1. INTRODUCTION

1.1 Solid Waste and Waste Reduction

The increasing volume of solid waste is a matter of great environmental concern. Waste is a serious problem for several reasons: the large amount of space needed for disposal facilities; the loss of natural resources; and the loss of energy previously used for the refinement of raw materials, for processing and transporting these materials and for producing goods. Moreover, waste is a significant source of greenhouse gases: waste incineration leads directly to the production of CO$_2$, and large amounts of methane are released into the atmosphere as landfill waste decomposes.

Ackerman (1997) cites two major environmental benefits for recycling: those resulting from the waste management process and those that arise in the extractive and manufacturing industries. Examining these benefits, we conclude that they are also valid for waste reduction. The benefits are:

1. reduction in the need for disposal capacity;
2. lowered emissions from landfills and incinerators;
3. reduction in litter and improper disposal;
4. reductions in energy use and related emissions;
5. reduction in extraction and manufacturing process impacts and emissions, and
6. increase in the long-term value of raw materials (by conservation).

The first three benefits for waste reduction can be attributed to waste management. The last three benefits result from the use of recycled materials and the application of cleaner production in industry. With cleaner production we mean: changing the product, changing the production process, changing the inputs to the production process, and re-using wastes within the company or applying better housekeeping options in order to reduce the environmental burden associated with production (Reijnders, 1996). Cleaner production includes activities associated with benefits 4, 5 and 6. These activities also contribute to achieving the first three benefits, which are the areas focused upon in this thesis.

The main advantage of waste reduction, briefly stated, is that it leads to reduced substance flows: less waste in disposal and less virgin material used in production. In this research project our main concern, however, is not how waste reduction can best be realized, but how the elements of waste handling (collection, processing and disposal), especially those that affect the amount and kind of waste streams, can stimulate waste reduction.

In this thesis unusual definitions of waste and waste reduction will be used. Waste is often defined as something that is generated by consumers. For example, in the Netherlands the Environmental Management Act or EMA
(1994) defines waste as: “All substances, preparations, or other products, of which the holder - regarding its handling - parts with, wants to part with, or has to part with.” In this thesis we will take a different perspective. Although the consumer is the source of the substances that eventually may become waste, the point in the chain where the decision is made whether or not a substance will become ‘waste’ is not when a consumer decides to dispose of the substance. In this thesis, we assume that a substance becomes waste at the point when a waste handling organization decides to bring the substance to a disposal facility (landfill site or incineration plant). We consider waste as all solid, non-hazardous materials and products that have entered a waste collection system in order to be transported to a disposal plant. It is inevitable that the figures on waste that will be presented in this thesis do not reflect our way of defining waste, but rather reflect a broad definition as mentioned in the EMA (1994).

In our definition, waste reduction is minimizing the amount of waste that has to be disposed of by recycling or source reduction (see also Fishbein & Gelb, 1992).

We define recycling as the re-input or regeneration of materials and products for their original purpose or for other purposes. This includes re-use (original purpose, no treatment), useful application (other purpose, no treatment), reprocessing (original purpose, after treatment), and useful processing or (resource) recovery (other purpose, after treatment) (Eberg, 1997). We also include composting (treatment of organic waste) under recycling.

We define source reduction as all activities that reduce the amount or toxicity of ‘waste’ before it enters the municipal solid waste stream (EPA, 1994). Source reduction includes cleaner production, repair of products and backyard composting of yard trimmings and other biodegradable waste components. In our view, source reduction includes all strategies that reduce the amount of material that is used to deliver a product or service and that avoid the use of toxic components.

1.2 Solid Waste in the Netherlands

1.2.1 A few figures

Compared to other industrialized countries, the Netherlands produces a relatively large amount of waste per capita. Municipal waste is the term used for solid waste that is collected by, or on behalf of, municipalities. Figures on municipal waste, bulky and commercial waste, as well as the litter removed from the streets, show that the average annual amount of Dutch waste in 1991 was 504 kg per capita (OECD, 1995). The same study showed that the
average production of waste by the European OECD members was 370 kg per capita. Differences in the amounts of waste are usually explained by the fact that different parameters are applied and that the sources of data are unreliable. Van Beek (1997) has attempted to reinterpret the OECD calculations by using some additional sources. According to his calculations, the average annual amount of Dutch waste in 1993 was 566 kg per capita, compared to a European average of 537 kg per capita. Van Beek states that the main explanation for the higher per capita waste production in the Netherlands lies in the much higher population density compared with that of other European OECD countries. Rural households offer less solid waste for disposal due to the fact that curbside collection services are provided less frequently in thinly populated areas, and less compostable waste is offered.

Solid waste production in the Netherlands has steadily increased over the last years. The increase is linked to the rise in the Gross National Product. Wolsink et al (1998) compared organizational trends in the Dutch electricity, water and waste sectors. Figure 1.1 shows the electricity and water consumption and waste production per capita.

The water consumption level has stabilized over the last decade. According to the authors this phenomenon can be explained by two factors. The first is that households have not shown a significant increase in the ownership of apparatus that use drinking water, as is the case with electricity consumption. The second factor is that there has been a large-scale conversion to water-efficient apparatus, especially concerning the activities that use the most drinking water: showering and toilet flushing.

Figure 1.1 Electricity, water end-use and waste production per person in the Netherlands, 1987-1996 (CBS, in Wolsink et al, 1998)

As can be seen in Figure 1.1, the increase in income (Gross National Product, BNP) is strongly correlated with a higher consumption of electricity and production of waste. Electricity demand per person increased by more than 25% during the last ten years, but the production of waste per person has grown even more. However, the data on which these figures are based
include not only substances that are offered for incineration or landfilling, but also those for recycling.

To give an indication of the extent of the waste problem, we will provide some more figures. The total amount of ‘waste’ that was generated in 1996 was almost 51.0 million tons. Of this total, 14% were attributed to households (RIVM, 1997).

The figures in Table 1.1 show that the amount of waste going to landfills has been decreasing in favor of incineration and recycling. Since January 1996 the landfilling of combustible waste has been prohibited. Higher tariffs for landfilling were instituted in January 1999. It is expected that the decrease in landfilling will continue as a consequence.

Table 1.1: The amounts of household waste in kilotons and the method of handling (RIVM, 1997)

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Recycling</td>
<td>990</td>
<td>985</td>
<td>2925</td>
<td>3025</td>
</tr>
<tr>
<td>Incineration</td>
<td>1665</td>
<td>1925</td>
<td>1970</td>
<td>2235</td>
</tr>
<tr>
<td>Landfilling</td>
<td>2730</td>
<td>3285</td>
<td>2210</td>
<td>2035</td>
</tr>
<tr>
<td>Total</td>
<td>5385</td>
<td>6195</td>
<td>7105</td>
<td>7295</td>
</tr>
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The number of landfill sites has drastically decreased in recent decades. In 1970 there were about 1,000 landfills, in 1990 only 120, and the number is still decreasing (Wolsink et al, 1998). In 1996, only 47 sites were still in use (WAR, 1997). In the meantime, incineration capacity has increased. In 1989, a 200% expansion in incineration capacity was proposed over a ten year period (Langeweg, 1989). The actual growth (84% between 1989 and 1999) was substantial, but less than proposed. Wolsink et al (1998) give two reasons for this difference in expected and realized growth. First, the siting of new incineration plants was difficult due to opposition from the public and local authorities. The second reason concerns the (limited) success of waste reducing activities. The mandatory separate collection of biodegradable waste components by municipalities, in force since 1994, has been particularly successful. The amount of compostable waste provided in this way has grown rapidly, from about 0.3 million tons in 1991 to almost 1.5 million tons in 1996 (WAR, 1997). The separate collection of paper and glass has also been successful; nearly 50% of all waste paper was collected in 1993, and almost 80% of all glass (AOO, 1995).

The total incineration capacity was 2,775 million tons per year in 1988 and 3,97 million tons per year in 1996 (Eberg, 1997). In 1997 the largest increase was realized, and at present the total incineration capacity is 4,8
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Concerning waste production, the total amount of industrial waste amounts to 19 million tons per year (WAR, 1997). Despite the fact that industrial solid waste is incinerated in these plants, in addition to household waste, this sector may still be at overcapacity.

1.2.2 Policy objectives

Since 1979, the official Dutch waste policy has established priorities in the waste management hierarchy: avoidance, minimization, recycling, treatment and disposal. This hierarchy (also known in the Netherlands as ‘Lansink’s ladder’, after a member of the Dutch parliament who proposed it in 1979) is not used in a prescriptive way, but rather as a framework, in both Dutch and EU policy. For consumers, the hierarchy means that avoidance and minimization should be the first priority and waste separation for recycling the second priority. For the actors in the waste sector, the hierarchy means that efforts in terms of activities and investments should be directed primarily at offering possibilities and support for waste reduction by consumers. Then these actors have to support and create facilities for separated collection and recycling.

The aim of Dutch national policy on waste management is to minimize the quantity of waste that has to be incinerated or landfilled. Consequently, prevention/source reduction (10% less waste in 2000 than in 1990) and recycling (66% of total waste in 2000) must be stimulated. In the National Environmental Policy Plan Plus, an overall goal was formulated for waste disposal (VROM, 1990a). It called for the total amount of waste for disposal to be reduced from 20,0 million tons per year (excluding dredging and manure) to 12,0 million tons by the year 2000. Disposal in landfills must be reduced from 17,0 to 5,0 million tons per year.

Such tendencies towards growth (e.g. energy and water consumption, waste production) are common in modern welfare states. Tellegen (1995) cites the examples of housing, road and transport, social security, social welfare and the use of total institutions, to show that similar processes are taking place that can be defined in terms of ‘growing uses of goods and services’. Growth becomes problematical when it has negative implications, like harmful consequences for the environment or for financial and social reasons. A growing use of services can become too costly and have unwanted social effects.

Growth in waste production is not only related to growth in prosperity. There are also some other structural factors that can be held responsible for growth in waste production. The size and composition of waste streams are also influenced by demographic factors (population growth), sociological factors (individualization, mass consumption as a way to attain social equality) or technological factors (mixing of materials, development of technologies). In this thesis, the main focus will be on the institutional factor. Our
basic assumption is that size and composition of waste flows are partially
determined by the organizational conditions for providing services in the
areas of collection, processing and disposal.

1.3 The Structure of the Waste Sector

1.3.1 The origin of organized waste handling in the Netherlands

The focus in the discussion on waste handling has changed over time. The
beginning of the organizational structure as it exists nowadays started in the
second part of the 19th century, when the increasing concentration of popu-
lation caused hygienic problems and epidemics in Dutch cities. At that time,
waste was mainly faeces, which was often dumped into the city canals (Ver-
doorn, 1981). Because water for the citizens also came out of the canals, an
idealistic lobby group consisting mainly of doctors, called 'hygienists', wan-
ted to stop this practice. The waste had economic value when mixed with
other biologically degradable components. Collection of waste and selling
manure and compost was leased in most municipalities to foundations for
poverty relief. In the last decades of the 19th century, municipalities did not
continue the leasing agreements. According to Van Zon (1986), the reason
must be sought in the activities of the hygienists. They stressed the causality
between epidemics and general living conditions, in particular hygienic con-
ditions. The hygiënist movement forced authorities to make waste removal a
public and a municipal task.

Waste handling became problematic when the demand for organic mate-
rial decreased greatly at the end of the century, when artificial fertilizers
became available on a large scale. Because the economic use of waste was
barely existent at that time, and the amount of solid waste was increasing,
waste disposal also became a public task.

Until that time the amount of waste had hardly been an issue, although the
first incinerator was built in 1912, in Rotterdam, to reduce the volume of
waste generated by this city. In the western part of the country, the most
densely populated area, there were already four incinerators operating in
1918 (Van der Knaap, 1986). The incinerator in The Hague was even used
for generating electricity (VAM, 1979). This kind of disposal continued on a
small scale for several decades.

During the second half of the 20th century, waste problems were seen as
threats to the environment and as economic issues. Since the sixties, environ-
mental standards for waste handling activities have become increasingly
stringent. The combination of setting high environmental standards for dis-
posal facilities and developments in technology required greater investments,
which forced an increase in scale to decrease costs (Eberg et al, 1998). From
1970 the practice of landfilling changed from almost uncontrolled municipal dumping to controlled landfilling, as a result of generally growing environmental awareness within the public as well as among authorities. The number of landfill sites started to decrease quickly and the need to initiate waste reduction programs became urgent. Incineration of waste provided a good option to reduce waste volume by about 75%. Because waste disposal was considered a public task since the start of the century, investments in incinicators were in most cases public as well.

The Waste Substance Act, established in 1979, endorsed the traditional situation of municipalities providing waste collection services and acting as investing parties in disposal facilities. The act also gave provinces the task of providing regional planning. The Provincial Solid Waste Plan (PAP) had to contain estimates of the needed disposal capacity; these were the basis for municipalities to invest in landfills and incineration plants. Provincial self-sufficiency was the guiding principle underlying the PAP. The purpose of this principle was to avoid unnecessary transport of waste and to increase transparency in waste streams. In principle, the export of waste to other provinces was prohibited.

1.3.2 Recent developments

The focus of the public debate on waste issues changed from the perception of hygienic risks and concerns for public health and the environment to awareness of the financial consequences of maintaining public utilities for the supply of solid waste management services. One could also say that waste became an item of both public and political concern in the eighties.

At the end of the eighties the National Commission for the Coordination of Waste Policy or LCCA was installed as an advisory body to deal with improving the coordination and planning of waste handling facilities. Quantities of waste were still growing, environmental standards made stricter, landfilling of combustible waste was banned and a shortage of disposal capacity was anticipated. There also was the phenomenon of growing local opposition to new incinerating and landfilling facilities as a consequence of dioxin scandals and cases of soil pollution. In 1989 the LCCA, proposed an improved cooperation between different governmental bodies regarding waste policy and the planning of solid waste handling. The idea was realized with the creation of the Afval Overleg Orgaan (AOO), which was basically meant to be a consultation body. This new body, that called itself in English already the 'Waste Management Council', became the most important policy formulating organization in the sector, although the official policy agent for waste is the Directorate of Waste Policy within the Ministry of VROM (Physical Planning and Environmental Management). The Directorate of Waste Policy asked the AOO to organize waste management on a national scale. Every three years a ten-year program is published, indicating required
incineration and landfill capacity, making prognoses of waste streams and formulating policy on prevention, reuse and recycling. Within a few years the AOO has developed into the central actor in the waste sector network (De Jong & Wolsink, 1997). Most major participants in the waste sector were involved in the AOO consultation process from the beginning. Local (municipalities) and regional (provincial) authorities have always been represented in the AOO; therefore, the public waste collectors and disposers are represented as well. A member of the employers' organization indirectly represented the private waste disposal companies. Finally, consumer organizations and national environmental organizations also joined the council.

Reviewing the developments in waste legislation, we see that the framework for waste management, in particular for the decisions taken by municipalities, has changed over the last decade. Officially, planning is still a task of the provinces, but a few years ago inter-provincial planning organizations were founded. Meanwhile, this development is already outdated as a result of the proposals of the commission CTOA, which advised a change in the planning of waste infrastructure and of waste processing and disposal (CTOA, 1996). The division of waste streams should result from market forces, instead of being determined by the borders of planning regions or provinces. One national waste management plan for hazardous and non-hazardous waste should replace the 10-year programs of the Waste Management Council (AOO). As a result of defining new parameters for transporting waste streams, regional and provincial planning will become less significant. The national waste management plan should have a legal basis, and in practice the plan should be prepared by the AOO or its successor and then sanctioned by the Minister (CTOA, 1996). Currently, it is expected that the law will be changed according to these proposals of the Commission on the Future Organization of Waste Handling, also known as the CTOA.

In comparison with the situation five years ago, the time of the first analysis of the Dutch waste sector in our study, the structure of the waste sector has not changed much yet, but it probably will change in the near future. The results of the CTOA study (1996) are not the only reason; some other autonomous developments are having an influence as well, such as:

- Privatization of the waste market;
- Integration of the waste management services collection, processing and/or disposal into one organization;
- The emergence of internationally-operating waste companies and of Dutch energy companies as participants in waste market activities like incineration, and
- Internationalization: the waste market will probably become a European market, which will have a great impact on determining which method is chosen to handle waste streams and the manner in which policy decisions are made.
Although there is a trend towards privatization, competition remains limited in the Dutch waste sector. Waste collection as well as disposal are still seen as utility services, which should be performed within the public domain. Disposal facilities are mainly public property and they will continue to be considered utility services in the next decade. These facilities are operating under non-market conditions for the part of their capacity that is filled by waste collected from households. The financial risks of constructing such facilities are (artificially) spread over periods of 20 to 25 years; therefore, the public waste collectors are forced to sign long term contracts with disposal companies.

The public character of landfill facilities has become a matter of discussion recently. This discussion among municipalities was started in regard to the public management of landfill facilities (VNG, 1998). If the management of landfills is privatized, it will only be a small contribution to an overall trend towards privatization, because the shift from landfilling to incineration will probably continue, thereby making landfilling less significant.

A continuing trend of limited privatization can also be found within the area of processing. This function is already largely in private hands, and because the waste-streams in processing and recycling are growing, the market share of private companies in the waste market is growing as well. Nevertheless, there is also a market share in the processing done by public waste disposers, who are expanding their waste processing activities. Examples are known of waste disposers who not only incinerate, but also develop activities like composting, gasifying or decomposing materials that might be recycled on site. They often do so for environmental or political reasons. All of these developments combined result in an increase in the organizational integration of functions.

The integration of several functions within the same organization is also contributing to scale increases. Private waste sector organizations have been merging, and most of them are part of a few nationally and internationally operating companies. Public bodies involved in waste collection and management are growing to larger scales as well. Dutch municipalities are cooperating in waste collection, either by setting up co-operative collection firms, or by contracting private firms for waste collection. Most of these municipalities still carry out their own public service alone or in cooperation with neighboring municipalities. However, the number of municipalities contracting private companies is slowly rising. This privatization trend is being complemented by a trend toward privatizing municipal services. These services are being transformed into autonomous waste collecting firms (with the municipalities as shareholders). In 1998, 42% of the Dutch municipalities (mostly the smaller ones) had their waste collected by private companies; 20% had it collected by a public service jointly owned by several municipalities; 32% by a solely municipally-owned service, and the remain-
ing 6% of the municipalities chose to transform their municipal service into an autonomous waste collecting firm. According to Dijkgraaf & Gradus (1998), the likelihood that a municipality chooses to have its solid household waste collected by a private company is small in municipalities with a relatively high unemployment rate, because they want to be able to provide jobs. In addition, the number of inhabitants can also determine whether private companies are active within a municipality. The explanation Dijkgraaf & Gradus give is that for smaller municipalities the waste handling costs are relatively lower when the waste is collected by private companies.

Whether or not the trend of transforming municipal services to waste collecting firms will continue is not certain, because it creates new problems for municipalities. Usually the municipalities try to contract out the collection to their ‘own’ companies, but this practice cannot be continued due to EU regulations on free competition (WMO, 1997). It may be expected that EU competition policy will affect the waste market in the near future (Van Vliet, 1998). Waste will most likely be traded on the international market, at least within the EU. Waste processing and waste collecting firms are already working on an international scale. Most small waste handling companies in the Netherlands have merged and have been sold to internationally operating firms like BFI. These firms will continue to challenge national borders and national waste policies.

In accordance with the results of the Commission on the Future Organization of Waste Handling (CTOA, 1996), the planning of waste management will be coordinated on a national level. The principle of self-sufficiency at the provincial level will be dropped. As a result, the planning of waste management policy is moving from the regional to the national level. Municipalities, in particular, are questioning themselves about what their position in the waste market will be in the near future (VNG, 1998). Currently, municipalities are still responsible for the collection of household waste. They either collect it themselves or they hire private companies. Municipalities are required to have the household waste disposed of at environmentally sound sites, and this leads them to invest in incineration plants. Municipalities are reconsidering the financial risks they now bear through investing in disposal capacity, and are debating whether it would be more advantageous to have private companies collect the waste and let the national government take over their investments in disposal capacity.

1.3.3 The relation between the structure of the waste sector and waste reduction

The functions we identified within the waste sector are disposal, processing, collection, and consumption. The organizations operating in these four categories are actors in the waste market, which is mainly an economic arena.
Within these four functions several public as well as private organizations operate, which have stakeholders trying to influence the conditions for the removal and processing of solid waste. Beside these participants in the waste market, other actors participate in the broader waste sector. These actors either create, influence or are otherwise affected by waste management policy, and include: policymaking authorities, research groups and consultants, interest groups and umbrella organizations. Because of the conflicting interests and combined execution of tasks within the waste market on the one hand, and in the domain of policy formation and regulation on the other hand, the total sector has to be considered in this study. When the structure of a policy field is considered, the (im)possibilities of policy can be analyzed properly (Pressman & Wildavsky, 1984).

When we examine the Dutch waste policy field, it quickly becomes clear that even when policymakers are responsible for implementation, they often simultaneously have interests as participants in the waste market. The entire complex of actors and organizational factors in the waste sector, such as property relations, rate systems and the market situation, is not aimed at the stimulation of waste reduction. Rather, the complex, which will be referred to as the structure of the waste sector, is aimed at reliability and low waste disposal costs, and at affirmation of historically developed interests. Attention and investment are aimed at the organization and process of waste disposal, which actually has the lowest priority in the waste management hierarchy. For producers and end-users, spending money on source reduction and recycling is often not a logical option in the current market situation, because costs are increased without financial returns. In a review of twelve countries of the European Union, Wilson (1996, p.385) concludes: "People have merely paid lip service to the hierarchy, acknowledging the supremacy of waste avoidance, minimization and recycling, while in practice, the vast majority of wastes in all of the EU member states have either gone to landfill or incineration."

Therefore, formulation of a good waste policy alone is not a guarantee for getting the best results. Besides the fact that goal attainment on the micro level and meso level are difficult to combine, another explanation may be that the more developed EU States, which consider it their responsibility to provide goods and services essential to human well-being, are also heavily involved in economic development. According to Tellegen & Wolsink (1998), coalitions of actors in the relevant policy domains hold strong policy beliefs directed at avoiding restrictions on economic development, and at decreasing costs for business. This factor would explain why technical solutions are favored above measures that include restrictions, conditions, and new methods of taxation, particularly in the era of growing global competition. "In the domain of waste management ... technical solutions are particularly to be found at the end of the cycle in the stage of treatment and
disposal. Besides, all efforts in earlier stages of the product cycles involve more social than technical engineering. It requires more behavioral change, which will always meet resistance, apart from the interest of economic development.” (Tellegen & Wolsink, 1998, p. 221)

Leaving the initiatives to the market and hoping that within the free market the right incentives towards the first step in the waste management hierarchy occur, is also not a good option. The market will not automatically select the most appropriate and efficient technology. The chosen priorities in waste management more often reflect the outcome of competition that is determined by factors like expectations, increasing returns, network externalities, technological interrelatedness, economies of scale in production and, finally, the learning processes. These factors can strengthen or impede the development process of an environmental strategy. Environmental strategies like recycling and incineration are more competitive compared with options like re-utilization and reduction at source (Van Leenders & de Jong, 1996).

This analysis concurs with the one made by Ackerman (1997), who discusses the reasons that conventional economics fails to understand the environmental issues raised by recycling. He states that the market selects technologies that do not always reflect the best possible choices, given the state of knowledge and available resources. More often the market selects technologies that reflect historical accidents and social forces. Ackerman agrees with the analysis that the conditions for technological lock-in are present in the history of material use. He also brings up two other reasons. “The concern for long-term environmental problems and the welfare of future generations cannot be adequately represented by market mechanisms, which are oriented to choices within a single lifetime. Finally, there are social decisions that cannot be reduced to individual consumer preferences, and intrinsically non-economic values that cannot be translated into dollars and cents; a different kind of decision-making is required to address these questions.” (Ackerman, 1997, p. 46)

In this research project, the arguments from the policy discussion, the discussion among the market participants and the knowledge about economic explanations for the lack of certain developments in the field of source reduction are not our main concern. Instead, we will take a closer look at the relationships between the structure of the waste sector and waste reduction. The main research question is:

*Can adaptations to the structure of the Dutch waste sector stimulate waste reduction?*
1.4 Purpose and Research Questions

The purpose of this research project is twofold. The first aim is the identification of impediments in the structure of the Dutch waste sector that hamper waste reduction. The second aim is the formulation of proposals for adaptations to this structure in order to stimulate waste reduction.

The nature of this research project is descriptive, comparative and exploratory. As a descriptive and comparative analysis, this research project demonstrates a systematic examination of the institutional structure of (waste) sectors. As an exploratory project it attempts to illuminate certain relations between waste sector structure and waste reduction, which in turn became the input for proposals to adapt the present structure of the waste sector in the Netherlands.

In order to find an answer to the research question, an analysis of the structure of the Dutch waste sector was first conducted. A systematic examination of the institutional structure of the Dutch waste sector had to be done. The following questions had to be answered:

- Which actors are part of the inter-organizational network in the waste sector?
- How can these actors influence the way in and extent to which waste streams flow through society?
- Where in the structure of the waste sector are impediments that hamper the achievement of waste reduction?

The identified impediments have indicated the existence of certain key elements in the structure of the waste sector that may be amenable to adaptation. These key elements are separation of functions in the waste market, the conditions for transactions, the role of public authorities, the level of scale in the planning of waste management, and the actors to which the responsibility for waste reduction is attributed.

Comparative case studies have been conducted in order to find an answer to the following question:

- What lessons can be drawn from an investigation of the structure of the waste sector in foreign contexts, and from a comparison between the Dutch waste and electricity sectors?

The results of case studies abroad are presented first. These studies describe the structure of three foreign waste sectors. The relevant question that will be answered in each study is:

- How are structural key elements related to waste reduction?

Then, the Dutch waste and electricity sectors are compared. In this comparison an attempt has been made to answer the following questions:

- How can the situation that leads to demand-side management in both
sectors be described;
• What fundamental constraints to reduction initiatives can be found in both sectors;
• What are the likely consequences of applying the hypothetical intervention (that is proposed as a possible solution to remove the inherent fundamental constraints): (1) does the proposed intervention result in an incentive for demand reduction, i.e. is it effective; (2) is it economically efficient; and (3) does it interfere with the reliability of service provided?

Comparing the three case studies abroad with the Dutch situation, the following questions were formulated:
• Is it possible to modify elements in the structure of the waste sector in such a way that the first priorities in the waste management hierarchy are properly addressed?
• What is the relation between each of the following key elements and waste reduction:
  1. Does vertical separation of market functions stimulate waste reduction?
  2. Does the imposition of conditions on market transactions have a positive effect on reduction?
  3. Should the government be more or less involved with the waste market?
  4. Does organization of the waste sector on a national scale encourage waste reduction?
  5. On whom must the responsibility for waste reduction lie in order to stimulate source reduction and recycling?

All conclusions from the case studies and all other information beyond the case studies have been integrated. These conclusions form the basis for formulating five proposals for optimizing the structure of the future Dutch waste sector. By means of an ex-ante evaluation, the feasibility of the five proposals, as well as the probable effects on waste reduction were explored. The following questions were addressed:
• Will the five proposals result in incentives for waste reduction; i.e. will adaptation of the structure be effective?
• What will be the consequences of implementation of the five proposals for the quality of the services (collection, processing and disposal) that have to be provided by the organizations in the waste market? Does adaptation interfere with the reliability, the affordability and the attainability of services?
• What possible problems can be expected in case the proposals are applied?
1.5 Structure of the Thesis

The first chapter has briefly described the trends emerging in the waste sector and formulated the research questions. Chapter 2 will describe the conceptual research approach to analyze the relationships between the structure of the waste sector and waste reduction, and will discuss the process of the research project.

Chapter 3 is a report of the findings of the first inventory of the Dutch waste sector. It is an analysis of the structure of the Dutch waste sector (De Jong & Wolsink, 1997). In that chapter all actors within the waste sector are characterized and the configuration of the relations between them are examined. It was not possible to formulate organizational features on which the description of the waste sector would be based beforehand. Preliminary to this project there was neither an overview available of the structure of the waste sector, nor any theoretical frameworks that could be used. Next to a description of the Dutch waste sector, the inter-relatedness of waste sector organizations is analyzed. Some aspects in the relationships between actors appear to be crucial for creating conditions that can result in positive stimuli for waste reduction. Five elements are considered significant to stimulate waste reduction. These elements are the focus in the rest of this project, and help in finding an answer to the central research question.

Chapters 2 and 3 are essential for a proper understanding of the case studies that are presented in chapters 4, 5 and 6. Because there was no theoretical starting point, the analysis of impediments in chapter 3 forms the backbone for the inductive process through which alternatives for structural elements are sought. The relations between structural elements and waste reduction are focused upon in case studies. Chapter 4 presents the result of a case study in New Jersey (USA). Chapter 5 gives an analysis of the Dual system in North Rhine Westphalia (Germany). In Chapter 6, a closer look is taken at the situation in Denmark. All case studies have been structured similarly for the purpose of comparison.

In chapter 7, the case study results are summarized and conclusions drawn. Here, a process of deduction leads to the formulation of recommendations for adaptation of the Dutch waste sector. The results are published in De Jong & Wolsink (1999).

In chapter 8, a comparison is made between the Dutch waste and electricity sectors. The results are published in Slingerland & De Jong (1998). This comparative case study also provides some evidence for conclusions that go beyond the case studies.

Finally, in chapter 9, the results of an ex-ante evaluation among some key actors within Dutch and foreign waste sectors are presented. The effective-
ness and the feasibility of the recommended proposals for adaptation of the Dutch waste sector are evaluated, and form the subject of discussion in a paper for the Conference on the Greening of Industry in 1998 (De Jong & Wolsink, 1998). The conclusions of this ex-ante evaluation answer the main research question.

Chapters 3, 7, 8 and 9 have been published previously. The original manuscripts of the first two texts have been entered integrally in this thesis; the second two have been altered but only slightly. As a consequence there is some overlap in texts, due to the fact that the articles should be understood on their own and they often start, for example, with a general explanation of the research subject.