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The Waste Tax 1987 - 1996 - an ex-post evaluation of incentives and environmental effects

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Such publications do not necessarily reflect the views of the Danish Environmental Protection Agency.

However, the Danish Environmental Protection Agency believes that such reports and papers are a significant contribution to the ongoing debate on Danish environmental policy.

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Summary

1987-1996

The present report gives an evaluation of the Danish waste tax introduced on 1.1.1987 with the aim of reducing and controlling the development in solid waste amounts. Originally, the rate of the waste tax was DKK 40/tonne waste delivered to landfills and incineration plants, but the tax has subsequently been increased and differentiated, so that the rates in 1996 were DKK 195/tonne waste delivered to landfills and DKK 160/tonne waste delivered to incineration. The tax is levied on waste delivered to registered plants, but a refund is granted for waste that is subsequently removed, e.g. for recycling. The report analyses developments in the decade from 1987 to 1996.[1]

Ex-post evaluation

The evaluation is a so-called ex-post evaluation, which means that the actual effects of the tax have been studied. The evaluation is hence different in its perspective from the more conventional ex-ante evaluations normally carried out by means of economic modelling prior to the introduction of a tax. As the present evaluation seeks to estimate the actual effects of the tax, including the interplay with other policy instruments, the report also presents a more general status of the results achieved with the Danish waste and recycling policy in the last decade.

Interplay with other policy instruments

A brief analysis of the Danish waste sector shows that there are several different policy instruments affecting the management of waste. Several of these instruments focus specifically on certain types of waste, and the main barrier to the incentive of the waste tax is the pricing of local waste collection fees, which normally do not reflect the amount of waste actually delivered. When the Danish waste tax was designed the idea was, rather, to influence waste management companies towards making facilities available for recycling and separation. In addition, an analysis of policy instruments reveals that a number of important waste fractions have not been regulated separately, and that industrial and commercial waste and construction and demolition waste are likely to be sensitive to the weight-based waste tax.

Net waste delivered

[1] With effect from 1.1.1997 the tax was increased to DKK 335/tonne waste for landfills, DKK 260/tonne waste to incineration and DKK 210/tonne waste to incineration with a minimum of 10% power generation.

By means of waste tax data from the Central Customs and Tax Administration, descriptions of the changes in the amount of taxed solid waste from 1987 to 1996 have been drawn up. It has been necessary to adjust for the change in the taxable base, which took place in 1990, as small inert waste landfills and private landfills were also levied from this year. An account has been made of gross waste delivered, waste subsequently removed, and net delivered waste. Net waste delivered is the most appropriate indicator of the development in waste amounts, as this figure has been adjusted for the transfer of waste and the subsequent removal of slag which is re-delivered to landfills. Net waste delivered is gross waste delivered minus waste subsequently removed.

Net reduction of 26%

From 1987 to 1996, a 26 per cent decrease in net taxable waste delivered to municipal plants was registered [2]. With regard to the small private landfills for inert waste and other private landfills, a decrease of 39 per cent was observed from 1990 to 1996. This decrease took place mainly in the period from 1987 to 1993. Since 1993 the amount of waste has been slightly increasing, and this trend is believed to be connected with the positive economic development in Denmark since 1993.

Industrial and commercial waste increase

No coherent waste statistics are available which allow for a more detailed description of developments in the different types of waste in the decade studied. However, by using figures compiled by RENDAN (Danish Waste Management Info Centre) in their 'Material Stream Analyses' for 1987 to 1993, it has been possible to analyse developments in the main types of waste. The analysis shows that industrial and commercial waste has increased (by 8 per cent), while household waste, construction and demolition waste and other types of waste have decreased. The relatively most significant reduction has taken place in construction and demolition waste (63 per cent), but reductions in household waste (16 per cent) and other wastes (22 per cent) are also noteworthy. Other wastes include slag and sludge. Statistics also show that a marked increase in recycling has taken place, in particular of heavier fractions (construction and demolition waste, compost, bulky waste), whereas mandatory collection of glass and paper only makes up a smaller proportion of the total decrease in waste amounts. Current paper collection is estimated by RENDAN to comprise only about half of the potential, whereas the recycling of the heavier fractions amounts to 70-80 per cent. The more limited success with paper and glass collection indicates that the "command-

[2] Municipal plants are municipal, intermunicipal and other plants receiving municipal domestic waste, cf. Chapter 4.

and-control" instrument has been less efficient, whereas the development in heavier fractions indicates a positive effect of the waste tax.

Studies

Three studies have been carried out in order to identify the role of the waste tax in the development in solid waste amounts;

1) an analysis based on in-depth interviews with 16 enterprises, to clarify the development in industrial and commercial waste and construction and demolition waste,
2) a questionnaire study among local environment and waste administrations, to investigate the motivations for implementing local recycling schemes,
3) a review and analysis of waste data from ten municipalities with different pricing of waste collection fees, with and without weight-based fees.

Industrial and commercial waste, construction and demolition waste

The study of industrial and commercial waste, which was completed before the analysis of the RENDAN waste data, showed that among enterprises interviewed, attention to waste management and costs varies. The most professional systems of waste management were found at breweries and in the iron and steel industry, while newspaper printing houses, the service and trade sector and public institutions did not have a well-developed waste management system. Typically, the physical management of waste takes place without any knowledge of financial aspects. Most of the enterprises interviewed have taken initiatives to increase recycling, but apparently the waste tax has not played a significant role for these initiatives. Apart from the lack of attention to the financial aspects of waste management, it also seems to be a problem that the rate of the waste tax in 1996 was too low to offset the additional costs connected with sorting and separate collection of recyclable materials. Typically, separation entails high costs, and often there is not a profitable market price for residual products. The relatively high increase in the tax rate, which took effect from 1.1.1997, may, however, tip the balance in favour of recycling. Paradoxically, the study showed that the amount of solid waste generated at enterprises in the service and trade sector and in public institutions exceeds that at more conventional manufacturing enterprises.

With regard to construction and demolition waste, considerably more attention is paid to the waste tax as large sums can be saved through recycling. With the rate that applied in 1997, estimated possible sav-

ings of DKK 300/tonne are obtainable by crushing, as compared to landfilling.

Recycling in municipalities

The study of recycling activities in local administrations and intermunicipal waste companies shows that recycling schemes are well established today. There has been different motivation for these efforts, but in general local political priorities are seen as the most significant factor. The desire to keep waste management costs low for citizens by giving priority to recycling in order to reduce the waste tax, is generally stated as an important reason, particularly when it comes to the heavier fractions of waste. For some of the heaviest waste fractions sensitive to the waste tax (garden waste, bulky waste, construction and demolition waste) about 70-80 per cent of local administrations with collection schemes mention the waste tax as being significant for the economy of the waste collection systems.

Weight-based collection fees

The degree to which citizens actually use the recycling schemes made available to them is a significant issue. For example, recycling schemes established due to the impact of the waste tax, are not necessarily used. The collection fee for households is normally based on the volume of the waste bin and the frequency of collection, and not on weight, so there is little financial incentive for householders to reduce their amounts of waste. A few local administrations have, however, introduced systems with weight-based collection fees, and a review made by the Danish Building Research Institute of waste data from ten municipalities with different schemes of waste fees indicates that weight-based fees lead to a more effective recycling effort. In the municipalities of Tinglev and Bogense, which are both running this scheme, the amount of residual waste from households has been reduced to about 100 kg/capita. The drop in waste quantities is matched by increased recycling, and the figures do not indicate that fly-tipping is a serious problem.

In municipalities with more conventional systems of waste collection fees, the amount of residual waste is still between 200 and 300 kg/capita, despite the availability of recycling facilities. Only the municipality of Vejle has reached the same low level of residual waste per capita as Tinglev and Bogense, but this result has been achieved with a comprehensive collection system that is costly to operate. These results indicate that more substantial reductions in waste amounts are possible with the present level of the waste tax, provided there is better 'transmission' of the price signal to the individual waste producer.

The tax has an impact

The evaluation shows that the waste tax has had a significant impact on the reductions in taxable waste. The tax has been decisive for the reduction in construction and demolition waste, while for the heavier fractions under 'other wastes' and 'household waste', it has provided an important incentive for separate collection. With regard to household waste, the effect has been achieved by the incentive from the tax to local administrations and waste companies to introduce separation schemes, but experience from municipalities with weight-based collection fees shows that household waste can be reduced even more with the present rate of the waste tax, provided that payment for waste collection has a more direct relationship to the amount of residual waste actually generated.

There are no indications that the waste tax has led to fly-tipping, as recycling facilities have received increasing amounts of materials, balancing the reduction in residual waste.

In Chapter 9 the design of the waste tax is discussed, and proposals for adjustments are given. Further increases in the tax should await an evaluation of the effects of the increase that took effect in 1997.

1. Introduction

Introduction of waste tax in 1987

The Danish waste tax took effect on 1.1.1987, and the rate was originally DKK 40/tonne waste collected under municipal waste collection schemes and delivered to public incineration plants or landfills. The tax has been increased in several steps, and as of 1.1.1997 it amounts to DKK 335/tonne for waste delivered to landfills and DKK 260/tonne for waste delivered to incineration. Waste to incineration plants with a minimum of 10 per cent power generation (in addition to heat generation) is taxed at DKK 210/tonne. Furthermore, the taxable base of the tax has been extended several times, and since 1990 landfills for inert waste and private landfills etc. are also covered by the tax.

Environmental objective

The effect of the waste tax as an environmental policy instrument is of interest, as it was among the first real environmental taxes introduced in Denmark. Already in the 1970s, taxes had been introduced on electricity, single-use packaging and sales packaging, but the waste tax had a more direct environmental policy objective: to stem the increasing waste amounts. It was expected that the tax in itself would give an incentive to reduce waste generation. The incentive was enhanced by increases in the tax rate in 1990 and 1993, and again through the green tax reform adopted in 1993 and taking effect in 1997. In Budget negotiations for 1997, the tax was increased further.

Internalisation in market transactions

With regard to environmental economics, the waste tax is interesting as it is a "true" emission charge, i.e. a charge seeking to internalise environmental costs in market transactions, and which is expected to have an effect only by virtue of its price signal. According to an outline of environmental taxes in OECD countries, many economic instruments are much more complex in their design, and the yield is often earmarked for environmental purposes (OECD, 1989, 1994). This is not the case for the waste tax; the yield is a general revenue in the Finance Act. Part of the yield in the first years was used for financing a subsidy scheme for recycling projects, but also in this period the tax was not earmarked.

Policy instrument

This report gives an evaluation of the waste tax as a policy instrument, and especially environmental results are described. This task has proved to be very extensive, partly because no good and coherent data were available to assess developments in waste amounts. As a consequence, it has been necessary to use many resources for collecting and analysing available data. The report analyses developments in taxable residual waste. Residual waste means waste which is not recycled, or waste which is left over after recycling and subsequently incinerated or landfilled.

No cost-benefit analysis

The evaluation takes its starting point in the objectives laid down for waste and recycling, and it analyses whether the waste tax can ensure that these objectives are achieved. The evaluation does not carry out a cost-benefit analysis of the efforts in waste and recycling, neither does it analyse whether the tax reflects a correct valuation of the pollution deriving from landfilling or incineration. These questions are interesting, but certainly difficult to answer. This would require a more comprehensive study than the present one.

The evaluation has been prepared by associate professor Mikael Skou Andersen, Centre for Social Science Research on the Environment at the University of Aarhus, and research assistants Niels Dengsø and Stefan Brendstrup. The evaluation has been financed by the Danish Environmental Protection Agency under an appropriation from April 1996.

Results of the evaluation have been regularly reported to a steering committee which has given valuable comments and ideas to the work. Steering committee members were:

Jens Balslev, Danish Environmental Protection Agency, Industrial Waste Division (Chair),
Jens Holger Helbo Hansen, Danish Ministry of Taxation,
later replaced by
Thomas Larsen, Danish Ministry of Taxation,
Hanne Grøn, Central Customs and Tax Administration,
Lilja Kristjansson, Central Customs and Tax Administration,
later replaced by
Thea Sand, Central Customs and Tax Administration
Henrik Duer, MSc (Eocnomics),
Michael Bundgaard, Danish Environmental Protection Agency, Information Resources Division,
Katrine Bom Hansen, Danish Environmental Protection Agency, Household Waste Division,
later replaced by

Peter Kjær Madsen, Danish Environmental Protection Agency, Household Waste Division,
Jørgen Schou, Danish Environmental Protection Agency, Economy Division,
Lisbeth Strandmark, Danish Environmental Protection Agency, Economy Division,
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2. Theory and methodology in the evaluation of economic instruments in environmental policy

2.1 Differences between environmental economic theory and use of environmental taxes in practical regulation

Taxes are cost-effective

According to environmental economic theory, the use of economic instruments (taxes or marketable permits) in environmental policy will lead to a more cost-effective pollution abatement than the use of administrative instruments (Baumol and Oates, 1975; 1988). Administrative requirements to the effect that all players must reduce pollution to the same pre-set level will normally be more expensive, as there are no safeguards that the reduction takes place where reduction costs are lowest.

Polluters have different marginal abatement costs

With a tax, players with abatement costs lower than the tax will choose to limit pollution, whereas players with abatement costs higher than the tax will prefer to pay the tax. To obtain a given reduction of pollution, imposing a tax has less economic cost than requiring all polluters to reduce their pollution equally. This is explained by the fact that marginal costs of a pollution reduction are different for different players, and a correctly fixed environmental tax will secure that reductions are made where they are cheapest to obtain.

However, it is difficult to fix the precise rate of an environmental tax. Ideally, it is assumed that this is best done on the basis of a valuation of the environment based on a survey of citizens' preferences in relation to "environment" compared to other goods (Pearce and Turner, 1990). Based on the value of the environment it is possible to fix a tax on pollution. There are several methods of valuing the environment, and there is considerable disagreement whether they are satisfactory (O'Neill, 1996). Many also consider political preferences more significant than economic preferences when deciding how much pollution is to be abated.

Standard pricing approach

The problems of developing methods of valuating the environment have led to an interest in more pragmatic approaches to determine environmental taxes. A recognised alternative is the so-called "standard pricing approach" (Baumol and Oates, 1971). This approach involves an environmental standard that has been defined politically, and subsequently an economic instrument is used to secure its fulfilment in a cost-effective way. Interest in this approach can also be explained by the fact that it was recognised that economic instruments often led to a higher degree of fulfilment of objectives than administrative instruments. This was after extensive regulation in the environmental field in the 1970s and also on the basis of Japanese experience. Environmental taxes were therefore seen not only as a cheaper, but also a better (more effective) way of achieving objectives.

Recycling rate of 54%

Environmental taxes in effect today in the OECD countries are almost all based on more pragmatic criteria - mostly the need for finding funds to solve an environmental task or the desire to reach a given environmental standard (OECD, 1989; 1991; 1996; 1997). There is only one example of a tax for which it was attempted in advance to value environmental damage: the British landfill tax introduced in 1996 (Riley, 1996). Many of the economic instruments that are known in Danish environmental regulation are determined on the basis of the standard pricing approach - based on the desire to secure a specific politically determined environmental standard. For example, this was for example the starting point in the Dithmer-report (Finansministeriet, 1994). For the waste tax, the desire was to fulfil the objective of a recycling rate of 54 per cent, cf. Chapter 3.

2.2 Methodology considerations in the evaluation of environmental taxes

Theory assumptions are restrictive

In the evaluation of environmental taxes, it must not be neglected that the predictions of environmental economic theory, that the use of economic instruments will lead to more efficient solutions, rest on relatively strict assumptions that are not likely to be fulfilled in practice. For example it is assumed that all players act in an economically rational way, and that they are fully informed. Furthermore, the environmental economy theory is biased, as it assumes that the only instrument used against pollution is an economic instrument. The theory does not deal with the interplay between economic and other instruments, and neither does it deal with the nature of the sectors in which

the economic instruments are used. Also, resource allocation in enterprises is not considered in the theory.

Interplay with other instruments

These limitations are recognised among environmental economists, and they are not so important in the economic and theoretical world. However, they may have significant importance in evaluating the use of economic instruments in practice: here, economic instruments are often used in an interplay with other instruments, mostly rules and standards. They are also often used in sectors and sub-markets in which competition is not complete, and where players' options are limited by institutionalised standards and routines, as it is the case in the energy sector, in agriculture and in the waste sector.

Ex-ante or ex-post

Environmental economy generally acts in an *ex-ante* paradigm, and its theories and methods allow us to analyse expected effects of taxes on pollution *all other things being equal*, before their coming into effect. If, however, we want to evaluate the actual effect of an environmental tax *ex-post*, i.e. after its implementation, it is problematic to ignore the interplay with other instruments and the institutional framework. An ex-ante analysis is based on assumptions of rationality and perfect information among the players; by contrast, the purpose of an ex-post analysis of economic instruments is to analyse and reconstruct the perceptions of players in a situation where they have mostly acted with limited capacity to handle the necessary information. In an ex-post analysis, in other words, we move from economy towards sociology. Consequently, an ex-post analysis will take its starting point, not in the relatively strict assumptions and expectations of environmental economic theory, but in knowledge from sociological and political evaluation and implementation literature (Winter, 1994).

Evaluation methods

Attempts have been made to evaluate the use of taxes within the framework of environmental economy. It has been attempted to model the connection between developments in an environmental tax rate and developments in a pollution parameter (see for example Statistisk Sentralbyro, 1996). The problem of these analyses is, however, that it seems unonvincing to ignore that there are also other instruments used for controlling pollution. For example, Bressers (1988) in his analysis of Dutch wastewater taxes demonstrated a strong correlation between the development in the tax rate and the drop in wastewater quantities, but his analysis did not attempt to identify the role of the approval instrument (i.e. standards and norms) in wastewater emissions of enterprises. A more convincing study of the same

taxes was carried out a few years later by Schuurman (1988) who, through interviews with enterprises, attempted to unveil the motivation behind the reduction of emissions, and thus to demonstrate the role of taxes in relation to other instruments. The Schuurman motivational analysis showed that taxes had been the most important factor, but that the interplay was more complex than the Bressers study showed.

The question of isolating the effect of economic instruments from the effect of other instruments is discussed in an OECD report (OECD, 1997). The authors of the report state that only in rare cases will it be possible to isolate the effect of economic instruments from the effect of other instruments. As a consequence it is recommended to carry out evaluations analysing the effects of a mix of instruments and comparing these results with results from other "instrument mixes".

Institutions are a filter on the tax incentive

Environmental taxes are often used in areas and sectors where there are not only other instruments, but also very well-defined routines and standards for the interplay among players. These markets are not free, and transactions between players are linked to well-defined channels. For example, these markets may be dominated by specific players, subsidies distort the market, and well-established rights may be difficult to question. Such institutions may act as a filter on price mechanisms and the use of economic instruments. Therefore, it is not only necessary to control for the interplay with other instruments; it is also necessary to carry out a more detailed analysis of the entire institutional framework in which taxes have been implemented. If an environmental tax is without effect it is not necessarily because it is too low; it may also be due to institutional barriers to players and their ability or willingness to react on incentives from the tax.

Target group's perception of alternatives

The consequence of this knowledge is that the study must leave the simplified control perspective of the ex-ante analysis and adopt the more complex player perspective of the ex-post analysis. This means that the focus of economic theory on marginal behaviour change as a response to a tax will have to be somewhat extended. It is more necessary to take the starting point in the target group's perceptions with regard to basic objectives and ranges of real possibilities of action. Even if a minor tax increase, in an ideal world, is expected to shift the balance to a situation with less pollution, it may for the target group be more rational to ignore the incentive. There may be several reasons for ignoring a tax. One reason may be that the target group of the tax has an opportunity through established institutional structures to avoid the tax, for example by passing on the cost to others. Another reason may be related to transaction costs, meaning costs of collecting sufficient information and adapting to a new behaviour. If such costs are

assessed to be higher than the possible gains of changing behaviour, it may be rational to ignore the tax. A third reason may be related to non-economic rationality, for example people do as "they have always done" and do not consider new alternatives of action because of changed costs.

2.3 Necessary elements of an ex-post evaluation of environmental taxes

Described below are the elements that are considered necessary in an ex-post evaluation of economic instruments in environmental policy.

2.3.1 Pre-investigations

Design of tax

First, it is necessary to understand the reasoning behind the precise design of the economic instrument. How did the architects behind the tax expect it to work, and which assumptions did they have for expected effects of the chosen rate of the tax? What was the precise taxable base, and what exceptions were made? Which images prevailed of the interplay with other instruments? If these questions are not clarified it may be difficult to identify the relevant data to be analysed in order to evaluate the tax. If no study is made of the design of the tax it may lead to wrong assumptions of expected effects. Some taxes make use of complicated refunding mechanisms, other taxes are expected to have an effect only by way of price signals. Basic misunderstandings of causal relationships among decision-makers, or politically-based decisions, may lead to errors in the design of a tax, and this will have implications for the fulfilment of objectives.

Context of regulation

Furthermore, as already mentioned, it is important to understand the context of regulation of the tax. What are the characteristics of the sector or the market where the tax is to be implemented? Which other regulations are in place, and how can the interplay between these and the tax be interpreted? This may often lead to a more in-depth analysis of the institutionalisation of a given regulation over time. However, it will also be necessary to make a concrete evaluation of implemented legal, normative, economic and informative instruments and of how they relate to the intentions of a tax. Are they directed towards the same phenomena or are they complementary? The purpose of this evaluation is not only to study whether we have "excess control", i.e. whether several instruments are implemented with the same purpose, but also to decide precisely how the instru-

ments relate to each other. Which emissions or inputs are expected to be regulated through administrative guidelines, and which through economic measures? If it is possible to identify clear distinctions analytically, this may be very valuable to a subsequent study of the effects of various instruments.

2.3.2 The dependent variable

Environmental data

Next step consists of identifying the dependent variable, i.e. the environmental parameter the tax is levied on. The identification of the relevant parameter is closely related to the study of the design of the tax. Normally, it will not be sufficient to look at a variable of environmental quality, whereas a concrete emission variable will often match a tax better, though much depends on the precise design of the tax. Availability of data on developments in emissions in the time period in question will have to be evaluated. If no data are available matching the taxable items, a proxy, i.e. a substitution will have to be identified. For example, if it is not possible to obtain data on emissions from enterprises, and if data on their consumption are available, a conversion factor will have to be defined. For evaluation of concrete environmental data, it will be necessary to relate such data to a baseline, which can be defined as expected developments without regulation. Often, such a baseline will be identifiable on the basis of an economic development index. In order to analyse the dependent variable it is of advantage to disentangle it, allowing a specification of relevant subparameters and subgroups of polluters. Such disentangling, however, may often cause difficulties if original data are not available, and it will often be impossible to make a disentangling if the study relies on statistical publications only. Instead, it may be possible to move forward on a trial basis by using various combinable information in order to elucidate the development in the dependent variable.

2.3.3 Motivational analysis

Interviews

It is not possible to draw any conclusions on the analysed tax based on developments in the dependent variable alone. Also, the effect of the economic instrument in relation to other instruments and institutions identified above must be evaluated. The problem here is to decide with certainty which of many instruments in place will influence the options of the players in relation to the regulated environmental parameter. In contrast to the economic approach which assumes players to be rational and analyse their actions only on this basis, the sociological approach analyses the actions of players through interviews or questionnaires which shows how players have perceived their possibilities of action and response. Players' actual options are

often somewhat more complex than expected, but through such a "backward mapping" of the motivations of players for making their choices concerning the environmental parameter(s) in question, it is possible to identify and compare the importance of various instruments and institutions. Often, this may be possible by asking players to identify instruments or considerations which were most important for specific actions. Only in rare cases will this lead to an unambiguous identification of one decisive instrument, but it will give a fair understanding of the complexity of instruments and their effectiveness. Interviews will also often indicate intervening variables such as development of new technology or shifts in market demands that may have influenced developments in the environmental parameter.

Economic calculations

A motivational analysis must be supplemented by a more economically-based, player-level analysis of marginal costs of pollution reduction in relation to marginal tax rate. An economic analysis will show what is "worthwhile" for the various players and thus explain their actions. However, it will often be difficult to obtain sufficient data for evaluating the economic consequences of various options for various players. If the player is an enterprise, economic consequences will often vary depending on turnover, emissions, production equipment, historic rights etc. Not always do enterprises want to give away such internal information, and attempts to acquire access to such information will often reveal that in their daily operation enterprises work with quite rough calculations of costs and profits of behaviour-change. To calculate marginal pollution abatement costs for a specific enterprise is often a very complicated task, and it is rarely done in connection with the evaluation of economic instruments. Often one will have to be content with average estimates which deviate quite significantly from the situation of individual enterprises. It will, however, be possible to carry out more macro-economic calculations on the basis of statistical data. Such calculations will show economic gains of using economic instruments compared to a baseline with traditional command-and-control, insofar as it is possible to identify comparable units in the analysis, such as regions or municipalities with different systems of regulation.

2.3.4 Qualitative analysis incorporating quantitative data

Combination of qualitative and quantitative data

Conclusions will basically be based on a qualitative analysis even if this is supported by quantitative data. It should be noted that the analysis is qualitative, because it has to be based on reasonings and interpretations relating the results of the motivational analysis of the

different instruments and the institutional framework in which the economic instrument is implemented.

The present evaluation of the waste tax is structured according to these points. Chapter 3 describes the design of the waste tax and its place in overall waste regulation. In Chapter 4 the dependent variable - waste amounts - and the development in the different waste fractions are analysed. Chapter 5 presents the motivational analysis of enterprises and Chapter 6 an analysis of local waste administrations. More detail is given in Chapter 7 on waste collection fees in municipal collection schemes and their impact on the development in waste amounts. In Chapter 8 data are presented on waste taxes, waste charges and waste amounts in a number of other EU Member States. Chapter 9 gives conclusions of the analysis, and recommendations are given concerning the waste tax.

This approach has been developed and applied to a comparative analysis of the use of wastewater taxes in the regulation of industry emissions (Andersen, 1994). The advantage of the comparative approach is that it is possible to compare different systems of regulation. In this evaluation, such comparisons are not made, but as mentioned a brief reference is given to the development in waste amounts in some of our neighbouring countries.

3. Purpose and design of the waste tax

3.1 Introduction

Understanding the context of the waste tax

This chapter summarises the considerations of legislators on the introduction of the waste tax as well as on subsequent increases in the rate and adjustments of the taxable base. Furthermore, an outline is given of the area of application of the tax, and separate regulation of various waste fractions is presented. Also, the waste sector is analysed in order to clarify price transparency and response options for the different players. This analysis, in conjunction with the two first items, will bring about a precise description of the purpose of the motivational analysis of waste management and recycling practices in enterprises and waste companies.

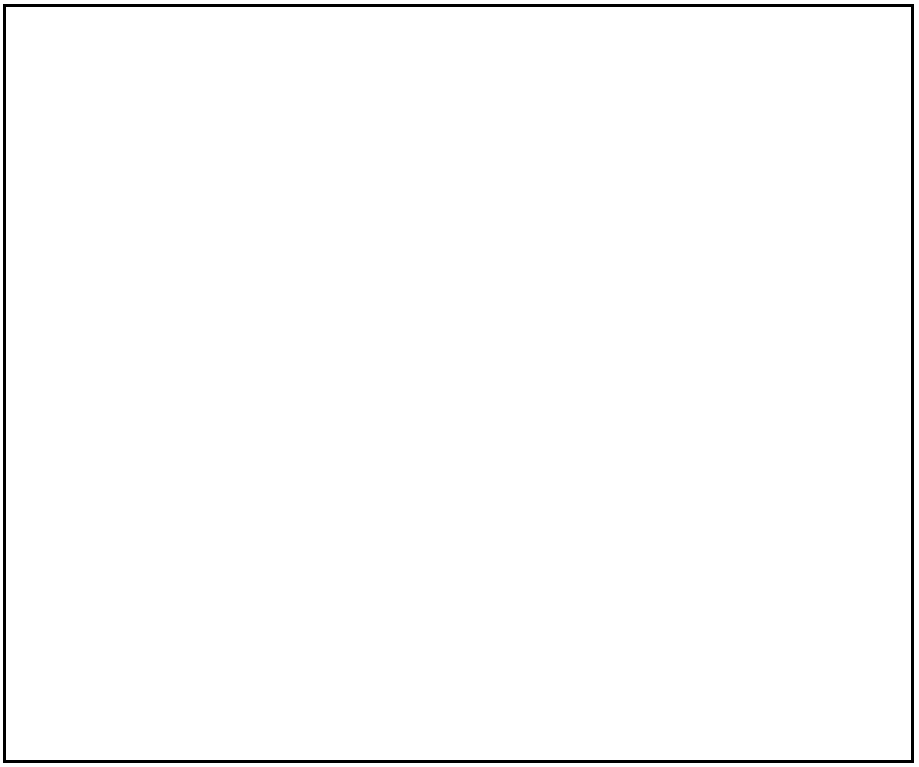

***Figure 3.1**. Development in tax rates for the waste tax 1987-1997*

3.2 Design of the waste tax

Step 1: Introduction of the waste tax

Need for prevention

The situation in waste management in the mid 1980s was that there were considerable problems in siting new landfills. Furthermore, the dioxin debate had put focus on waste incineration plants as the source of diffuse dioxin pollution. The need for new and more preventive ways in waste regulation was recognised. Conceptually, the background of the interest in economic instruments can be found in an OECD conference held in 1984 and a subsequent study carried out by the Danish Environmental Protection Agency (OECD, 1984; Miljøstyrelsen, 1985). A tax on waste was mentioned and discussed in detail in a report from the Danish Environmental Protection Agency on possible use of economic instruments in environmental policy, published in 1985. At the Budget negotiations in 1985, political agreement was obtained on the introduction of a waste tax, and the tax was included in the Bill to reform the Danish Environmental Protection Act, which was presented in February 1986 and adopted with broad political agreement the same year. (L176, 1986).

The purpose of introducing a waste tax, originally of DKK 40/tonne, was described as follows:

> "The purpose of the proposed tax is to reduce the amount of waste going to incineration or landfills. The tax will promote recycling and incite companies to apply low waste technologies" (Lovforslag nr. L176, sp. 4425).

Ensure profitability of recycling

The chosen rate of the tax reflected the need to ensure the profitability of recycling plants for construction and demolition waste and collection schemes for glass. Calculations on C&D waste indicated at that time a need for a tax of at least DKK 30/tonne in order to allow collection and crushing without public subsidies. (Miljøstyrelsen, 1985:25-26).

The Act introduced a possibility of refund, granting a refund for waste subsequently removed from registered plants. One argument for the refund option was:

> "It will be an incentive for companies (landfills and incineration plants) to separate waste with the purpose of recycling" (Lovforslag nr. L176, sp. 4450).

Furthermore, the objective was to avoid double taxation of waste which after treatment in an incineration plant is disposed of at another registered plant.

Yield included in the Finance Act

The yield of the tax, estimated at DKK 120 million annually, was included in the Finance Act as a revenue for the Ministry of the Environment, and part of the yield was used to finance subsidy schemes for recycling and clean technology projects (Betænkning 16.5.1986, sp. 1779). Part of the reasoning behind the subsidy scheme was that the tax level of DKK 40/tonne was relatively low, and subsidies for recycling measures financed by the tax would contribute to reducing waste amounts.

Limited to certain plants

At that time, the tax was limited to waste going to plants receiving waste from municipal collection schemes, whereas waste going to private landfills for inert waste or other private landfills was not included. Industrial and commercial waste delivered directly to municipal plants was covered by the tax. The reason for the limitation to such plants was especially the need for simple administration of the system.

Plan of action

Step 2: Increase in waste tax rate adopted in 1989
In 1989, the Minister for the Environment presented to the Folketing a comprehensive plan of action for increased recycling, prepared by the Danish Environmental Protection Agency (Miljøstyrelsen, 1989). The plan of action predicted an increase in waste amounts of 50 per cent if no measures were taken, and increased efforts in recycling were proposed. The main objective was a recycling rate of 54 per cent in 1996.

The same year, a first evaluation of the waste tax was carried out. The evaluation was made by GENDAN and revealed that the rate of DKK 40/tonne was too low to have a general effect on waste management, but that for construction and demolition waste, and heavy industrial and commercial waste, an effect could be seen, as waste amounts fell from 1987 to 1988 by some 200,000 tonnes (Holmstrand m.fl., 1989). In connection with this evaluation, an assessment was made among experts in the waste sector indicating that a rate of DKK 100/tonne would be necessary to obtain a significant effect.

"Locomotive" for the plan

In the Finance Act of 1990, the waste tax rate was increased to DKK 130/tonne. The Minister for the Environment commented on the purpose of this increase in relation to the plan of action for increased recycling:

> "A significant increase in the waste tax rate will be a locomotive for the initiatives included in the plan " (Folketingstidende, 89/90, del F, sp. 3056).

Extension of taxable base

At the same time an extension of the taxable base of the waste tax was made, so that private landfills for inert waste etc. were also covered. According to the presentation speech of the Minister for the Environment, the main purpose was to increase recycling of construction and demolition waste which had previously been landfilled at such sites. In 1986, no estimates of the environmental effects of the waste tax were given, but this time the Minister stated that the tax increase was estimated to divert around 1 million tonnes of construction and demolition waste from landfilling to recycling, and that this corresponded to a decrease of 15 per cent in total waste amounts. As a supplement to the mitigating effect on consumption at the start of the material flow, a raw materials tax was introduced, amounting to DKK 5/cu.m[3]. With this proposal, the waste tax was transferred from the Danish Environmental Protection Act to a stand-alone Act on taxes on waste and raw materials. (L100, 1989). The increase in the waste tax was estimated to produce an additional yield in 1990 of DKK 340 million.

The change in the taxable base took place with the Danish Statutory Order on Waste which was presented in early 1989. The Statutory Order replaced the provisions of environmental regulation and partly imposed an assignment obligation on local councils, partly extended the concept of municipal waste collection schemes. (Bek. nr. 188 af 23.2.1989 om affaldsbortskaffelse).

External evaluation

Step 3: Increase and tax differentiation adopted in 1992
In late 1991, an external evaluation of the waste tax was commissioned to the Institute of Local Government Studies - Denmark. Completed in November 1992, this report concluded "that the waste

[3] Before this, a fee of DKK 0.50/tonne raw material was in force under the Raw Materials Act

tax in its present form has an impact on waste streams in significant areas", but also that due to data problems (and lack of time in connection with the evaluation) it was not possible to give a statement of the precise effects of the tax (Christoffersen, m.fl., 1992). Furthermore, the evaluation noted that a number of players in the waste field had limited possibilities of action and avoidance in relation to the waste tax, especially householders whose fees to municipal waste companies were not based on the weight of their waste. Also, it was proposed to extend the taxable base of the waste tax so that, for example, waste from energy generation and oil and chemical waste were covered.

In 1992, an inter-ministerial committee was established with the purpose of extending the market orientation of waste and recycling efforts. The committee was to investigate the possibilities of abolishing the special recycling subsidy scheme, which had been established parallel to the introduction of the waste tax. The committee was also to investigate increasing and differentiating the waste tax and increasing the raw materials tax (Finansministeriet, m.fl., 1992).

Need for tax differentiation

The reasoning behind differentiation of the tax was that differences between municipal fees for landfilling and incineration led to an economic favouring of landfilling. Whereas fees for landfilling on average amounted to DKK 170-220/tonne (excluding state waste tax), fees for incineration amounted to DKK 320-420/tonne, i.e. an average difference of some DKK 150-200/tonne, though with large local variations (Finansministeriet m.fl., 1992: 13). The committee proposed three models for increasing and differentiating of the waste tax. The most extensive model proposed to differentiate by only DKK 65/tonne between incineration and landfilling. The committee also proposed to abolish the subsidy scheme for recycling projects and to aim at more producer responsibility and take-back agreements.

Increase to DKK 160/tonne and DKK 195/tonne respectively

The Minister for the Environment presented a proposal in late 1992 on an increase and differentiation of the waste tax. This led to an increase in the waste tax to DKK 195/tonne for waste to landfills and DKK 160/tonne for waste to incineration. These rates took effect on 1.1.1993. At the same time, the subsidy scheme for recycling projects was abolished with the adoption of the 1993 Finance Act. The purpose of the increase was partly to compensate for the abolition of the subsidy scheme, and partly to increase the incentive to incinerate instead of to landfill. It is evident that the chosen differentiation could not fully outweigh the differences in municipal fee rates. However, the Government's Plan of Action for Waste and Recycling for 1993-1997 proposed to ban the landfilling of waste suitable for incineration.

In practice, also the loss of yield due to the parallel abolition of the tax on milk cartons played a certain role for the tax rate. The yield from the tax increase was stated at some DKK 122 million, so that the total yield from the tax now came close to DKK 600 million.

Refund scheme

With the amendment of the Act, the refund scheme for recycling companies was embraced in statute. This scheme had been introduced in connection with the waste tax increase in 1990. The background of the refund scheme is that the activities of recycling companies often generate a certain amount of residual waste which has to be landfilled or incinerated. According to the scheme, these companies were granted a refund on their waste tax of DKK 90/tonne, a rate which was increased with effect from 1993 to DKK 120/tonne and DKK 155/tonne for incineration and landfilling respectively. By not granting full refund for the waste tax, the incentive to prevent residual waste was maintained. The refund scheme does not cover construction and demolition waste, slag, and compost, and it is a prerequisite that industrial reprocessing of materials takes place (Bemærkning to L70; sp. 1826).

Waste imports from Germany

Also waste imports from Germany played a certain role at the 1992 amendments. This was evident as the Act stated that plants only receiving imported waste must be registered. The Act also stated that an increase in the tax rate was supported by the argument that total disposal costs in Germany (around DKK 7-800/tonne) would increase interest in exporting to Denmark. With the tax increase, total disposal costs in Denmark (municipal fees and state tax) remained, however, below the German level.

Step 4: Tax reform in 1993

Green tax reform

In connection with the conversion from personal taxes to green taxes, which was part of the tax reform, a further increase in the waste tax rate took place, however not taking effect until 1.1.1997. In connection with this increase, a further differentiation of the tax was made, so that from 1997 a distinction is made between incineration plants with and without energy recovery in the form of power or combined power and heating generation. In December 1996, the waste tax was further increased by DKK 50/tonne for all three categories.

1997: DKK 335/tonne for landfilling

Since 1.1.1997 the tax has amounted to DKK 335/tonne waste going to landfill, whereas the rate for incineration with heating generation and a minimum of 10 per cent power generation has been DKK 210/tonne. For other incineration the tax is DKK 260/tonne. As the major part of Danish incineration plants have combined power and heating generation, the latest changes mean in practice an enhanced differentiation by DKK 75/tonne and DKK 125/tonne respectively, where the differentiation between landfilling and incineration used to be DKK 35. The increases in 1997 represent a significant increase especially for landfilled waste, from 195 DKK to DKK 335/tonne, corresponding to an increase of 72 per cent.

Summary

Mix of environmental and fiscal motivations

The waste tax is meant to serve environmental purposes, but more exact environmental effects of the waste tax were only estimated for the increase that took effect in 1990. For the other increases, reference has been made to action plans for waste and recycling. Especially the increase in 1993 clearly seems to be marked by fiscal considerations, as the objectives stated for tax differentiation (balancing of costs of landfilling and incineration) and for the increase (limiting the import of German waste for incineration) are not followed consistently at the design of the tax. With the increase and enhanced differentiation that came into effect in 1997, however, this situation was remedied.

3.3 Regulation of different waste fractions

Legislation and rules

Waste and waste streams are carefully regulated through legislation and plans, and the waste tax is far from the only instrument affecting different waste fractions. At the increase in the waste tax rate in 1990, the Minister for the Environment called the tax a locomotive for the effort, and this illustrates the perception that the waste tax does give a general economic incentive to reduce waste amounts and increase recycling, but at the same time there are a number of other rules regulating waste streams. These regulations are briefly described below. It is not intended to give a comprehensive outline of legislation in the waste area (can be found in Basse, 1995), but to clarify which waste types are covered by special regulations influencing the management and choice of waste treatment method. Some regulations were introduced parallel to the waste tax, while others have been introduced later. As the outline shows, most regulations

are related to special and, by weight, mostly less important waste streams.

Tax exempt plants

Tax exempt plants

Certain waste treatment plants are not covered by the obligation to register, and as a consequence waste going to these plants is not taxable:

Plants for destruction of oil and chemical waste (hazardous waste): Since 1972, a collection scheme for oil and chemical waste has been in effect.

Plants for the incineration of hospital waste (clinical risk waste).

Incineration plants for sewage sludge: The exemption for sludge incineration plants was abolished with effect from 1.1.1997.

Sewage sludge can be applied to farmland if it complies with specified limit values. In this case, sludge is tax exempt.

Plants for the disposal of power plant residues: Special plants for the disposal of residues from power plants based on fossil fuel, i.e. slag/bottom ash, fly ash, TASP and gypsum are tax exempt. As from 1.1.1997 the exemption has been extended to also comprise power plants based on biomass. Under the terms of a Statutory Order of 1983, slag and fly ash may also be used in building and construction works and thereby be exempt from the waste tax. Also slag from incineration plants used for building and construction works is tax exempt.

It is possible to deliver sewage sludge and residues from power plants and incineration plants to registered plants, but in this case the waste is taxable.

Contaminated soil: Special plants for the disposal of contaminated soil are exempt from the waste tax.

Tax exempt waste types

Tax exempt waste types

The following waste types are not covered by the waste tax:

Straw, which is transported to incineration plants in clean, separate loads.

Clean wood waste and wood chips from wood-processing industry transported to incineration plants in clean, separate loads.

Clean soil filling and clean soil used for covering at registered landfills.

Hazardous waste and hospital waste in special loads to conventional incineration plants.

Waste covered by other regulations

Special collection requirements

Under the terms of the Danish Statutory Order on Waste and one special Statutory Order (Statutory Order on food waste from catering centres) local councils must assign or collect the following waste fractions for recycling:

- paper, cardboard, carton and cardboard materials and products made of cardboard materials from enterprises and public and private institutions,
- waste transport packaging in the form of plastic from enterprises,
- steel drums from industrial and commercial enterprises,
- newspapers, magazines and similar as well as glass packaging from private households,
- food waste from catering centres.

For the following products, deposit and return systems, charges or taxes have been introduced to ensure separate collection:

- packaging for beer and soft drinks. A separate Statutory Order requires the establishment of a deposit and return scheme for such packaging.

- rechargeable NiCd accumulators. A former voluntary agreement on collection, financed by a small fee, did not show satisfactory results and was replaced in 1996 by a tax financing a reimbursement scheme directed towards collectors.

- a fee on lead accumulators finances a subsidy for collection.

- a fee on tyres for motorbikes, private cars, vans and small trucks finances a subsidy for collection.

Furthermore, agreements have been made on recycling the following products:

PVC is covered by an agreement with the plastics industry which includes the establishment of a private recycling scheme for PVC construction materials.

Construction and demolition waste - an agreement has been made between the Minister for Environment and Energy and local councils that they must issue regulations on recycling construction and demolition waste (detailed requirements for regulations are given in circular no. 94 of 21st June 1995).

Circular no. 132 of 13th June 1996 on municipal regulations on disposal of CFC-bearing refrigeration equipment stipulates that local councils must establish assignment or collection schemes for CFC-bearing refrigerators to ensure environmentally acceptable disposal and recycling.

Also, environmental taxes exist with the purpose of regulating the consumption of products:

Other environmental taxes

Packaging tax is a specific tax on refillable bottles and single-use bottles, differentiated according to material and volume. The tax supports the use of recyclable packaging.

Disposable tableware; the tax amounts to 50 per cent of the gross price before VAT.

Raw materials tax was introduced in 1989 and amounts to DKK 5/cu.m. The purpose of the tax was to supplement the waste tax incentive to recycle construction and demolition waste.

Energy taxes are not directly related to the waste area. Waste incineration is exempt from energy and CO_2 taxes, but SO_2 taxes are charged.

3.4 The waste sector - institutional framework

Regional and local monopolies

The waste tax gives a price signal to players in the waste sector concerning society's assessment of waste as an economic externality. However, the waste sector is a complex network of players who have a relatively well defined inter-relationship. Transactions among them are institutionalised through regulation of the waste area. As a result, the waste management market is not a free market with complete competition and full transparency, but a market characterised by regional and local monopolies, with complex control and planning instruments resulting in difficulties for players to act with economic rationality. One feature worth mentioning is the very different conditions of waste disposal for households and enterprises.

The waste tax is calculated and levied by plants receiving the waste, i.e. incineration plants, landfills, landfills for inert waste etc. Most such plants are municipal, but there are also many small private plants (landfills for inert waste). In addition, some enterprises have their own landfills or incineration plants.

Collection or assignment

Waste producers are either covered by a collection scheme or an assignment scheme. The definition of a collection scheme is a scheme where the local council is responsible for collecting waste. An assignment scheme is a scheme where the local council assigns treatment plants, but the waste producer is in charge of transport to the plant.

.....but professional carriers

Both for municipal collection schemes and assignment schemes, it is rarely the case that each waste producer brings their own waste directly to the treatment plant. If a producer is not covered by a collection scheme, it will often choose to contract with a waste carrier. In this way, most waste producers will pay a total sum for waste disposal, comprising both direct disposal costs (rent of containers, collection, transportation and treatment fee) as well as the state waste tax.

By law, local councils are under an obligation to establish a collection scheme in areas with more than 1,000 inhabitants. This obligation derives from the historic responsibility of local authorities to take care of waste disposal, and it also serves the environmental purpose of ensuring citizens economically efficient collection and disposal, with prices based purely on costs. Often, several local councils operate joint intermunicipal waste companies, but both in the case of municipal and intermunicipal waste disposal, these companies normally use private waste carriers and collectors.

Horizontal and vertical integration

The need for collection and transportation of waste has brought about an independent market for purchase and sale of services. Whereas operators used to be mainly carriers, in recent years we have seen more private waste companies operating as "turnkey" contractors. Through EU tenders, these companies compete with traditional municipal companies on delivering services in the waste market. The market is characterised by both horizontal and vertical integration. The largest of these enterprises also operates its own plant for the disposal and treatment of waste, but in general, such plants are operated by the local council.

The principles underlying transactions in the "waste service market" have a big impact on internalisation of the incentives from the waste tax in these transactions.

Collected waste

Waste collection fees

For the collection of waste (domestic waste and some recyclable waste fractions) from households and enterprises, the local council normally fixes a waste collection fee. This fee must be fixed according to the non-profit cost-coverage principle, on the basis of total disposal costs, i.e. initial and operating costs of collection, transportation, treatment and taxes (state waste tax and VAT). The waste collection fee may be fixed as a total fee covering several different schemes. The local council may also, in part or totally, finance waste expenses via taxes on real estate (see also Basse, 1995: 399-412).

It is important to bear in mind in this context that the fee is rarely fixed on the basis of weight, but more often on the basis of volume, e.g. per unit of collection. This means that the waste tax - which is calculated per tonne - is often integrated in a fee calculated on the basis of units of collection according to volume.

Formally speaking, the fee is payable by owners of real estate. For tenants, the cost is integrated in the rent. Legislation on cost-based rents regulates the calculation principles for tenancy and means that the full waste collection expense may be passed on to the tenant (often with a delay). For owner-occupied flats the fee will often be integrated in the contribution to the residents' association.

Waste tax = 13-16% of fee

The tax only makes up part of total disposal expenses. In the comments to the Act from 1986 on the implementation of the waste tax, it is stated that annual waste collection expenses per household are estimated at some DKK 500, whereas the tax (at that time DKK 40/tonne) was estimated at some DKK 35 annually (Lovforslag nr. L176, sp. 4433). With today's prices - around DKK 1,200 in waste collection fees for a one-family house, and a considerably higher waste tax - the waste tax is estimated at a somewhat higher share. With an annual waste generation of some 1 tonne/household and depending on residual waste amounts per capita in the municipality and on the treatment form, it will amount to DKK 160 to 195 or 13 to 16 per cent of the waste bill. With the 1997 increase, the share will increase to 18 to 28 per cent.

Tax payable by companies

However, the waste tax aims rather at waste companies. This view is also reflected by the comments to the Act on the implementation of the waste tax:

> "For household waste, a tax on final disposal will make it more profitable for the *waste collection services* in each municipality to establish recycling and separation systems. For each tonne of waste delivered for recycling, the *waste collection services* will save the corresponding fee". (L176, sp. 4426; italics by author)."

As waste companies calculate fees for their services according to a cost principle and also have a monopoly on local collection, it has been questioned (in economic literature on public service companies) whether they have an economic interest in minimising costs. However, waste companies' fees must be approved by the local council; there have been examples of direct delegation of pricing to the companies in municipal regulations on waste (which is hardly in compliance with legislation, cf. Basse, 1995), but considerable increases in costs of waste disposal, water supply, wastewater treatment etc. have led local councils to also see these expenses as part of the municipal tax burden, which means that councils try to find ways of lowering such costs.

Assigned waste

Assigned waste = freedom of choice

When it comes to assigned (non-collected) industrial and commercial waste, enterprises have a certain freedom of choice between plants and disposal forms.

Waste which can be used directly by other enterprises, for example so-called homogeneous by-products, may be delivered directly to other enterprises.

For other industrial and commercial waste types, enterprises must comply with assignments in the municipal waste regulation. It depends on local conditions whether separate waste fractions are assigned to one or more named plants, or whether certain types of plants are assigned. The Guidelines from the Danish Environmental Protection Agency on disposal, planning and registration of waste state that according to the Danish Statutory Order on Waste, enterprises have freedom of choice for recyclable materials (Miljøstyrelsen, 1994). Enterprises may, however, be ordered by regulations to deliver certain waste fractions for recycling.

Competition influences prices and fees

Often, enterprises will use one or more carriers, and the interest shown in industrial and commercial waste has meant that municipal and private waste companies compete to a certain extent in the waste-service market with regard to helping enterprises dispose of their waste. In cases of vertical integration between carriers and treatment or recycling plants, there will hardly be transparency in the relationship between actual cost components and prices offered. If carriers or treatment plants can find a market for recyclable waste fractions, this will have an impact on the price offered to the enterprise. Actual waste disposal costs, also for recyclable materials, will consequently be determined to a certain degree by the competition in the local waste service market.

The result is that for assigned industrial and commercial waste, the waste tax will be internalised to a certain degree - and thereby become invisible - in transactions between the players in the waste service market. If the enterprise uses only external carriers, the waste tax will, however, normally be specified separately on the invoice.

Analytical description

Analytical description of waste market

Transactions in the waste market are determined to a certain degree by the institutional framework shown in figure 3.2.

There are three options for waste disposal: landfilling (L), incineration (I) and recycling (R). The waste producer (P) is limited by rules and agreements on collection and fees, and it cannot estimate the price relationship between the three options. The transaction is arranged through the institutional structure illustrated in the centre of the diagram. The local council (LC) plays a central role. Firstly, it decides the design of the local disposal structure, i.e. treatment by incineration or landfilling, and waste fractions to be collected separately. Secondly, the local council decides in its waste regulation (WR) the relation between collected and assigned waste. Thirdly, the local council establishes a waste company or contracts with such a company (CO), and determines the market for private operators (PO) or carriers (CA). Finally, the local council fixes waste collection fees. Waste producers' situation depends on the form of payment of waste disposal which may be made via the owner (OW).

Choice of waste management is made within a given framework

Waste producers must make their choices within the framework given for waste disposal. Here, a number of other cost components

will play an important role for both waste producers and professional players in the waste sector. How much does it cost to operate a recycling plant and what is the sales price of collected and processed material? How expensive is it to operate an incineration plant compared to a landfill, and what are the revenues from the sale of power and heating from such a plant? How much does it cost for the waste company to collect waste and can this task be subcontracted totally or in part? What are the possibilities of minimising waste amounts through in-plant recycling or sale of by-products? What are the transport costs related to recycling compared to transport costs of landfilling or incineration, for example if the recycling plant is located in another region? Which system has the local council chosen for levying fees for collected waste, and how is the tax reflected in this fee? It is not surprising that the waste tax is only one of may components of the price of waste disposal. And it is difficult to determine the share of the tax component in relation to other elements, as this will depend to a large extent on the different waste fractions.

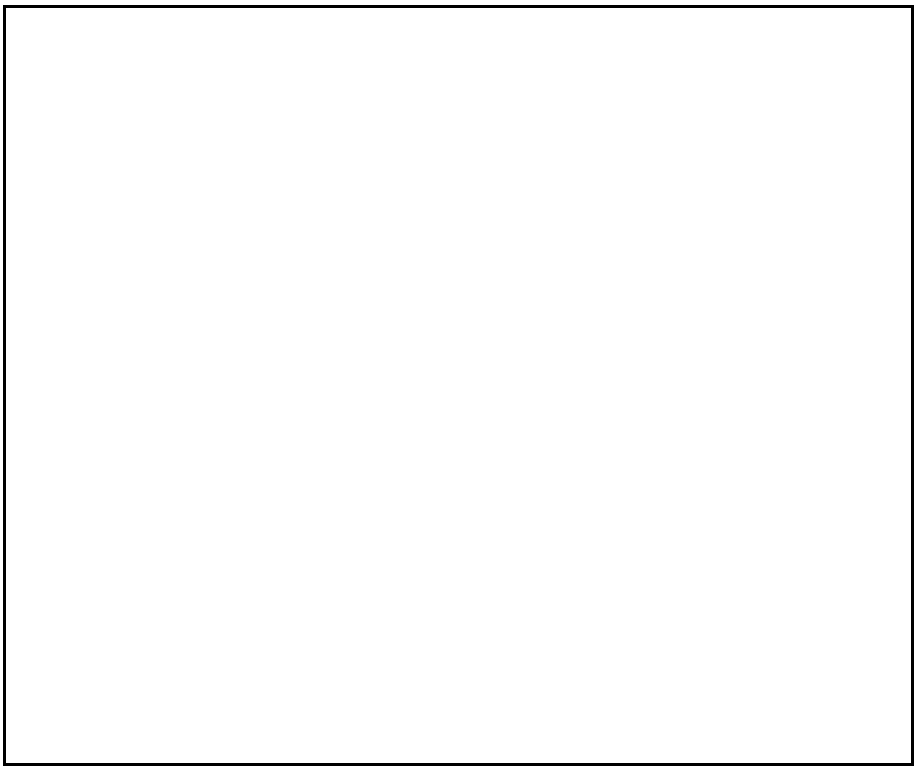

***Figure 3.2**. Analytical description of waste market*

4. Developments in taxable waste amounts

4.1 Introduction

Significant reduction from 1986 to 1996

This chapter gives a description of the developments in taxable waste amounts, and the developments in various groups of waste producers are analysed. The background of this relatively brief description is a very extensive work of compiling, estimating and, to a certain degree, verifying data on waste amounts.

Firstly, an outline is given of the developments in total taxable waste amounts, based primarily on data from the Central Customs and Tax Administration on waste delivered and waste subsequently removed for recycling.

Secondly, an attempt is made to describe the changes in amounts of different waste types in the years since the introduction of the waste tax. This analysis is primarily based on the RENDAN waste statistics for 1987 to 1993 and special statistics from the RENDAN material stream analyses.

The description below shows a significant decrease in taxable waste amounts from 1987 to 1996. This decrease is estimated mainly to be attributable to construction and demolition waste and household waste.

4.2 Taxable waste amounts

4.2.1 Data on waste to and from plants

Reports from the customs and tax regions

The basis for the calculation and levy of the waste tax is a weighing of waste delivered to registered waste treatment plants (incineration plants, landfills and landfills for inert waste). Waste subsequently removed for recycling is also weighed with regard to a refund of the tax. For this purpose, all plants must be equipped with a weigh-bridge approved by the customs and tax authorities.

On the basis of reports on amounts of waste delivered to, and subsequently removed from, each plant covering 1987 to today which were

submitted by waste treatment plants to the customs and tax regions, it is possible to describe the developments in waste amounts in this period.

Registered plants report waste quantities on a quarterly basis and both amounts delivered and amounts subsequently removed are stated. These statements are used for the calculation of waste tax payable. As from 1993, waste quantities are detailed further into incineration and landfilling due to the differentiation of the tax.

Basis of statement

From 1987 to 1989 returns were made to local customs offices. After the change in the local customs and tax administration in 1989, returns have been submitted to the local customs and tax regions. From 1989 to 1990, local customs offices forwarded a copy of returns from registered plants to the Central Customs and Tax Administration. With effect from 1990, copies are sent to the Danish Environmental Protection Agency and statistics on waste amounts have been made. The Central Customs and Tax Administration calculates yields from the tax and since 1987 has only made monetary statistics.

This means that, for the period 1990 to 1996, waste statistics have been made by the Danish Environmental Protection Agency based on quarterly reports from registered plants with statements of amounts delivered and amounts subsequently removed. From 1993 these amounts are broken down into landfilling and incineration. For 1987 to 1989 a total statement is available from the Central Customs and Tax Administration covering payment of taxes for amounts delivered and refunds for amounts removed. On the basis of these figures it is possible to calculate waste amounts, as the rate at that time was the same for all types of waste. Data for the different plants in 1987 and 1988 are also found by collecting information from the customs and tax regions. Due to the procedure of destruction of documentation after 5 years, not all regions were able to supply data for 1987 and 1988 at plant level, and consequently data for half of the plants for 1987 and 1988 are calculated on the basis of the RENDAN material stream analyses.

Amounts stated

In the following description, the statement of taxable waste amounts is based on actual amounts delivered and amounts removed in each calendar year. The statement per year cannot be directly compared with the revenue statement from the Central Customs and Tax Administration or with the statement from Statistics Denmark. The waste tax is payable on a quarterly basis and is paid in arrears, and this means that the statement and thus the payment for the fourth quarter in a calendar year will be reported to the tax authorities in the

following calendar year. In the Finance Act and statistics from Statistics Denmark, the tax yield is accrued so that revenues of a given year are the tax actually paid in the tax year - i.e. the tax yield from the fourth quarter of the preceding year, and the yield from the first to third quarters of the present year[4]. Any deferred reports of taxable waste quantities are registered at the time of reporting. Some deferred reports at enterprise level resulting from rulings in the VAT Appeal Board in 1996, are kept out of the statement, as these waste amounts concern the entire period from 1990 to 1995. It has not been possible to state these amounts on an accruals basis.

4.2.2 Changes in registered plants

Municipal plants

In the first three years, from 1987 to the end of 1989, the waste tax was only levied for plants receiving waste from municipal collection schemes. Also waste that was not collected in municipal schemes was taxable, if it was delivered to such plants. In practice, these plants were large, primarily municipally operated landfills and incineration plants. A total of 93 plants were registered in this period.

Inert waste landfills etc.

With effect from 1990 the taxable base was extended to comprise all plants receiving collected or assigned waste. In practice, this meant that a large number of small, primarily private, inert waste landfills and enterprises with own landfills were required to register. Especially inert waste landfills received a part of the "free" waste which was not collected. The change in the Act led to a further 65 plants being registered in 1990. Since then, a further 19 plants have been registered, partly due to rulings in the VAT Appeal Board on landfills at private enterprises etc. Some of these plants have subsequently withdrawn their registration.

As a result, when evaluating the developments in taxable waste amounts, it is crucial to take into account the 1990 change in the registration requirement, as data from 1987 to 1989 cannot be compared directly with data from 1990 to 1996.[5]

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[4] Statistiske Efterretninger, Miljø, 1996: 12, according to the footnote to Table 1, page 10 (State revenue from environment and energy taxes), the statements for different years are corrected for the time of payment. Statistics Denmark has informed that this is not the case for the waste tax.

[5] At the introduction of the waste tax in 1987 the requirement to register comprised, cf. §82c of the Environmental Protection Act only "enterprises or plants receiving waste from municipal waste collection schemes for landfilling or incineration ". Taking effect from 1st January 1990 the requirement was extended to comprise "enterprises receiving waste from municipal waste collection schemes, including waste assigned by the local council to landfilling or incineration ", cf.

Separate time series

By drawing up a statement of the development in waste amounts at plants registered in 1987-89, a separate time series has been made for 1987-96 for municipal plants[6]. Also, a separate time series has been made for plants registered in 1990 or later, primarily inert waste landfills, but also plants at enterprises.

In the comparison between new and old plants, it has been necessary to take into account certain plants that are registered separately after 1990 which, due to corporate ownership, previously reported jointly with other plants. A study of Danish Environmental Protection Agency files (based on information from the customs and tax authorities) concerning the status of registered plants in 1990, revealed that seven plants have registered in their own name after the amendments to the Act, which used to report received waste together with another plant. It has also been necessary to take into account that some plants have changed their name, often in connection with new facilities coming into operation.

Before/after 1990

In the following statement of taxable waste amounts, a distinction is made between taxable plants before and after 1990. Plants registered before 1990 are referred to as municipal plants, and plants registered after 1990 are referred to as inert waste landfills etc. These designations are simplified, as municipal inert waste landfills also exist. "Municipal plants" means plants receiving waste from municipal waste collection schemes. Plants registered before 1990 means physical plants so that any subsequent plants connected to the same collection area are also included here.

Waste diversion no real problem

One could imagine that waste would have been diverted from taxable to non-taxable plants in the period 1987-89. The reception of waste from municipal collection schemes released the registration and taxation requirement, but for non-collected waste from enterprises etc. until 1990 there was a certain possibility to freely choose plants. The problem of a diversion effect of the waste tax was studied in the 1989 evaluation of the tax (Holmstrand m.fl., 1989). In the GENDAN report, a detailed study of waste diversion was carried out, comparing

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§11 in Act on Taxes on Waste and Raw Materials.

6 This distinction was also made in the DEPA note on the effects of the waste tax presented to the Parliamentary Environment and Physical Planning Committee in 1991 and in the RENDAN material stream analysis.

locations of taxable and non-taxable plants. On the basis of a statement of transport costs it was calculated that the waste tax of DKK 40/tonne in effect at that time did not outweigh the extra transport cost when using non-taxable plants[7]. It must therefore be assumed that in 1987-89 waste diversion caused by the tax has not taken place to an extent that has significantly influenced total amounts delivered to registered plants. For the period after 1990, it cannot be excluded that waste similar to domestic waste has been delivered to private inert waste landfills, but due to the strict regulation of waste streams in recent years, especially through municipal waste regulations, it is estimated that this has been very limited and that the inaccuracy of the statement is small.

4.2.3 Developments from 1987-1996

Distinction between gross and net

A distinction is made between gross and net delivered waste amounts. Net waste amounts are calculated as gross waste amounts delivered to registered plants, with a deduction for waste subsequently removed from the plant.

Gross delivered amounts are an indicator of total taxable waste amounts, and decreases in these amounts may indicate less consumption, less activity in the building sector, or increased efforts in recycling in society. Figures of gross amounts, however, are blurred by waste being counted twice, for example at transfer stations, or when incineration residues are removed from incineration plants and delivered to landfills. As a result, net delivered amounts are a better indicator of the developments in taxable waste amounts, as this figure is corrected for several counts of the same waste and also represents the final impact of waste after the effect of waste separation and external sale of residues from waste treatment plants for recycling.

[7] Waste diversion caused by the waste tax was, according to the analysis, only profitable a very few places in Denmark (3 for industrial and commercial waste and 3 for construction and demolition waste).

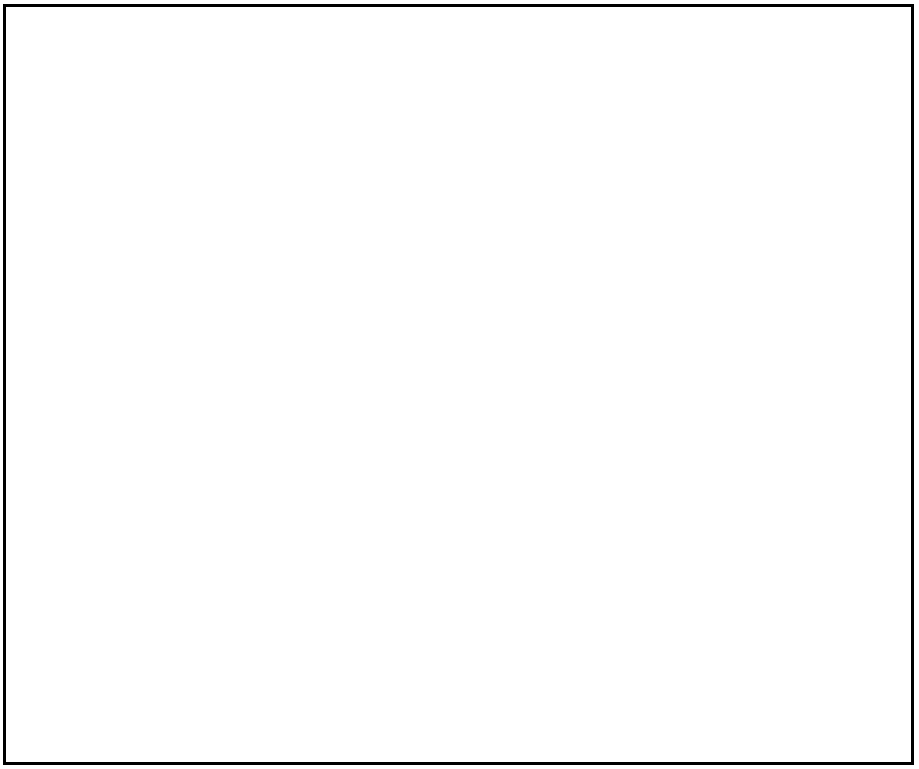

Figure 4.1. *Gross waste amounts at registered plants 1987-1996 (Source: Reports from customs and tax regions).*

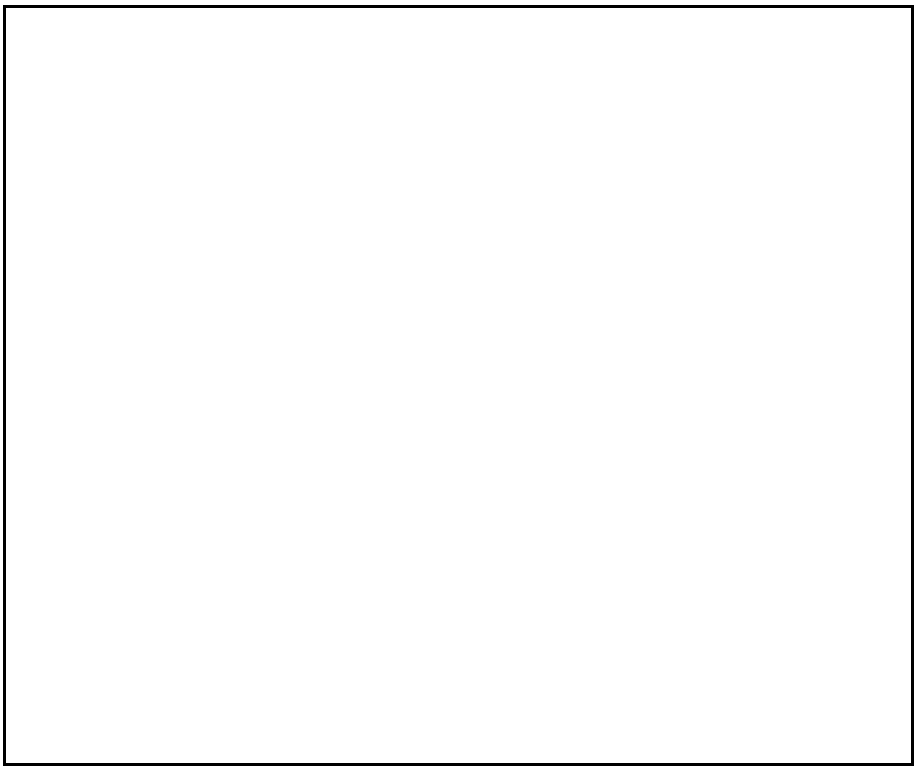

Figure 4.2. *Amounts of waste removed from registered plants 1987-1996 (Source: Reports from customs and tax regions).*

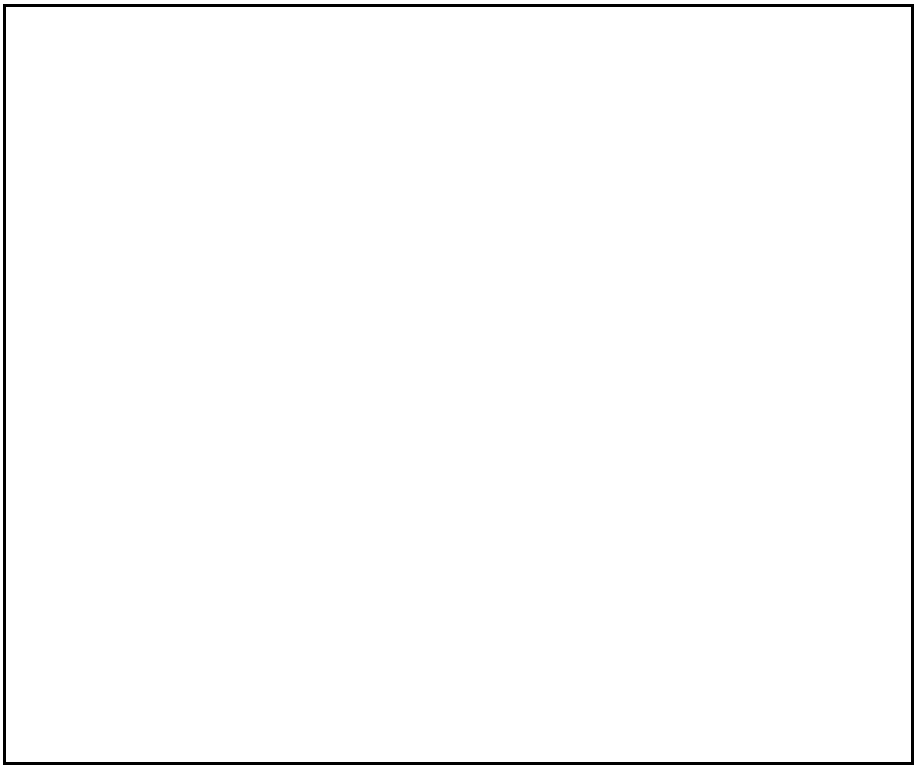

***Figure 4.3**. Net waste amounts delivered (delivered minus removed) to registered plants 1987-1996 (Source: Reports from customs and tax regions).*

Gross

Figure 4.1 shows the developments in *gross* delivered waste amounts, stated for municipal plants and inert waste landfills etc. The development at the so-called municipal plants, the first to be subject to the waste tax, shows a reduction[8] from 1987-93 in gross delivered amounts from 4,659,000 tonnes to 3,873,000 tonnes, i.e. a total of 786,000 tonnes or a decrease of 17 per cent. From 1994-96 waste amounts increase, to 4,054,000 tonnes in 1996 so that the total result for the period is a reduction by 605,000 tonnes or 13 per cent. The Figure shows a reduction in amounts delivered to inert waste landfills etc. from 1990-96 from 567,000 tonnes to 417,000 tonnes, i.e. a reduction of 150,000 tonnes or 27 per cent.

Subsequently removed

Figure 4.2 shows the developments in waste amounts *subsequently removed*, stated for municipal plants and inert waste landfills etc. Total amounts removed increase from 1987 to 1996. At municipal plants the increase in amounts removed from 1987 to 1996 is from 636,000 tonnes to 1,060,000 tonnes, i.e. an increase of 67 per cent. At inert waste landfills etc. amounts removed remain relatively stable in

[8] In the following, data have been rounded to thousands. Precise data are found in the annex.

the period from 1990 to 1996. They increase slightly from 173,000 tonnes in 1990 to 218,000 tonnes in 1994, and the level drops in 1996 more or less to the starting point of 178,000 tonnes.

Net reduction of 26 per cent

Figure 4.3 shows the development in *net* delivered waste amounts (delivered minus removed), stated for municipal plants and inert waste landfills etc.

At municipal plants a considerable decrease in net delivered amounts is seen from 1987 to 1996. The result for the period 1987-96 is a reduction of 1,029,000 tonnes, corresponding to 26 per cent. The net amount in 1996 was 2,994,000 tonnes, compared to 4,023,000 tonnes in 1987. Waste amounts increase somewhat from 1993 to 1996, despite the increase in the waste tax rate in 1993. This may be explained by the economic recovery after 1993 and the resulting increase in private consumption. However, there is a significant overall reduction in waste amounts from 1987 to today. Also waste amounts delivered to inert waste landfills show a decrease, and again amounts were lowest in 1993. The total reduction is 155,000 tonnes from 1990 to 1996, corresponding to 39 per cent.

4.3 Statistics illustrating the development in waste fractions

Data sources

Data from the Central Customs and Tax Administration do not allow a statement of the development in different waste fractions, i.e. how waste is distributed between domestic waste, industrial and commercial waste, construction and demolition waste etc.

These developments can be found in other data sources:

- Waste Survey 1985 by the Danish Environmental Protection Agency and regional councils (Miljøstyrelsen, 1991a, 1991b),
- RENDAN material stream analyses 1987-1993 (RENDAN, 1990; 1991; 1992; 1993).
- The ISAG (Information System for Waste and Recycling from the Danish Environmental Protection Agency) (Miljøstyrelsen, 1996a, 1996b).
- RENDAN special statistics from recycling plants etc. (RENDAN, 1996)

These data sources are evaluated below and subsequently used to evaluate developments in different waste fractions.

Waste Survey 1985 by the Danish Environmental Protection Agency and regional councils

1985 survey

The 1985 survey was made by the regional councils based on a Danish Environmental Protection Agency Statutory Order on waste surveys (Miljøstyrelsen, 1991a; 1991b). This was the first survey of waste amounts, and it was attempted to make data from the different regions comparable in a nation-wide survey.

For domestic waste, data are in most cases based on weighed amounts at treatment plants. For other waste streams, however, the statement is mainly based on estimates and theoretic calculations of amounts, and they are subject to some uncertainty. This is especially the case for the statement of industrial and commercial waste. Construction and demolition waste is mostly fixed as a unit amount, either by number of employees in the building and construction sector, or number of inhabitants, and data are not based on measured quantities (Miljøstyrelsen, 1991b: 16). Furthermore, it is stated that recycling may be somewhat underestimated, especially for industrial waste.

RENDAN material stream analyses

RENDAN

At the request of the Danish Environmental Protection Agency, RENDAN has stated the distribution of waste amounts on different waste streams from 1987 to 1993 by collecting information from all treatment plants on a quarterly basis (RENDAN, 1991; 1992; 1993; 1994). On the basis of these data, waste amounts are stated for four waste types: domestic waste; commercial and industrial waste; construction and demolition waste; and other waste. These statements have been financed by funds from the Council for Recycling and Cleaner Technology and have been reported regularly to the Danish Environmental Protection Agency.

For the years 1987 to 1990, data have been collected at plants required to register under the provisions of the Waste Tax Act. In this period, some two thirds of these plants reported for the RENDAN statistics. For the years 1991-93 the statistics were made considerably more comprehensive, so that 95 to 98 per cent of plants were included. For these years, statistics have also been extended to comprise private inert waste landfills etc.

The ISAG

The ISAG (Information System for Waste and Recycling from the Danish Environmental Protection Agency)
The ISAG is the Danish Environmental Protection Agency's information system for waste and recycling. It has replaced the RENDAN material stream analyses (Miljøstyrelsen, 1996a; 1996b). The ISAG is based on annual reports from all waste treatment plants. Furthermore, the ISAG includes a number of waste fractions that were not covered by the RENDAN statistics.

The ISAG states the distribution of waste by waste type and the most important waste fractions, as well as the distribution by incineration, landfilling and recycling. Furthermore, the ISAG states the waste source. In future, the ISAG will give a much better base for following developments in waste streams, but the first full year covered is 1994. The 1993 ISAG statement is based on a conversion of reports from the last two quarters.

Due to the different methods of calculation, it is difficult directly to compare ISAG figures for 1994 and 1995 with RENDAN figures for the period 1987-93.

Recycling

RENDAN special statistics from recycling plants etc.
In recent years, RENDAN has kept special statistics for construction and demolition waste, compost waste etc. Furthermore, for certain traditional waste fractions such as paper/cardboard, glass and metal/scrap, RENDAN has in recent years calculated figures going back to the beginning of the 1980s. These special statistics can be used for interpreting the overall developments in waste types (RENDAN, 1996a).

4.4 Evaluation of the developments in different waste types

4.4.1 Waste types

Time series 1987-1993

RENDAN figures represent the only figures for waste types covering the major part of the 10 years' existence of the waste tax, i.e. the period 1987-1993.

Below, RENDAN statistics for 1987-1993 are used to describe and analyse developments in different waste types.

Table 4.1. shows the RENDAN statement for four waste types:

- Household waste: domestic waste, bulky waste and garden waste.

- Industrial and commercial waste: waste from trade, offices and industry.
- Construction and demolition waste
- Other waste: residues from incineration plants, waste from wastewater treatment plants, mixed waste and residues from power generation

	1987	1988	1989	1990	1991	1992	1993
House.	1,034	1,082	1,051	1,370	1,917	1,879	1,798
Ind/com	539	578	547	728	819	918	999
C&D	442	363	340	225	582	432	361
Other	615	571	494	647	1,234	1,056	887
Total	2,631	2,596	2,434	2,972	4,454	4,287	4,046
Cov-erage	64%	64%	64%	65%	92%	96%	98%

Table 4.1. Waste types, total statement 1987-93, (in 1,000 tonnes) with indication of coverage of registered plants (RENDAN, 1994: 25).

As mentioned, RENDAN statistics are inconsistent as from 1987-90 mainly municipal plants have reported, and from 1991-93 all plants have reported, including private inert waste landfills.

If the two periods are evaluated separately, the following comments can be made on Table 4.1.:

Inconsistencies over time

For household waste, amounts remain stable in the first period, and an increase is seen in 1990 due to increased reporting. From 1991 to 1993 there is a reduction of some 120,000 tonnes. For industrial and commercial waste, amounts are also stable in the first period, whereas in the second period waste amounts increase. For construction and demolition waste, a considerable reduction is seen from 1987 to 1990. The reduction is almost 50 per cent or 200,000 tonnes. In 1991, amounts increased to a level above the 1987 level, but this is because inert waste landfills etc. are now incorporated in the statistics. From 1991 to 1993 the amount of construction and demolition waste falls again and is reduced by some 200,000 tonnes or a good 40 per cent. For other wastes it is difficult to evaluate the development, but also here there is a break in 1990.

Calculation of distribution

Figure 4.4 shows the result of a calculation in which RENDAN data on composition of waste have been used to estimate the distribution of gross waste amounts delivered to municipal plants. Figure 4.4 corresponds to Figure 4.1 above as both figures show gross amounts delivered; Figure 4.4 in addition gives a distribution of waste by type.

For the present evaluation, RENDAN has delivered data at plant level for the years 1987 to 1993 allowing isolation of inert waste landfills etc. from the statement. However, it is not in all cases that there is agreement between waste amounts reported to RENDAN and amounts reported to the Central Customs and Tax Administration. Therefore, the basis has been taken in data on gross amounts from the Central Customs and Tax Administration. Subsequently, data from RENDAN statistics have been used to evaluate the composition of these waste amounts. For plants that have not reported data to RENDAN statistics in the first years, the waste composition has been estimated as an average of the distribution in following years. This leads to some uncertainty, as estimates have been carried out at a few, large landfills. It is estimated that the reduction in construction and demolition waste is somewhat underestimated in Figure 4.5, and that the reduction in household waste and mixed waste is correspondingly overestimated. The advantage of carrying out the calculations, however, is that it allows calculation of a complete time series for 1987 to 1993 giving a more realistic picture than a comparison of the 1985 survey with new ISAG figures.

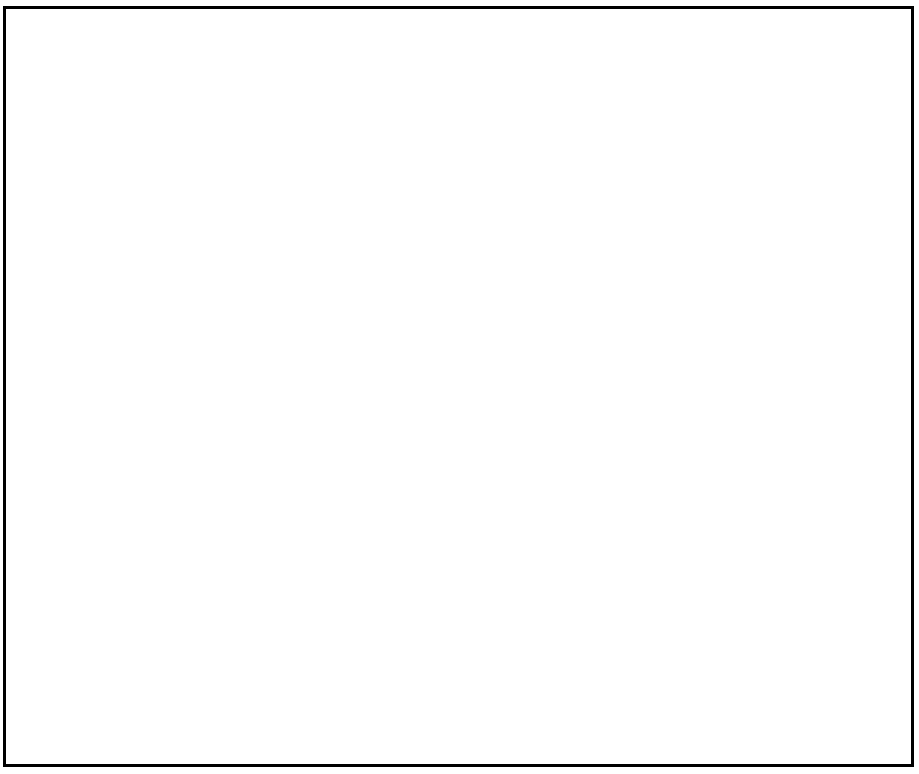

Figure 4.4. *Waste amounts and distribution of waste types 1987-1993. Municipal plants. Partly estimated statement based on plant data from the Central Customs and Tax Authorities and RENDAN.*

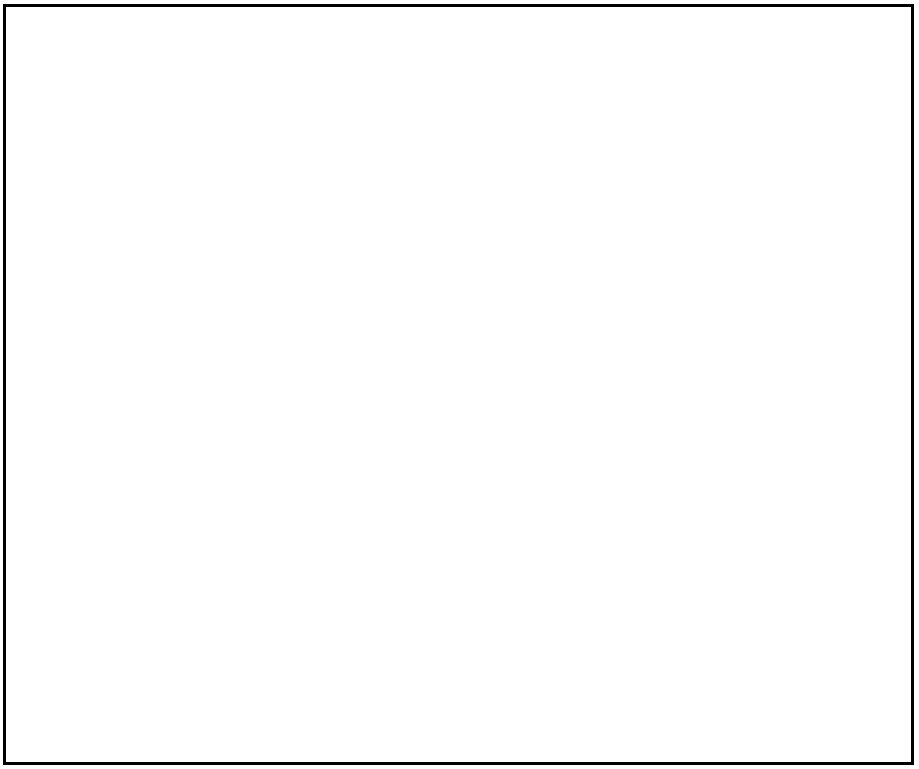

Figure 4.5. *Data for recycling, various material types (Source: RENDAN, 1996).*

Increase in industrial and commercial waste

Figure 4.4. shows that especially construction and demolition waste has decreased significantly from 1987-1993, but also household waste and other wastes show significant reductions. By contrast, industrial and commercial waste, after a reduction in the middle of the period, is increasing. Construction and demolition waste fell by 63 per cent, from 465,000 tonnes to 172,000 tonnes. Household waste fell by 16 per cent from 2,144,000 tonnes to 1,792,000 tonnes. Other wastes are reduced by 22 per cent, from 1,031,000 tonnes to 805,000 tonnes. Finally, industrial and commercial waste increased by 8 per cent, from 1,017,000 tonnes to 1,104,000 tonnes.

4.4.2 Waste fractions

Developments in recycling

In its Waste Handbook (RENDAN, 1996), RENDAN has published special statistics of the following waste fractions: iron and metal; paper; glass; compost and construction and demolition waste. These statistics are valuable when evaluating which waste streams are affected by increased separation and recycling. In Figure 4.5, the developments in these figures are shown.

Brief comments are given below; for a more detailed description, reference is made to the Waste Handbook.

Iron and scrap

The collection of iron and metal from 1986 to 1994 amounted to a relatively stable amount of some 600,000 tonnes[9], with small fluctuations. It is assessed that more than 90 per cent of potential iron scrap is collected, and it can be seen that even though iron and metal scrap is a heavy waste type sensitive to a tax on waste, the tradition of collection was established long before a tax was introduced. Enterprise interviews in the iron and metal sector show (see Chapter 5) that scrap iron has a positive economic value which promotes collection.

Paper/cardboard

Paper collection in Denmark has increased from 333,000 tonnes in 1986 to 521,000 tonnes in 1994. A potential of some 1 million tonnes is estimated. Despite requirements of the Danish Statutory Order on Waste concerning paper collection, only half the potential is collected.

Glass

The collection of glass etc. has increased from some 66,000 tonnes in 1986 to some 103,000 tonnes in 1994. The collection shall be seen in relation to a total glass consumption of approximately 158,000 tonnes. Despite requirements of the Danish Statutory Order on Waste concerning collection, only some two thirds of glass are collected. Again, the increase in collection is relatively moderate from 1986 to today, especially considering the extensive effort of establishing bottle banks etc.

Compost

[9] A more recent statement method incorporating other data sources leads to an estimate up to around 850-975,000 tonnes, but this cannot be compared with older data (RENDAN, 1996: 84; Miljøstyrelsen, 1996: 11).

A more positive development is seen when it comes to organic waste. Compost statistics show that amounts of source separated organic domestic waste, garden and park waste and sludge from wastewater treatment plants delivered to composting and biogas plants have increased from around 86,000 tonnes in 1990 to 500,000 tonnes in 1994. For 1995, the ISAG stated the amount at around 600,000 tonnes[10]. In addition, home composting is estimated at 15-20,000 tonnes annually. The Danish Statutory Order on Waste does not establish any requirements for recycling of organic waste, but many waste companies and local administrations have paid special attention to this waste fraction in recent years, cf. Chapter 6.

Construction and demolition waste

In 1993, only around 381,000 tonnes of construction and demolition waste were transported to taxable plants; of this amount around 206,000 tonnes were subsequently removed for recycling (RENDAN, 1996: 61).

In 1993, around 1.5 million tonnes of construction and demolition waste were transported to recycling plants. Furthermore, construction and demolition waste was applied in non-taxable backfillings (harbours, ski slopes, noise barriers etc.). This special form of recycling accounts for around 250,000 tonnes annually.

For construction and demolition waste RENDAN has estimated the total recycling rate at around 79-80 per cent.

Since 1991, RENDAN has made statistics of construction and demolition waste delivered to and removed from four different types of plant: 1) taxable plants; 2) non-taxable recycling plants with permanent address 3) non-taxable demolition 4) non-taxable backfillings. Data in Figure 4.5. state recycling at plants of types 2 and 3 (construction and demolition) and type 4 (backfillings).

Data for 1991 and 1992 underestimate actual amounts as not all plants delivered data for the statistics. From 1993 statistics are estimated to have an almost complete coverage. Especially concerning non-taxable backfillings (ski slopes, harbours etc.) it should be noted that the registration only attempts to cover amounts over 500 tonnes. Local administrations have contributed with information on such backfilling projects to RENDAN.

For taxable plants, registration was almost complete as early as from 1991. The delivery to taxable plants of construction and demolition waste decreases markedly from 1991 to 1994: from 689,000 to 403,000 tonnes (RENDAN, 1996: 62). Statistics of construction and

[10] Excl. sludge, but incl. around 120,000 tonnes mainly organic industrial waste for biogasification.

demolition waste show a larger delivery of construction and demolition waste than the waste type statement (Figure 4.4), and it may be explained by the inclusion in the first statistics of private inert waste landfills etc., and by the general uncertainty in the waste type statement.

Especially within construction, crushing of materials for reprocessing and recycling is common. Asphalt, bricks and concrete account together for around 1 to 1.2 million tonnes of construction and demolition waste, and these materials are widely recycled. For asphalt, however, statistics show that recycling has not increased significantly since 1986. It has remained stable at around 2-300,000 tonnes annually. By contrast, there seems to have been a considerable increase in the recycling of concrete and bricks, from 1991-94 alone by some 200,000 tonnes.

Composition of gross reduction

4.4.3. Evaluation of composition of taxable waste reduction
Firstly, the reduction in gross waste amounts delivered to municipal plants is evaluated. This is only done for 1987 to 1993 as waste type statistics (Figure 4.4) are only stated for gross amounts delivered. Subsequently, the composition of net waste amounts delivered to municipal plants is evaluated.

Figures 4.2 and 4.4 show a total gross reduction by 786,000 tonnes from 1987 to 1993. There was a minor increase in amounts from 1993 to 1996, but if it is assumed that in this period no significant shift between the fractions took place, there is no major differences between the situation in 1993 and that in 1996 with respect to the composition of the reduction. The estimated waste type statement (Figure 4.4) shows that from 1987 to 1993[11] there was a relatively significant drop in construction and demolition waste, and also in household waste and other wastes. There was no reduction in industrial and commercial waste.

Below, an evaluation is given of the consistency between the estimated waste type statement and recycling statistics.

Construction and demolition waste down by 400,000 tonnes

Construction and demolition waste
The waste type statement (Figure 4.4) shows that a reduction took place in gross delivered construction and demolition waste by some 285,000 tonnes from 1987 to 1993. Original RENDAN figures show (Table 4.1) that in each of the two periods a decrease of 200,000 tonnes was registered, i.e. a total of 400,000 tonnes, but this figure

[11] From 1993 to 1996 waste amounts increase somewhat, but as the RENDAN material stream analyses stopped after 1993, this year is used as the year of reference for an evaluation of the reduction distributed by waste fraction.

includes inert waste landfills. RENDAN special construction and demolition waste statistics, covering only 1991 to 1993 show that in these years alone there was a decrease in gross delivered amounts by around 300,000 tonnes. Also this figure, however, includes inert waste landfills. Against this background, it seems probable that the waste type statement underestimates somewhat the reduction in gross delivery of construction and demolition waste to municipal plants, but the reduction is not estimated to exceed 400,000 tonnes.

Increased recycling

Recycling statistics for construction and demolition waste show that considerably larger amounts are recycled than the drop in amounts delivered. However, as the recycling statement only achieved satisfactory coverage of construction and demolition waste from 1993 onwards, it is difficult to compare the two sources. In 1993, 1.5 million tonnes construction and demolition waste were transferred to crushing plants, and 250,000 tonnes were used for backfillings. This gives a considerably larger recycling than the estimated reduction in waste amounts. However, there are indications that already before 1987 a certain amount of recycling of construction waste took place, as 2-300,000 tonnes of asphalt were recycled already in the mid 1980s (RENDAN, 1996). Recycling statistics confirm in one area the tendency of the estimated waste reduction. The decrease in construction and demolition waste amounts by around 2-300,000 tonnes in the period 1991-93 stated in RENDAN figures (Figures 4.4. and 4.6), corresponds to an increase in recycling of bricks and concrete also by some 200,000 tonnes in the same period. The explanation of these larger amounts is partly that construction and demolition waste that used to be transported to inert waste landfills now goes to recycling, and partly in the considerable increase in construction activity cf. Figure 4.8 below.

Household waste

Household waste down by 352,000 tonnes

If the starting point is taken in the estimated waste distribution (Figure 4.4) made on the basis of RENDAN and Central Customs and Tax Administration figures, it is seen that from 1987 to 1993 a reduction in household waste of around 352,000 tonnes took place.

On the basis of RENDAN special statistics for recycling (Figure 4.5) it is seen that from 1987 to 1993 a total increase in recycling of paper/cardboard (190,000 tonnes), glass (38,000 tonnes), and composting (around 500,000 tonnes) has taken place - a total of 735,000 tonnes. The difference between this figure and the 352,000 tonnes reduction in household waste given in the waste type statement (Figure 4.5) is partly due to the fact that only part of this separation and col-

lection can be attributed to households. Of the around 500,000 tonnes of paper collected, the ISAG estimates that in 1994 some 140,000 tonnes came from households. Of the around 103,000 tonnes of glass collected, the ISAG estimates that in 1994 some 70,000 tonnes came from households. Of the around 600,000 tonnes of composting/garden waste in 1994 the ISAG estimates some 280,000 tonnes came from households. It is difficult to assess how large a part of the increase in the different fractions can be attributed to households, but if it is assumed that households' part of the increase in recycling of paper and glass corresponds to their total part of recycling of these waste fractions, the following figures can be calculated: around 60,000 tonnes paper, 25,000 tonnes glass and 125,000 tonnes garden waste/organic waste. This leaves a residual amount of some 140,000 tonnes which is assumed mainly to be made up of bulky waste and other waste types from households, but which also reflects that the drop in household waste amounts may be somewhat overestimated, though hardly by more than some 50,000 tonnes.

Other wastes

Other wastes down by some 200,000 tonnes

It is not possible to compare the waste type statement with recycling statistics, but the 200,000 tonnes reduction shown by the waste type statement probably reflects especially the increase in recycling of slag from waste incineration plants.

Amounts subsequently removed

In addition to the around 786,000 tonnes of waste in reduced delivery from 1987 to 1993, the same period has seen an increase of 292,000 tonnes in amounts subsequently removed from municipal plants. These amounts are materials for recycling, slag and waste transfers, but it is not possible to make a breakdown by types for the period 1987-1993.

4.5 Waste amounts in relation to a baseline

Baseline index

In Section 4.2, general data from the Central Customs and Tax Administration on waste amounts are used to describe developments. Section 4.3 gives an outline of existing waste statistics, and Section 4.4 uses the RENDAN material stream analyses to detail the type distribution of waste. In this section, developments in waste amounts will be related to a baseline. The baseline represents a picture of developments in waste amounts without regulation, taxes etc.

In Figures 4.6, 4.7 and 4.8 waste amounts from households, industry/commerce and construction/demolition are related to relevant indices from Statistics Denmark. For construction and demolition waste, the development in construction investments has been chosen, as this waste derives mainly from construction activities rather than from building activities. For industry and commerce the net production index has been chosen. For households the private consumption index has been chosen.

De-linking construction index and waste

Figure 4.8 shows that construction activities in particular increased in the period, and at the same time construction and demolition waste has decreased significantly. This may also explain the significant amounts delivered to recycling plants. Without the efforts to recycle construction and demolition waste, residual waste amounts could have increased considerably in the 10-year period in question. By contrast, the change in the net production index has followed quite closely the change in industrial and commercial waste. For households, there has been a slight de-linking between waste amounts and developments in consumption.

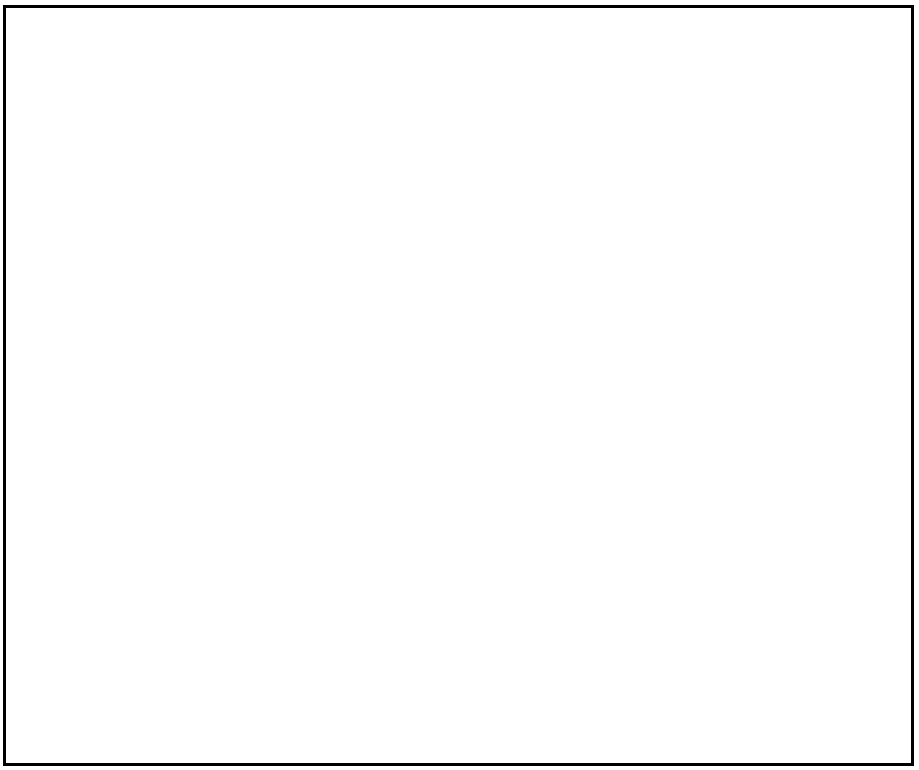

Figure 4.6. *Index of households and consumption index.*

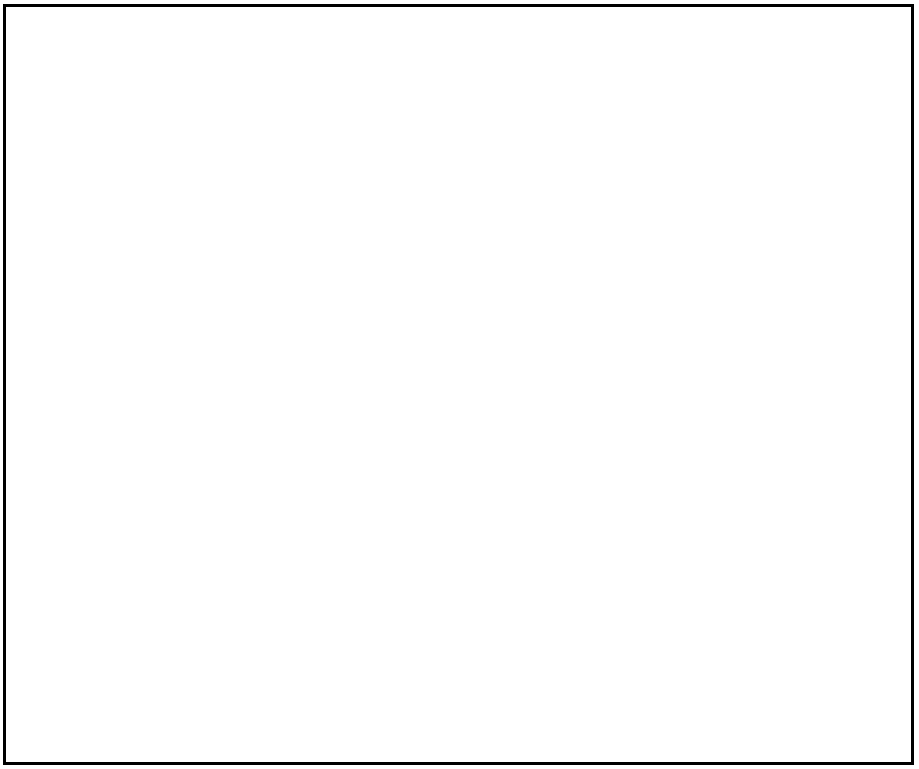

Figure 4.7. *Index of industrial/commercial waste and net production index.*

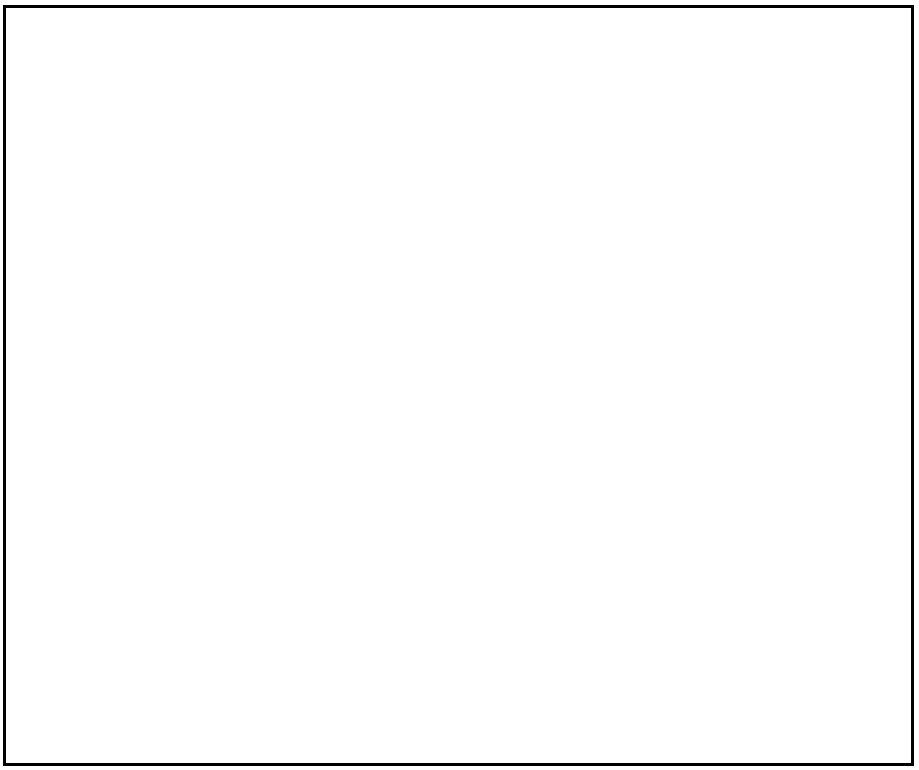

Figure 4.8. *Index of construction and demolition waste delivered to municipal plants and index of construction investments.*

4.6 Balance and summary

Focus on net amounts delivered

On the basis of data from the Central Customs and Tax Administration on waste tax yields, developments in taxable residual waste amounts have been analysed. In order to account for transfer of waste and separation of waste for recycling, the central parameter for the evaluation of the development in residual waste amounts has been net amounts delivered. Net amounts delivered are calculated as gross amounts delivered, with a deduction for amounts subsequently removed. As the taxable base for the waste tax was extended in 1990 it has also been important to account for this at the evaluation of developments in residual waste amounts, and consequently developments have been stated separately for municipal plants and inert waste landfills etc.

Reduction of 26 per cent

In the period from 1987 to 1996 there was a drop in waste amounts delivered to municipal plants of 26 per cent. At inert waste landfills etc. there was also a decrease in waste amounts which were taxable in 1990. From 1990 to 1996 this decrease was 39 per cent net. The reduction for both categories of plant took place in the period from 1987 to 1993. From 1993 to 1996, waste amounts increased slightly, which is probably due to the economic recovery.

By processing RENDAN material stream analyses from 1987 to 1993, it has been possible to analyse the composition of the waste reduction at municipal plants. It has only been possible to calculate developments in the composition of gross amounts delivered.

Type distribution and reduction

The reduction at municipal treatment plants is evaluated as comprising a reduction in household waste of around 352,000 tonnes, a reduction in construction and demolition waste of around 293,000 tonnes and in other wastes of 226,000 tonnes. An increase in industrial and commercial waste of 86,000 tonnes has taken place.

Data from the Central Customs and Tax Administration from 1987 to 1993 show an increase of 294,000 tonnes in waste subsequently removed from plants, which is assessed primarily to comprise construction and demolition waste and slag from incineration plants, but the composition cannot be detailed further.

At inert waste landfills there is a decrease in net amounts delivered from 1990 to 1993 of around 167,000 tonnes, and the major part is assessed as a reduction in construction and demolition waste.

Heavy waste fractions reduced most

This means in total that the most significant reduction has taken place for construction and demolition waste which is assessed to account for a waste reduction of around 560,000 tonnes at taxable plants.[12] The second largest share is the composting of garden waste. Even though recycling has increased by around 500,000 tonnes, it must be assumed that some garden waste was previously burned locally, so that the reduction in taxable amounts hardly accounts for more than half this amount. Householders have reduced their waste considerably, by around 352,000 tonnes, but glass and paper are assessed to only constitute a minor part of this, a total of 85,000 tonnes. Two thirds are estimated to be garden waste and bulky waste.

As a conclusion it is seen that the most significant reductions in residual waste amounts have taken place for "heavy" waste fractions: construction and demolition waste, garden waste and bulky waste. In addition, an increase in recycling of slag from incineration plants is seen. The mandatory collection of glass and paper only accounts for a minor part of the reduction in taxable waste amounts.

[12] The figure of 560,000 tonnes is composed of 293,000 tonnes less delivery according to the material stream analysis, an assessed 100,000 tonnes removed subsequently for recycling at municipal plants 1987-93, and 169,000 tonnes less delivery to inert waste landfills from 1990-1993.

5. Industrial/commercial waste and construction/demolition waste

5.1 Introduction

Lack of good data

In this chapter the results of the study of the effects of the waste tax on industrial and commercial waste and construction and demolition waste are described. Industrial and commercial waste (waste from trade and offices and industry) accounted for some 30 per cent of total waste amounts in 1995, whereas construction and demolition waste accounted for around 23 per cent (Miljøstyrelsen, 1996:6). Total waste amounts include waste for recycling.

Due to the lack of good statistics on industrial and commercial waste and corresponding sector specifications, the starting point for this study was rather difficult. It is not possible to set up time series for the development in the different sectors' waste generation and to compare these to the development in production, employment or consumption. Consequently, it is not possible to calculate key figures of waste amounts and to estimate their development over time.

5.2 Study of enterprises

Interview studies

The purpose of the study of industrial and commercial waste and construction and demolition waste was to clarify the role of the waste tax for the waste management in different enterprises. The study was planned as an interview-based case study of selected enterprises. At the planning of the study, the starting point was taken in selected sectors, and subsequently a certain dispersion was aimed at, geographically and by size. The study of enterprises was not planned as a representative random check, but more as a case study of the behaviour of enterprises towards waste separation and recycling and of their perception of the effect of the waste tax on their own waste management. Enterprises in the following sectors/areas were interviewed: iron/metal, newspapers, breweries, trade and service, a public institution, and building and construction.

Characteristics of sectors

In the manufacturing industry, iron and metal represents a sector with quite large waste amounts. It is also a sector generating heavy waste and as such it should be expected to be sensitive to a weight-based tax. Large waste amounts generated in newspaper production make it reasonable also to consider newspaper production as a waste intensive sector. A large part of Danish manufacturing industry processes food, but surveys of abattoirs and fish-processing industries showed that very limited amounts of residual waste were generated here. In this study, breweries are included as a more waste-intensive sector in the generally low-waste food-processing industry.

The opportunities for recycling especially of paper, cardboard and packaging are good, and consequently the study comprises trade and service. Focus has been put on supermarkets (packaging waste etc.) and a telecommunications company. Furthermore, one public institution and an enterprise in the building and construction sector have been included.

Selection criteria

Interviewed enterprises have been selected relatively randomly by checking commercial registers and by using criteria of geographical location and size. The use of environmental management, certification or similar has not been a selection criterion, even though such facts might have improved the information base at the individual enterprises. The reason for not using such criteria was that more conventionally operated enterprises would then have been underrepresented in the study. The study has not made a systematic survey of waste streams and costs at the enterprises if such a survey was not already available. For each sector, a visit was paid at the first selected enterprise, whereas subsequent interviews were carried out by a mixture of visits and telephone interviews.

Questioning technique

Enterprises have presented their waste streams, separation measures and recycling of material fractions, if any. This presentation took the form of an open discussion which was completed with a summing up of information in a structured questionnaire. At the completion of the questionnaire, the enterprise was also asked to evaluate the effect of the waste tax. The central question in the study was to urge enterprises to identify themselves the motivation for their behaviour towards waste separation, and to give their views on the impact of treatment costs and waste taxes on this behaviour.

5.3 Outline of selected sectors and enterprises

An outline is given below of selected sectors and enterprises.

Iron and metal

Recycling tradition

In this sector four enterprises were interviewed - three relatively large enterprises with more than 500 employees, and one small enterprise. The enterprises manufacture pumps, transport material, machinery and various metal articles.

Enterprise A is very advanced in environmental management and has recently received an EMAS certificate. It has a very detailed knowledge of waste streams at the enterprise. Waste - especially stainless items - has a considerable economic value. Sales generate an income of some DKK 26 million annually which should be compared to the overall result in the last accounting year of DKK 80 million. Around 93 per cent of waste - scrap and plastic items - is transported to recycling.

Also at the three other enterprises, separation and sale of metals take place. At enterprise B the recycling rate is 37 per cent of total waste amounts, and primarily scrap is recycled. Plastic and other waste types go to landfill or incineration. Recently, the enterprise has launched a project on environmental management and green accounting. Enterprise C is a medium-sized ISO certified enterprise. Extensive separation of waste takes place, but for reasons of competition the enterprise does not want to state quantities (production can be derived from these figures, and the enterprise is in heavy price competition with another Danish enterprise). Enterprise C does not see any significant financial benefit from separating and selling scrap, but no detailed outline of revenues could be given. Enterprise D has taken no special initiatives to reduce waste amounts and only sells metal for reprocessing, whereas other fractions are disposed of conventionally. At enterprise D it was not possible to state total waste amounts or rate of recycling, but it was estimated that scrap accounted for some 95 per cent.

Newspaper printing houses

Modest knowledge of costs

Enterprises interviewed are distributed over the entire country: one very large enterprise in Copenhagen, two medium-sized in Jutland/Funen and a small enterprise on Sealand. In general, there is no very precise knowledge of actual costs of waste disposal in the sector, including the effect of the waste tax as a cost component in relation to other cost components. The reason for this is that responsibility

for the physical disposal is often separated from financial responsibility. The most solid knowledge of physical amounts is found in a recent life cycle analysis in one of the printing houses. The dominating waste type is waste paper and residual rolls from the printing process. 12 to 14 per cent of paper purchased is wasted in production. Waste paper constitutes 90 per cent of total waste amounts. The largest enterprise has invested in a new material handling system, limiting the damage to paper rolls and thereby also waste amounts. Separation for recycling of paper is systematised at all four enterprises, and all enterprises have collection of metal (especially aluminium), plastic, electronic waste and ordinary domestic waste.

Breweries

Good environmental management

Two of the largest enterprises in the sector were interviewed. Breweries have a wide range of waste types; kieselguhr from filtration, draff and yeast are special to this sector. A large proportion of these waste types are transported to wastewater treatment plants, biogas generation or agriculture. Breweries had the most precise knowledge of waste amounts and related costs of all interviewed enterprises.

Enterprise A has a comprehensive environmental management system, and for the last two years a separate section on the environment has been included in the annual report. Waste is separated according to the municipal waste regulation into 16 different fractions, and for each fraction the enterprise has stated costs of carrier, treatment and taxes so that it is possible to act continuously in response to developments in costs. However, it is first and foremost the pressure from local authorities that has led to the extensive separation; at another plant belonging to the group in another part of the country the local council allows less extensive waste management.

Enterprise B has no dedicated waste policy, but has introduced extensive separation and collection systems for a number of fractions. Also at this enterprise, precise knowledge of different cost components has been established. The enterprise tries very consciously to optimise waste management. Separation of plastic and plastic film has been given up, and due to low prices at the moment of waste paper, labels are not sold to recycling, but disposed of with other waste.

Trade and service

Interviewed enterprises are a large supermarket chain, a regional shopping centre and a small local supermarket. Furthermore, a telecommunications company has been interviewed as an example of a modern service enterprise.

Limited attention

In the supermarket chain A, responsibility for environmental management is centralised at the head office where the interview also took place. In another supermarket chain, which is not included in the study, responsibility was delegated to individual shops, so the interviewed chain is not totally representative of this retail type. Enterprise A has centralised waste management, and all invoices are sent to the head office which is in charge of contact to carriers. No actual registration of waste amounts has been made at individual shops. The enterprise has a turnover of DKK 2 billion and waste generation of 500 tonnes per year. All food waste is collected in accordance with the Danish Statutory Order on Waste. Transportation of this fraction is relatively expensive, and by finding a carrier using weight-based invoicing, it has been possible to reduce costs by half.

Enterprise B is a regional shopping centre covering almost all articles. Enterprise B has no formulated strategy of waste management which is rather ad-hoc and decided by possible financial advantages gained from modified procedures. No central registration of costs and revenues of waste management takes place, and economic optimisation of waste management is also ad-hoc.

Enterprise C is a local supermarket. The enterprise has taken no measures to reduce waste amounts, but does separate waste in three fractions: fruit/vegetables, meat waste and paper/cardboard.

Enterprise D is a nation-wide telecommunications company. Responsibility for waste management is shared by five different people, and it was difficult to get a full view of waste amounts. In addition to iron and metal, paper and cardboard is separated. Costs of waste management are considerable, around DKK 1 million annually, but the enterprise did not give the impression of being very active with regard to the environment compared to manufacturing enterprises in other sectors.

Generally, the impression is that trade and services are not very attentive to waste management and related costs.

Public institution

Considerable amounts

The institution interviewed is a state-owned university. Waste streams at the university consist mainly of traditional office waste (paper/cardboard, electronics, plastic, batteries, fluorescent tubes etc.), but also park waste and problem wastes are generated, for example from laboratories. Paper/cardboard is collected, as is mandatory. Park waste is transported to a municipal collection centre. The responsibility for problem wastes is delegated to the different

institutions. Disposal costs amount to DKK 1 million annually, but the university informs that it has taken no specific initiatives to reduce waste amounts apart from the mandatory collection scheme.

Building and construction

The enterprise interviewed is engaged in train operation (Danish State Railways - Building and Construction). The enterprise is state owned, but is operated as an independent company.

Source separation of construction and demolition waste

DSB Building and Construction was recently divided into DSB building division and a service division of the Danish National Railways Agency. The latter is responsible for bridge construction, rail establishment, establishment of stations and platforms etc. In this service division, two employees are responsible for guidelines on waste management to the different project groups. The aim is to establish source separation (in 35 fractions) and to increase internal recycling. The recycling rate amounts to 50 per cent. The Danish National Railways Agency is preparing general project guidelines that will comply with all municipal waste regulations. A/S Øresundsforbindelsen (fixed link between Denmark and Sweden) is mentioned as the first client to make environmental requirements to the enterprise, but requirements did not exceed already established practice. The largest single fraction of waste is broken stone from railway tracks, polluted with oil residues and heavy metals; this fraction amounts to 50,000 tonnes per year.

Summary

Big variation in waste management

In conclusion, especially breweries and iron and metal enterprises have a well developed waste management system. In these sectors, an acceptable statement of waste amounts is found, and costs and possible revenues are in most cases surveyed. This is also to some extent the case for the Danish National Railways Agency, which is preparing a coherent waste strategy. Waste management in newspaper printing houses is decided by requirements in the Danish Statutory Order on Waste to recycle paper and cardboard and by the fact that enterprises are positive to recycling; also here there is a large recycling rate. The least developed waste management is found in trade and services and at the university. Amounts are merely estimated, and knowledge of costs of waste management is only found in the bookkeeping department where it was not possible without some effort to state such costs separately. The poor attention at these enterprises cannot be explained by small residual waste amounts. The supermarket chain A, for example, has a residual waste amount of

500 tonnes per year, whereas the university generates 1,000 tonnes per year. In comparison, residual waste amounts at the iron and metal enterprises A and B amount to around 500 tonnes and at the brewery A to some 2,000 tonnes per year. However, it may be of some importance that total waste amounts before recycling are considerably larger in manufacturing enterprises.

5.4 Results of interviews

Results of the questionnaire study are presented below.

Measures to reduce waste amounts

Initiatives towards waste reduction

By way of introduction, enterprises were asked whether in recent years they had taken any measures to reduce waste amounts. 13 enterprises answered in the affirmative; only three enterprises have taken no initiatives to reduce waste amounts. These three enterprises are iron and metal enterprise D, supermarket C and the university. However, the iron and metal enterprise sells its scrap iron, and the supermarket and the university undertake the mandatory separation of paper/cardboard.

Has the enterprise taken any measures to reduce waste amounts in recent years ?	Yes
Iron and metal	3
Newspaper printing houses	4
Breweries	2
Trade and services	3
University/building and construction	1
Total	13 (of 16)

Table 5.1. *Number of enterprises which have taken measures to reduce waste amounts.*

Tables 5.2 and 5.3 show in more detail which waste types are generated at which enterprises, and which are separated for recycling or recovery.

	Metal	Paper/ board	Plastic	C&D	Glass	Electronic	Oil/ chem	Domestic	Other
Iron/metal	4	4	2		1	3	3	3	4
Printing	4	4	1	2	1	3	3	4	2
Breweries	2	2	2	1	2		2	2	1

Trade + services	2	4	1	1	1	1	1	4	1
Univ/build +construct	1	2	1		1	1	2	1	2
Total	13	16	7	4	6	8	11	14	10

***Table 5.2**. Which waste types are generated in the enterprise ?*

	Metal	Pa-per/board	Plastic	C&D	Glass	Elec-tronic	Other
Iron/metal	4	3	1			3	1
Printing	4	4		1		2	
Breweries	2	2	2		2		1
Trade/services	2	3					3
Univ/build+construct	1	2	1	1	1	1	2
Total	13	14	4	2	3	6	7

***Table 5.3.** Which waste types are separated for recycling or recovery ?*

Collection of metal and paper most widespread

Table 5.2 shows that iron and metal, waste paper and ordinary domestic waste are the dominating waste streams, but many enterprises also generate electronic waste and oil/chemical waste. A comparison of Table 5.2 and Table 5.3 shows that primarily iron and metal waste and waste paper are separated. Concerning plastic, construction and demolition waste and glass, efforts are modest. It is surprising that only three enterprises separate glass.

Concerning separation within the different sectors it is seen that all four iron and metal enterprises separate iron and metal waste, all four printing houses separate both paper and metal waste, both breweries separate metal, paper, plastic and glass, three trade and service enterprises separate paper, and the university and Danish State Railways separate paper. Manufacturing enterprises have the widest range of separation, whereas trade/services and the university focus mainly on paper and cardboard.

Other recycling

Reduction in waste amounts may also be achieved in other ways than by conventional separation, for example through in-plant recycling, changed raw material consumption and requirements to suppliers.

Such measures were clarified by an additional question to those enterprises that had taken initiatives to reduce waste amounts.

Four enterprises have in-plant recycling: enterprise A uses for example paper and cardboard residues as shock-absorbing packaging instead of the traditional expanded polystyrene "chips". Two enterprises answer that they have made requirements to suppliers. Iron and metal enterprise A has requested a changed format of iron sheets entailing less wastage, and newspaper printing house A has modified production equipment to reduce paper wastage. Two enterprises reply "other", including a newspaper printing house which has introduced thinner paper.

In what ways has the enterprise reduced waste amounts ?	
In-plant recycling	4
Changes in raw material consumption	0
Requirements to suppliers	2
Other	2

Table 5.4. *Other measures to reduce waste amounts.*

Motivational analysis

Many different factors play a role for enterprises' decision to reduce waste amounts, and these factors were surveyed through interviews on waste management.

Motivation for separation and recycling

As mentioned in Chapter 4, the iron and metal industry has a well-established tradition of not discarding metal and scrap. It is sold, often entailing a quite considerable revenue. Newspaper printing houses are subject to requirements in the Danish Statutory Order on Waste to recycle paper and cardboard, but as waste amounts from this source are quite significant (especially paper rolls from the press constituting close to 90 per cent of waste collected), it is probably finansially advantageous to avoid landfilling or incineration. However, the printing houses had no picture of financial advantages of recycling, as they primarily wished to comply with the requirements of the Statutory Order. Both at breweries, several of the printing houses and one iron and metal enterprise, it was a management decision to opt for recycling based on more general considerations of the environmental profile of the enterprise. Within trade and service and at the university economic advantages of recycling were less in focus. One supermarket chain desired to strengthen its environmental profile. Two other supermarkets and the university were found to have internal organ-

isational and institutional barriers that make waste management costs more or less invisible to specific decision makers.

Essential factors

In order to identify factors that have had an impact on waste management in enterprises, interviews were completed by asking enterprises to state which factors had been essential for them in their effort to reduce waste amounts.

Which factors have had an essential impact on the decision to reduce waste amounts?	Number
Requirements in municipal waste regulation	7
Requirements in environmental approval	4
Revenues from sale of residual products	10
Costs of disposal	8
Request from clients	2
Enhanced environmental profile	8
Other	6

Table 5.5. *Results of motivational analysis*

Frequent mention of sale of residual products

Table 5.5 shows that the most important reason for the reduction in waste amounts - mentioned by 10 of 13 enterprises having taken measures to reduce waste amounts - is the possibility of generating revenues through the sale of residual products. Second-most important factors are the desire to reduce costs of waste disposal and the desire to enhance the environmental profile of the enterprise, both reasons mentioned by eight enterprises. Seven enterprises mention requirements in municipal waste regulations (most frequently, the obligation to separate paper). Requests from clients is the lowest ranking factor.

Enterprises stating a desire to reduce costs as an important factor were specifically asked about the impact of the waste tax.

If yes to cost factor - has the waste tax had an impact ?	

To a large extent	1
To some extent	1
To a minor extent	3
None at all	3
Waste reduced, but costs of no importance	5
No measures to reduce waste	3

Table 5.6. *Direct impact of waste tax in relation to the reduction in waste amounts.*

Direct effect of waste tax

Table 5.6 shows that only two of eight enterprises mentioning the reduction of costs as an important factor, found that the waste tax had a direct impact "to a large extent" or "to some extent" in relation to other cost components. Six enterprises saw no impact from the tax. The enterprise stating an impact "to a large extent" is brewery B, one of the few enterprises with a total picture of costs of waste management.

The modest attention to the waste tax at enterprises is demonstrated by the fact that few enterprises envisaged changes in behaviour as a consequence of the tax increase agreed in 1993 and effective from 1.1.1997, cf. Table 5.7. Three enterprises envisaged increased recycling or other measures, whereas the remaining enterprises either expected no impact or were not aware of the tax increase.

Which impact on waste management in the enterprise do you expect from the tax increase as from 1.1.97?	
Increased recycling	1
Changed raw material consumption	0
Other	3
No impact	8
No answer [1)]	5

[1)] In some cases due to lack of knowledge.

Table 5.7. *Reactions to the increase in the waste tax rate as from 1.1.97.*

5.5 Financial evaluations of enterprises' behaviour

Waste cost components

As mentioned in Chapter 3, the waste tax is only one of several cost components related to waste disposal. In addition to the tax, total disposal costs will normally also comprise cost components such as rent of containers, transportation, fees for landfilling or incineration, as well as internal staff and surface costs. Apart from fees and the tax, the same cost components will in principle apply to recycling. Whether the tax can shift the balance between recycling and conventional disposal will also depend on the price of recyclates. The enterprise will also be able to save costs by reducing costs of transportation or by compressing waste more, so it is not necessarily true that an increase will result in a reduction in waste amounts. A tax increase will, however, often draw attention to waste management.

Enterprises which have carried out precise financial calculations have generally been reluctant to give specific financial information as this will require detailed insight in contracts on disposal of industrial and commercial waste including discounts, as well as sales prices of residual products.

Better exploitation of staff resources

Brewery A stated that the largest saving in waste management has been achieved by a better exploitation of staff resources. Better planning of work has led to savings of DKK 350,000 which can be related to a total waste bill of some DKK 3 million. The sale of residual products has for a long time generated revenues. Before 1988 revenues amounted to DKK 950,000 annually, and after the introduction of recycling measures revenues have increased to around DKK 1.1 million. Direct savings in the waste bill as a consequence of recycling are limited to around DKK 100,000.

Enterprise B in the iron and metal sector separates and recycles 37 per cent of waste generated, and the costs of disposal of residual waste, including hazardous waste, amount to around DKK 300,000 annually. This amount is modest and does not immediately give hope for large economic gains from enhanced recycling efforts. At the time of the interview, the enterprise had just engaged an environmental expert who, in addition to optimising waste disposal, was also to analyse wastewater treatment which for this enterprise represents a considerable cost.

Limited gain from increased paper separation

The university and the telecommunications company, each with a total waste bill of around DKK 1 million annually, do not seem to have a possibility of considerable savings. At the university separation of paper and cardboard takes place, but is not very efficient. The waste company charges the same rate for container rent and collection of residual waste and waste paper when container volumes are

identical. The rent of a 6 cu.m. container amounts to DKK 2,280/year and each collection costs DKK 150. Due to the development in the waste paper market with negative prices for several years, disposal of paper must be paid for. The sales price for one tonne of paper fluctuates, but ranks from DKK +100 to -275/tonne. Contracts ensure that sales prices are adjusted regularly. This amount should be compared with the price of disposal of one tonne of residual waste which comes on top of the price for container rent and collection. This price was in 1996 DKK 459/tonne. This means that savings of between DKK 184 and 559/tonne waste paper that is separated instead of disposed of as residual waste can be achieved. However, the sales price of waste paper has almost constantly been negative.

DKK 46,000 savings by 25% increased recycling

The calculation below illustrates well why the question of recycling often depends on the price of recyclates. The university has around 1,000 tonnes of residual waste annually, and the composition of this waste is not fully known. If it is assumed optimistically that around 25 per cent of this waste is paper that could be recycled, it would be possible with the present price of paper to save around DKK 46,000 on the annual waste bill. This is a modest gain from a reduction in residual waste amounts by 25 per cent, when total waste disposal costs around DKK 1 million. The limited gain is due to the fact that the sale of paper for recycling also entails considerable costs, primarily for container rent and collection.

Surplus capacity for recycling is expensive

The situation for the university, or any other enterprise considering increasing recycling, is furthermore that the question of exploitation of capacity becomes central for the marginal economic gain from increased recycling. If the institution already pays for a certain capacity of collection of residual waste, and it will have to pay extra for a capacity for the collection of another fraction, for example paper, it must be decided with certainty how much capacity should be moved from residual waste to paper. If, as a consequence of recycling, there is unexploited capacity in the containers for residual waste, the recycling effort will entail extra costs for the enterprise. Thus, it will be rational for the enterprise to calculate the capacity of recycling conservatively, as all waste can always be disposed of as residual waste. Only under the assumption that paper is such a valuable residual product that companies would collect it free of charge and also be in charge of containers, would it be possible to disregard costs of containers and collection completely and to enjoy the full savings corresponding to the waste reduction.

Positive price of waste products help

The impact on recycling from the positive price of waste products was also seen above in the interview results and is supported by the enterprise studies. Especially in the iron and metal sector there is a market for residual products, cf. enterprise A that sells relatively valuable waste products for DKK 26 million annually.

The exception from this is shown in the building and construction sector. Waste amounts for some construction and demolition works are so large that costs of disposal incl. taxes are visible and will have an impact on profitability.

Effect on construction and demolition waste

In the case of the Danish National Railway Agency having 500,000 tonnes of broken stone, total disposal costs, including DKK 50/tonne for the cheapest landfill and DKK 335/tonne in taxes, are estimated at around DKK 19.2 million excluding transportation. Without the state tax the cost would be some DKK 2.5 million. It has not been possible to set up a precise calculation of alternative disposal costs of recycling, which would also comprise transportation costs, but the Danish National Railway Agency, however, is aware that landfilling is very costly. It has succeeded in selling the broken stone for reprocessing.

A study of crushing and recycling of a concrete bridge of the Danish State Railways revealed additional costs of DKK 38/tonne in relation to conventional demolition, which balanced with a waste tax of DKK 40/tonne (Miljøstyrelsen, 1990b: 13). The sales price of the crushed concrete was not included. At today's prices, the landfilling of 4,700 tonnes of concrete from the bridge would cost DKK 1.8 million and recycling would give a surplus of DKK 297/tonne.

5.6 Summary

In conclusion, it is seen that the waste tax has had a modest impact on industrial and commercial waste, whereas it plays a more significant role for construction and demolition waste in large, concentrated fractions.

Limited knowledge of costs

In general, interviews left the impression that many enterprises had limited knowledge of costs of waste management. Often it was not possible for the person responsible for waste management to calculate total costs of waste management, neither immediately nor at a follow-up after the interview. At newspaper printing houses, as also in other sectors, physical responsibility was isolated from financial responsibility, and therefore there was limited knowledge of various

cost components and their interrelationship. This also seemed to be the case within trade and service and at the university.

The modest attention to economic aspects of waste management is in itself not very surprising, as costs of disposal of residual waste normally do not exceed 0.5 per cent of enterprises' turnover. This phenomenon is known from the energy area where costs rarely exceed 2 per cent of turnover, and waste evidently is placed one step lower than energy in cost consciousness.

Price span not large enough

Some manufacturing enterprises, especially within iron and metal and food processing, have a tradition of recycling which has now been enhanced. Waste costs are generally modest compared to operations as a whole, but some enterprises, in connection with the introduction of more general environmental management systems, have tried to reduce amounts and increase recycling. With the often modest or even negative price of waste products, the waste tax does not seem to have created a price span large enough to create a strong incentive for recycling. This may be changed with the tax increase taking effect on 1.1.1997.

6. Strategic decisions in waste companies

6.1 Introduction

Questionnaire study

In connection with the present evaluation, a questionnaire study was carried out among local administrations in order to clarify which factors influence the design of collection schemes. Local administrations were asked to state for which waste fractions separate collection schemes or treatment plants were established. They were furthermore asked to state the motivation of their choices. In this context, the influence of treatment costs saved by better separation compared to other motivation was studied. Local administrations were finally asked to state the consequences of the increase in the waste tax rate for the planning of collection schemes, and to comment on the influence of the tax rate differentiation between incineration and landfilling.

The questionnaire was sent to the local environmental administration. As there are considerable differences between administrations, it was requested to have the questionnaire filled in by an "experienced staff member" in the area of waste. In some cases the questionnaire was passed on to an intermunicipal company with practical knowledge of the area who then filled in the questionnaire on behalf of several local administrations. For 36 municipalities questionnaires were filled in by an intermunicipal company. A total of 189 local administrations responded to the questionnaire corresponding to a rate of 68 per cent, which is a satisfactory coverage.

Local administrations and companies want to minimise tax payment

At the study of behaviour in local administrations, the waste tax was expected to have an effect on municipal and intermunicipal waste companies implying that they design collection in a way that costs are minimised. As described, the waste tax may be avoided by opting for recycling as much as possible, and it can be reduced by prioritising incineration at the expense of landfilling. Recycling can be promoted by establishing separate collection schemes for example for paper/cardboard, glass, organic waste, bulky waste, plastic, metal and construction and demolition waste. Furthermore, collection schemes can be designed in various ways: for example collection schemes, decentralised reuse banks, or recycling centres.

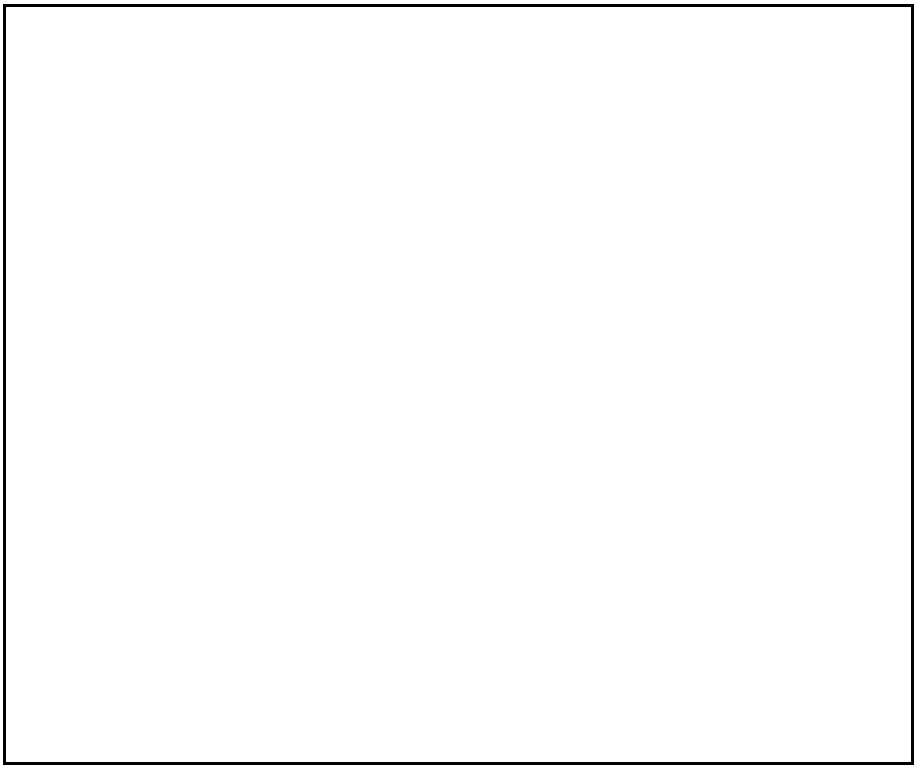

Figure 6.1*. Waste fractions and proportion of municipalities with separate collection of such fractions.*

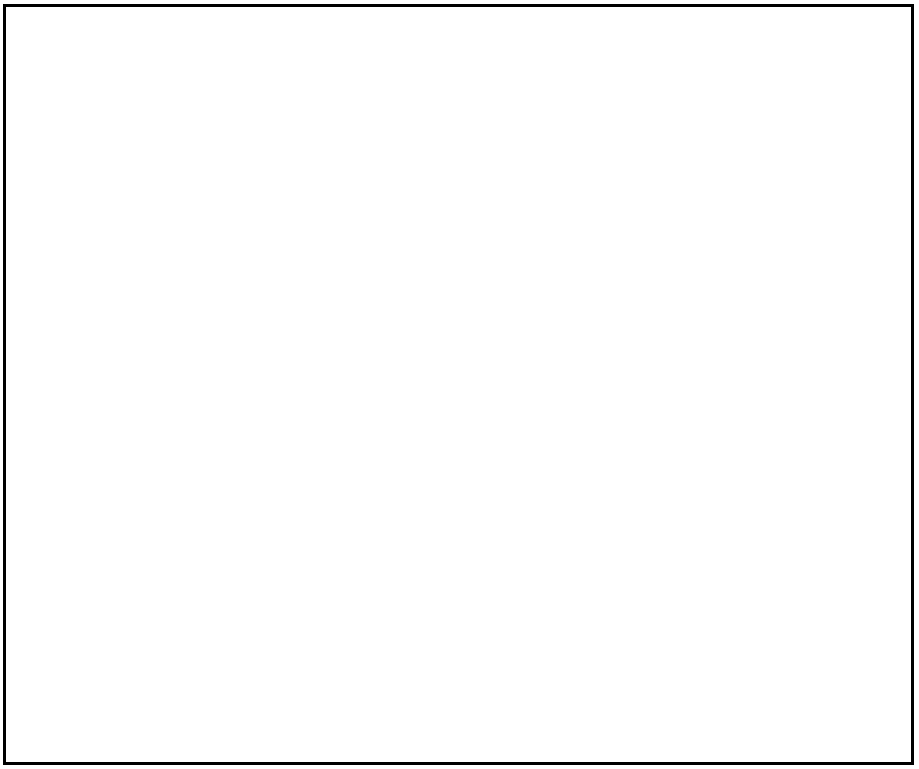

Figure 6.2. *Proportion of municipalities with collection, broken down by year of introduction*

6.2 Extent of separate collection schemes

Large range of separation options

Figure 6.1 shows how many local administrations have established separate collection schemes for different waste fractions. In the wording of the question no distinction has been made between different collection systems. Thus, a scheme may vary between a collection system, decentralised container schemes, and central recycling centres (bring systems). Collection may either be done by a municipal or an intermunicipal company, but options are immense. For example, paper/cardboard and glass may be collected by a municipal company, while other fractions are collected by an intermunicipal company. The purpose of the study was not to make a survey of the variation in municipal and intermunicipal waste operations, but to get a picture of the number of local administrations that have taken initiatives in relation to different waste fractions.

The Figure shows that 99 per cent of local administrations have established separate collection of paper/cardboard and glass - which was a requirement under the terms of the Danish Statutory Order on Waste. For waste fractions without mandatory separate collection, many local administrations have established separate collection. Ranking third are bulky waste schemes which are established in 87 per cent of municipalities, and ranking fourth is garden waste which is collected in 82 per cent of municipalities. Next comes metal and scrap (80 per cent), construction and demolition waste (71 per cent), organic waste (50 per cent), and plastic (43 per cent). The category "other" (23 per cent) comprises, for example, electronics, tyres, expanded polystyrene packaging, clothes and wood.

6.3 Implementation of schemes

Figure 6.2 shows when the various schemes were introduced, based on replies from the local administrations. Small deviations in relation to Figure 6.1 are explained by the fact that not all respondents have stated year of introduction. The statement shows that 26 per cent of municipalities had separate collection of paper/cardboard and glass before 1987 - the year the waste tax was introduced.

Extension stages

In the years from 1987-89, especially collection of paper/cardboard and glass gained ground. In the period from 1990-92 this collection was further consolidated, but the largest extension was within garden waste, bulky waste, construction and demolition waste, and metal and scrap. In the years from 1993 onwards, especially collection schemes for organic waste from households were established.

6.4 Motivation for introducing schemes

In order to clarify the importance of the waste tax in relation to other factors that may lay behind the introduction of these collection schemes, a motivational analysis was made.

Eight possible motives were given:

1. Legal requirements;
2. Objectives of the Government's Plan of Action for Waste and Recycling;
3. Problems of limited landfill or incineration capacity;
4. Desire to reduce treatment costs, e.g. save waste tax;
5. Pressure from citizens;
6. Requirement/proposal from intermunicipal company;
7. Possibility of subsidies from the Council for Recycling and Cleaner Technology (abolished late 1993);
8. Political desire to increase recycling in the municipality.

Furthermore, it was possible to state other essential motives. Local administrations were asked to indicate the three most essential motives behind the establishment of the scheme. Results of the motivational analysis are shown in figures 6.3 to 6.11.

Political motivation most important

In general, the motivational analysis shows that the political factor, i.e. the desire of the local council to increase recycling, is estimated as the most essential factor for all nine waste fractions. The two second-most important factors are the desire to comply with the objectives of the Government's Plan of Action for Waste and Recycling and the desire to reduce total treatment costs. Furthermore, requirements in the Danish Statutory Order on Waste play an important role in relation to the fractions paper/cardboard and glass. In general, problems of limited treatment capacity have played a more modest role. Pressure from citizens and requirements from intermunicipal companies also have had a very modest role. The subsidy scheme of the Council for Recycling and Cleaner Technology has also been of minor importance, when paper/cardboard and glass are excluded (many subsidies were used for these fractions in the first years). The motivational analysis seems to have included the most essential motives, as only few additional factors were mentioned under "other", including - most frequently - the desire to improve public services.

For the different waste fractions it is seen that the trend for paper/cardboard and glass is almost identical. Legal requirements and local councils' desire to increase recycling are mentioned by around 60 per cent of respondents. Around 30 per cent mention the desire to

reduce costs and to comply with the Plan of Action for Waste and Recycling.

Desire to limit costs for heavy fractions

When it comes to garden waste, organic waste and bulky waste, 50-60 per cent mention the political desire to increase recycling. However, for these fractions there are no legal requirements, and therefore it is unclear why this is stated by quite so many local administrations. Second ranked is the desire to reduce costs, stated by a little more than 40 per cent. For bulky waste, however, it is to a larger extent pressure from citizens that plays a role. For construction and demolition waste it is again the political desire to increase recycling, both locally and nationally, as well as the desire to limit treatment costs that are stated as the reason for establishing collection schemes. An identical pattern is found for plastic and metal.

For an analysis of the effects of the waste tax it is especially paper/cardboard, garden and park waste as well as construction and demolition waste that call for a more detailed analysis. This is due to the fact that especially these three waste fractions are subject to increased separation and recycling, cf. the analysis in Chapter 4 of developments in waste amounts.

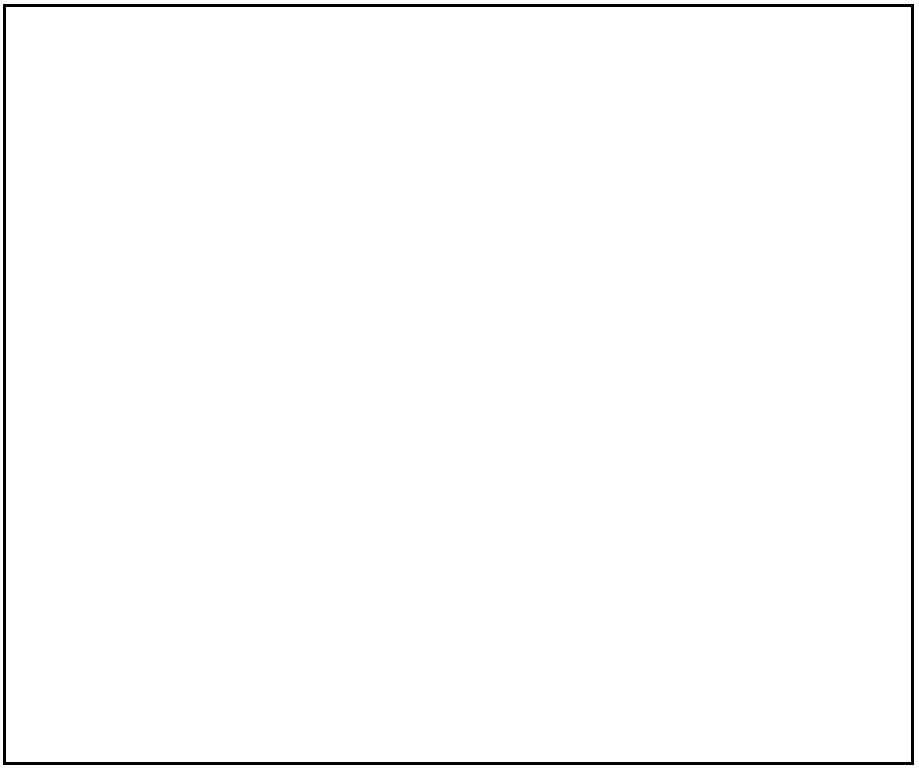

Figure 6.3. *Paper and cardboard: Respondents' motives for establishing separate collection.*

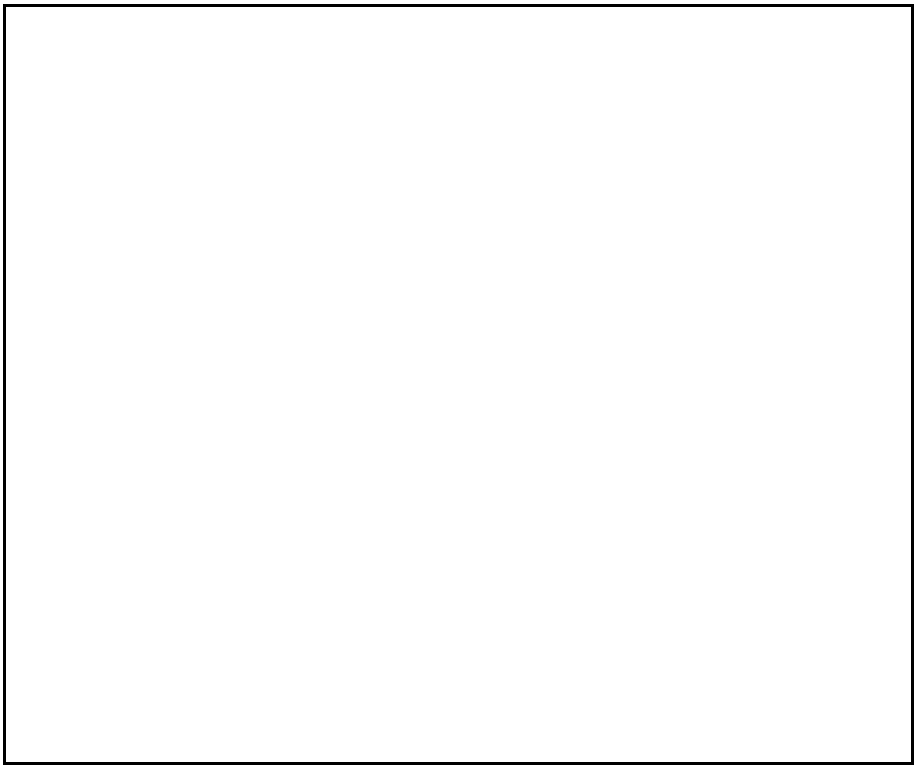

Figure 6.4. *Glass and cullets: Respondents' motives for establishing separate collection.*

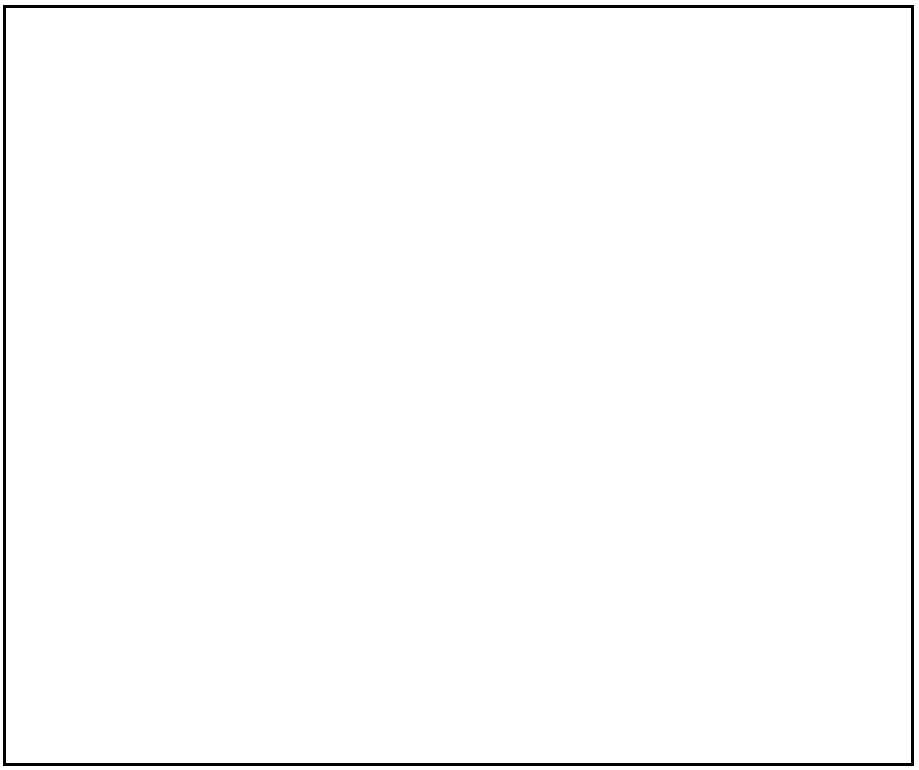

Figure 6.5. *Organic waste etc.: Respondents' motives for establishing separate collection.*

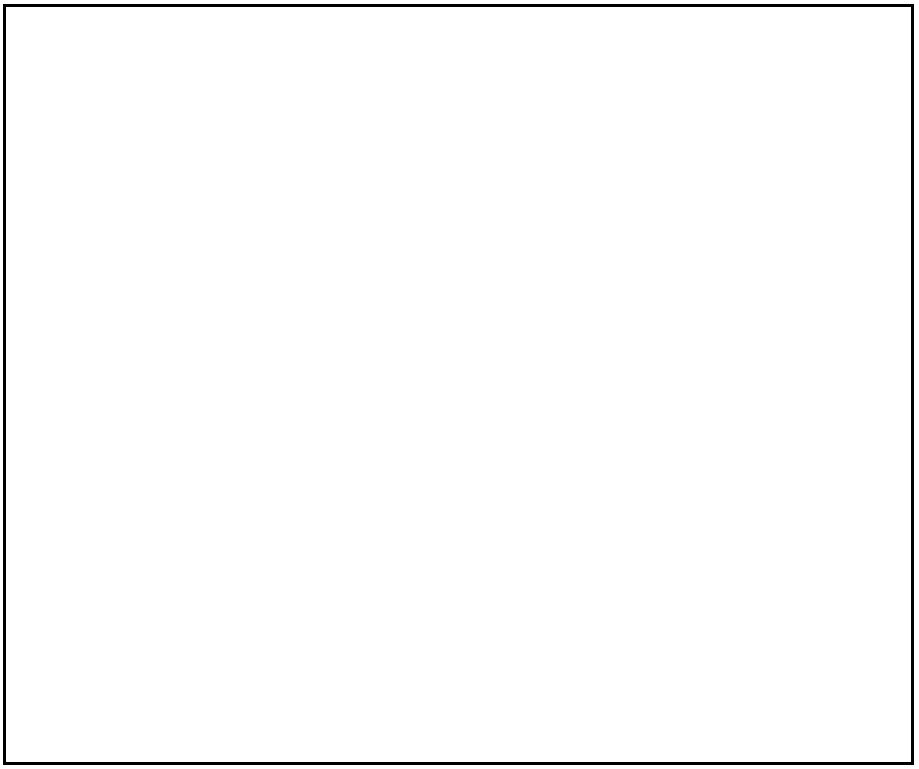

Figure 6.6. *Garden and park waste: Respondents' motives for establishing separate collection.*

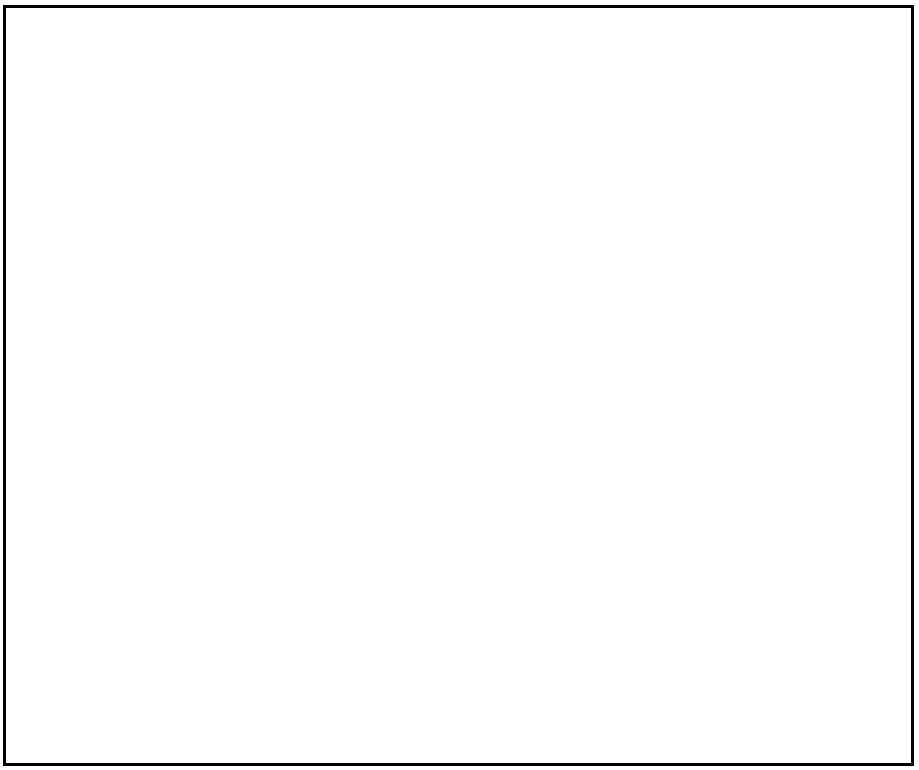

Figure 6.7. *Bulky waste: Respondents' motives for establishing separate collection.*

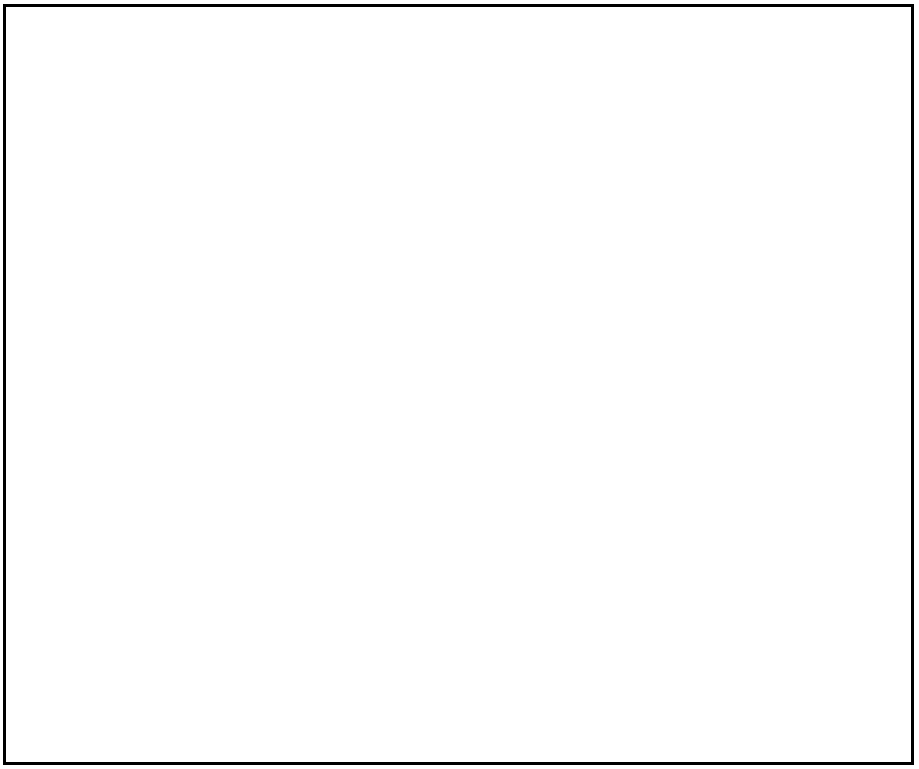

Figure 6.8. *Construction and demolition waste etc.: Respondents' motives for establishing separate collection.*

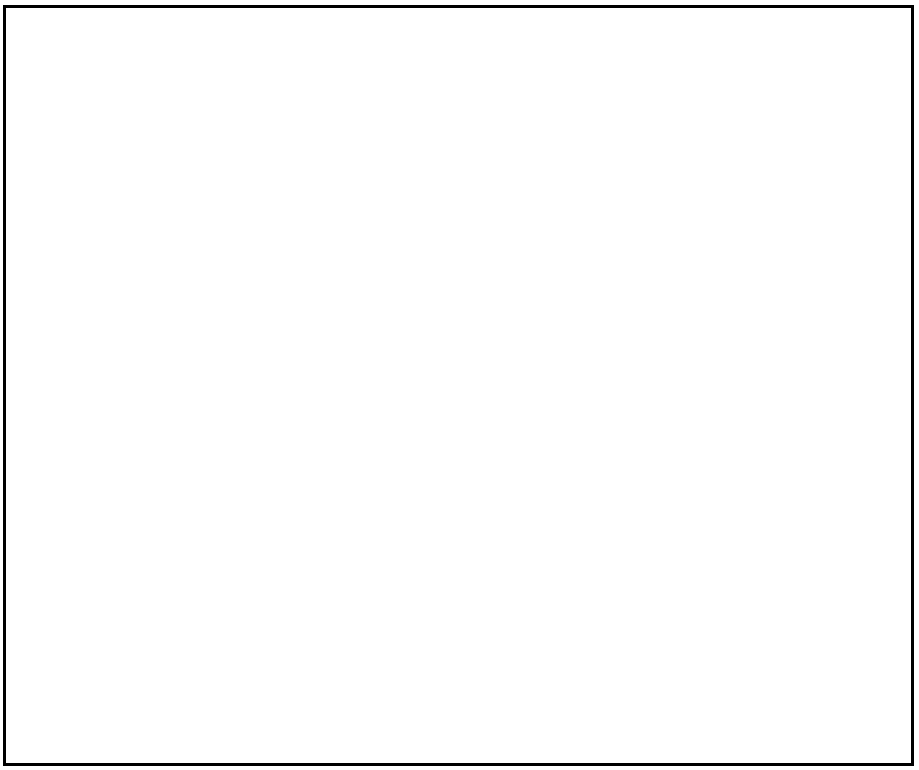

Figure 6.9*. Plastic waste: Respondents' motives for establishing separate collection.*

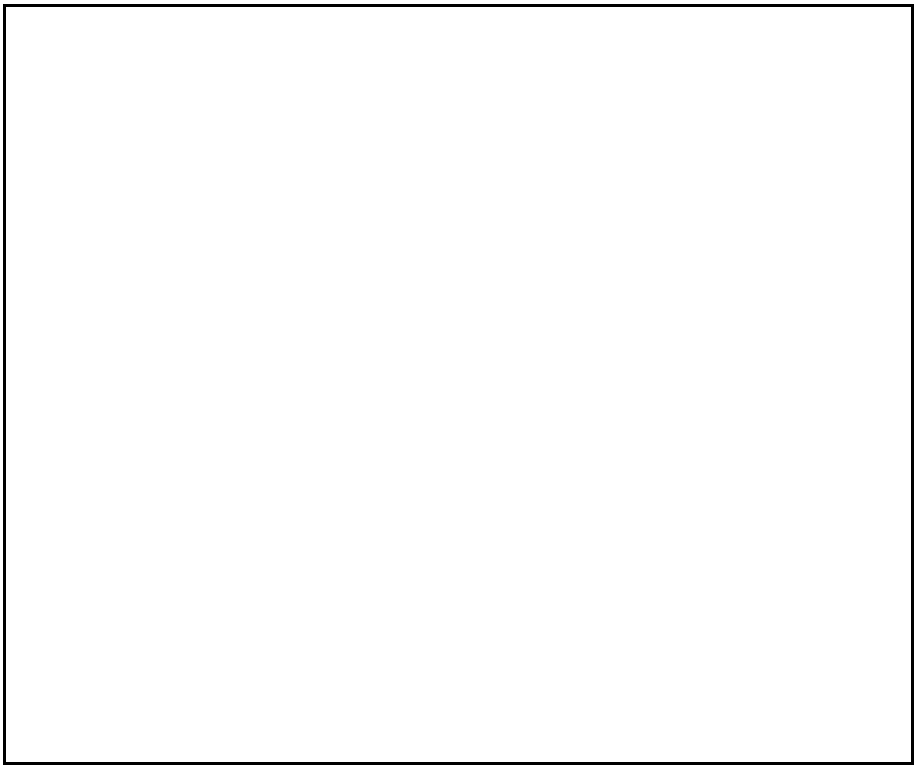

Figure 6.10*.Metal and scrap etc.: Respondents' motives for establishing separate collection.*

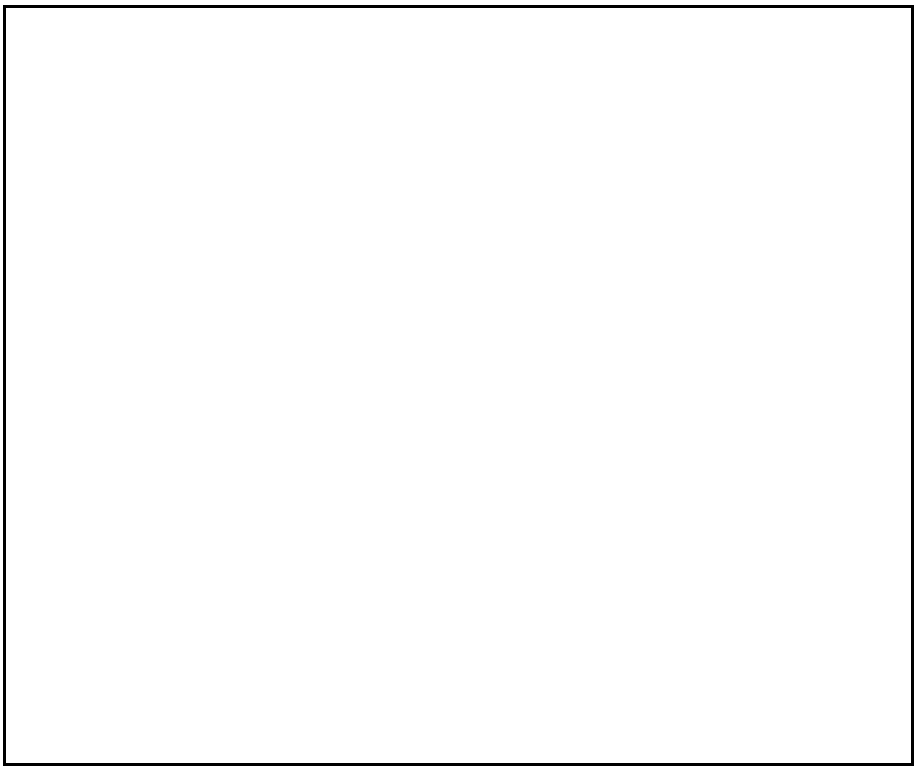

Figure 6.11*. Other waste fractions (food waste, electronics, clothes etc.): Respondents' motives for establishing separate collection.*

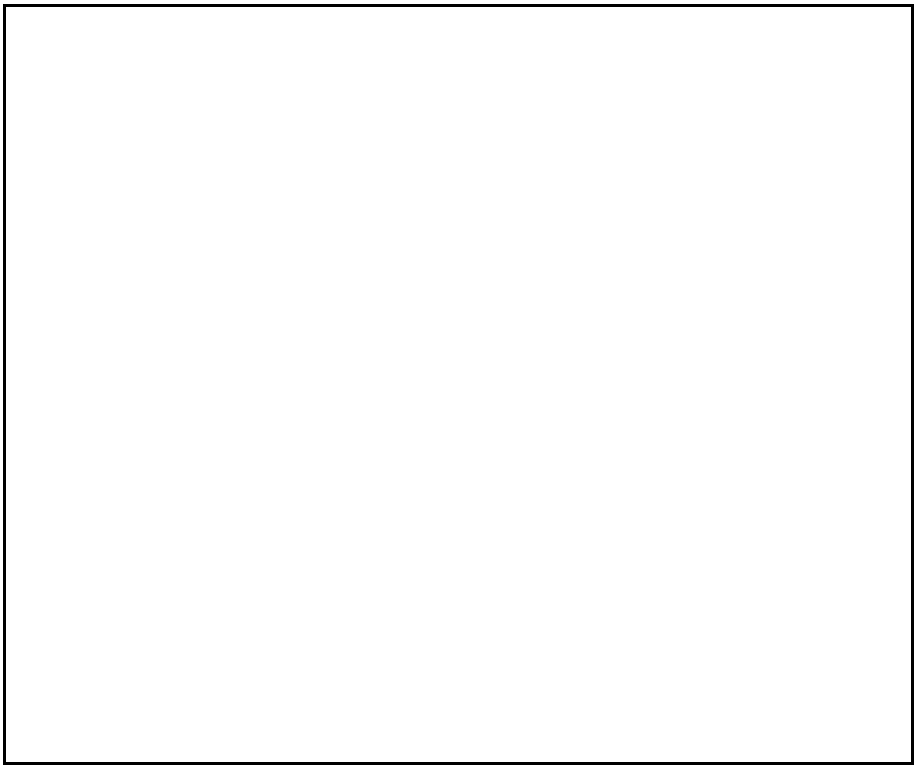

***Figure 6.12**. Effect of waste tax on financial aspects of collection and/or treatment system.*

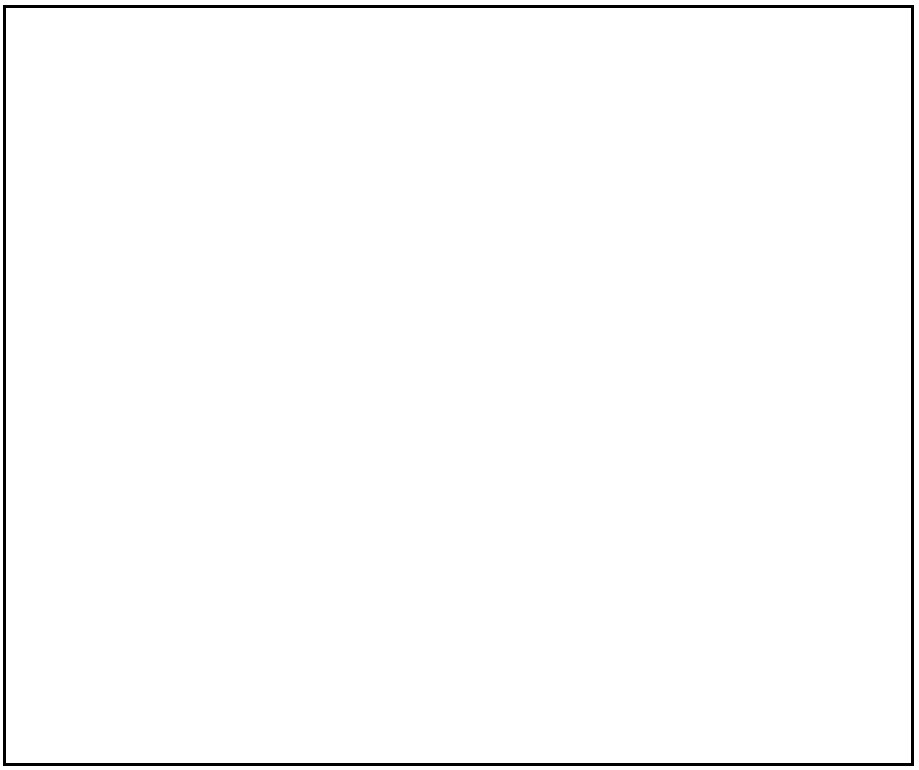

***Figure 6.13**. Effect of waste tax on design of collection and/or treatment system.*

6.5 The impact of the waste tax on financial aspects of the municipal system

Figure 6.12 shows how local administrations estimate the impact of the waste tax on the financial aspects of the collection system and/or treatment system. It should be noted that the design of systems varies considerably, depending on treatment method, separation and recycling systems as well as collection scheme, and there will therefore be very different calculations of possible financial advantages of improved separation.

Impact of tax

Questions related to evaluation of the impact of the tax were put broadly, as it was not the intention to enter into a detailed study of the financial aspects of waste schemes. The tax may have an impact both on operating costs and initial investments in new plant, and the impact will depend also on local decisions of administration of waste schemes, including the more detailed administration of the non-profit cost-coverage principle (Kirkelund, 1997).

Figure 6.12 shows that 48 per cent of respondents estimate that the tax has a decisive impact on the collection of construction and demolition waste. For garden and park waste and bulky waste 32 per cent estimate that the tax has had a decisive impact, whereas a little more than 24 per cent are of this opinion concerning metal/scrap and organic waste. For conventional collection of paper/cardboard and glass some 19 per cent of respondents estimate that the tax has had a decisive impact.

Plays a role for 60-80%

A large share of respondents attribute "some" impact on the finances of their schemes to the tax. By this is meant that the tax contributes to shifting the financial balance towards recycling, without being totally decisive. For all waste fractions with the exception of plastic, between 60 and 80 per cent of local administrations attribute a decisive or some impact to the waste tax on financial aspects of established recycling schemes. By contrast, only 20-30 per cent of municipalities have schemes for which the tax is not believed to have had any impact. Relatively few respondents "do not know" the impact of the tax on the schemes.

Local administrations were also asked how the waste tax influences the design of collection schemes, i.e. the choice between centralised or decentralised collection. Figure 6.13 gives an outline of results of replies for different waste fractions. In general, no more than 10 per cent of respondents find the tax to have had a decisive impact on the design. For heavier waste fractions, a further 20 per cent of respondents attribute "some" impact to the tax on the design, but all in all the

result seems to be that the waste tax does not influence the design of schemes to a significant extent.

6.6 Open questions

Weight-based fees

23 local administrations already have or intend to introduce weight-based fees
Local administrations were asked to inform whether they have introduced or intend to introduce weight-based fees in the collection system. The study shows that this is the case in 23 municipalities, corresponding to 12 per cent.

Local administrations without weight-based fees were asked to state considerations made in this respect. Most respondents find that it will be too expensive and difficult and that there is no reliable technology available. There is a fear of fly-tipping, and the financial incentive for the individual householder is estimated to be limited.[13]

Effect of waste tax increase

Under the Tax Reform in 1993 an increase in the waste tax rate was adopted, taking effect from 1.1.1997. At the same time, the increase entailed a further differentiation between incineration and landfilling.

Local administrations were asked to state which measures were planned as a reaction to this increase. 38 local administrations have taken initiatives to improve recycling or plan to do so, including by increasing collection of garden waste and organic waste, and by improving conditions for home composting.

Evaluation of tax rate differentiation

Incineration prioritised

39 respondents state that tax rate differentiation has had no consequences for the choice between incineration and landfilling, but almost 80 respondents state that the tax rate differentiation has led to various forms of prioritisation of incineration.

An obligation was introduced from 1.1.97 to incinerate waste suitable for incineration, and the rate differentiation between landfilling and incineration will therefore no longer have a direct impact. From 1.1.97, further differentiation between incineration with and without

[13] See also Chapter 7 for a detailed discussion

power generation has been introduced, but evaluations of this differentiation were not studied.

General evaluation of waste tax

Effects of tax

In a last open question, respondents had the possibility of giving a more general evaluation of the waste tax. Evaluations are very different, and there is no unambiguous pattern. Following statements are taken from the replies and indicate that:

- "Better separation of waste takes place at the recycling station ",
- "Garden waste, which used to be collected with bulky waste and incinerated, is now to a larger extent transported to central composting. This saves money".
- "It has become easier to have industry and commerce separating waste ".
- "Increased recycling - increased incineration ".
- "Taxes push in the direction of increased recycling. Nevertheless, new schemes can only be introduced if they are cost neutral - and this can be difficult despite the saved tax when investments and operating costs are included."
- "Has had the planned effect in relation to promotion of recycling and reduction in amounts landfilled "

Critical comments

Also critical comments were given:

- "The tax is perceived as taxation or punishment, as the local council already works goal-oriented on increased recycling. It has almost been perceived as an obstruction from the Danish Environmental Protection Agency because of ambiguities and lacking guidelines, for example within industrial and commercial waste".
- "Problems of fly-tipping or illegal burning. We catch 1-2 lawbreakers each year. But such processes are very hard to handle due to loopholes in legislation."
- "The waste tax on landfilling of construction and demolition waste is so high that people cheat. Much waste never enters the system, and the liberalisation of recycling makes it hard to compete".
- "Increased taxes no longer have a large impact in municipalities. It is difficult to reduce amounts further".

Proposals

Finally, some more future-oriented comments were made:

- "We need money to establish and operate recycling schemes. Local administrations carry the costs, the State gets the revenues"
- "Some of the tax should be diverted back to the municipality to help the establishment of environmentally sound schemes"
- "DKK 160 for incineration is too low, now that prices for paper are down"
- "The landfill tax should be at least doubled before it becomes profitable to deliver burnable waste to an incineration plant"

It should be noted that the last two comments are based on tax rates in late 1996. As explained, the landfill tax was increased from DKK 195/tonne to DKK 335/tonne and the incineration tax from DKK 160 to DKK 210 and DKK 260 respectively as per 1.1.1997.

6.7 Conclusions

The study of local administrations' behaviour has shown that the political factor - the desire to increase recycling - is the most important factor behind the quite extensive collection schemes that have clearly exceeded the requirements of the Danish Statutory Order on Waste. The two second-most important factors are the desire to comply with the Government's Plan of Action for Waste and Recycling and the desire to limit total treatment costs. Furthermore, legal requirements play an important role in relation to the fractions paper/cardboard and glass.

Tax influences heavy fractions

The desire to limit treatment costs - including the waste tax - for citizens plays a key role, especially for heavier waste fractions such as garden waste, organic waste and construction and demolition waste. 48 per cent of respondents estimate that the tax has had a decisive impact on the collection of construction and demolition waste. For garden and park waste and bulky waste 32 per cent estimate that the tax has had a decisive impact. By contrast, the tax does not significantly influence the detailed design of schemes.

Reactions to the waste tax increase from 1.1.97 have been moderate, but some local administrations plan further measures with a view to improved separation. The tax differentiation between incineration and landfilling is also estimated to have a certain impact.

In general, local administrations seem to pay attention to the waste tax and the intentions behind it. Some respondents are concerned

about fly-tipping, and there is a desire to have funds diverted back to the recycling schemes.

7. Price sensitivity and the impact of weight-based pricing

7.1 Introduction

The purpose of this chapter is to discuss how the waste tax is reflected in prices in the waste sector and to estimate how these mechanisms influence price sensitivity of waste. Experience with weight-based pricing is described together with the consequences of this approach on waste amounts generated.

7.2 Pricing in the waste sector

Professional carriers

The waste tax is calculated and levied per tonne of waste delivered for treatment at registered plants. However, very few waste producers deliver their own waste directly to a plant. Waste is normally collected by professional carriers, and the way in which the price signal from the tax is passed on to waste producers depends very much on the pricing used by carriers.

When it comes to payment for waste disposal there is a basic difference between *collected* waste and *assigned* waste:

Collected waste

Filter on incentive

Householders and enterprises covered by municipal collection schemes pay a fixed fee for waste disposal which will often depend on volume and frequency of collection of the waste bin. Pricing also varies considerably between municipalities and intermunicipal companies. Current rules of payment are very broad resulting in considerable local variations. Basically, schemes must follow the non-profit cost-coverage principle, but the way in which the individual local council or company distributes costs between different users is a matter that is decided locally (Kirkelund, 1997).

For individual households (single-family houses etc.) fees will normally be paid to the local council which in return settles its accounts with waste companies and treatment plants. In practice, the waste fee is often levied together with taxes on real estate. For privately

and publicly owned tenancies, waste costs are paid with the rent, and the fee is included in the calculation of the cost-based rent.

This pricing means that while the waste tax is weight-based, waste collection fees are normally volume-based. Also, waste costs are not directly visible to the waste producer.[14] Finally, there is a time difference in relation to waste volume and payment, as payment in practice is settled on the basis of waste amounts of the preceding year.[15]

Assigned waste

Visible price signal

Waste producers not covered by a collection scheme, but requested to deliver waste to a plant under the terms of municipal assignments, are typically industrial or commercial enterprises. In some cases, the waste producer himself brings waste to the plant. In this case, the waste tax is calculated on the basis of weight, and visibility and simultaneity are achieved. However, professional carriers are often given the task of transporting waste. These carriers may be local hauliers or private waste companies. Consequently, also for assigned waste it will often be the case that the waste tax is comprised in a total fee for waste disposal, i.e. the tax is internalised in price signals in the waste sector. For assigned waste, however, disposal costs will normally reflect more directly waste amounts and weight, and it must be assumed that enterprises will seek to optimise the relationship between disposal costs and waste amounts.

Few options for householders

Householders and others covered by collection schemes are in a different situation. Such waste producers have limited possibilities of action in relation to the waste tax, as they cannot individually reduce waste costs by reducing waste amounts. Their ability to separating part of the waste for recycling also depends on the extent of collect or bring systems in the community. Especially for single-family houses, increased separation of waste only leads to unexploited capacity in the waste bin. A study of municipal information on fees has identified a small number of municipalities in which there is a freedom of choice concerning volume and collection frequency for single-family houses. With volume-based fees (by bin or bag) fees are

[14] This is in contrast to taxes on electricity and CO_2 which are specified on the bill. However, a fixed tax is paid on electricity on top of the consumption-based fee.

[15] For tenancy when the cost-based rent is adjusted, for owners when the local council fixes the rate of conversion between weight and volume on the basis of last year's operating result.

charged for normal waste production, and in this case the price signal of the waste tax does not reach these waste producers.

Waste producers in blocks of flats in principle have somewhat better possibilities for optimising with regard to treatment costs. By increased separation and recycling, the number of waste containers can be reduced, and it is thus possible to reduce costs. This possibility of response is estimated to be neutralised, as costs of waste collection are integrated in the rent. Thereby, these costs are invisible to the individual householders.

Free-rider problem

As mentioned in Chapter 3, these price relationships in the waste sector were to some extent considered at the design and adoption of the waste tax in 1986. Therefore, in a first stage, it was not expected that the waste tax would influence waste generation in individual households. However, it was expected that it would be possible to influence municipal and intermunicipal waste companies to establish an infrastructure allowing for increased separation and recycling.

However, the problem is that the use of these recycling facilities is voluntary, and in general there is a free-rider problem related to separation and recycling of waste. For each waste producer, more time and effort is required to bring different waste fractions (paper, glass, garden waste, scrap, electronics etc.) to the right containers. This effort may be reduced by collect systems. Environmental and financial gains from increased recycling, however, benefit all citizens in the area of the waste company, as reduced waste taxes are distributed over the normal fee for waste disposal. Many citizens want to do an extra effort for the environment, but there are also many who do not find it worthwhile.

This has been one of several reasons for the increased interest in weight-based fees in recent years. Such pricing is perceived as more fair, and it can better encourage increased separation and recycling. The municipality of Tinglev in the south of Jutland has been a pioneer in the development and use of weight-based pricing, but more municipalities have followed.

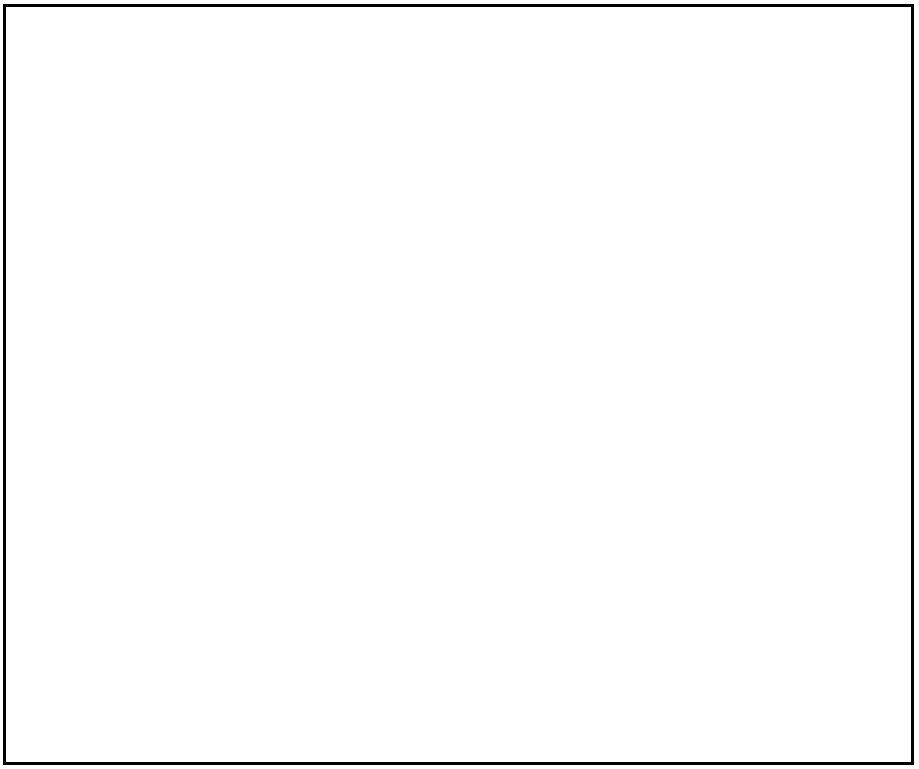

Figure 7.1. *Residual waste amounts before and after change in waste system in ten Danish municipalities (Source: SBI, 1996).*

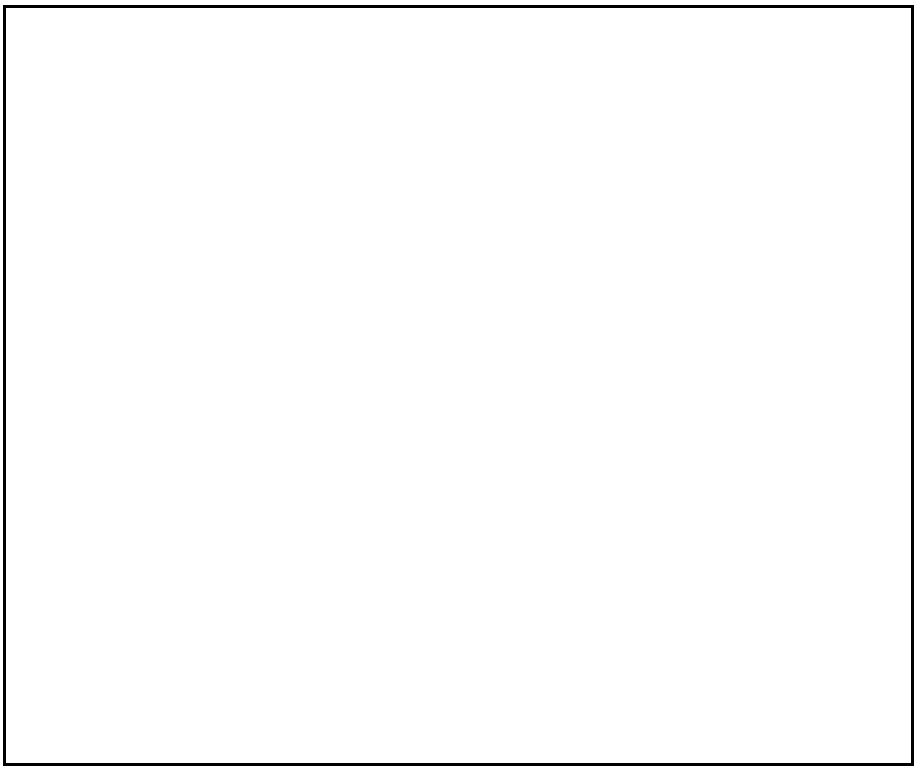

Figure 7.2. *Waste collected broken down by waste fractions and residual waste in ten Danish municipalities 1993/94 (Source: SBI, 1996, p. 105-125).*

7.3 Results in municipalities

SBI study

A study from the Danish Building Research Institute (SBI) shows that residual waste amounts to a large extent vary with life style and consumption in different residential areas. The study also shows, however, that the pricing system and waste management system as a whole play a decisive role (SBI, 1996).

Figure 7.1. shows residual waste amounts in ten municipalities before and after the introduction of new waste systems. The figures "before" refer for the major part to the period around 1990 and the figures "after" to 1993-94. The statement is based on waste data from the local administrations, in some cases as reported to the ISAG.

Large local variations

The statement shows large variations in residual waste amounts, from only around 100 kg/capita in some municipalities to as much as around 300 kg/capita in other municipalities, despite the fact that all ten municipalities have taken initiatives to increase recycling. The largest residual waste amounts are found in the municipalities of Albertslund, Kolding and Århus. Residual waste amounts are smallest in the municipalities of Bogense, Tinglev and Vejle. In Bogense and Tinglev, collection fees are weight-based.

Figure 7.1 shows that in most municipalities waste amounts have decreased after the change in waste management system. This is not the case for the municipality of Kolding, where increased waste amounts are reported. In the municipalities of Albertslund and Århus the decrease has been very modest.

Figure 7.2 shows total waste amounts collected for the ten municipalities, both residual waste and separated fractions.[16] The statement of quantities of recyclable materials is subject to some uncertainty and is not the same for all municipalities; however, it does give a reasonable picture of the extent of collection. Separated waste does not in all cases go to recycling. For example at recycling centres some waste is delivered that must subsequently be incinerated or landfilled.

Significant effect in Tinglev

The statement shows large variations in the separation of waste fractions in the different municipalities. Paper and glass separation does not vary much from one municipality to another, but large variations

[16] Reference is made to detailed data sheets in the SBI report.

are seen for organic waste, bulky waste and garden waste. The three municipalities with largest residual waste amounts have no or very modest separation of organic waste and garden waste. Correspondingly, five municipalities with separate collection of organic waste (Bogense, Kerteminde, Nyborg, Ringkøbing and Vejle) have achieved considerable reductions in residual waste. In Bogense, Kerteminde and Vejle, dual collection of domestic waste has been introduced, with a residual waste fraction and an organic waste fraction. In Tinglev, organic waste is not collected separately, but the SBI report notes that it is "noteworthy that Tinglev has achieved the same effect *in separation* as these three municipalities just by charging weight-based fees". Ringkøbing and Munkebo have achieved their drop in waste amounts by offering containers for home composting.

The study warns against drawing too extensive conclusions, but does note that:

> "It seems that weight-based pricing at household level is an efficient way of reducing residual waste amounts. This is demonstrated by the schemes in Tinglev and Bogense. For Kerteminde, the tendency is the same. Here, a policy of differentiated fee rates combined with a large selection of bin volumes and the possibility of voluntary home composting give a similar economic incentive. The effect of the economic instrument seems to decrease, however, the closer we come to big cities, where large waste concentrations and waste amounts are also found " (SBI, 1996: 44).

Albertslund

In Albertslund weight-based fees have been introduced, but only for tenancies. It is very likely that lack of results compared to Tinglev and Bogense are due to the way in which waste costs are integrated in rents, cf. above. In Albertslund each citizen does not enjoy a direct economic benefit from increased separation. At first, only the housing society or owner has the benefit, and only in a longer term perspective will it be reflected in the cost-based rent.

Vejle

It is remarkable that the municipality of Vejle has achieved almost as good results as Tinglev and Bogense, without using weight-based fees. Especially in Tinglev and Vejle, the starting point before and the result after the introduction of the new system are almost identical. This indicates that the SBI report is not necessarily right in its conclusions regarding big cities and possibilities of achieving large reductions in residual waste amounts in cities without using economic incentives and by establishing the right collection systems. Especially it should be noted that Kolding and Århus have bring systems for their garden

waste, and that the potential for collected garden waste as a consequence is not exploited fully.[17]

However, the question remains whether environmental results have been achieved at the same low cost as in Tinglev, Bogense and other municipalities using weight-based pricing.

Below, experience from these municipalities is described on the basis of data in the SBI report, reports from the Danish Environmental Protection Agency on weight-based pricing as well as information collected in relevant municipalities.[18]

7.4 The Tinglev system

Individual weighing

The municipality of Tinglev has developed and achieved approval of a weighing system that registers waste amounts from each household at the time of collection of the waste bin (Miljøstyrelsen, 1994b). The waste bin is equipped with an electronic identification tag. At the automatic emptying of the container into the collection truck, waste is weighed and registered electronically. Once a year the household receives a specified invoice for actual waste amounts collected.

Low residual waste amounts

Tinglev is interesting because the weight-based fee is the fundamental part of the waste system. The environmental system in the municipality comprises one recycling centre and 14 small environmental centres for glass and paper. Furthermore, home composting is encouraged. Tinglev is remarkable as total waste amounts (i.e. including waste for recycling) per capita are among the lowest in the country, cf. figure 7.1. The amount of residual waste has been reduced in very few years, from 248 kg/capita in 1990 to 105 kg/capita in 1992.

The fee is composed of a fixed element, based on the volume at the disposal of the household (choice between two bin volumes) and a variable element per kilo waste delivered in excess of 3 kg per col-

[17] The lack of efficient collection schemes for organic waste and garden waste in these cities may be explained by the desire to exploit available incineration capacity.

[18] The SBI study is based on actual waste amounts for treatment or recycling. In other studies, such as that on the Bogense system, no physical environmental data have been used, but only reported separation behaviour. In the Bogense study it is also assumed that there are no differences in collected waste amounts among the different municipalities (Thøgersen, 1994; Beckmann og Thøgersen, 1995; Grunert-Beckmann, 1996). SBI data are considerably more precise and show significant differences between municipalities.

lection. In the first year, a fee was charged corresponding to a waste amount of 300 kg per household, and the next year a precise account was made and levied with the real estate tax of that year. Subsequently, each year an amount is charged corresponding to the waste amount of the preceding year and levied with the real estate tax.

The new system

The system has been introduced in three steps, and this allows to some extent an evaluation of the effects of each measure. In the autumn of 1990 the environmental and recycling centres were established. On 1 September 1991 domestic waste bins were replaced, and a shift to fortnightly collection and weighing was made. On 1 January 1992 the waste collection fee was differentiated, based on weighed amounts. However, it may be argued that citizens have not distinguished clearly between the introduction of the new collection system and the weight system in itself, and thus the effects of step 2 and step 3 cannot be distinguished.

The establishment of the environmental and recycling centres gave a reduction in collected residual waste amounts of just 5 per cent. Step 2, the shift to fortnightly collection, gave a further reduction of 46 per cent (down to an average of 105 tonnes/month in the last six months). Finally, amounts were further reduced by around 7 per cent in step 3, the introduction of weight-based fees, so that the total reduction reached 58 per cent (i.e. waste amounts of around 91 tonnes/month against 214 tonnes/month before the introduction of the system).

Evaluation of data

There is some uncertainty connected to the figures. According to waste collectors, there may have been some mixing of industrial and commercial waste and household waste in the collection (and thus in statistics) before the introduction of the weight-based fee. It is remarkable that, compared with earlier estimated figures, waste amounts from industry going to incineration have increased after the introduction of the new domestic waste system, separating domestic waste and industrial and commercial waste (Miljøstyrelsen, 1994b, figure 8.2a). It may be necessary to deduct some 30 tonnes/month from earlier estimated domestic waste amounts. Therefore, the total reduction in residual waste amounts may be estimated at 51 per cent[19]. Waste separation increased in Tinglev from 75 kg/capita in

[19] The gain of step 3, the introduction of weight-based fees, must therefore be estimated to be larger than the 7 per cent reduction mentioned above. The collection of industrial and commercial waste and household waste has been effectively separated since the introduction of the new system from 1.9.91, and if waste amounts are compared for the last four months of 1991 with the first four months of 1992, a reduction can be seen by 17 per cent in residual waste amounts. However, this may also be due to seasonal fluctuations.

1990 to 189 kg/capita in 1992 - or from 14 per cent to 47 per cent of total waste amounts.[20] (SBI, 1996: 120). The largest increase in separation has been for garden waste, but also bulky waste and glass collection has increased markedly.

Increased separation and recycling

The above-mentioned reduction in residual waste from 248 kg/capita to 105 kg/capita is composed of an increase in waste separation of 113 kg/capita and a reduction in waste amounts of 29 kg. (SBI, 1996: 120).

The reduction in total waste amounts, however, corresponds quite well to the amount of industrial and commercial waste that used to be stated together with household waste. Therefore, it must be assumed that the reduction in residual waste amounts is due to enhanced separation and recycling. There are no indications that waste reductions in Tinglev are only achieved by an environmentally unsound avoidance of the waste regulation, such as home burning of household waste, fly-tipping etc. The municipality of Tinglev has stated that the system functions satisfactorily.

Financial evaluation

For the local council, some savings have been achieved by the new system. The largest impact is attributed to the shift to fortnightly collection and the fact that citizens must place the collection bin at the kerbside - a change that has meant that now only one man operates the collection truck against three men before. Furthermore, the costs of disposal have also decreased, as no waste tax is levied on waste for recycling. However, there have also been expenses on the new container system for recycling.

For citizens, financial consequences vary with the waste amount generated. Before the introduction of the new system, each household paid a fixed fee of DKK 1,098/year. This fixed fee has now been reduced to DKK 380/year. In the Yearbook of Municipal Statistics, the average waste collection rate for a single-family house in Tinglev is stated at DKK 850/year which corresponds to an average waste amount of 269 kg/household/year or around 10 kg per collection. This means that waste collection costs have fallen by an average of around 26 per cent per household. In 1992 there was an actual profit for citizens from the introduction of the new system.

[20] Not all separated waste goes to recycling. A minor fraction of garden waste and bulky waste is incinerated or landfilled. The increase in this fraction is 19 kg from 1990 to 1993.

7.5 Evaluation of the Bogense system

94 kg residual waste/capita

Bogense has also introduced weight-based fees. This system is interesting because residual waste amounts per capita are the lowest among the ten municipalities included in the study (94 kg/capita in 1993). Residual waste amounts have been reduced by 60 per cent per capita, from 235 kg/capita. This reduction is composed of an increase in recycling of 124 kg/capita and an actual decrease in waste generation of 17 kg/capita.

The new system

In Bogense, the new waste management system was introduced on 1 November 1992. The system consists of a dual bin in which organic waste and residual waste are separated, and weight-based pricing of the two fractions. At the shift to the use of these bins, collection was also reduced from once a week to once every two weeks, and citizens had to place the bin at the kerbside. Furthermore, a contract on two collection sites and collection of part of the recyclable waste eight to ten times a year was entered with the local scouts. A staffed recycling centre has also been established.

Experience

A fixed fee is levied, covering costs of the recycling centre and the collection schemes. The weight-based fee is calculated on the basis of waste amounts in excess of 5 kg per collection. Residual waste and organic waste were charged at different rates to start with, but this differentiation is no longer in effect, as it gave an incentive to mix residual waste into the organic waste, which had a lower fee.

The Bogense system has run into certain practical problems. The original truck was not completely reliable, and errors occurred in data transfer. As a consequence it was necessary to invest in a new truck in 1995. Also, the two volumes in the dual waste bin do not correspond to needs, which means that part of residual waste is mixed with organic waste. At the intermunicipal composting plants it has been noticed that the quality of organic waste has declined, and the local council believes that an effort will soon be needed to improve separation quality. As in Tinglev, an increase in industrial and commercial waste has been reported, but it is unclear whether part of domestic waste has been transferred to this type of waste, or whether it is due to uncertainties in earlier waste statistics.

Financial evaluation

For citizens, costs vary with waste generation. The fixed fee amounts to DKK 625, and a household with an average amount of waste pays annually DKK 514 in variable fees, so total costs are DKK 1,139. Before the change, the fixed annual fee was DKK 1,113 (1992), which means that an average household pays more or less the same as before.

7.6 Comparison with other systems

In Tinglev and Bogense, remarkable reductions in residual waste amounts have been achieved in very few years. It seems cleat that this effect is due to the use of weight-based fees.[21]

Only 15 per cent meet objectives

In many municipalities, facilities for separation and recycling of waste have been established, but only few have achieved as high recycling rates as these two municipalities. According to an outline prepared by RENDAN on the basis of ISAG data, only 15 per cent of municipalities meet objectives in the Plan of Action for Waste and Recycling (Lassen, 1996). 60 per cent of municipalities are actually very far from meeting the objective. The study of municipalities in this report showed that they have come a long way with establishing facilities for recycling, so there are indications that the problem lies with citizens' use of these facilities.

The municipality of Kolding has introduced source separation with collection of four recyclable fractions and residual waste. Furthermore, there are bring systems for bulky waste and problem wastes. However, residual waste amounts have increased from 225 kg/capita in 1990 to 246 kg/capita in 1993. At the same time, the amount of waste collected for recycling has increased by 53 kg/capita. Total waste amounts were 457 kg/capita in 1993. One reason for the large residual waste amounts in Kolding may be that garden waste is covered by a bring-system. Kolding is thereby an example of the fact that the presence of extensive collect schemes and separation facilities will not always lead to a reduction in residual waste amounts.

Other ways

[21] Tølløse should briefly be mentioned as a third municipality that has achieved remarkable results with the introduction of weight-based pricing. The system is quite identical to the Bogense system. The result has been a reduction in residual waste amounts of 47 per cent, primarily explained by an increase in recycling, as the reduction in total waste amounts has been 8 per cent. Disposal costs have dropped from DKK 3.4 million in 1993 to DKK 1.6 million in 1995. It should be noted, however, that the fixed fee in Tølløse before the change in systems was as high as DKK 2,336 (1992).

It should not be neglected that certain municipalities have achieved quite significant reductions in residual waste amounts without using weight-based fees. In municipalities that have only introduced home composting schemes (such as Munkebo and Ringkøbing) reductions are seen in residual waste amounts of around 30 per cent. In Munkebo, residual waste amounts are still quite large: 184 kg/capita, whereas in Ringkøbing they amount to 120 kg/capita.

The municipality of Nyborg, having introduced source separation of organic waste and residual waste without introducing weight-based fees, has achieved a reduction in residual waste amounts of around 40 per cent. The new system consists of a shift from weekly domestic waste collection to alternate collection of green and grey waste, i.e. fortnightly collection of the two fractions respectively. However, residual waste amounts were as large as 152 kg/capita in 1993. Total waste amounts have increased by 25 per cent. The waste collection fee in 1993 was DKK 1,445/household, though for households with their own composting only DKK 1,075/household. Even though weight-based fees have not been introduced, there is still a considerable discount for householders composting their own waste.

The Vejle system

The municipality of Vejle seems to be the only municipality which has achieved residual waste amounts comparable to those of Tinglev and Bogense - 112 kg/capita - without introducing weight-based fees.

In Vejle, the system is based on source separation of organic waste and residual waste. In contrast to other municipalities, source separation takes place by citizens using differently coloured plastic bags for different fractions which are placed in one common container. Fractions are subsequently separated automatically by colour identification at a central reception site at the waste treatment plant. Furthermore, kerbside collection of bulky waste is made once a month, and citizens can bring recyclable fractions to a large centre with more than 17 different containers.

For enterprises, clear economic incentives have been introduced in the waste management system, whereas householders pay a fixed, annual fee independent of amounts. The only sanction on householders not separating correctly is a quarantine implying that they must bring their own waste to the recycling centre for a certain period.

Residual waste amounts as a total have been reduced by 55 per cent after the introduction of the new system, from 248 kg/capita in 1987 to 112 kg/capita in 1993. Amounts of waste for recycling have not been stated for 1987, but in 1993 were 461 kg/capita, excluding garden waste of 207 kg/capita. Total waste amounts per capita are very high in Vejle and amounted to 573 kg/capita in 1993.

Financial evaluation

There have been large costs related to the establishment of the central separation and composting plant. Excluding subsidies from the Danish Environmental Protection Agency, the plant has cost DKK 64 million. The local council has also equipped households with the necessary waste bag stands, free plastic bags have been distributed etc. in order to ensure a smooth operation of the system.

All in all, waste collection fees for households have doubled from 1987 to today, and a little less than DKK 2,000 is paid by single-family houses, whereas flats are charged half this amount. The costs of the system would have been even higher, if the municipality had not received the subsidy from the Danish Environmental Protection Agency.

7.7 Summary of evaluations

Below, focus is put on Tinglev, Bogense and Vejle, the municipalities having achieved the most notable results. Bogense is the municipality that has come the longest way with a reduction in residual waste amounts per capita per year to only 94 kg, whereas Tinglev and Vejle have 105 and 112 kg respectively.

Almost identical starting point

The starting point for the three municipalities before the shift to new systems was almost identical, though Bogense was some 5 per cent below the two other municipalities. It should also be noted that Vejle has achieved its reduction over a longer period - from 1987 when the first separation possibilities were established to 1993 when the new central separation plant went into operation. The results from Vejle should probably therefore be seen in connection with a longer period of adaptation than in Tinglev and Bogense.

The Vejle system demands the least effort from citizens as they only have to separate in different waste bags under the kitchen sink. This makes the system especially suitable for blocks of flats where existing waste chutes etc. can still be used. Also bulky waste is collected, while other recyclable waste must be brought. The system can furthermore be extended to comprise several different fractions in differently coloured plastic bags.

In Bogense, the system comprises a separation facility in the waste bin, and there are collect systems for a number of other recyclable fractions. In Tinglev citizens must bring their waste to recycling and carry out home composting.

Tinglev cheapest

These differences are also reflected in municipal waste collection fees for single-family houses. In Tinglev, the average fee is around DKK 850, in Bogense around DKK 1,100, and in Vejle just below DKK 2,000. It should be noted, however, that citizens in Vejle in contrast to Tinglev and Bogense do not have to bring the waste container to the kerbside. The Vejle system is also more expensive, because it still requires weekly collection, and, without further changes it does not allow for a shift to fortnightly collection, as in the other cities, because total waste amounts have not been reduced. On the other hand, the Vejle system would have been even more expensive without a quite considerable subsidy from the Danish Environmental Protection Agency. It is beyond the scope of this project to make a detailed study of cost structures in the three municipalities, and it would probably also require access to municipal accounts.

In Vejle, it should be noted that a recent study has shown extensive satisfaction with the waste management system, which is believed to give further scope for municipal initiatives in the area. This satisfaction is estimated to outweigh the larger costs paid by householders compared to Tinglev and Bogense.

Does the Vejle system attract more waste?

It seems, however, as if more service-oriented systems in Vejle and other municipalities with conventional pricing attract more waste. It is remarkable that total waste amounts increase in these municipalities despite more facilities for recycling. The amount of bulky waste is larger in these systems, and especially in Vejle there is a large "various" fraction at the container sites that cannot be recycled.

Conclusion

Larger reductions are possible

It is important to ensure that no environmentally unsound disposal takes place as a consequence of weight-based fees. Experience from Tinglev and Bogense does not indicate that this should be a big problem, and the financial gain would also be limited. Better documentation of behaviour-changes, for example in the form of a questionnaire study, would bring about more information on this aspect.

On the basis of available experience, there are many indications that if the waste tax were given better possibilities of penetrating directly to households, for example through weight-based fees, it would lead to larger reductions in residual waste amounts. Furthermore, it will

lead to considerably more cost-effective reductions in residual waste than in systems without weight-based fees. Where there is no coherence between waste amounts and payments, the local council must use resources for "servicing" and "informing" citizens into delivering waste for recycling. Naturally, it is also a prerequisite for weight-based fees that the local administrations make certain basic facilities available for the disposal of waste for recycling. In principle, weight-based fees are also possible for blocks of flats, but it will require an amendment to legislation on cost-based rents to make the gain from a reduction in waste amounts visible.[22]

[22] Legislation on rents has also been very restrictive when it comes to levying fees for water supply which cannot be made individually.

8. International aspects

8.1 Introduction

The purpose of this short section is to provide an outline of other EU countries that have introduced taxes on waste similar to Denmark, and to evaluate the rate of the Danish waste tax in comparison to total disposal costs in a number of EU countries. Furthermore, developments in waste amounts in some of these countries is evaluated.

8.2 Waste taxes in other EU countries

In recent years, several countries have introduced environmental taxes on waste. Both the rate of these taxes and their design vary considerably, as described below.

France

In France, a waste tax was introduced in 1992. It is levied at plants receiving collected waste (OECD, 1994: 87). The purpose of the tax is to support the phasing-out of conventional landfills. The tax is FRF 40 (DKK 45) per tonne waste. The tax yield is collected in a fund and earmarked for environmental purposes. The funds are used among other things to develop new technology and to invest in inter-municipal waste treatment plants.

The Netherlands

In the Netherlands, a waste tax was introduced taking effect from 1995 (Henderson, 1996). The purpose of the tax is to raise costs of landfilling compared to incineration, and as a consequence, the tax is only levied on waste going to landfill. Most types of waste are subject to tax, also industrial and commercial waste. As in Denmark, plants are charged and costs integrated in the total waste bill. The tax amounts to NLG 29.20 (approx. DKK 98) per tonne of waste. The yield enters as a revenue in the state budget together with other green taxes.

Great Britain

In Great Britain a landfill tax was introduced taking effect from 1996 (only two per cent of waste goes to incineration). The purpose of the tax is to support the overall waste policy, including the promotion of recycling (Riley, 1996). All waste going to landfill is subject to the tax which is levied per tonne of waste. There are two tax rates. A stan-

dard rate of GBP 7/tonne (DKK 76) and a lower rate of GBP 2/tonne (DKK 22). The low rate applies to inert waste (i.e. neither physically nor chemically reactive waste with a negligible liberation of material). The tax yield is used partly to lower employer taxes, and partly to establish funds for promotion of recycling. Thereby, a considerable share of the yield is earmarked for environmental purposes.

Norway and Sweden

In Norway and Sweden, proposals have been presented to introduce waste taxes, partly modelled on the Danish tax.

In Norway, the Green Tax Commission recommended in its report from 1996 to introduce a tax on landfilling and incineration. In a consultation statement from May 1997, the Norwegian Miljøvernsdepartement (Ministry of the Environment) has proposed that the tax amounts to NOK 300 (DKK 282) for waste to incineration and landfills with recovery of methane gas etc. For landfills without recovery of methane gas etc. it is proposed that the tax is fixed at NOK 500 (DKK 471) per tonne. Methane from landfills in Norway accounts for around 12 per cent of all greenhouse gases, but as it is not possible to relate the tax directly to the emission of gases, a tax differentiation is proposed. The tax is expected to promote the establishment of gas recovery at all landfills and lead to a 55 per cent reduction in organic waste resulting in a reduction in total Norwegian greenhouse gas emissions of 9 per cent. No refunds will be granted for waste subsequently removed.

In Sweden, a bill on waste taxes on waste going to landfill has been drafted. The bill implies the introduction of a tax of SEK 250 (DKK 223) per tonne of waste delivered to landfills, whereas incineration plants are excluded. The bill has been prepared in a special survey (SOU 1996: 139). The bill is expected to be enacted and take effect in 1998.

Other countries[23]

In Germany, taxes on special waste have been introduced at state level in six states. Taxes vary from DEM 100 to DEM 300/tonne (DKK 380 - 1,142). In Belgium, the state of Flanders introduced a general waste tax as early as 1987. The tax is differentiated and varies from BEC 231/tonne (DKK 43) for incineration with energy recovery and up to BEC 963/tonne (DKK 178) for conventional landfilling.

In Austria and Finland, national taxes on landfilling of waste have been introduced. In Austria, the tax varies from ATS 60 to ATS 1,000 per tonne waste (DKK 33 - 550). In Finland, a landfill tax was

[23] Source of this section: "Avgift på sluttbehandling av avfall", Rapport fra en interdepartemental arbeidsgruppe, Oslo: Miljøverndepartementet, pp. 94-98, 4.6.1997.

introduced from 1.9.96. The tax amounts to FIM 90/tonne waste (DKK 115), exempting in most cases soil and construction and demolition waste.

8.3 Waste management fees in the EU

No statistics on prices

In order to be able to evaluate the possible effects of the waste tax, especially on cost burdens in enterprises and competitiveness, it is necessary to evaluate total treatment costs, i.e. the sum of taxes and treatment fees. Just as taxes, the rate of treatment fees varies very much between various countries, but it also varies between regions and municipalities in the different countries. The variation is partly due to different regulations on design and safety measures of plants, and partly to considerable variations in financing concepts, also within the countries. No authoritative statistics on prices are available, and it is very complicated to make comparisons.

Denmark at a level with the Netherlands and Germany

Figure 8.1. shows a comparison of lowest and highest rates for landfilling in 1993. The highest rates are found in Germany, the Netherlands and Italy, the lowest in Great Britain. Denmark was not included in the study, but, also due to the waste tax, it is among the cost-heavy countries, with an interval between lowest and highest rates similar to the level of Germany and the Netherlands. The cheapest rates of landfilling in Denmark are estimated to be at certain coastal landfills, where the fee including waste tax was around DKK 250/tonne in 1993.

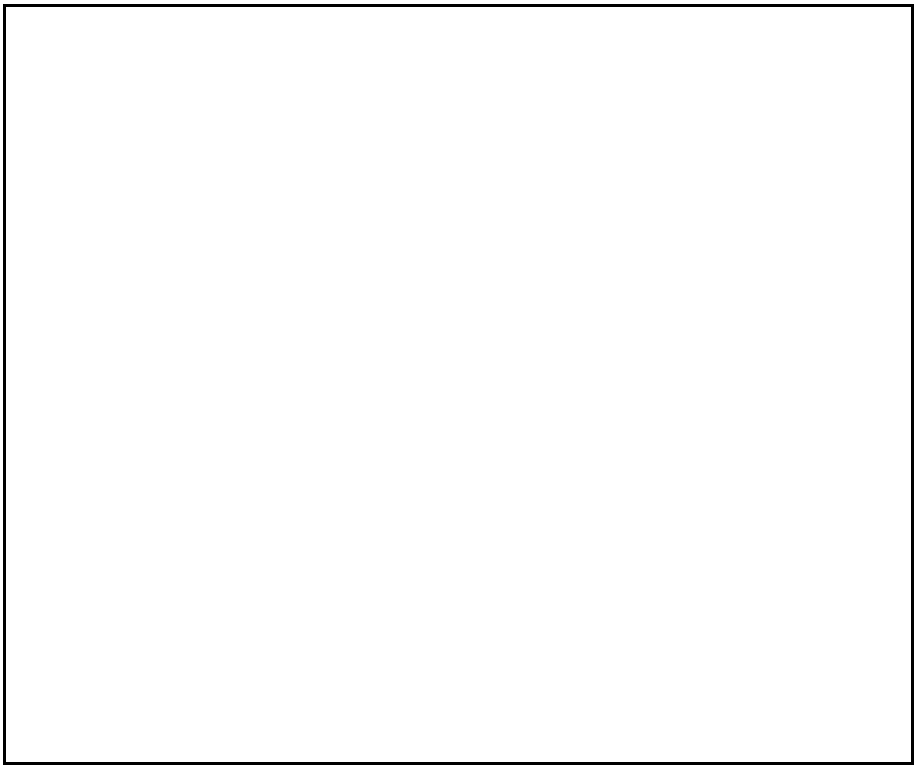

***Figure 8.1**. Comparison between lowest and highest rates for landfilling in a number of EU countries 1993 (Source: Riley, 1996).*

8.4 Development in waste amounts

Increase in waste amounts

At European level there are large problems in maintaining reliable and comparable waste statistics. Data in figure 8.2. are stated by the European Environment Agency in Copenhagen and are assumed to be the most reliable data available. The figure shows the development in municipal waste amounts.

As figure 8.2 shows, waste amounts are increasing in EU countries.

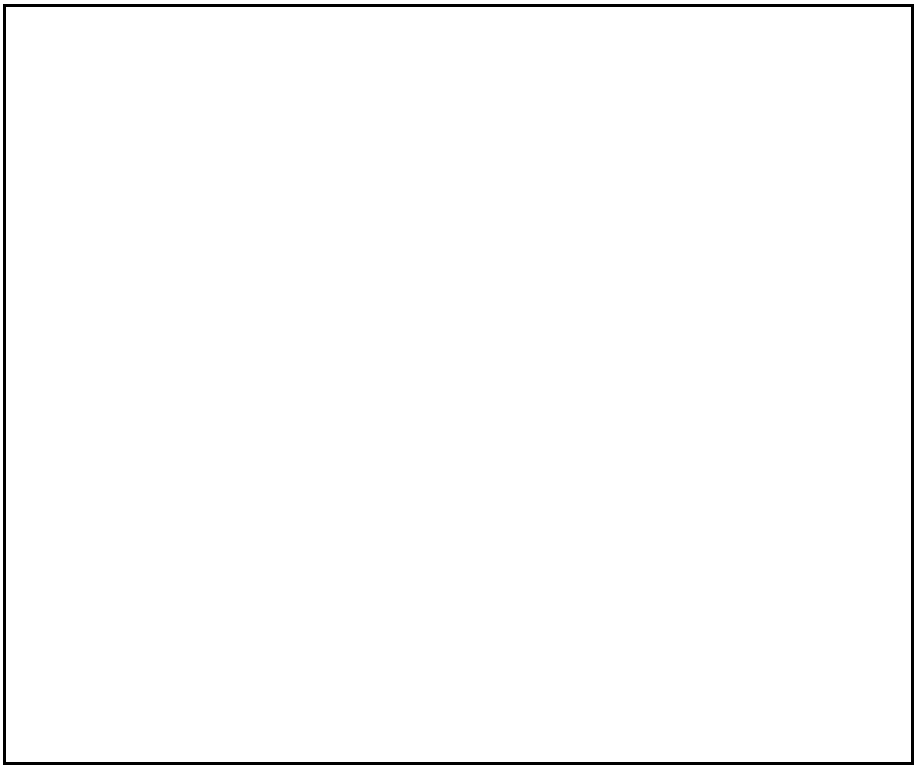

Figure 8.2. *Development in municipal waste amounts (Source: EEA, 1998:347)*

9. Conclusions and recommendations

9.1 Introduction

The effects of the waste tax must be evaluated in connection with general results and other instruments in the waste area, and for that reason - even though focus in the present evaluation has been on the tax - the evaluation to some extent appears as a more general evaluation of results of the Danish waste and recycling policy from 1987 to 1996.

Reduction of 26 per cent

As the taxable base for the waste tax was extended in 1990 it has been important to account for this change at the evaluation of developments in waste amounts. An analysis of data from the Central Customs and Tax Administration's levying of the waste tax in the period from 1987 to 1996 shows a decrease in net collected waste delivered to municipal plants of 1,029,000 tonnes (26 per cent).

At inert waste landfills etc. there has also been a reduction in amounts of waste subject to tax from 1990 onwards. Here, the decrease from 1990 to 1996 amounts to net 155,000 tonnes, corresponding to a reduction of 39 per cent.

Increased recycling

The reduction in waste amounts should be seen in connection with the increase in recycling activities since 1987. The decrease in waste amounts cannot to any significant extent be explained by fly-tipping.

The reduction in taxable waste amounts can be seen as a result of the general Danish waste and recycling policy in the period from 1987 to 1996, but our evaluation of the effect of the waste tax on total development is summarised below.

9.2 Analysis of effects of waste tax

Tax is a "locomotive"

It is important to make clear expectations of the waste tax at its design. The analysis showed, cf. Chapter 3, that it was expected to give municipal waste collection companies and private enterprises an incentive to improve separation and recycling, and that the refund possibility for subsequently removed waste would increase separation at landfills and inert waste landfills. The analysis also showed that architects of the tax were aware that it could not penetrate directly to private households and other waste producers covered by collection schemes, as the weight-based waste tax is integrated into volume-based collection fees. However, the idea was to influence professional waste companies into establishing facilities allowing householders etc. to separate their waste. It was also realised that the waste tax would operate in connection with other instruments in the waste sector, and the Minister for the Environment at that time, Lone Dybkjær, referred in 1989 to the waste tax as a possible "locomotive" for the measures on recycling in the Plan of Action for Waste and Recycling.

Against this background, an analysis of existing waste data was made, and studies of the effects of the tax on enterprises and municipal waste companies were carried out. The results of these studies are summarised below.

Analysis of composition of waste reduction

No reduction in industrial and commercial waste

In Chapter 4 it is shown through an analysis of RENDAN material stream analyses 1987-93 that waste reduction at municipal plants has mainly taken place within construction and demolition waste, household waste and other wastes. No reduction in industrial and commercial waste could be identified. The decrease from 1987-93 at municipal treatment plants is evaluated to be composed of a reduction in household waste of around 352,000 tonnes, a reduction in construction and demolition waste of at least 293,000 tonnes, and in other wastes of 226,000 tonnes. This is outweighed to some extent by an increase in industrial and commercial waste of 86,000 tonnes. In addition to this comes increased removal of waste for recycling, a total of 294,000 tonnes, comprising around 100,000 tonnes of construction and demolition waste. The decrease at inert waste landfills is estimated to be mainly due to construction and demolition waste (further 167,000 tonnes). The total increase in recycling of construction and demolition waste is thereby around 560,000 tonnes. From 1994 to 1996 there is a small increase in waste amounts, but the composition of this increase cannot be determined. The increase most likely is caused by the economic recovery.

Impact from instruments
The major part of the reduction has taken place within heavy waste fractions. Reduced household waste amounts are evaluated to be mainly within garden waste and bulky waste, whereas reductions in paper and glass waste are modest. This indicates that the waste tax has had a decisive impact. This impression is strengthened when the whole range of instruments is taken into consideration.

Modest results of "command-and-control" for paper and glass

The separate collection of paper and glass has been mandatory under the terms of separate Statutory Orders of 1986, but the increase in collection has been moderate, so that only around half the paper and glass waste potential is collected. By contrast, local councils have not been required to establish separate collection of construction and demolition waste or composting of garden waste. Still, today more than 80 per cent of construction and demolition waste goes to recycling, often at special crushing plants. Composting of garden waste has increased significantly since around 1990, and today more than 90 per cent of garden waste is recycled. Also some of the heavy waste types, including sludge from treatment plants, show very high recycling rates. The explanation of the differences in recycling of "mandatory" and "non mandatory" waste fractions can be found especially in various economic incentives related to the recycling of these waste types through the weight-based waste tax.

Motivational analysis of enterprises
A number of enterprises within the manufacturing industry, trade/services and the building and construction sector were interviewed, and the study described in Chapter 5 shows that the attention of enterprises to waste costs varies considerably among the sectors. Not surprisingly, attention is highest in the most waste-intensive sectors such as breweries, iron and metal industry, and building and construction. There was less or almost no attention in less waste-intensive sectors.

Waste-intensive enterprises

At waste-intensive enterprises, recycling has been systematised so that residual waste amounts are very limited, often less than 10 per cent of total waste amounts. For example, the iron and metal enterprises interviewed generate hardly 500 tonnes of residual waste annually, whereas a supermarket chain and a university each generates around 1,000 tonnes of residual waste annually. 13 of 16 enterprises interviewed have taken initiatives to reduce waste amounts, and there is a wide range of motivation for this effort of recycling. The most important motivation is the possibility of revenues from the sale of waste and residual products. A verification of costs of recycling

compared to conventional disposal confirms the impression that the waste tax is not high enough to give enterprises an incentive to increase recycling, as long as they must still pay for disposal of recyclable materials.

The reduction in landfilling of construction and demolition waste has especially taken place within the construction sector, where bricks, concrete and asphalt are recycled. Enterprises with very large amounts of construction and demolition waste may achieve large savings by prioritising separation and recycling. With the present tax on landfilling there are estimated savings of around DKK 300/tonne from crushing compared to conventional disposal.

Motivational analysis of municipal waste companies

Several motives for recycling

The questionnaire study among municipal and intermunicipal waste companies described in Chapter 6 showed that first and foremost political considerations are decisive for the establishment of local separation and recycling schemes. However, a number of other factors also play a role. These factors vary from one waste fraction to another - and for some waste fractions the waste tax is estimated to be more important than for others.

Not surprisingly, for paper and glass, legal requirements are of significant importance. When it comes to construction and demolition waste and garden waste, the desire to reduce costs is the most important factor after the political variable; this reflects the role of the waste tax for these two waste fractions. The cost variable is also important for a number of other waste types.

Decisive impact for C&D waste

The impact of the waste tax was further studied through questions concerning its impact on operating costs in local recycling and separation schemes. Here, an average of around 60 per cent of respondents attribute "some" or "a decisive" impact to the tax on the profitability of established schemes. For construction and demolition waste and garden waste this applies to around 75 per cent of municipalities. 45 per cent of respondents attribute "a decisive impact" to the tax on the recycling of construction and demolition waste.

Replies from municipal and intermunicipal companies show that the waste tax is part of a larger regulatory whole, but it is also a quite significant parameter for decisions on the establishment of recycling schemes.

Analysis of experience with weight-based fees

Very few waste producers bring their waste directly to landfills or incineration plants. They are either included in a collection scheme, or they contract with one or more carriers which collect and dispose residual waste for an overall price. In both cases, this means that the waste tax is internalised in transactions between waste producer, carrier and treatment plant.

For collected waste especially it is a problem that payment is normally based on volume, while the waste tax is calculated on the basis of weight. If increased recycling cannot be converted into less volume or less frequent collection, the gains of a reduction in the waste tax cannot be enjoyed.

Weight-based fees show results

However, experience from two municipalities - Tinglev and Bogense - which have introduced weight-based fees (cf. Chapter 7) shows that more cost-based pricing to households can lead to significant reductions in residual waste. In these municipalities, residual waste amounts have been reduced to around 100 kg/capita, corresponding to a reduction of 50 per cent. In municipalities without weight-based fees, but with recycling facilities made available to citizens there is no similar drop in residual waste amounts, but rather a stagnation. An exception is the municipality of Vejle where a comprehensive and service-oriented collection system has been introduced. Vejle has achieved a reduction in residual waste similar to that of Tinglev and Bogense, but the system is considerably more expensive for citizens. In Tinglev, the weight-based fee system, together with other changes, has led to a reduction in waste collection fees of some 25 per cent. Experience therefore also indicates that wider application of the weight-based fee system will lead to considerably more cost-effective waste management, though this and other aspects should be analysed in more detail.

Adaptations are necessary

It is important to note that the two municipalities in question are two small, rural municipalities with many single-family houses, and it is uncertain whether it would be just as simple to introduce weight-based fee systems in cities, for example with many blocks of flats. The risk of evasion is also higher in cities. On the other hand, environmental and economic gains from the use of weight-based fees seem noticeable, and the tendency also seems to move towards more local councils introducing weight-based fees, cf. the study of municipalities. Weight-based systems can be designed in many ways. An alternative to the Tinglev system could be an intermediate solution giving larger freedom of choice concerning waste bin volume and frequency of collection. It will also be important to find a model appli-

cable to blocks of flats. Such a model might be a 'pay-per-bag' system, as it is known abroad. Changes applying to tenancies will furthermore require amendments to legislation on rents, so that payment for waste disposal can be separated from the general rent.

Summary

Against this background, the effects of the waste tax can be summarised as follows:

As the decrease in residual waste amounts has mainly been seen for construction and demolition waste, household waste, and mixed waste, and not for industrial and commercial waste, this indicates that the waste tax has had different effects in different sectors.

Industrial and commercial waste

For industrial and commercial waste, before the introduction of the tax there was a tradition for sale of recyclable waste products in many waste-intensive enterprises. As it has not been possible to reduce waste amounts further, this must be because the economy of recycling requires in practice that there is a positive price on recyclable materials. The rate of the tax in 1996 was not high enough to lead to recycling, if the enterprise were to finance collection and transportation of these materials. Financial gains, primarily consisting of reduced disposal costs, are marginal in relation to the total turnover of enterprises. This is due to high fixed costs of collection and transportation of recyclable materials that have no positive market price. It is not possible to evaluate whether the tax increase in 1997 has been sufficient to enhance the incentive.

Construction and demolition waste

For construction and demolition waste, it is crucial that landfilling of such waste has become very expensive, and at the same time that recycling, especially of concrete, bricks and asphalt can be made at special plants at very low cost. Especially construction activities and certain demolition activities generate much construction and demolition waste, and due to their waste-intensive nature the waste tax has a significant and measurable effect on total costs of the activity. Especially separated construction and demolition waste can be disposed of at very low costs, and in large construction or demolition works, it is rarely very resource-intensive to carry out this separation.

Other wastes

For other wastes, the same mechanisms come into effect as for construction and demolition waste. Especially slag and sludge are expensive to dispose of by conventional landfilling.

Household waste

For household waste, a large reduction in amounts has been seen. This decrease in residual waste amounts has mainly taken place in heavy and non-regulated waste fractions (construction/demolition and garden waste) and only to a lesser extent in regulated waste fractions (paper/cardboard and glass). Local administrations state that the desire to reduce costs of treatment of these fractions in general has been the second-most important factor for establishing separation facilities (so important that around 75 per cent consider that the waste tax has some or a decisive impact on the profitability of recycling of heavy fractions). As a consequence, it is evaluated that the waste tax has been a catalyst for recycling. It cannot be estimated how comprehensive separation and recycling of waste would have been in households without the tax. It could be argued that if local authorities had had enough political will, the facilities would have been established in any case.

Recycling facilities not always used

The study has also revealed that it is important to distinguish between establishing facilities and actually using them. Experience with weight-based fee systems shows that recycling increases significantly when the financial incentive is allowed to penetrate to households: good intentions regarding separation do not always have the impact one might have hoped for. Many local administrations make separation and recycling facilities available to citizens, but use of these facilities is significantly higher in municipalities with weight-based fee systems.

Effect on heavy fractions

Finally and not surprisingly, it can be seen that financial incentives such as a weight-based waste tax lead to reductions in waste amounts where waste is most concentrated (heaviest) and cheapest to dispose of in an alternative way. Neither is it surprising to note that it is difficult to bring down waste amounts where it is most expensive and troublesome to carry out recycling. It cannot be expected that a tax will lead to reductions in waste amounts for all types and fractions. No economic calculations have been made on costs of recycling, but it seems that, with the tax, more cost-effective reductions in waste amounts have been achieved than if all waste producers had been ordered to carry out the same reductions in their waste

generation. However, there still seems to be a possibility of cost-effective reductions, on the condition that institutional barriers in the waste sector are removed.

9.3 Evaluation of the design of the waste tax

Below, an evaluation is given of the design and administration of the waste tax.

Waste tax rate

Originally, the waste tax was a modest tax of DKK 40/tonne, but over the years it has been differentiated and increased up to five to eight times the original amount. The reduction in waste amounts was most important in the first years of existence of the tax, while in recent years waste amounts have stagnated. This stagnation is partly explained by the growth in private consumption and production.

Saturation of recycling

Recycling of construction and demolition waste and garden waste is considerable today, and it is assumed that the possibilities for waste reduction are fully exploited in areas where marginal costs have been lowest. Marginal costs of increased recycling of household waste and the remaining industrial and commercial waste are assumed to be significantly higher. The so-called institutional rigidities in the waste sector put a filter on the price signal, so that it does not penetrate fully to waste producers, in particular when it comes to waste which is collected.

It can also be expressed in the way that elasticity is low for these waste fractions. The increase in the waste tax rate that took effect from 1.1.97 is relatively significant, and a statement of waste amounts at the end of 1997 will give an indication of whether the assumption of low elasticity is correct. Based on replies from local administrations and enterprises it must be expected, however, that response to the tax increase will be limited.

Weight-based fees

Institutional rigidities in the waste sector not only consist of pricing principles often based on parameters other than weight, but also of players being normally obliged to use certain collection systems, including for recyclable waste. In practice there is a monopoly for this collection. To ensure better penetration of the waste tax, it should be considered to introduce more weight-based pricing for collected waste, and to increase competition in the collection sector.

More competition

For industrial and commercial waste it has been seen that in cases where the price of waste products is not positive, the costs of collection and reprocessing of recyclable materials will often be so high that the price difference between conventional disposal and recycling is limited. The reason for this modest difference is fixed costs of container capacity and collection. For industrial and commercial enterprises a shift towards less fixed costs and more weight-based pricing might play a certain role. However, there is also reason to question whether competition is sufficiently free in the markets for recyclable materials. Due to transport costs, waste products must often be delivered locally. Monopolistic situations may be exploited to establish a practice of charging fees for collecting recyclable materials. Therefore it is essential to ensure sufficient competition in the market for recyclable materials.

Whether there is a need for further increases in the waste tax rate will have to await an evaluation of the not insignificant increase that took effect on 1.1.97. The evaluation does indicate, however, that better "transmission" of the price signal in the waste sector through institutional changes might lead to a further decrease in residual waste amounts.

Non-taxable waste

As mentioned in Chapter 3, certain plants receiving waste are exempt from the waste tax. The most important exemption, in terms of amounts, is landfills for residues from coal-fired power plants, such as fly ash and slag. Today considerable recycling of such residues takes place, and according to the ISAG, in 1995 residual waste amounted to some 300,000 tonnes, corresponding to around 7 per cent of the taxable waste amount. However, it seems difficult to argue for this exemption for environmental reasons.

Fly ash etc.

Large amounts of fly ash etc. are generated from flue gas cleaning. The waste tax was introduced at a time with political efforts to find an agreement with power companies on installing flue gas cleaning at power stations. The exemption must probably be explained by this desire to promote flue gas cleaning.

However, these waste types are primarily generated at coal-fired power plants, while natural gas-fired plants to not generate similar amounts of residual waste.

Hazardous waste

Oil and chemical waste is also exempt from the waste tax. The reason for this exemption is the desire not to hamper collection and environmentally sound destruction. However, treatment costs for oil and chemical waste will often be several times higher than the waste tax itself, so a waste tax would hardly influence the decision for environmentally sound management. Oil and chemical waste only constitutes a few per cent of total waste, and a tax would have little impact on the management of this waste.

Tax differentiation

Until 1997, tax differentiation was too small to neutralise the differences in treatment costs at landfills and incineration plants, and therefore it is difficult in this context to evaluate the effect of the differentiation. It is premature to evaluate the enhanced differentiation of 1.1.97 and the new differentiation between waste incineration with and without power generation.

Ban should be evaluated economically

It seems contradictory that a ban on landfilling waste suitable for incineration is introduced parallel to a financial incentive favouring incineration. It could be feared that the ban on landfilling waste suitable for incineration might lead to expensive solutions for local councils without a noticeable environmental or economic advantage from incineration. If the ban on landfilling waste suitable for incineration is to be upheld, the tax differentiation between landfilling and incineration does not serve an environmental purpose in itself. In contrast, the desire to have better energy recovery from waste incineration seems to be a reasonable argument for the differentiation between different types of incineration plants.

Tax refund scheme

Possible profits created by regulations

Plants reprocessing materials for recycling are able to recover a partial refund for the waste tax. The reason for this is that, in comparison with other operations the reprocessing activity may generate relatively large amounts of residual waste. However, limiting this possibility of low rates for certain types of recycling plants should be considered.

The refund scheme has not been studied in detail in the present evaluation. If, however, the waste tax generates certain 'windfall-profits' at recycling plants, there does not seem to be a good reason to uphold the exemption for the normal waste tax rate. On this basis, limiting the exemption to new and more innovative types of plant

could be considered, for example for plastic and electronics, whereas the exemption could be abolished for more conventional plants in the iron and metal area etc.

Problem waste

Waste tax to be supplemented

The waste tax is a weight-based tax, and it does not discriminate problem wastes. For example, plastic waste and electronic waste are considerably more problematic to recycle than ordinary household waste. On this basis, the tax is not a very precise instrument.

In Great Britain, differentiation is made between waste types so that construction and demolition waste is taxed at a lower rate. It will, however, be difficult to design a waste tax that corresponds more to the exact impact of waste. It is considered more expedient to establish take-back schemes, perhaps supported by deposit systems, for problem wastes, and to use the waste tax as a more general instrument aimed at total waste amounts.

Evasion

Need for inspections

The very high waste tax entails a risk of fly-tipping, especially of construction and demolition waste. Nothing indicates that extensive fly-tipping has taken place, as very large amounts of construction and demolition waste are transported to crushing and recycling plants. However, there might be good reason to pay attention to the 250,000 tonnes per year transported to backfillings (harbours, ski slopes, noise barriers etc.) as in order to enjoy tax exemption such backfillings must comply with a number of requirements. Comments from interviewed local administrations also indicate the risk of more widespread fly-tipping in open countryside.

Administration

Costs of measuring and weighing

Registered plants must use a weigh-bridge approved by the Central Customs and Tax Administration. At the 1990 extension of the taxable base to also cover inert waste landfills, the requirement for weigh-bridges caused discussion of the administrative costs of the tax. Investment in this equipment was stated at DKK 2-300,000 per weigh-bridge. It is estimated that the requirement to use weigh-bridges has only had an impact at few inert waste landfills, despite an acceptable transitional scheme. Several municipal plants had already installed weigh-bridges before the introduction of the tax.

In relation to the total yield of the waste tax in the years 1987-96 (a total of around DKK 4 billion) investment in weigh-bridges has been modest and has hardly amounted to more than DKK 9-10 million as a consequence of the change in 1990.

9.4 Monitoring of waste: continuity and quality in waste statistics

Available statistics on waste amounts constituted, as mentioned in Chapter 4, a considerable problem for the present evaluation and caused a great deal of data analysis which to a large extent also contributed to prolonging the work.

An assessment of different data sources led to the conclusion that the 1985 survey made by the regional councils could only be compared to more recent data with difficulty. The 1985 survey is often used as a basis year by both the ISAG and RENDAN, but this should not be done without noting the significant differences in statement methods.

The ISAG

With the introduction of the ISAG, the Information System for Waste and Recycling of the Danish Environmental Protection Agency, a new data system for waste information was established from 1993, covering both taxable and non-taxable waste. The Danish Environmental Protection Agency receives copies of declarations to the customs and tax regions on waste amounts delivered to and amounts subsequently removed from registered plants, and these data are used as a control in relation to reports to the ISAG. However, it would be appropriate that the ISAG asks plants to check amounts declared to the customs and tax administration against amounts stated in annual reports to the ISAG. This could be done by asking plants in the questionnaire to state how the different taxable waste streams match with amounts declared to the Central Customs and Tax Administration, as these data are assumed to be the most authoritative.

RENDAN

RENDAN still carries out more specialised material stream analyses, financed by the Council for Recycling and Cleaner Technology. This means that waste treatment plants give information on waste amounts to three different institutions: the Central Customs and Tax Administration, the Danish Environmental Protection Agency and RENDAN. In addition, information must also be given to local and regional councils. It does not seem expedient that partly overlapping information is given to several different institutions. From an evaluation point of view, it is also a problem that there is no concord between figures reported to the different institutions.

Central Customs and Tax Administration

It is recommended to ensure better co-ordination of waste statistics. With the ISAG, a clear prioritisation and consolidation of waste statistical work has taken place in the Danish Environmental Protection Agency, but it is recommended to develop single-string waste statistics, with a starting point in the ISAG and with a more consistent use of data from the Central Customs and Tax Administration. Considerations to this effect should be part of the study of simplification and optimisation of waste data management which was recently launched, financed by the Council for Recycling and Cleaner Technology.

9.5 Summary

The results of this evaluation can be summarised in the following points:

* residual waste amounts delivered to municipal plants were reduced by 26 per cent net from 1987 to 1996,

* residual waste amounts delivered to inert waste landfills etc. were reduced by 39 per cent net since these plants were included in the waste tax base in 1990,

* reductions in residual waste amounts have taken place in heavy fractions of household waste, construction and demolition waste and mixed waste, despite increased private consumption and steeply increasing construction activities,

* there has been no reduction in the amount of industrial and commercial waste for landfilling and incineration; waste amounts have followed developments in the net production index,

* the waste tax has played a role for the reduction in household waste as it has been an incentive for local councils to separate the heaviest fractions,

* the waste tax has played a decisive role for the recycling of construction and demolition waste, and a new industry has emerged,

* until 1996, the waste tax had difficulties in penetrating to industrial and commercial enterprises, except for areas where the price span was large due to a positive price of waste products,

* householders and others with collected waste will separate their waste to a larger extent if the fee for waste disposal were more weight-based or more in relation to the amount of waste generated.

The following recommendations are given to the design of the waste tax:

* if the increase in the tax rate in 1997 does not result in further reductions in waste amounts, and if the objective for recycling is maintained, there may be reason to consider an increase or differentiation of the tax in order to improve profitability, especially with regard to recycling at enterprises,

* attention should be paid to the fact that lack of competition in the recycling industry may distort the price of recyclable materials and thus damage the economy in recycling,

* it should be considered whether there are still environmental reasons for tax exemption for plants receiving residues from coal-fired power plants,

* a choice should be made between the ban on landfilling of waste suitable for incineration and the use of tax differentiation,

* the ISAG and other statistics on waste amounts should be co-ordinated better with data on waste from the Central Customs and Tax Administration,

* experience with weight-based fees should be analysed in more detail.

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