacturers door, and therefore provides an incentive for design-for-recycling, as well as an incentive to work out economically feasible solutions. Some very important waste streams cannot be avoided in this manner (packaging, organic waste), for some product (group)s therefore other options are indicated.

The role of regional governments in inducing a change in consumer behaviour or consumption patterns is not automatically clear, since most of the product or service chains operate on a national or even international level. Very little can be arranged by command-and-control or in permits. Still there are some distinct possibilities to influence developments, which emerge from the fact that the local governments are closest to the citizens. The local level seems most appropriate to influence behaviour and engage a discussion with citizens. Several options of promoting dematerialisation initiatives can be thought of:

1. Generation of information: initiating studies with respect to the feasibility and environmental benefits of specific options, and introducing the results in the relevant platforms (national and international policy making, deliberations with producers / companies, information campaigns for consumers etc.).
2. Stimulating and subsidising: if certain options for dematerialisation have been established as environmentally sound, regional governments could try to stimulate these by subsidies (for example in the case of a nappy service), or by giving the good example (carpet,

furniture and office equipment leasing in government offices, the telephone book on CD-ROM).

3. Mediating: in some cases groups of stakeholders may be indicated to identify options and provide directions for sustainable production, for example the eco-teams or the product panels as mentioned in Chapter 5. Governments may play a role in establishing such groups and facilitating their functioning. The demand for environmental plans of companies may also fall within this category. Governments might emphasise the increased need to include aspects of chain management, EPR etc..
4. Initiating attractive pilot projects: an example is the case on mobile dishwashing at public events. The environmental gain may not be large in a direct sense, but it could provide an important signal to the local community. Such initiatives may pave the road towards other, more effective options.

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- Wernick, I.K., R. Herman, S. Govind & J.H. Ausubel (1996). Materialization and Dematerialization, Measures and Trends. *Daedalus* 125(3):171-198 (Summer 1996)
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Websites used for the Examples in Chapter 5

Websites example diapers and nappy services:
http://www.wageningen.nl/aktueel/luier.html
http://www.eco-babes.co.uk/, http://www.nappiewash.com.au/, http://www.kaatjekatoen.nl/, http://www.nappies.net/, http://www.naturwindeln.de/, http://www.mothernaturesdiapers.com/, http://www.cottonfresh.co.uk/
http://www.ecoline.org/verde/infobladen/35luiers.shtml
http://leden.tref.nl/~luyer/babyinfo/
http://www.realnappy.com/
http://leden.tref.nl/~luyer/babyinfo/

Website example digitised telephone books
www.telefoondiensten.be

Websites example repair of electronics

repair services for electronics (all brands): http://www.anatekcorp.com/faq/applianc.htm, http://www.edri.com/ , http://avr-services.4mg.com/service.html , http://www.deltaelectronicsw-tx.com/, http://www.approvedaudioservice.com/,
in the Netherlands: http://www.kooymans.nl/av%20reparatie.html (also sales of parts)
repair and parts for Play Stations, Game Boys etc.: http://www.vdo-specialties.com/index.htm
idem for photo camera's: http://www.midwestcamera.com/
idem for camcorders and some other appliances: http://www.pro-cam-electronics.com/
repair and sale of second hand electronics: http://avr-services.4mg.com/service.html
idem in the Netherlands: http://www.indurep.nl/indurhol.html
door to door repair service: http://members.tripod.com/~mondeo/snelservice.htm
some repair addresses in the Netherlands and Belgium:
http://www.zoeken.com/categorie/524500_1.htm
"home management" including all kinds of repair services: http://www.myhomekey.com/, http://www.servicemagic.com/servlet/CategoryServlet;jsessionid=8606%3A3b938ac7%3Abc1ae8a1b047eed?catOID=-9205&link_id=255
Website voor professional repair with repair tips: http://www.videotech.org/, http://www.repairworld.com/
Repair tips for professionals and informed users: http://www.repairfaq.org/, http://www.electronic-repair.com/tips1.htm, http://elmswood.guernsey.net/, http://www.electronix.com/,
http://www.oce.com/about/environ/environ.asp#products,
http://www.greenmarketing.com/articles/ama_Jan97.html
http://www.environment.philips.com/EcoShop/tvset.html
http://www.computer.org/proceedings/ecodesign/0007/0007toc.htm
http://a1936.g.akamai.net/7/1936/51/577d84239ab11c/www.apple.com/about/environment/design/case_study/powermac_g4.pdf

Websites example house-to-house delivery
http://www.dekruidenier.be/
http://ah-thuisservice.ah.nl/hss/shop
http://www.tesco.com/
http://www.peapod.com/fcgi-bin/gateway.fcg?006=1987
http://www.maxfoodmarket.nl/

Websites example mobile dishwashing
http://www.capcon.de/agenda/isk/projekte/geschirrspuelmobil/index.html
http://www.geschirrmobil-verleih.de/
http://www.waca.de/de_default1.html
http://www.oekoservice.at/Geschirrmobil.htm
http://www.geschirr-mobil.de/tarife.htm
http://www.berg.net/region/wermelskirchen/freizeit/geschirr.htm
http://www.waca.de/de_default1.html
http://www.berg.net/region/wermelskirchen/freizeit/geschirr.htm
http://www.heman.nl
http://www.geschirr-mobil.de/tarife.htm

Websites example carpet leasing
http://www.tapijtnet.nl/milu/milu.html
http://www.amersfoort.nl/intranet/amersfoort/ris/ris99/BWBS9902/b52372a.htm
http://www.milliken.com/environment/bargraphs.html
http://www.gut-ev.de/
http:/www.carpet-recycling-europe.de/
http://www.millicare.com/services/earth_trash.html
http://flooring.dupont.com/content/about_us/dfs01_02_03.shtml
http://interfaceeurope.com/ , http://www.sunoffice.com/ , http://www.b2000lease.com ,
http://www.creativeoffice.com/environmental/green.html , http://4floors.com/services.html
http://www.epa.gov/epaoswer/non-hw/reduce/wstewise/index.htm
http://www.ciwmb.ca.gov/wrap/default.asp
http://www.corporateoutfittersfurniture.com/used_furniture.htm
http://www.rent-ifr.com/

Websites example product panels
http://europa.eu.int/eur-lex/en/com/cnc/2000/com2000_0626en01.pdf
http://www2.tcd.ie/Natural_Resources/Agenda21/ng-gap.htm#int
http://www.ecoteam.nl/home/body.htm, http://www.emis.vito.be/thuis/ecoteam/inleiding.htm,
http://www.dse.nl/ecoteams/niebri/, http://www.awbury.org/ecoteam.html.
http://www.nwo.nl/nwo/nieuws/onderzoekberichten/00maart10/content.html
http://www.globalff.org/Library/Case_Studies/cat-dema.htm
http://www.sushouse.tudelft.nl/wijzigen/paginas/publications.htm

Websites example immaterial goods
http://www.ddh.nl/nwd/2000/krant/
http://www.ddh.nl/nwd/2000/krant/pag03b.html

Other interesting dematerialisation websites:
- Website Centre for Sustainable Design: http://www.cfsd.org.uk/events/tspd6/tspd6_3s_cases.html, http://www.cfsd.org.uk/events/tspd6/tspd6_abstracts.html
- Website Gemeente Amersfoort: http://www.amersfoort.nl/intranet/amersfoort/ris/ris99/BWBS9902/b52372a.htm
- Website Global Futures: http://www.globalff.org/Library/Case_Studies/cat-dema.htm and http://www.globalff.org/Library/Case_Studies/cat-mat.htm
- Website ID-wijk, proeftuin voor intelligente en duurzame wijken: http://www.id-wijk.nl/
- Website Ministerie voor Ruimte en Tijd: http://www.sev.nl/sev/ictwijk/boek.htm
- Website Oikos: http://www.oikos-stiftung.unisg.ch/academy/papers.htm
- Website project Sushouse: http://www.sushouse.tudelft.nl/not/frames.htm
- Website ASID (American Society of Interior Designers): http://www.asidnews.com/press.asp?article=32
- Website CEI (Competitive Enterprise Institute): http://www.cei.org/books/earthreport3.html
- Website Helsinki School of Economics and Business Administration: http://www.hkkk.fi/organisaatiot/research/programs/dema/dema2.htm
- Website AT&T: http://www.att.nl/ehs/brad/articles/dematerialization.html
- Website Rockefeller University: http://phe.rockefeller.edu/Daedalus/Demat/
- Website University of Sussex, Science and Technology Polic Research: http://www.sussex.ac.uk/spru/publications/imprint/sewps/sewp20/sewp20.html
- Website Natuur & Milieu: http://www.snm.nl/publicaties/artikelenjuni2001art.html
- Website USA EPA: http://www.epa.gov/epaoswer/non-hw/reduce/epr/products/index.html