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Waste prevention: Environmental effects and policy instruments

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ABSTRACT

Swedish waste prevention, corresponding to the outcome of US efforts in 1990-2000, would significantly reduce greenhouse gas emissions. This is primarily because of a slower growth in paper and board production. The environmental benefits of the waste prevention depend on the products and materials affected, and on the waste-prevention strategies. However, most of the benefits are likely to arise because of reduced production of materials.

Most potential policy instruments for waste prevention take effect outside the waste management sector. They include fees and regulations that make the use of materials more expensive (taxes on natural resources, expanded producer responsibility, etc.), instruments to stimulate technological development (for material efficiency, repairability, etc.), and instrument to affect consumption patterns. However, a unit-based pricing system for waste collection might also be effective.

INTRODUCTION

For the past decades Swedish waste management has focused on improving the treatment technologies and on reducing the amount of waste going to landfill. These are both positive developments from an environmental perspective (see, e.g., Tillman et al. 1991, Finnveden & Ekvall 1998, Sundqvist 2007).

Although the treatment of the waste has improved, the quantity of municipal solid waste (MSW) grows, in average by approximately 2% per year. As a result, Sweden in 2000 exceeded the EU target to stabilize the quantity on the 1985 level (300 kg/capita,yr) by over 40 % (EEA 2003, RVF 2001).

The quantities of industrial waste are much larger, but it is difficult to investigate how they change over time. SEPA (2004) compared total industrial waste quantities for the years 1998 and 2002. The quantity of mining waste fell from 64 Mtonne in 1998 to 54 Mtonne in 2002, because of reduced mining activities. The recorded quantity of other industrial waste fell from nearly 20 Mtonne to less than 19 Mtonne, but this change was not significant given the uncertainties involved.

SMED (2008) compared the waste quantities for the years 2004 and 2006. Here the recorded quantities of industrial waste, excluding mine tailings, where more than double the quantities recorded in the previous study, but this increase is probably mainly due to differences in the methodology. Most of the changes between 2004 and 2006 are also insignificant given the rather large uncertainties, and differences in methodology.

Hence, the total quantity of Swedish waste is uncertain and depends on the method for defining and recording the waste. The quantity of MSW grows steadily, however.

ENVIRONMENTAL EFFECTS OF WASTE PREVENTION

We have estimated the reductions in greenhouse gas (GHG) emissions that would result from waste prevention in Sweden (Olofsson et al. 2004, Bisaillon et al. 2008). This study includes a reference scenario (Scenario A in Figure 1), where the MSW quantity is assumed to be proportional to Personal Consumer Expenditure. Based on a prognosis by the Swedish Ministry of Finance, we assumed PCE to grow by 2% each year. The reference scenario is dominated by incineration with energy recovery.

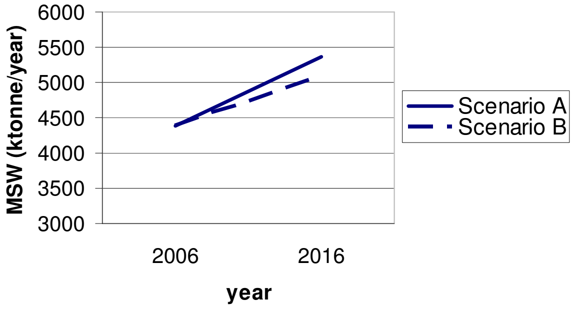

Figure 1. Swedish MSW prevention investigated by Bisaillon et al. (2008).

The study also includes a waste prevention scenario (Scenario B), where the MSW quantity is decoupled from PCE. This decoupling is assumed to be similar to the decoupling obtained in the US from the year 1990 to 2000. It reduces the growth in Swedish MSW quantity from 2% to approx. 1.5 % per year

The waste prevention assessed is the difference between Scenarios A and B. It is dominated by paper waste (newsprint, corrugated board, and office paper), but glass and metal waste is also prevented to some extent.

The waste prevention is assessed through a life cycle assessment, except that only GHG emissions are included in the analysis.

Waste prevention affects the quantity of Swedish waste collected for recycling and also the Swedish use of recycled material. Hence, the analysis requires a careful modeling of the flows of recycled material into and out from Swedish product systems. Our model applies own price elasticity of the supply of and demand for material collected for recycling, in order to account for an equilibrium between supply and demand of these materials (Ekvall 2000). As a consequence, Swedish collection for recycling offsets collection in other countries where uncollected material is deposited at landfills.

Our results indicate that the waste prevention indicated in Figure 1 reduces GHG emissions by 240-300 ktonne/yr. This is approximately the same as the total CO_2 emissions in an average Swedish municipality. Olofsson et al. (2004) conclude that waste prevention has the potential of being far more effective than material recycling in reducing GHG emissions. We believe this is the case for other emissions as well.

The environmental benefits of waste prevention stem mainly from the reduced need for production of material, virgin as well as recycling. Effects on the waste-management system itself are small in comparison (see Figure 2). This indicates that environmental policy should focus on material leanness or efficiency, i.e. on reducing the quantity of material needed to provide for a good life.

Not all waste-prevention measures increase the material efficiency. Home composting of kitchen waste, for example, reduces the waste quantity recorded in the national waste statistics, but it does not reduce the quantity of food purchased or the environmental impact of food production.

On the other hand, material efficiency can be improved without waste prevention. Reuse of returnable bottles reduces the need for glass production, but it does not count as waste prevention in the national waste statistics.

The conclusion is that material efficiency is a more adequate environmental policy objective than waste prevention.

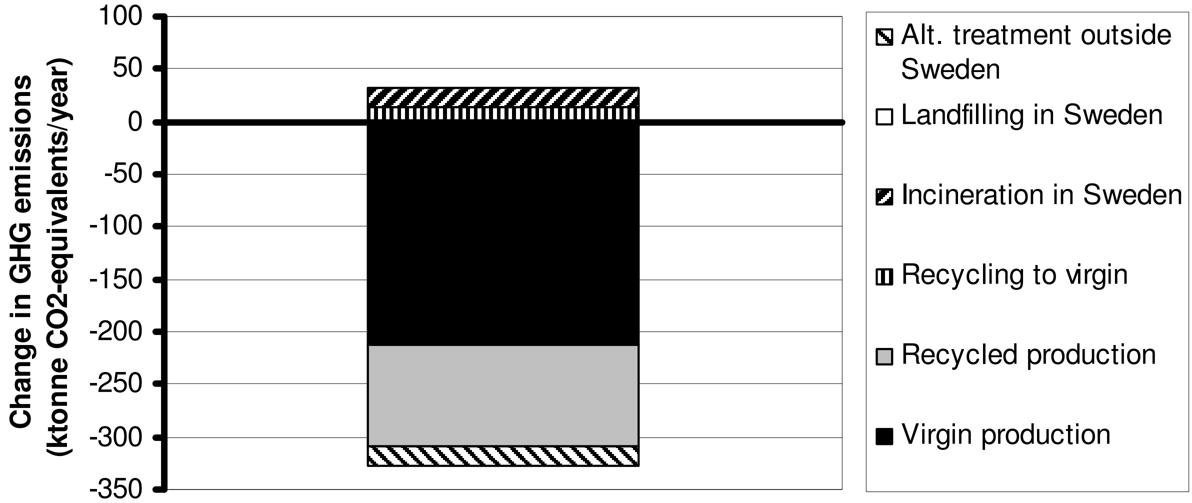

Figure 2. The effect on GHG emissions of Swedish MSW prevention in the model of Bisaillon et al. (2008).

STRATEGIES FOR MATERIAL EFFICIENCY

Material efficiency can be improved through several types of measures (see Table 1).

Material-efficient processes

Increasing the material efficiency of industrial processes reduces production waste. As an example, prefabrication of buildings and building components can increase the material efficiency significantly. When building on site, it is important not to run out of building materials. Extra material is brought to the site to be on the safe side. When the construction is completed, the remaining material becomes waste. Prefabricated buildings and building components, on the other hand, are produced in a factory. Here, the material remaining after the production of one building or component can be used in the production of next.

Increased material-efficiency reduces the raw-material cost of the industry. Often it also reduces the waste-treatment cost; however, in some cases the production waste is a by-product with an economic value, either as fuel or as raw material in other processes. It is safe to assume that the savings in raw materials is more important than the revenues from by-products in most cases. For this reason, continous improvements in material efficiency already takes place in the industry.

This is typically also good for the environment, because the impacts of producing raw materials in most cases are greater than the environmental benefits of using the by-products.

A possible exception to this rule is the by-products from forest industry and saw mills. These can be used as biofuel, possibly replacing fossil fuel. Here, an increase in material efficiency might increase the use of fossil fuel. On the other hand it reduces the growth in demand for cutting trees. If the net effect is positive or negative probably depends on the priority given to different environmental issues.

Material-efficiency of processes can be increased by the companies that use the processes, and by companies that produce the equipment for the processes. They can develop and invest in more efficient techniques, technology and processes. Increased gate fees will strengthen the economic incentive for such investments somewhat, although the cost of the raw material is probably still more important. Increased material-efficiency can perhaps also be stipulated by authorities giving environmental permits to the companies where the processes are used.

Table 1. The role of stakeholders in strategies for material efficiency.

	Industry	Households & business	Waste management sector	Authorities
Material-efficient processes	Develop and invest		Increase gate fee	Environmental permits
Material-lean products	Develop, produce, and market	Buy		Extended producer responsibility
Products with long service life	Develop, produce, and market	Buy; use for a long time		
Products that can be repaired	Develop, produce, and market	Buy; repair		Tax reductions for repair services
Second-hand trade		Buy; sell	Initiate markets	
Leasing/co-ownership		Organise; use		
Change focus of consumption	Develop, produce, and market	Develop and market; choose		Reduced taxes on salaries; Information campaigns
Change focus on consumption		Work less		Information campaigns
General			Unit-based waste collection fees	Taxes and fees on natural resources, raw materials, energy, and emissions

Material-lean products

Reducing the material content in each product reduces consumer waste, and also industrial waste when the products are used in industry. Examples on material-lean products run from nano-technological applications, over beverage cans with thinner sheets of aluminium, to small cars.

Material-lean products reduce the raw-material cost on the industry.

They are also typically good for the environment. An obvious exception from this rule is insulation materials in buildings. Here, an increased use of material reduces the energy demand of the use-phase of the building, which dominates its total environmental impact (Brunklaus & Baumann 2002). Nano-materials can also have significant and partly unknown health effects.

On the other hand, a smaller car is not only material-lean; it is also likely to be fuel-efficient, which is even more important to the environment.

To pursue the strategy of material-lean products, the industry needs to develop, produce and market such products. Consumers and other customers also have to buy them. Authorities stimulate this development through the extended producer responsibility for packagings, which makes the use of materials more expensive.

Products with long service-life

If products have a long service-life, fewer items go to waste for each time-unit of use. This reduces consumer waste, and also industrial waste when the products are used in industry.

A long service-life also means that fewer items will be sold. This is a disadvantage for the industry unless consumers are willing to pay extra for the long service life. However, individual companies can gain from producing items with a long service-life, if this makes their products more competitive.

A long service life is typically good for the environment. The exception to this rule is products with a high energy demand at use, where the energy efficiency is rapidly increasing. In such cases, it can be beneficial for the environment to switch the old equipment for new, more efficient equipment in spite of the environmental burdens associated with the additional production and waste management.

To pursue the strategy of products with a long service-life, the industry needs to develop, produce and market such products. Consumers and other customers have to buy them. They also have to keep using them for the full technological life. This requires that the products do not only have a high-quality, but also that they do not run out of fashion. Hence, an air of timelessness in the product design is an advantage for this strategy.

Products that can be repaired

Reparing a broken product prolongs its service life. This strategy has essentially the same advantages and disadvantages as products with a long service life.

To pursue the strategy of products that can be repaired, the industry needs to develop, produce and market such products, and also spare parts for the products. Consumers and other customers have to buy the products, and to repair them when they are broken. In many cases this requires that repairing businesses are established.

If repairing services were associated with the same tax reductions as services in the household, they would be more competitive compared to throwing away the broken product and buying a new. A similar, although weaker effect would be obtained if the consumption tax was reduced for repairing services.

Second-hand trade

Second-hand trade also prolongs the service life of the traded products. This strategy has essentially the advantages and disadvantages listed above for products with a long service life.

To pursue the strategy of second-hand trade, venues for such trade have to be establish and run. Such venues can have various forms: physical second-hand shops, internet sites like Blocket.se, or advertisment sections in newspapers. They can be established by, businesses, non-governmental organisations (NGOs), municipalities, etc. As an example of the latter, venues for second-hand trade have been established at the recycling centre Alelyckan in Gothenburg, Sweden (Kretsloppsparken 2008).

In addition, consumers have to use the venues for giving, selling and buying items.

Leasing/co-ownership

Car-cooperatives, car rentals, rentals of formal dresses and costumes, and co-ownership and renting of summer cottages allows for sharing each car, dress, and cottage between several persons or families. This reduces the number of items needed and the quantity of consumer waste, if compared to a situation where each family has a car and cottage and each person a formal dress.

Leasing and co-ownership takes place when it is practical and economically competitive. Consumers and rentals both benefit from this, at least at the current level of activity.

It is also good for the environment, because it reduces the number of items produced and the associated waste quantity. In addition, car-cooperatives and car rentals typically use modern cars with correspondingly modern engines and exhaust gas cleaning.

To increase leasing, rentals need to be established and/or grow. They have to market their services. Consumers and other customers need to use them.

To increase co-ownership, consumers need to initiate formal or informal cooperation.

Change focus of consumption

Buying material-lean products and products with a long technological and aestethical service-life, repairing broken products, and buying and selling second-hand products all contributes to increasing the material efficiency. Other changes in the consumption pattern can also contribute to this end. A greater focus on buying services rather than products is one example, since services tend to require less material than products. If we buy more expensive products, we cannot afford the same number of products, and this also reduces the need for materials.

Such a change in consumption is economically beneficial for industry and businesses that provide services and small and/or expensive high-quality products. It is bad for industry that produces bulky and/or cheap low-grade products.

A change into more material-efficient consumption is likely to be good for the environment, because it reduces the growth in materials production.

Changing the focus of consumption is primarily the responsibility of the consumers; however, industry and businesses also need to develop, produce, and market material-efficient services and products. In addition, authorities and NGOs can inform consumers about the environmental benefits of such services and products. Reduced taxes on salaries are likely to reduce the costs of services compared to products, since services often requires more people and less capital investments compared to production processes.

Most potential policy instruments for waste prevention take effect outside the waste management sector. Most potential policy instruments for waste prevention take effect outside the waste management sector. Most potential policy instruments for waste prevention take effect outside the waste management sector.

Change focus on consumption

The quantity of material and waste is not only related to the focus of consumption, but also to the level of consumption. If growth in consumption can be reduced without a reduction in the quality of life, this would increase the material efficiency as defined above.

Consumer earnings are used for spending or savings; however, savings allows for future spending. In the long run, consumer spending is roughly equal to consumer earnings. This means that reducing consumpton requires a reduction in the earnings. Since employees are not likely to accept lower pay per hour, the realistic way to reduce the growth in consumption is to work less hours.

Less working hours affects not only individual consumption but also the production. This reduces economic growth in the society.

The environment is likely to benefit from reduced consumption. An exception from this rule is when a new technology can replace an old technology with a greater environmental impact (for example, microwave ovens that reduce the use of less energy-efficient stoves). Buying such equipment when it is new on the market is likely to contribute to the development of this technology, making it cheaper and more likely to become widespread (Mattsson & Wene 1997).

To reduce the growth in consumption, consumers should work less hours, as discussed above. This will result in less economic wellfare but allow for more time to be spent on hobbies, friends, and family.

The percieved optimal mix of economic wellfare and leisure time depends on the priorities of the individual. Such priorities can be affected by external influence such as marketing. Industry and business have a great and legitimate economic interest in selling their products and services. As a result great amounts of money are spent on marketing that aims at increased consumption. There is no corresponding source of money for promoting increased leisure time. Due to this unbalance in promotion, there is a risk that the level of work and consumption is higher than optimal. This unbalance can be partly offset through promotion of leisure time by NGOs and authorities.

General

In addition to the policy instruments directed towards specific strategies, there are instruments that promote material efficiency in general. Taxes and fees on the extraction of natural resources, the use of raw materials, energy, and emissions all make the use of material more expensive. This should stimulate nearly all of the strategies in Table 1, with the possible exception of reducing the growth in consumption.

A unit-based waste collection fee means that consumers pay a fee that depends on the weight of the waste, on the volume of the waste containers, and/or on the rate in which the containers are emptied. This could also stimulate nearly all of the strategies in Table 1, with the exception of material-efficient processes.

WEIGHT-BASED COLLECTION FEE

Dijkgraaf (2003) compared collection fees and household waste quantities from kerbside and bring systems in 538 Dutch municipalities. The total quantity per capita was lower in municipalities with unit-base pricing, compared to municipalities with a flat fee. The reduction was 7% in municipalities where the fee depended on bin size. It was 21% lower where the fee depended on both bin size and collection rate. But the greatest impact was found in municipalities where the fee was based on the weight of the unsorted waste. Here, the recorded waste quantity per capita was 38% lower, compared to municipalities with a flat fee. In addition, the sorting of waste was higher in these municipalities, which means the reduction in residual waste was even greater.

Similar results can be found in individual Swedish municipalities. As a weight-based fee was introduced, the quantity of residual waste was reduced by 30% in Eda, 50% in Varberg (Bartelings & Sterner 1999), and 50% in Bjuv (Dahlén et al. 2007). Increased sorting and recycling could explain only a small part of this reduction, at least in Bjuv.

Dahlén & Lagerkvist (2008) investigated the effects of a weight-based fee through comparison of the household waste quantities in 240 Swedish municipalities. A weight-based fee had been introduced in 26 of these. Here, 20% less household waste per capita was collected, compared to other municipalities. However, with some surprise the authors noted that the rate of collection for recycling was not significantly higher in municipalities with a weight-based fee.

There are several possible explanations to why the total recorded household waste quantity (collected through kerbside and bring systems) is lower in municipalities with a wieght-based fee. Home composting of garden and food waste might increase. Food waste is otherwise a heavy component in residual household waste.

The households might transport more waste to the municipal waste centrals.

More waste might be burned in fireplaces or even in bins in the garden. Increased illegal combustion was documented as a weight-based fee was introduced in Clonakilty, Ireland (Scott & Watson 2006).

More garden waste and other types of waste might be deposited in nearby forests or other inapropriate places.

And consumers might consider the possibility to reuse food leftovers, packagings, used products etc. Such actions would increase the material efficiency, and reduce the growth in waste quantities as well as the production of materials and the associated environmental impacts.

CONCLUSIONS

The quantity of Swedish MSW grows steadily, but the total quantity of Swedish waste is uncertain and depends on the method for defining and recording the waste.

Material efficiency is a more adequate environmental policy objective than waste prevention, since most of the environmental benefits from waste prevention stems from the reduced need to produce materials (see Figure 2).

Material efficiency can be improved through several types of strategies (see Table 1).

Most potential policy instruments for waste prevention take effect outside the waste management sector; however, introducing a weight-based fee for waste collection might also be effective.

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