

# Household sorting of waste at source\*

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*How much time and energy are used to sort household waste, and should the time spent on sorting be taken into account? We asked a random sample of the Norwegian population about their waste sorting activities. Nine out of ten reported that they sort at least one type of waste, and on average, each of those asked reported that they use close to a half an hour a week for sorting. Four out of ten reported that they use hot water to clean the materials. On average, they are willing to pay NOK 176 a year so that others can do the sorting for them. And even though some perceive the activity as a mandatory requirement, moral motives for sorting at source are also widespread.*

## 1. Introduction

The Norwegian government has stated as an objective that at least 75 per cent of the waste in Norway shall be recycled or energy recovered by the year 2010 (Report no. 8 to the Storting, 1999-2000). This increased reliance on recycling implies more sorting of different waste components by households.

Households already sort a large amount of waste. We wash mackerel tins, fold milk cartons and carry jam jars to the recycling collection container on the street corner. The share of household waste that was delivered for material recovery increased from 8 to 33 per cent from 1992 to 1998 (Statistics Norway 2000). The systems for collecting and treating sorted household waste have been expanded, but opinions are still divided concerning the environmental effect. The actual size of the additional costs of increased sorting at the source is also unclear, and it is uncertain to what extent households actually perceive their contribution as a cost.

In an analysis of the social costs of waste treatment, a value was placed on the time households spend on sorting waste (Bruvoll 1998). The value constituted a substantial share of the total costs of material recovery. This gave rise to a debate on the valuation of households' use of time. It was maintained that "households' work on sorting is put at a very high

cost" (Holm 1998), that "many households may consider sorting to be so meaningful that it would be unreasonable to place a cost on it at all" (Kronen 1998), and that one must "question how real this cost is (...) both because the time spent on it is very low per day and because the activity is voluntary" (Hanssen and Magnussen 1998).

Against the background of this discussion, it is useful to find out more about the extent of the time spent on sorting and households' attitudes towards this time use. In this article, we present the results from a survey asking the respondents about the extent of and attitudes towards their own waste sorting activities. Data from surveys will always be associated with some methodological problems. However, if we wish to obtain a picture of households' contribution, we must either resort to surveys or to laboratory experiments. So far, very little information about households' waste sorting activities has been available.

The data presented in this article was collected by Statistics Norway's Omnibus Survey, conducted in November and December 1999. The Omnibus Survey includes routine questions about several background variables such as age, gender, family status, income, etc. In addition, commissioned questions are included. In this survey, the respondents were asked questions concerning their attitudes towards source separation (as reported here), smoking and communal work. A sample of 2,000 respondents in the age group 16-79 years were drawn from the Norwegian population in two stages, in accordance with Statistics Norway's standard sampling procedure. The net sample, for which we report the results, consists of 1,162 respondents, i.e. the response rate was slightly less than 60 per cent. For 76 per cent of the sample, the respondents were interviewed in person in their

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own home, while the remainders of the interviews were conducted by telephone.

In interpreting the results below, one should bear in mind that there are several possible sources of errors in surveys like this one. In our case, *interviewer bias* may for example be of importance; i.e. respondents may exaggerate their recycling efforts in order to please the interviewer. Also, it is possible that recycling efforts are different among those who refused to participate in our study than among our actual respondents.

In the following, we discuss the time use, the extent of waste cleaning and use of energy in cleaning the waste in households. Then, we shed some light on the motivation behind waste sorting and to what extent the work is perceived as a burden by the households. We also present figures on the stated willingness to pay in Norwegian households for others to handle the sorting for them. Finally, conclusions from the analysis are drawn and some concluding remarks are made.

## 2. Time and energy use

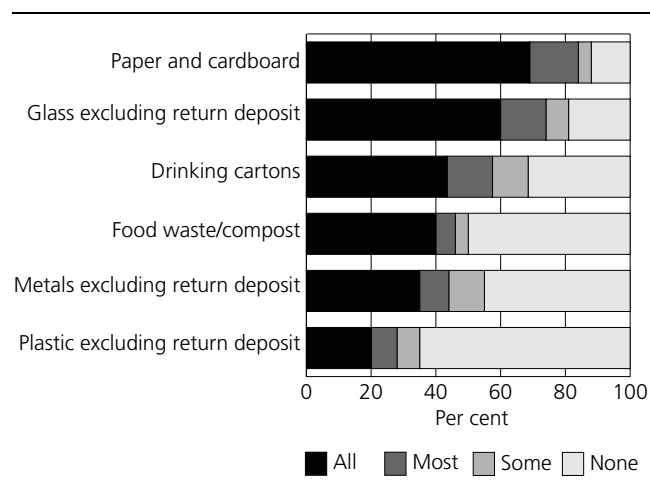
In the survey, 93 per cent reported that they sort waste, at least to some extent. In figure 1, we have plotted the percentage of the sample that reported that they sort all, most, some or none of paper, cardboard, glass, metal and plastic. The figure shows that the effort varies between different waste groups. This is not surprising since the scale and quality of the collection systems vary between the groups. Most respondents reported either to sort all or none of each waste group. Far fewer stated that they sort most or some. This may indicate that most people use rules of thumb concerning how to handle household waste. We see that sorting of paper, cardboard and glass is most widespread. 60-70 per cent reported that they sort all of this waste. Least widespread is the sorting of metal and plastic.<sup>1</sup>

The responses presented in figure 1 are relatively high compared to the waste quantities actually collected from households and in relation to the return schemes that exist. For example, in 1998, collection schemes for sorted plastic waste were only available to about 10 per cent of households.<sup>2</sup> One possible explanation for this may be that the respondents have not taken into account that the return of beverage containers for their deposit was not to be included in the time used for sorting plastic, metal and glass.

### 2.1. Time-use for waste sorting

Figure 1 provides no information on the amount of time used for sorting waste in the households. However, we also asked the respondents how much extra

**Figure 1. Share reporting that they sorted all, most, some or none of the various waste types. Per cent of all asked**



Source: Omnibus Survey fourth quarter 1999, Statistics Norway

**Table 1. Time spent on sorting waste. Minutes per week per person and hours per year per household. Average**

How many minutes extra do you on average use per week for ...	Average for those who sort	Average for entire sample
... cleaning sorted waste	9	9
... folding, sorting and carrying sorted household waste	14	13
... transporting sorted waste to central depot. Disregard return deposit	7	6
Total	30	28
Total time spent per household per year in hours	44	41

Number of respondents: 1084 (those who source separate) and 1162 (entire sample)  
Source: Omnibus Survey fourth quarter 1999, Statistics Norway.

time they used on different sorting activities. Table 1 shows the average time used per person, both for the entire sample and for only those respondents that reported to recycle. Respondents who sort their household waste report that they use 30 minutes a week doing this. Of this time, 9 minutes are used for washing the items, 14 minutes for folding milk cartons, sorting and carrying materials, and 7 minutes for transporting the sorted recyclables to a central reception depot.

If we calculate the average use of time for the entire sample, i.e. including the 7 per cent who do not recycle, each person uses an average of 28 minutes a week for sorting at the source. Our survey comprised only adults, and the question related to one's own sorting, not the total contribution in the household. If we assume an average of 1.7 adults in each house-

<sup>1</sup> Here we do not include the return deposit, as for example for soft drink bottles and beer cans.

<sup>2</sup> Figures for 1999 are not yet available.

hold<sup>3</sup> and that all sorting in the household is performed by adults, the total figure in table 1 will correspond to an average use of time per household that sorts of 44 hours a year.

In order to see the contribution in connection with the government's aims on household recycling and the usefulness of the contribution, we have calculated the time-use per tonne of sorted waste. Some materials take a considerably longer time to sort per tonne than others. For example, it takes more time to wash and sort a kilo of milk cartons than to sort a kilo of newspapers. However, we do not have detailed information on how much time is used for each waste type. Thus, we have to calculate an average for all waste that is sorted. If we assume that our survey is representative of the adult population, we can distribute the time-use on the 452,000 tonnes of household waste delivered for material recovery by Norwegian households (Statistics Norway 2000). Then, irrespective of fraction, an average of about 185 hours is used per tonne of sorted household waste.

### **Is the reported use of time high?**

How does the reported time-use compare to the results from other studies? The average 22 minutes weekly per person for cleaning, folding, sorting and carrying waste (see the first two lines of table 1) can be seen in relation to figures from Statistics Norway's Time Budget Survey in 1990-1991 (Statistics Norway 1992). In this survey, each person reported to use an average of 5 hours weekly washing dishes, cleaning and tidying the home. If we assume that the time spent on housework has remained approximately unchanged during the 1990s, it may imply that the time spent on sorting waste is equivalent to between 5 and 10 per cent of total time spent on housework, which may appear high. (Time spent on transporting waste to central reception depots comes in addition to the above figures.) There is some evidence in the literature that direct questions of the type we have asked may result in over-reporting in relation to data collected using time journals as used in the Time Budget Surveys (Marini and Shelton 1993), which is considered a more precise method.

The Swedish Consumer Agency (1997) found in a laboratory experiment that the cleaning of all packaging waste in a household during one week involves an average time-use of 22 minutes. In our data, 73 per cent of respondents who source separate reported to clean the waste, using an average of 14 minutes for this activity. If we assume that there are an average of

1.7 adults in each household, and that only adults are doing the source separation, then each household that cleans waste uses an average 23 minutes weekly on this activity. This is not much different from the Swedish Consumer Agency's figure of 22 minutes. However, the average Norwegian household consists of only 2.2 persons, whereas the Swedish Consumer Agency's test was based on a household of four persons. Our figures may thus be high compared to the Swedish Consumer Agency's estimate.

### **2.2. Use of energy washing waste**

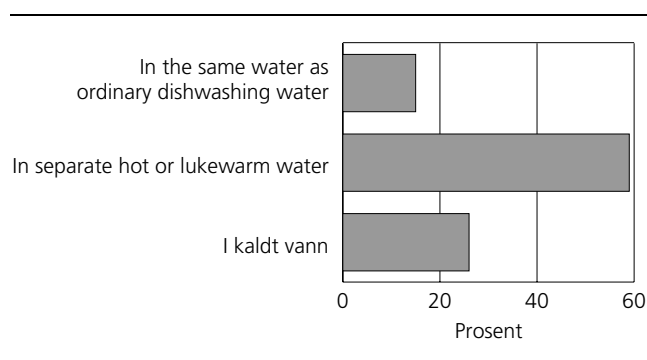
As previously noted, 73 per cent of the respondents sorting at the source report that they clean the waste. Of these respondents, almost 60 per cent use separate hot or lukewarm water (see figure 2). Respondents who state that they wash in hot/warm water use four minutes more weekly on cleaning waste than respondents who use cold water or the same water as for washing dishes. This results in higher energy use and expenditures for the household as well as higher costs associated with the use of water.

We have not asked respondents to estimate how much water they use cleaning waste. In the Swedish Consumer Agency's experiment, 22 minutes and 50 litres of water were used per week. If we assume that the relationship between time and water use to be the same as in the Swedish Consumer Agency's laboratory experiment, we can estimate energy and water consumption in washing recyclables. Using this ratio, we have estimated that households who clean materials in hot or warm water use 3.1 m<sup>3</sup> of hot water a year. Assuming the water to be heated by 35 degrees C, this corresponds to an annual consumption of electricity of 126 kWh. This amounts to an annual increase in electricity expenditures of NOK 63<sup>4</sup> for households cleaning waste in hot or warm water, assuming the electricity price to be NOK 0,5 per kWh (including taxes). If our results are representative for the Norwegian population, the total electricity consumption for washing sorted waste in Norwegian households will be approximately 100 GWh per year. This energy volume represents 0.3 per cent of total electricity consumption in Norwegian households, or half the amount of electricity to be produced at the proposed development of the Beiarn watercourse in Nordland County. If we assume the same relationship between water consumption and time use as above, households that wash waste in cold water use on average 2.5 m<sup>3</sup> a year.<sup>5</sup>

3 This was the average number of adults per household in Norway in 1999.

4 NOK 1 ≈ US\$ 0,11.

5 The Norwegian National Health Association states that the average fee paid by households for water consumption is NOK 6.35 per m<sup>3</sup> (excluding VAT). This includes both consumption-dependent and fixed charges, and therefore does not necessarily indicate households' extra costs for higher water consumption. Nor does it necessarily indicate the marginal costs of waterworks for obtaining extra water for consumers because the fees shall cover both fixed and variable costs.

**Figure 2. Cleaning waste. Per cent of those who report that they clean waste for sorting**

Source: Omnibus Survey fourth quarter 1999, Statistics Norway.

So far, we have *only* calculated the use of water for respondents who wash their waste and the use of energy for respondents who wash in separate hot or warm water. Many respondents, however, do not wash the waste, and only a share of those who do clean the materials in hot or warm water. In the first column of table 2, we have calculated the average contribution to sorting at the source for *all* households in the sample, i.e. including those who do not sort at all. The second column shows the estimated contribution per tonne of waste recycled. Here, we assume that households sort an average of 221 kilos of waste per year, which was the average quantity of household waste delivered for material recovery per household in 1998 (Statistics Norway 2000). Applying this, we estimate the use of energy at about 220 kWh per tonne of waste, valued at about NOK 110 (including taxes), and water consumption at 7.3 m<sup>3</sup> per tonne of material recovered.

It is important to note that the numbers presented in the second column of table 2 are averages per tonne of *total sorted waste quantities*. The use of energy is distributed on all household waste delivered for material recovery, including newspapers, food and garden waste and textiles. Cartons, plastic, glass and metals, which account for the bulk of the waste that is washed in households, account for less than 10 per cent of the delivered household waste. Both time use and energy use per tonne are therefore higher for the waste types that are washed and less, or zero, for other types of waste.

### 2.3. Use of energy transporting sorted waste

Respondents who source separate state that they use an average of 7 minutes weekly transporting the sorted waste to a central reception depot (see table 1). It is reasonable to assume that a part of this time is used for driving, but how much is not revealed by our data. For the sake of comparison, we can illustrate the use of energy transporting the sorted waste by the petrol use per minute of driving. If we assume

**Table 2. Households' sorting activities<sup>1</sup>. Estimates. Average for all households and per tonne sorted waste**

Contribution	Average per household	Per tonne waste
Total use of time	41 hours	186 hours
Energy use, washing waste	48 kWh NOK 24	218 kWh NOK 110
Water consumption	1.6 m <sup>3</sup>	7.3 m <sup>3</sup>

<sup>1</sup> Important assumptions:

- an average 1.7 persons who sort waste in each household.
- same relationship between use of time and water as in Swedish Consumer Agency (1997).

Source: Omnibus Survey fourth quarter 1999, Statistics Norway

an average speed of 40 km/h and a fuel consumption of 0.9 litres of petrol per 10 km, one minute of weekly driving corresponds to three litres of petrol a year per household. This amounts to approximately NOK 30 a year if we assume a petrol price of NOK 10 per litre. This corresponds to a cost of NOK 140 per tonne waste for each additional minute of weekly driving per household.

### 2.4 Sources of uncertainty

When drawing conclusions about an entire population based on a sample of respondents, there are several sources of uncertainty. In addition to the sources resulting from the procedure of sampling found in all surveys,<sup>6</sup> some are particular to our survey. Some respondents may want to appear more positive towards waste sorting than they actually are. If this is the case, the reported contribution in the sample is higher and the reported attitudes towards sorting are more positive than is the case in the population in general. There is also a tendency to over-estimate the time used for boring activities, such as housework, in surveys. This may result in too-high figures on the time used for sorting.

In addition, several of the questions may have been difficult to answer for the respondents. First, it may be difficult to have a clear picture of the time used for waste management compared to the time use if one did not sort at source. Second, studies have demonstrated that respondents often have problems remembering how much time they used on activities not clearly distinguished from other daily chores. This may make it difficult to separate the time used for sorting from the time used for other housework, for example preparing dinner or house cleaning. Third, sorting is an activity that takes place frequently, but which does not take very long each time. It may therefore be difficult to estimate the weekly time-use with sufficient precision. In the data we also find that many respondents report "round" figures like 5, 10 or

6 See e.g. Bhattacharyya and Johnson (1977), Ch. 16, for more information.

**Table 3. Motives for sorting waste among those who report sorting in the sample. Per cent figures add up to 100 for each of the statements (deviations due to rounding)**

I sort partly because	Agree	Partly agree	Partly disagree	Disagree	Don't know
I perceive it as a requirement imposed by the authorities	38	25	11	26	1
It is a pleasant activity in itself	16	22	18	44	1
I want to contribute to a better environment	86	11	2	1	1
I want to think of myself as a responsible person	42	31	8	18	1
I should do what I want others to do	65	23	5	6	1
I want others to think of me as a responsible person	22	19	12	46	2

Number of respondents: 1102 (excluding those who do not sort at the source).  
Source: Omnibus Survey fourth quarter 1999, Statistics Norway.

15 minutes per week for each activity, which indicate that the responses are rough estimates. This uncertainty may, for example, result in too high figures if the respondents have a tendency to round off the time estimates upwards.<sup>7</sup>

### 3. Why do we sort at the source?

As noted in the introduction, it is questionable whether time use for sorting household waste represents a cost for the society when we take into account that sorting is voluntary and that many perceive it as a meaningful task. In order to gain some insight into how households look upon their own contribution, we asked some questions to capture the motives that people have for source separation. We presented the respondents six different assertions and asked them to specify to what extent they agreed with these assertions. The assertions do not provide an exhaustive picture of the existing motives, and there may be motives other than those mentioned. The assertions mentioned were chosen to test some assumptions that figure prominently in the literature.

In table 3, we show the share of respondents sorting at the source who agreed, partly agreed, partly disagreed or totally disagreed with some assertions as to why they sort waste.<sup>8</sup> In the following, we comment on some of these motives in further detail.

#### 3.1. Because we feel it is mandatory?

Pursuant to the Norwegian Pollution Control Act, municipalities can require that households sort their waste, and can impose fines when this is violated. However, as far as we know, this is not common in practice. Nevertheless, a fairly high percentage of our respondents perceive sorting of household waste as a

mandatory requirement. Table 3 shows that 63 per cent of respondents who sort at the source entirely or partly agreed that they perceive sorting as a requirement imposed by the authorities. About a fourth entirely disagreed that sorting was based on a requirement imposed by the local government.

If a mandatory requirement is the most important motivation factor, we would expect to find that respondents who perceive sorting as voluntary are sorting less than others. We found, however, that respondents who entirely disagreed that they sort because it is required by the authorities use almost as much time sorting waste as others do. They sort just as much paper, drinking cartons and glass, which are the waste types for which collection systems are most widespread. However, they report that they sort somewhat less food waste, plastic and metals than others do. One interpretation of this is that most people are willing to sort some waste on a voluntary basis, but that the willingness to sort declines when sorting is expanded to include many types of waste.

#### 3.2. Because we think sorting is a pleasant activity?

It is not obvious that everyone perceives sorting as a burden. Our survey shows that 38 per cent of the respondents who sort, entirely or partly agreed that sorting is a pleasant activity in itself (see table 3). Those who agreed with this sort waste somewhat more than others, and this applies to all waste types. More than half of the respondents who entirely agreed that sorting is a pleasant activity would prefer to sort themselves even if a firm could take over this activity for them at no extra cost. Of those who entirely disagreed that sorting is a pleasant activity, only 14 per cent replied that they would prefer to sort themselves.

7 For more information about distortions in surveys on the use of time, see Marini and Shelton (1993), Niemi (1993), Press and Townsley (1998) and Robinson and Godbey (1997).

8 In addition to the motives mentioned in table 3, it is well known that economic incentives, such as taxes on residual waste, encourage increased sorting at source (see, for example, Sterner and Bartelings 1999). In almost half of the Norwegian municipalities subscribers can reduce the waste fee by choosing between refuse collection services and those who deliver little waste will often choose the less expensive arrangements. The lottery that is held by Norsk Returkartong, where sorted cartons are drawn and the owner of the carton can win up to NOK 1 million, has proved to be effective for encouraging the sorting of drinking cartons. In addition to the possibility of winning money, people can experience a sense of excitement associated with the possibility of winning money. Our survey, however, provides no information on how important these motives are for our sample.

Nevertheless, most do not share the view that they sort partly because it is a pleasant activity as 62 per cent entirely or partly disagreed with this assertion.

A fourth of the respondents neither agreed that they sort because it is required nor because it is a pleasant activity. Why do they spend time sorting waste? We shall now look more closely at other motives that can contribute to explaining the participation.

### 3.3. Wanting a good environment

Environmental considerations represent the most obvious reason for sorting at the source. In our survey, 97 per cent of respondents who sort at the source entirely or partly agreed that they did this partly because they wanted to contribute to a better environment. A better environment may be considered desirable both for one's own sake or because others, for example, future generations, will benefit from it.

We also asked the sample to what extent they *believed* that sorting at the source contributes to a better environment. 85 per cent answered yes, while the remainder answered no or was uncertain. A lack of faith in environmental effects reduces sorting activities. Even so, most of respondents who did not believe in environmental effects also sort. More of the respondents who do not think it has environmental effects, sort because they perceive it as a mandatory requirement imposed by the government. As many as 72 per cent of these respondents entirely or partly agreed with this.

Making a considerable effort to benefit the environment will result in a noticeable cost for the individual in the form of time and energy, while the environmental gain of an individual's effort will barely be noticed, either for oneself or others. A person who is *concerned* about the environment will therefore not necessarily *contribute* to a better environment. As we refer to below, most people are not only interested in promoting a good environment but are also concerned about their own role. We shall discuss two variants of this type of motivation: *the pleasure of giving* and *moral responsibility*. These motives share many features, but provide different conclusions to the question of to what extent voluntary sorting at the source is to be considered a social cost.

### 3.4. The pleasure of giving

Andreoni (1990) suggested that voluntary efforts that benefit society can be explained by people's desire to feel the "warm glow of giving". The pleasure of giving may mean that the effort is worth the trouble for the individual even though the environmental effects of one's own effort is negligible. For a person who is primarily looking for the pleasure of giving, it will be an advantage if the authorities have plans for expanding household sorting arrangements, as long as this is voluntary. If, for example, containers for plastic waste are placed in each household, a small dose of

**Table 4. Attitudes towards an expanded sorting system**

Assume that the municipality expands the sorting system for households. Sorting is voluntary.	
Which of these statements do you agree with most?	Per cent
It is good that we take greater account of the environment, but for me personally it is a disadvantage that an even greater contribution is expected	26
It is good that we take greater account of the environment, and for me personally it is an advantage that I can increase my contribution	40
It wouldn't mean anything for me	34
Don't know	1

Number of respondents: 990.

Source: Omnibus Survey fourth quarter 1999, Statistics Norway.

good conscience can be felt simply by putting a bit of plastic into the container, while previously it was necessary to travel to the closest central collection depot.

In our survey, 40 per cent reported that it would be a personal advantage if the municipality expanded the arrangements for sorting by households (see table 4). It is thus conceivable that these responses were motivated by the pleasure of giving. In these questions, it was assumed that sorting at the source was good for the environment. It is difficult to imagine that the pleasure of giving motivation could be maintained if households stopped believing that sorting at the source has a positive environmental impact. If perceptions concerning this point were to change substantially, people's motivation must therefore also be expected to change.

### 3.5. Moral responsibility

Table 4 also shows that 26 per cent of those asked would consider an increase in arrangements for sorting at the source as a personal disadvantage even though the question specified that sorting was voluntary. It is conceivable that sorting is perceived as a duty even when it is not directly required by the authorities. One possibility is that people impose *moral requirements* on themselves. Many wish to look upon themselves as morally responsible individuals and, if necessary, are willing to sacrifice something to achieve it. In our survey, as many as 73 per cent entirely or partly agreed that they sorted because they wanted to think of themselves as responsible (see table 3).

Maintaining a self-image as morally responsible probably requires a genuine desire to do what one considers the right thing, such as making one's contribution to the work on improving the environment. A change in government policy can change people's perception of the individual's responsibility. Expanded arrangements for source separation in households may therefore entail stricter requirements which people impose on themselves if they are to continue

to consider themselves morally responsible. In isolation, this will be a disadvantage for the individual. On the other hand, expanded sorting arrangements may make the actual sorting process simpler so that people can sort more and feel even more responsible than before without using more time. We can therefore not say with certainty what people who are driven by their own moral requirements would have answered to the question in table 4. This is further analysed in Brekke et al. (2000).

In our survey, as many as 88 per cent entirely or partly agreed that they sorted partly because "I should do what I want others to do" (see table 3). This may be interpreted as a moral requirement people impose on themselves, cf. the simple golden rule. We find it reasonable to conclude that a feeling of moral responsibility is a widespread motive for household sorting.

### 3.6. Social acceptance

It is also conceivable that some feel that their standing among family members, neighbours and friends will diminish if they do not comply with the authorities' programme for sorting at home. An expanded system for sorting may then increase the requirements people feel that they must satisfy in order to gain the neighbour's acceptance. In that case it would, in isolation, be a disadvantage for the individual when the system is expanded. 41 per cent of those asked in our survey reported that they recycled partly because they wanted *others* to look upon them as socially responsible people (entirely or partly agreed, table 3).

### 3.7. Which motives entail a social cost?

Cost benefit analysis is a way of summarizing advantages and disadvantages of a political measure. It does, however, not provide a politically neutral answer to what is best for society. Considering sorting at the source to be a *social cost* in such an analysis is the same as saying that one believes that the effort represents a disadvantage for those who contribute, irrespective of the environmental consequences that are to be included. Since the various motives discussed above entail varying degrees of disadvantage, the motives underlying the contribution will also be of importance as to what extent the contribution represents a social cost and the possible size of this cost.

Many perceive sorting at the source as a mandatory requirement imposed by the authorities. This implies that the effort should be considered a cost for these respondents. There are also many indications that some respondents recycle on the basis of moral requirements they impose on themselves or because they feel a social pressure. For these people, extended recycling systems for households may be perceived as a requirement even though this requirement is not directly imposed by the authorities. In such cases it is also reasonable that the contribution represents a

social cost, although here there is room for more uncertainty than in the case of direct requirements.

On the other hand, there are some who report that they think sorting at the source is a pleasant activity in itself or who seem to be motivated by the pleasure of giving. For these respondents, source separation may represent a positive element in everyday life, and then the contribution should be considered a net social *gain*.

## 4. Would we prefer not to sort at the source?

Most respondents in our survey join several different motives. It is therefore difficult to draw clear-cut conclusions concerning the social value of households' waste sorting efforts on a purely theoretical basis. It is too simplistic to assert that sorting at the source is always regarded as compulsory, or to assert that sorting at source is always performed with pleasure. In order to indicate whether people experience their own effort as a personal disadvantage when we disregard the environmental gain from the effort, we asked the respondents several questions concerning their attitude towards and willingness to pay for others undertaking the sorting for them.

### 4.1. Attitude towards leaving the sorting to others

First, we asked the following question: "*Assume that a recycling company can make use of your waste. New technology makes it possible to sort waste centrally so that the environmental effect will be the same. The company collects the unsorted waste from your home. Would you make use of the offer if this did not increase your expenses, or would you prefer to sort yourself?*"

The question was asked all respondents who reported that they sorted waste at source. 72 per cent replied that they would make use of the offer, while 27 per cent would prefer to sort themselves. This indicates that the actual process of sorting is perceived as a burden for most people – but not for everyone. Among those who prefer to sort themselves, 60 per cent entirely or partly agreed that sorting was a pleasant activity, whereas only 31 per cent of those who would accept the offer agreed with this. It is, however, not certain that all respondents who reported that they would prefer to handle the sorting themselves really understood that the environmental effect was assumed to remain unchanged. If this is the case, they might want to continue sorting themselves in order to ensure a better environment. Moreover, some respondents may not perceive the offer as sufficiently credible, because in practise it is hardly feasible to sort in this way with satisfactory quality without substantial additional costs.

### 4.2. Willingness to pay to leave sorting to others

We also asked the respondents who agreed to the offer about their maximum willingness to pay for this

sorting system where a company takes over the sorting of all waste delivered from the household. The willingness to pay provides an indication of to what extent sorting at source is perceived as a cost for the household, and the size of this cost in money terms. The respondents were not asked directly about the value of the time spent on sorting. There are factors other than time and energy use for sorting that influence willingness to pay. For example, some respondents may be willing to pay to prevent having drinking cartons lying upside down to dry on the sink. Moreover, some respondents may answer what they think is a reasonable or fair price rather than giving an estimate of what the good or service is worth to them (see Kahnemann et al. 1986). Willingness to pay should therefore not be interpreted as a precise measure, but rather as an indication of the disadvantages of the time and energy used by households.

Of the respondents who would accept the offer, 35 per cent had a willingness to pay equal to 0, while 6 per cent were willing to pay more than NOK 1 000 a year. On average, the willingness to pay was NOK 243 a year among those respondents who would make use of the arrangement. At the same time, 27 per cent of the entire sample stated that they preferred to sort waste themselves. The latter were not asked the willingness to pay question. If we assume that respondents who will not accept the offer of free sorting are also unwilling to pay for it, the average willingness to pay for all respondents who sort at source is NOK 176 a year. Given the way the question was asked, it is reasonable to interpret this as willingness to pay per household, not per person.<sup>9</sup>

#### 4.3. Willingness to pay per tonne

If we compare the reported willingness to pay with the quantities, assuming that each household delivers an average 221 kilo sorted waste per year (the average in 1998, see Statistics Norway 2000), this results in a willingness to pay of about NOK 800 per tonne sorted waste. If we deduct the estimated costs for heating water (see table 2), willingness to pay is about NOK 690 per tonne sorted waste. This is slightly lower than households' time cost estimates used in Bruvoll (1998), but still within the margins of uncertainty in this analysis.<sup>10</sup>

#### 4.4. Willingness to pay per hour

Compared with the time spent on sorting reported by the respondents, the willingness to pay per hour is

relatively low. If we deduct the costs of higher electricity expenses, and adjust for the fact that willingness to pay is per household while the time used is per person, average willingness to pay for having the sorting done by others is only about NOK 3.50 per hour. This is a substantially lower valuation than NOK 53 per hour, which is the social value per hour of sorting work that was assumed in Bruvoll (1998). Bruvoll used the average hourly wages after tax as an estimate for the value of time used for leisure activities (see the Cost Calculation Committee 1997, 1998 for a more detailed discussion of the principles for the valuation of time). This must, however, be seen in connection with the time spent on sorting reported by our respondents which, as noted, seems to be fairly high.

However, there are considerable differences between respondents in the sample with regard to willingness to pay per hour. There is a clear tendency that respondents who use little time on sorting have a higher willingness to pay per hour than respondents who use considerable time. If, for example, we only look at households that use five hours or less on sorting per year, the average willingness to pay per hour is as high as NOK 173.<sup>11</sup>

We would initially expect that respondents who feel that time spent on sorting is not a great burden sort more than others. One interpretation of this result is that the social cost per hour of sorting at source is relatively low as long as the sorting activity is considered voluntary. Those who find that the effort has considerable disadvantages simply refrain from making a major effort. On the other hand, costs may rise substantially if sorting is further expanded through requirements imposed by the authorities because then everyone will be forced to contribute, including those who experience the time spent on sorting as a considerable burden. If more waste is to be sorted at the source through mandatory requirements, this will primarily affect those who today contribute little and have a high willingness to pay per hour. This is also in line with the theoretical reasoning concerning motivation presented above. The social cost per hour must be assumed to be higher the greater the degree of compulsion that is applied.

### 5. Conclusions

Sorting at the source involves an extra use of time and energy in households. The people who were inter-

9 Note that this is not willingness to pay for a better environment, but rather the willingness to pay for having others take over the sorting work with no change in the environmental effect. Here, we asked about the weekly time use, but willingness to pay per year. This was done in order to make the question as simple to answer as possible. Experience shows, however, that the results can be rather different depending on the unit used, e.g. day, week or year.

10 In Bruvoll (1998) the social costs of households' use of time were estimated at NOK 1003 per tonne waste, with an interval of uncertainty of NOK 290-1715.

11 Note that some respondents who have not reported that they use extra time to sort waste have nevertheless reported a positive willingness to pay. This illustrates that willingness to pay cannot automatically be interpreted as a measure of the disadvantage of using time on sorting. For example, it is conceivable that some are willing to pay so they avoid having to use extra space for more refuse pails.

viewed in our survey reported a use of time on sorting that approximately corresponds to 41 hours per year per household. On the basis of the time respondents estimated that they used for cleaning recyclable materials, an additional cost for heating hot water for this purpose is estimated at NOK 24 per household per year.

It is not clear how sorting activities by households should be valued in cost benefit analyses. Our analysis shows that sorting activities by households are based on many different motives, in addition to the desire for a better environment. If sorting is perceived as a requirement, it should definitely be considered a cost for society. If it is perceived as a social or moral obligation, the answer is more uncertain, while for those who think sorting is a pleasant activity in itself or are motivated by the pleasure of giving, the effort can actually be thought to represent a net social gain. The survey shows that all these motives appear to exist, but this does not provide a basis for determining the motives that should be assigned the highest weight in a cost benefit analysis.

Seven out of ten would agree to have others do the sorting if this were possible. Many of these respondents would also be willing to pay for this offer. If we interpret willingness to pay as a measure of the disadvantages of sorting waste oneself, we find a willingness to pay others to take over the sorting process that corresponds to NOK 800 per tonne of waste. When we calculate willingness to pay per hour, we arrive at a fairly low value, but the time used is also fairly high. However, it is particularly those who use little time on sorting at source that have a high willingness to pay per hour. The hourly social cost of sorting may therefore increase sharply if people are required to make a substantially greater contribution than today. It is primarily those who sort very little and, at the same time, have the highest willingness to pay, who will then have to increase their contribution.

There are several sources of uncertainty associated with the figures we have presented here. Further studies are therefore required to provide more precise estimates of the net social cost of sorting activities by households. It should nevertheless be emphasised that monetary valuation and cost benefit analyses cannot alone provide final answers to which waste treatment alternatives are best for society. Such analyses primarily represent a way of summarising complicated information, but will always have to be supplemented by discretionary judgement.

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