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**HAZARDOUS WASTE POLICY MANAGEMENT
– INSTITUTIONAL DIMENSIONS**

**CHAPTER FIVE:
Government Responsibility for Risk:
The Bavarian and Hessian Hazardous
Waste Disposal Systems**

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May 1984
CP-84–24

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PREFACE

This paper has been produced as part of IIASA's hazardous waste management work, which is the main component of the Institutional Settings and Environmental Policies project. The overall aim of this work, reflected in this paper, is to systematize our understanding of interactions between institutional and technical factors in policy making and implementation. The influence of institutional processes upon technical knowledge built into policy has been increasingly recognized. However, it has yet to be adequately clarified in comparative research on different regulatory systems. Institutional structures cannot be easily transplanted from one culture to another. Nevertheless, through the normal flux of policy, institutional development slowly occurs anyway, in more or less *ad hoc* fashion. Comparative insight may help to direct reflection and adaptation in more deliberate and constructive ways.

This paper forms one draft chapter of an intended book on hazardous waste management. The reader will therefore notice references to other draft chapters in this study which are also being circulated separately, and which are available from IIASA. A full list is given overleaf. At this stage the papers are drafts, and are not intended for publication in present form. They are being circulated for review and revision.

I would like to thank those policy makers and others who have exchanged papers and information with us, and those who generously gave of their time and experience in the many interviews which form a substantial input to this work. A full list of acknowledgements will eventually be published.

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Environmental Policies

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— INSTITUTIONAL DIMENSIONS**

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**CHAPTER FIVE:
Government Responsibility for Risk:
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Waste Disposal Systems***

Joanne Linnerooth and Gary Davis

I. INTRODUCTION

Most western, industrialized nations have passed legislation for identifying hazardous waste streams, tracking their transport, and controlling and monitoring their disposal. With few exceptions, legislators have recognized that the best disposal is "no disposal", and have established the reduction and recycling of industrial wastes as a first priority. For the wastes that inevitably remain, high temperature incineration and physical or chemical treatment are generally considered preferable to the direct land disposal of these wastes. With the exception of the United Kingdom** most national authorities call for the minimization of land disposal.

*This paper is based upon extensive interviews in the F.R.G. conducted by Jobst Conrad, Gary Davis, and Brian Wynne. We are indebted to Jobst for providing extensive material and insights into the F.R.G. system.

** The U.K. claims to have a geological structure especially well suited for landfilling of chemical wastes.

Despite ambitious legislation, there is concern on the part of regulators and the public about the effective implementation of hazardous waste management. Administrators are therefore looking to other countries for workable examples. Two states in the Federal Republic of Germany (F.R.G.), Hesse and Bavaria, along with the Scandinavian countries, stand out as having systems that generally promote the commonly recognized objectives for the management of hazardous wastes. Hesse and Bavaria reportedly place relatively little (around 40%) of their hazardous wastes in landfills and have taken steps to encourage industry to reduce and recycle its wastes. The remainder of the hazardous wastes in these two states is either pretreated before being deposited (around 20%) or, what is generally considered the superior method, incinerated at high temperatures (around 40%). These figures, although they are not readily comparable because of the significant national differences in defining and reporting hazardous waste, indicate that considerably less wastes are directly disposed of on land in Hesse and Bavaria than in many other European and North American countries.*

The apparent success of these two states in handling their hazardous wastes, relative to other countries, is usually attributed to their institutional systems. They have large, integrated public facilities for storage, treatment and incineration of wastes, which are, for the most part, equipped with up-to-date environmental technology. The state and local governments have taken the major role in financing, operation, and regulations promoting and sustaining these facilities, and have assumed central responsibility for the management of

* As cases in point, the Netherlands reportedly deposit 88% of their hazardous wastes in landfills [1], the U.K. 75% [2], and around 80% of U.S. wastes are disposed of on land [3]. Also, in the whole of the F.R.G., it is estimated that 80% of its hazardous wastes (including treatment residues) are disposed of on land [4].

hazardous wastes.

For other countries or regions, the merits of public financing or ownership of hazardous waste facilities, and related issues of comprehensive facilities and pricing schemes, should be viewed within the general political, institutional, and economic context in which these systems have evolved and are expected to work. In this paper, we describe the Hessian and Bavarian experiences with this more general perspective in mind. Following a brief discussion in the next section of the technical management options for dealing with hazardous wastes, the F.R.G. hazardous waste legislation and its implementation, will be described in Section III. We turn then to looking closely at practices in Hesse and Bavaria. In Section VI, we discuss some of the advantages of and the problems inherent to the Hessian and Bavarian hazardous waste management strategies. Finally, we offer some perspectives for other regions and countries, where the state of North Rhine-Westfalia in the F.R.G., with its combined private/public system, and the United States, with its similar federal and state political system and capitalist industrial traditions, serve as comparative examples. We limit our discussion to current hazardous waste practices, excluding both the problems of nuclear waste disposal and the clean-up of past dumping sites.

II. OPTIONS FOR HANDLING HAZARDOUS WASTES

The predominant method for dealing with hazardous wastes in most industrialized countries remains, land disposal. This includes surface impoundment or ponding, where liquid wastes are contained in natural or man-made depressions with special clay or synthetic liners, land spreading or farming, where

wastes are tilled into the topsoil; deep well injection, where wastes are placed below groundwater in formations sealed off from above, and landfill, where hazardous wastes are placed directly in or on the ground. In the U.S., for example, surface impoundments and landfills account for an estimated eighty percent of the disposal of industrial hazardous wastes [5], and many other industrial countries report similar figures. General purpose landfills, which receive most of the landfilled industrial wastes, are those facilities with no containment, monitoring or leachate collection systems, but in contrast to open dumps, these facilities do periodically cover the wastes. In sanitary landfills the wastes are spread in layers and covered after each operating day. Secure landfills, segregate wastes into separate cells, take measures to prevent contamination of natural water, and are continuously monitored.

Landfills can present two main types of environmental problems: fires, explosions and pollution of air, and contamination of surface and groundwaters. There is a growing, although not complete consensus, that state-of-the-art landfills are not appropriate for certain wastes, e.g. organic solvents and inorganic acids and that generally not enough is understood about the synergistic effect of chemical mixing or the reliability of natural or synthetic liners to guarantee proper long-term containment [6].

Increased documentation of the risks from surface impoundments and landfilling has led to growing interest in the development and promotion of alternative technologies, where the following hierarchy has been proposed as an optimal management strategy [7]:

- Waste Reduction or Recycling.
- Physical, Chemical, and Biological Treatment: These include physical processes, such as mechanical filtering, chemical processes by which the molecular structure of the waste is changed, and biological

processes that rely on microorganisms to treat organic materials. These treatment techniques can render wastes innocuous or reduce their toxicity.

- Incineration: Controlled thermal treatment destroys or renders wastes less hazardous and can be used to recover energy. High temperature incineration is generally considered one of the safest methods for treating organic wastes.
- Solidification/Stabilization of Residuals before Landfill: This method consists of various encapsulation techniques to "solidify" wastes and make them less permeable.

Although it is not the intent of this paper to discuss the scientific merits and uncertainties of hazardous waste management options (for a full elaboration, see Wynne, Chapter 3), it should be noted that any management hierarchy for hazardous chemical wastes is necessarily based on inadequate and uncertain scientific knowledge. For instance, high temperature incineration is widely considered a relatively safe method of treatment for organics. Yet little is known about the chemistry of incineration, especially how the technique deals with particular mixtures of hazardous wastes even in those cases where the breakdown characteristics of individual compounds are understood. Furthermore, management hierarchies, such as the one listed above, follow primarily from an engineering knowledge of the environmental risks and are based to a far less extent on institutional considerations involved in implementation. Where wastes are managed behind the factory gates and where the human factor plays a significant role, the possibility of mismanagement is not negligible. This is true for landfill, which relies on the operator's knowledge of mixing wastes, etc., as well as high temperature incineration which relies on fairly narrow optimal conditions, for example, to ensure complete combustion of the wastes and production of toxic emissions. These factors are all the more significant when the underlying technical uncertainties are significant.

The point here is not to question this generally accepted management hierarchy, but to recognize the inherent uncertainties and the inevitably dynamic nature of any current regulatory goals.* Because of the manifold uncertainties it is important to develop an institutional base for implementing regulations that is resilient to changes in scientific knowledge. With this in mind, we turn to experience in Hesse and Bavaria, where the state governments have assumed responsibility for the risks presented by the management of hazardous wastes.

III. FEDERAL HAZARDOUS WASTE LEGISLATION

Background

The constitution (Grundgesetz) of 1949 established the F.R.G. as a federation of what are currently eleven autonomous states, called Länder (see Figure 1). Most regulatory power is distributed between the federal government and the states; however, in contrast to the U.S., the F.R.G. constitution vests in the states the responsibility for implementing and enforcing laws enacted by the federal parliament. The German states therefore, enjoy a more powerful position in relation to the federal government than their American counterparts.

Political decision making in the F.R.G. cannot be understood adequately unless one takes into account the specific separation of powers between the legislature and the executive as laid down in the constitution. In contrast to the

* In Denmark, for example, the incineration of domestic wastes was considered the optimal disposal method and dominated all other technologies in the 1970's, but today it is no longer unquestionably the best method [8].

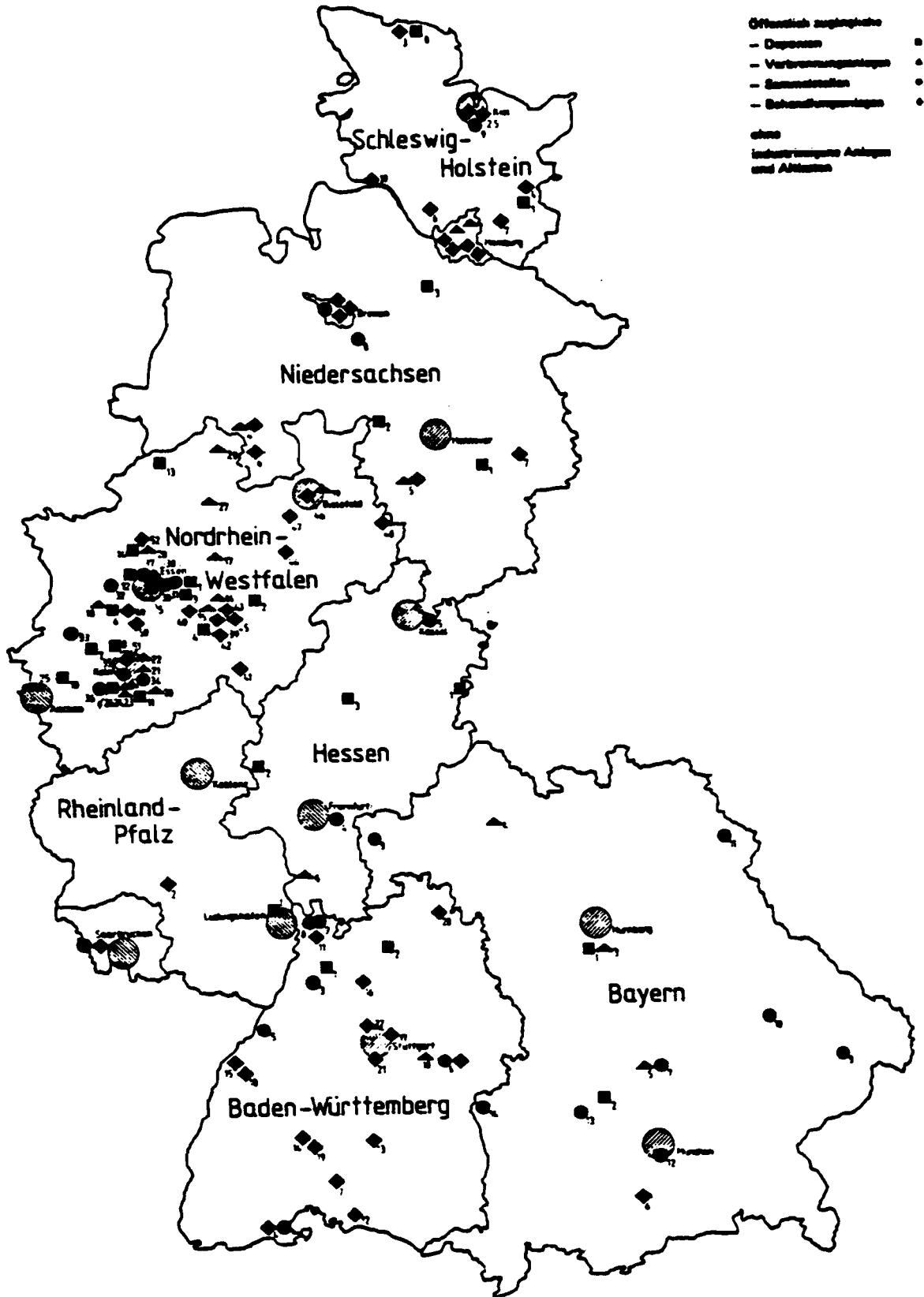


FIGURE 1. Location of Hazardous Waste Treatment and Disposal Facilities in the Federal Republic of Germany (11).

U.S. system, which fosters a unique competition between the executive and legislative branches, in most European countries the powerful ties of party membership greatly reduce the likelihood of discord between the executive and the majority in parliament. The history of recent chemical control legislation indicates that many of the systematic divergences between U.S. and European environmental law can be attributed to this difference in executive-legislative relations and underlying political culture [10]. By channeling draft legislation through a tight interministerial structure, most European governments, including the F.R.G., develop bills that most closely resemble their actual intended agenda for implementation.* In contrast, the American Congress formulates legislation with less emphasis implementation, leaving this task to the agencies responsible for formulating regulations.

This institutionalized cooperation between the federal ministries in working out legislative details before formal consideration of a bill in parliament mirrors a more general cooperative ideology both between the federal government and state governments and between government and industry. At the state level, where implementation strategies are formulated and carried out, it is normal for government authorities to work closely with industry, and possibly other interested or influential parties, in formulating policy. At this level, state and local officials generally have discretion to develop "workable" regulations and standards with industry. This historical partnership between government and industry, in addition to the power which the states enjoy in imple-

* This tendency towards political compromise in the F.R.G. is, in some cases, changing by the recent formation of citizen action groups of all kinds. With regard to environmental issues, for example, nuclear power, a growing number of these groups has entered into the political arena. There are also significant differences between European countries which have yet to be fully analysed, especially where coalition government is normal, e.g., the Netherlands and Denmark, (see Wynne, Chapter 7).

menting federal legislation, formed the basis for the close government and industry cooperation in the management of hazardous wastes in Hesse and Bavaria.

The Federal Waste Disposal Act

Hazardous waste in the F.R.G. is regulated under the Federal Waste Disposal Act (Abfallbeseitigungsgesetz, AbfG) of 1972, as amended in 1976, 1980, and 1982, which went into effect on 1st January, 1977. As in other countries, the legislation was designed to cope with waste in general, and not only hazardous waste. Certain types of hazardous waste are regulated separately and excluded from the Waste Disposal Act, such as waste oil, nuclear waste, waste water, military wastes, and wastes from mining. Dumping at sea is regulated by the Dumping at Sea Act of 1977.

The Waste Disposal Act, and its accompanying Administrative Orders, are formulated at the federal level and implemented by the states (Länder) in cooperation with counties (Kreise) and municipalities (Gemeinde). Consistent with F.R.G. regulatory tradition, this legislation lays out a framework which the Länder are obliged to follow, but which is general enough to allow them a great deal of discretion in choosing how the statutory goals will be met.

In relation even to the U.S. hazardous waste legislation (Resource Conservation and Recovery Act) of 1976, the general objectives of the Waste Disposal Act appear rather ambitious. Wastes must be disposed of such that the well-being of the general public is not affected, in particular to prevent dangers to the environment and public health. The Act makes no attempt to define further what is meant by "prevention of danger" by laying out specific safety or risk cri-

teria. It does state that a first priority with respect to hazardous wastes is to prevent or reduce their generation.

Dealing generally with wastes, household garbage as well as industrial waste, the federal legislation requires each generator to cede his wastes to the competent county (Kreise or Kreisfreie Städte) authorities for treatment or disposal. At the same time, it assigns responsibility to the local authorities by obliging them to handle the wastes generated in their region by providing adequate facilities. Exceptionally, with the consent of the respective Land authorities, these local bodies can be relieved of their obligation to handle certain wastes if, because of their nature (e.g., toxicity) or quantity (e.g., ice and snow), such wastes cannot be disposed of in local facilities (AbfG, Section 3.3). These wastes, which must be decided on a case by case basis, have become known as "special wastes", although the term cannot actually be found in the 1972 legislation. The purpose of this exception is to transfer responsibility for handling certain wastes from the local authorities to the generator of the wastes; the term "special waste" should thus be understood as an administrative definition.

Alternatively, the term "special waste" requires a more scientific definition. The 1972 legislation referred to certain wastes from commercial or other economic undertakings which, by their type, characteristics or quantity, may endanger health, air or water, be explosive or inflammable, or contain or cause infectious or contagious diseases (AbfG, Section 2). This concept was defined more precisely in an Administrative Order of 1977, which does not contain a list of chemicals, but rather a list of 86 specific wastes. (see Dowling and Linnerooth, Chapter 4). There is no procedure given for adding to or subtracting from this list; however, states have the right to supplement it in their own waste plans.

The Waste Disposal Act and its accompanying Administrative Orders set up a formally complete system of control, the "cradle to grave" system, which, in principle, allows for the comprehensive public control of hazardous wastes by tracing the path of each waste from its generation to its place of disposal. According to the Administrative Order on the Notification of Waste of 1974, as amended in 1978, a trip-ticket procedure and record keeping can be imposed on the owner of special wastes, and are mandatory for generators of hazardous waste. In addition, operators of certain facilities handling special wastes are required to appoint a waste disposal agent, protected from dismissal by law, who monitors the production, transport, and ultimate disposal of wastes.

Which waste disposal facilities are used is established in the waste disposal plans, which must be drawn up by the Länder, and are binding for local and district authorities. In principle, wastes may only be treated, stored or deposited in approved installations, and transported by certified operators. The licensing of waste disposal plants is generally done in planning permission proceedings, where all public and private interests that could be affected by the scheme should be considered.

From this brief description of the Waste Disposal Act, and its Administrative Orders, the F.R.G. appears to have a relatively comprehensive legislative system, at least formally, for regulating hazardous wastes. Commentators and regulators, however, point to a number of weak points in the system. To begin, the effectiveness of the regulatory framework to "protect the well-being of the general public" will depend crucially on whether all wastes that are in fact hazardous are included in the universe of regulated wastes or the 86 wastes defined as potentially dangerous. Some states, most notably Hesse, have greatly expanded this list. Ways of legally evading the system also exist. A

serious loophole appears to be the used oil exclusion, since used oil can legally contain a certain amount of hazardous substances, and is often sold as heating oil for apartment buildings and houses. A second, equally important, loophole concerns the recycling of waste; generators may declare their waste as an economic good if they have a willing buyer, and in so doing are not required to enter it in the notification system. A general clause allows the Minister of Defense to make exceptions from the Waste Disposal Act and the corresponding administrative orders for military wastes. In addition, the legal possibility exists in the Federal framework for generators to export their wastes to other states or countries with less stringent requirements. Bavaria and Hesse alone have imposed their own State level export restrictions, so as to protect the market of waste arisings for their own public facilities. These loopholes are considered to be serious, and attempts to close them by amending the Federal Waste Disposal Act are currently underway.

Implementation

Other than the general framework laid out in the Waste Disposal Act, and Administrative Orders, the federal government has little to do with the actual practices of waste management.* The German states assisted by the county and municipal authorities, have full responsibility for implementing the legislation.

The practices of the states in this respect vary considerably. Lists of hazardous wastes range from the 86 mandatory wastes in the federal regulations to 299 in Hesse; only a few states, notably Hesse, Bavaria, Hamburg, and Baden-

* The Federal Environment Ministry (UBA) carries out research, disseminates information, and provides technical assistance to the Länder, especially in the area of recycling and waste reduction.

Württemberg, are attempting to computerize the trip-ticket system and, in effect, make it operational;** the number of personnel, including inspectors, employed to implement the legislation also differs considerably among the states. The discretion which the state enjoys in implementing the Waste Disposal Act is reflected most strongly by the Waste Disposal Plans, which show significant inter-state variations regarding the type of disposal or treatment prescribed for different waste streams.

A main concern in this paper, is the strategic and organizational difference between those states which have publicly-owned or publicly-supported integrated facilities and those which rely on a larger number of privately-owned and decentralized facilities. Figure 1 shows how Hesse and Bavaria have organized waste disposal around a few comprehensive facilities, which are partially or fully owned by the local or state authorities, compared, for example, with North Rhine-Westfalia, which operates with numerous private waste enterprises (and a recently built regional facility). These differences go beyond that of organization, since the outcomes of the systems themselves are very different. Most notably, Hesse and Bavaria place a relatively small proportion of their wastes directly in landfills, compared to other states. In the next two sections, we will describe in some detail the Hessian and Bavarian waste management systems, including the way in which these states have defined hazardous wastes, the technologies employed, and their economic, legal and institutional context.

** This system puts a large burden on the regional authorities, who are responsible, in contrast to many states in the US, for checking that each shipment of hazardous waste reaches its intended destination, but, in practice, the paperwork is too excessive for effective control. For example, the municipality of Kassel in Hesse is relatively lightly industrialized with around 200 firms generating hazardous waste, 50 to 70 hospitals, and numerous gas stations. According to an official in the Kassel Regierungsbezirkspräsidium, there are over 12,000 trip-tickets per year, which is more than enough for three full-time employees to control effectively [11].

IV. HAZARDOUS WASTE DISPOSAL IN HESSE

Hesse is considered by many waste authorities of industrial countries to have one of the more progressive and successful systems for managing hazardous wastes. This is due principally to its modern, centralized facilities, especially the incineration plant at Biebesheim, and to its general performance record with respect to the way in which wastes are managed. According to the Hessian Ministry for Development, Environment, Agriculture and Forestry, the primary goal of a waste management system is to improve the environment to the greatest possible extent. This means that the highest priority must be put on *reducing* and *avoiding the production of wastes*, followed by recycling, and finally the safe disposal of the remaining wastes. As the following breakdown for the 300,000 tons of hazardous wastes generated in 1981 shows, only 40% of these wastes were deposited in landfills [12].

Landfill	120,000 metric tons	(40%)
Underground deposit	20,000	(6.7%)
Chemical-physical treatment	90,000	(30%)
Incineration on land	50,000	(16.6%)
Incineration at sea	20,000	(6.7%)

What is Hazardous in Hesse?

Hesse has greatly increased the number of wastes requiring special treatment; the authorities have listed 299 hazardous waste types compared with 86 on the federal list. According to the Hessian regulations, industrial wastes can be divided into the following three classifications, each with a recommended disposal method (which is decided more specifically by the government in the case of each waste):

- I. Industrial wastes that are similar to municipal garbage and can generally be treated as such.
- II. Industrial wastes that are hazardous and cannot be treated with household waste, thereby requiring special treatment, such as treatment, incineration, deposition in secured landfills.
- III. Industrial wastes that are especially hazardous and require treatment under "special technical conditions", i.e. salt mine deposition or high temperature incineration.

Categories II and III can be regarded as hazardous wastes, where category III wastes are special priority or especially hazardous.* From the 563 waste types listed in the LAGA catalog (see Dowling/Linnerooth, Chapter 4), 262 are identified as Category II, and 37 as Category III.

"Special waste" is, in Hesse, like in the federal legislation, a general administrative concept. It includes those wastes in any of the three categories, which, because of their type, quantity, or characteristics, cannot be deposited together with household wastes. Of the 2.1 million tons of industrial wastes produced in Hesse in 1982, 1.4 million tons were deposited with household wastes and 0.7 tons were considered special. The special wastes, in turn, consisted of only about half, or 0.3 million tons belonging to Categories II and III [13].#

The Legal and Institutional Framework

The organization of hazardous waste management in Hesse is legally based on the Federal Waste Disposal Act and Special Waste Order, the Hessian Waste Law, promulgated in 1978, and the Hessian Waste Management Plan, particularly the partial plan "Special Wastes from Industry and Firms" (1976). This plan assigns full responsibility for special wastes to the Hessian Industriemüll

* An analogous example of a state that has classified some wastes as "priority" is California. With some exceptions, the Hessian priority list (Category III) and the California priority list are surprisingly similar.

An example of a category 1 (non-hazardous) "special" waste would be large volumes of snow from road-clearance, earth ballast, etc.

GmbH (HIM), which was established in 1974. The HIM is currently jointly owned by the Hessian government (26%) and a consortium of 25 Hessian waste-producing industries (74%), both with equal voting representation. This arrangement evolved from a private waste management company financed by hazardous waste generators which encountered financial difficulties. The Hessian government rescued and part assumed joint responsibility for the facilities. With this public responsibility was also established the central control of wastes to restrict export and competition, and protect the economic viability of the infrastructure.

Government authorities in Hesse thus exert a direct control over hazardous waste management through the state's part ownership of HIM. The responsible agency is the Hessian Ministry for Development, Environment, Agriculture, and Forestry, which categorizes wastes, specifies how they will be managed, and promulgates standards for emissions from industrial facilities. The Hessian authorities require that all industries deliver their special wastes to the HIM, the so-called "Benutzungszwang" or "compulsory use". The regional authorities are primarily responsible for monitoring and regulating the transportation of wastes, and the actual operation of waste facilities.

The Facilities

The HIM operates four hazardous waste facilities in Hesse. The most recent is the Biebesheim incineration facility, which was completed in 1981, and which is considered by authorities to be the state-of-the-art in hazardous waste incineration. Two chemical-physical treatment facilities are in operation in Frankfurt and Kassel, and a small landfill is in operation for the district of Mar-

burg. A large landfill, which has encountered extensive public opposition, is now being planned for Mainflingen. In addition to these HIM facilities, Kali and Salz AG. operates an underground salt mine deposit near Herfa-Neurode.

Although there are now no transfer stations for special wastes in Hesse, several are planned, and the HIM is testing a waste pick-up service for small generators. The HIM in the Marburg district has set up a new service to encourage the safe disposal of small quantities of special wastes. Industrial customers that generate less than 500 kg/year can deliver wastes to a special truck and pay only 1 DM per kg. Citizens bringing household toxic wastes may do so free. The system is financed by a tax on waste production levied by the cities and counties, its level depending on the quantity and type of waste produced.

The Biebesheim incineration facility consists of two rotary kilns, after burners, heat recovery and a novel scrubbing system for the exhaust gases.* The chemical-physical treatment plant at Frankfurt and Kassel use standard technologies for cyanide destruction, neutralization, and precipitation. Only solids or dewatered sludges, usually treatment residues, are permitted to be landfilled in Hesse. Lacking landfill capacity, HIM exports most of the treatment residues and other wastes for landfill to neighboring states (Baden-Württemberg, Bavaria, Lower Saxony, and North Rhine-Westfalia). Only the most toxic and persistent wastes that cannot be easily treated are sent to the salt mines at Herfa-Neuroda. Wastes are imported to the salt mines from all states in the F.R.G. without restriction, but wastes may come from other countries

* This system scrubs wet but then dries the liquid to a powder. Halogenated organics are incinerated up to a chlorine content of 30%; above this level, the waste is sent to the salt mines at Herfa-Neuroda (but only in solid form). Though the facility employs good environmental control equipment, it would not meet all of California's air quality requirements [14].

only if the foreign authorities agree to cooperate with the F.R.G. in other types of waste management, such as nuclear waste disposal.

Hazardous wastes may be treated, incinerated, or disposed of on-site by the generator only with special permission from HIM; statistics on the amounts handled on-site are not available. Existing disposal facilities may continue to operate, but no new facilities, with the exception of water treatment, will be permitted. Firms handling their own wastes are not permitted to accept wastes from other generators.

Hesse is requiring documentation of waste reduction and recycling measures by those seeking permission from the planning authorities to construct new industrial facilities and to expand existing ones. The state will deny this permission unless the facility owner includes up-to-date measures for pollution reduction and recycling processes. This program which is not directly provided for by law, is very controversial and has been challenged by industry in court [15].

The Financial Arrangements

The original industry owners of HIM financed the first facilities, but cost difficulties forced the state government to become increasingly involved, first by supplying low-interest loans, and later by directly subsidizing investment expenditures. The Hessian government paid most of the capital costs for the Biebesheim facility (DM 100 million) and recently, contributed an additional subsidy of 9 million DM. The prices per ton for disposing of hazardous wastes by the HIM in 1981 were as follows [16]:

Landfill	80-300 DM	(\$25-130)
Chemical-physical treatment	20-530 DM	(\$9-230)
Incineration on land	340-950 DM	(\$150-420)
Disposal in salt mines	180 DM	(\$80)

These prices do not reflect the full costs of disposal, but are increasingly subsidized by the Hessian government. The subsidies are not passed on in full to the facility users in price increases. One reason for this is that the Hessian authorities are becoming concerned about over capacity, especially at the Biebesheim facility. The amount of Hessian wastes incinerated at Biebesheim has recently dropped from 50,000 tons per year to 36,000 tons and the facility is now importing a total of 27,000 tons of waste per year. (10,000 tons from Baden-Württemberg, 10,000 tons from the Netherlands, 5,000 tons from Switzerland, and 2,000 tons from Belgium and Luxemburg. In addition, 20,000 tons per year are imported to the Herfa-Neuroda salt mines.) [17]

Because disposal prices in Hesse are higher than in neighboring states with less stringent regulations, or countries, e.g. the GDR, there is a strong economic motivation for producers to export their wastes. For this reason, except with special permission, the export of hazardous wastes is forbidden. The importance of this compulsory use of the facilities, effectively creating a state-industry monopoly, for the economic viability of the facilities cannot be over emphasized. This will be discussed in more detail in Section VI.

V. HAZARDOUS WASTE PRACTICES IN BAVARIA

Bavaria is the largest of the F.R.G. states with an area of 70,500 sq. km. and nearly 11 million inhabitants. Yet, it is not highly industrialized, producing

less industrial waste (around 350,000 tons in 1983) than states such as Hesse or North Rhine-Westfalia. It is therefore a relatively dispersed system of waste production. Estimates show that there are approximately 6,000 hazardous waste generators in Bavaria and around 120,000 shipments of hazardous waste per year [18].

Bavaria is of special interest because it recognized the hazardous waste problem very early on and became a forerunner for hazardous waste practices even shaping to a large extent the federal legislation. As early as 1966, the district of Mittelfranken founded a municipal cooperative [Mittelfranken Cooperative for Special Wastes (ZVSMM)] responsible for disposing of special wastes, and in 1970 a semi-public organization [the Association for Handling Special Wastes (GSB)] was created to handle special wastes for the rest of Bavaria. In both instances, central facilities were built for treating, depositing, and incinerating hazardous wastes.

With their impressive management record, the organization of these two operations has served as a model for waste management in the F.R.G. and other European countries. In 1981, 215,000 metric tons and 148,000 metric tons of hazardous wastes were disposed of by the GSB and the ZVSMM respectively. The proportion of these wastes that were incinerated, treated by chemical or physical methods, and deposited in secure landfills (mostly treatment residues) is shown below [19]:

	GSB		ZVSMM*	
Incineration	53,000 t	29%	14,000 t	10%
Chemical/Physical Treatment	97,000 t	45%	46,000 t	31%
Landfill	55,000 t	26%	88,000 t	59%

* The relatively large amount of landfilling by the ZVSMM is principally due to one generator who disposes of large quantities of wastes containing vanadium and chromium that cannot be

In contrast to Hessian state documents (though not so much informal usage), the Bavarian authorities do not distinguish consistently between the terms "special waste" and "hazardous waste". "Special waste" is generally taken to mean it is hazardous, although some official recognition is given to the more administrative concept of special wastes as those excluded from the responsibility of local authorities. The original Bavarian list of hazardous wastes which included even a rough classification by degree of hazard, was later changed to accommodate the federal listing system. Currently, a total of 239 wastes requiring regulation are included on the Bavarian list (for more detail, see Dowling and Linnerooth, Chapter 4).

The Bavarian Law again echoes the framework legislation of the Federal Waste Disposal Act of 1972. More detailed provisions governing special waste management are contained in the Bavarian Waste Plan required by the federal law. Waste generators must notify the Bureau of Environmental Protection (Landesamt für Umweltschutz) of the Bavarian Ministry for Land Development and Environment of the types and quantities of wastes they produce. The Bureau then decides whether these wastes should be managed as hazardous wastes and in which category they belong.

As in Hesse, (and for the same reasons) the export of hazardous wastes from Bavaria is prohibited without permission from the Bureau,* and generators of hazardous wastes must obtain permission from the Bureau to dispose of their wastes on-site. Very large chemical companies such as Hoechst, for example, burn their own wastes. This practice, however, is generally

treated profitably.

* Exemptions from this prohibition can be secured for those wastes that cannot be burned, treated, or deposited safely in Bavaria; or, permission to export may be justified by the ability of a large company to treat wastes at its own facility in another state.

discouraged and approval would likely include strict conditions on how the wastes must be managed.

ZVSMM

Environmental concerns arising towards the end of the 1960s from indiscriminate dumping practices inspired the towns and districts within the region of Mittelfranken to form the ZVSMM, at which time there was no effective legislation in the F.R.G. for dealing with the disposal of hazardous wastes. This facility serves, in addition to Mittelfranken, other parts of Bavaria and Baden Württemberg. This region has a total area of 21,000 sq. km. (about 10% of the area of the F.R.G.), 3.7 million inhabitants, and approximately 4,000 industrial companies.

The ZVSMM is of special interest in that it is a fully public enterprise, in contrast to the joint government/industry owned facilities in Hesse and the rest of Bavaria. The operation of the ZVSMM is the responsibility of six different state, county and municipal authorities [20]:

The ZVSMM owns and operates the Schwabach disposal facility which consists of a rotary kiln incinerator, for organic wastes, a physical-chemical treatment plant, a waste water purification plant, and a clay-lined hazardous waste landfill. Control wells located around the landfill monitor the sealing capacity of the pit bottom and the integrity of the ground water. The ZVSMM does not operate collection vehicles, but relies on private transportation companies. The hazardous wastes delivered to the disposal facilities at Schwabach are weighed upon delivery and tested in the laboratory to check whether they match the description contained in the accompanying documents. This is a commercial as well as a risk management need.

The Schwabach facilities are fully financed by the ZVSMM and the Bavarian state government, without any additional contribution from industry. As of 1983, a total of 32 million DM had been invested in the facilities. The members of ZVSMM--5 large towns, 7 county districts, and 7 small towns--raised 5 million DM for the original capital investment, and the Bavarian government, approximately 5.6 million DM. The remaining funds came from low-interest government loans (approximately 5 million DM) and user fees. These figures reflect the much lower capital costs in the 1960s, when Schwabach was built. New construction now deemed necessary will receive a 40-60% subsidy from the Bavarian government which will not have to be repayed.

The state government, therefore, subsidizes the ZVSMM facilities directly by contributing to the capital investment and indirectly by offering low-interest loans. The prices charged at Schwabach for waste handling cover the remaining costs, including the non-subsidized capital costs, operating expenses, and interest payments. ZVSMM operates on a non-profit basis, and prices are set at the end of the year to reflect the anticipated costs for the next year. Prices for 1982 ranged as follows [21]:

Landfill	50-100 DM per ton	(\$22- 44)
Treatment	50- 70 DM per ton	(\$22- 31)
Incineration	80-280 DM per ton	(\$35-123)

The GSB

The GSB (the Gesellschaft zur Beseitigung von Sondermüll) manages hazardous wastes in the remainder of Bavaria. All special wastes outside of those handled by the ZVSMM must be delivered to the GSB unless permission is granted for on-site disposal or export. The GSB has four facilities, and seven

transfer stations located around the state consolidate wastes for shipment to one of these facilities. These transfer stations also dewater sludges and oil-water emulsions and perform some acid-base neutralization to reduce volumes before shipment.

The Ebenhausen plant, about 5 kilometers from Munich, includes two rotary kiln incinerators, a physical/chemical treatment plant, and a waste water treatment plant. The Schweinfurt disposal plant consists of an incinerator for industrial wastes, such as paper contaminated with oil, which can be incinerated with domestic refuse. GSB also operates a solvent recycling facility near Munich and a large landfill at Gallenbach. These facilities have been described in detail elsewhere [22]. For our purposes, it is important to note only the most hazardous wastes containing organics are incinerated and the landfills do not accept liquid wastes, only dewatered sludges and nontoxic solids.*

The original capital investment for the GSB facilities of 1 million DM was raised by industry (30%), the Bavarian government (40%), and member communities (30%), but subsequently the Bavarian government has underwritten all significant capital investment. As of 1980, the capital costs had totaled approximately 85 million DM. The original outlays on the part of the GSB members of 1 million DM had risen to a total of 21 million DM as of 1980. The remaining outlays have been financed by a combination of direct government subsidies, indirect subsidies of low-interest government loans, and user fees [23].

* Small quantities of untreated wastes can, however, be landfilled if the regulatory agency permits, a practice that resulted in an incident at the Gallenbach landfill, where a reactive waste was landfilled causing a fire and a release of chlorine that injured a nearby resident.

Again, the users do not pay the full costs of waste disposal. GSB charges disposal fees that cover operating costs (24 million DM in 1982), but not subsidies from the state government which average 60 - 80% of new capital costs. Prices in 1982 ranged as follows [24]:

Landfill	64-195 DM per ton	(\$37-86 per ton)
Treatment	70-285 DM per ton	(\$31-125 per ton)
Incineration*	350-620 DM per ton	(\$154-273 per ton)

It is striking that the prices charged by the ZVSMM are considerably lower than those charged by the GSB. The director of the ZVSMM attributes this difference to ZVSMM's lower operating costs [25]. Since the Schwabach facility has grown stage by stage, with capital expansions corresponding to increased demand, it supposedly does not have the Ebenhausen problem of over-capacity. The Schwabach plant, also according to its director, is more efficiently operated with less bureaucracy and without the expensive network of collection centers which were built by the GSB during a time of plentiful public funds. Finally, the Schwabach facility has a larger proportion of wastes being deposited, which decreases its relative costs. Other officials have suggested that an additional reason for the ZVSMM cost advantage is that the facility, because it was built earlier, was not required to install the costly environmental devices which were required for the Ebenhausen facility.

VI. PLURAL RATIONALITIES IN THE MANAGEMENT OF HAZARDOUS WASTE — THE STRATEGY OF HESSE AND BAVARIA

The disposal of hazardous wastes in an environmentally sound way, with first priority on the reduction or recycling of wastes, is the stated aim of the

* The price for incinerating PCB's may go as high as DM 1000 per ton.

federal government as well as of Hesse and Bavaria. In meeting these goals, Hesse and Bavaria have built technologically advanced, integrated facilities with a steadily rising investment of public funds, placed a high priority on treatment and incineration methods with relatively little direct land disposal, and shared the costs between industry and the taxpayer. This strategy has been successful through a delicate balancing of different social interests, those in support of maintaining a viable waste industry, disposing of wastes in an environmentally acceptable manner, and reducing wastes. What appears rational from one perspective, for instance, restricting exports and lowering prices, may appear irrational, from the perspective of, for example, those in favor of reducing wastes. Hesse and Bavaria seem to have found a workable compromise in balancing these various conflicting interests.

Public Ownership

The most striking and significant feature of these two states, especially in comparison with other German states and countries, is the extent of public ownership of the waste disposal facilities. By financing capital investments and taking responsibility for operations, the state and local government have, in effect, assumed responsibility for the *risks* of hazardous wastes. The liability and responsibility of the generator for the long-term disposal of his hazardous wastes ends once he turns his wastes over to the public authorities. This contrasts with the principle of generator responsibility in nearly all other countries. For example, in the United States under Section 7003 of RCRA, the EPA can bring legal action against anyone handling wastes in a way that represents an imminent hazard, where site operators, landowners, transporters, and even

generators are all potentially liable [26].

The entry of the Hessian and Bavarian authorities in what had been the clear domain of the private, commercial sector marked a change in the terms of the hazardous waste problem, from creating and sustaining an industrial-organizational infrastructure in support of the private commercial facilities to sustaining a viable system for the management of the risks presented by hazardous wastes (for a discussion of these problem definitions, see Wynne, Chapter 1). While these two perspectives on the problem, or "rationalities", are complementary, the state authorities appear to have identified themselves as "risk managers" as evidenced by their continuing efforts not only to support the facilities financially, but to participate in their management and, at the same time, to encourage the reduction of wastes.

The most widely recognized advantage of a public authority entering the "risk management" business by financing and operating waste disposal facilities is that the absence of the profit motive allows greater attention to be given to meeting environmental objectives. The conflict between the need to maintain an industrial waste catchment and the regulatory need to strictly control the types of wastes disposed, or even reduce the wastes, can, in principle, be avoided if the facility can rely on a back-up of public financing and aid. The strong financial support from the Hessian and Bavarian governments has contributed to the fact that wastes handled by the state facilities are generally managed by technologies that render them less toxic or of less risk to the environment and the public despite the fact that these technologies are more expensive than the cheaper forms of waste management, such as direct land disposal, commonly practiced elsewhere. (Also elsewhere as in the Netherlands for example, adequate treatment and disposal facilities have been preempted

by investment uncertainties given no guaranteed market.)

On the other side, the absence of competition and the profit motive for waste management may also lead to the tendency for public operations to increase their bureaucracy and operate inefficiently. As a case in point, the high costs of the GSB facilities have been, in part, attributed to the expensive and supposedly inefficient network of collection facilities which were installed during a period of abundant public money, and were later reduced in number when public financing became tighter. The disadvantage may be offset by the belief that a public facility can be monitored and controlled more effectively by the public regulators, although there are also opinions to the contrary.*

The control factor, or assuring that wastes are handled safely at their "grave", may be the most convincing and appealing argument for public facilities. Experience in many countries has shown the difficulties in planning, permitting and monitoring adequate private disposal facilities, which is complicated by a lack of funds for hiring the requisite personnel as well as the general nonavailability of people sufficiently trained for the jobs involved. A central, public or quasi-public facility concentrates expertise on the surveillance and control of a comprehensive disposal operation.

The advantages and disadvantages of government ownership fade somewhat with increasing public pressures for the facility to cover its costs. This pressure will occur naturally as the extent of private investment in the facilities increases. There are important advantages of combining public and industrial financing and control such as is the case with the HIM (Hesse) and GSB

* According to an official in North Rhine-Westfalia, a private facility can be controlled more effectively since it can be threatened with closure [27]. This has also been argued in Britain by the private industry consortium of national Waste Disposal Contractors.

(Bavaria) models. Many problems encountered in gaining the cooperation of the large industrial firms can be avoided if they become partners in the disposal venture. A waste expert from the Bavarian Bureau of Environmental Protection sees this cooperation as the essential ingredient in creating regional facilities, and even more difficult to establish than the financial base. The good cooperation between industry and government allowed a consensus to be reached quickly, and the GSB was founded after only a little more than a year of negotiations [28].

Alternatively, this close partnership between government and industry, which is more typical of European regulatory practices than American, can effectively diffuse control through "cooption" of the regulators. Advocates of more cooperative forms of environmental practices, however, argue that this disadvantage is overcome by the implementation advantages of collaboration and workable compromises between industry and government [29,30]. A more adversarial system must also reach such compromises, but this is usually accomplished through lengthy and expensive court proceedings, in a climate of bad faith.

The Pricing Strategy: A Double Dilemma

Central to any strategy for waste management is the choice of cost allocation. Usually this choice lies overall between industry and the taxpayer, but there are options in between. This choice is related to the question of ownership. Public ownership lends more flexibility to the pricing decision than a competitive, private market, but is not a necessary condition for public financial support which can come in the form of government subsidies to private enter-

prises, tax reductions to industry, and so forth. In fact, the early intention of HIM, ZVSMM and GSB was to operate as non-profit enterprises but to charge industry the full cost of disposal. Financial pressure forced each of these public or quasi-public facilities to gradually pass less of the costs on to their customers and more of the costs on to the taxpayers.

Yet, relative to out-of-state prices for less costly disposal practices, the prices to industry in Bavaria and Hesse remain intentionally high. As a result, the GSB and HIM facilities, and to a lesser extent the ZVSMM, are troubled with increasing over capacity. Predictions of waste generation, which formed the basis for construction of the plants greatly overestimated the quantities produced which has remained constant for the past several years. Although stricter air pollution and water pollution controls have resulted in the generation of more solid wastes, waste reduction due to rising costs of disposal and slow economic growth have combined to counteract any growth in the waste generation rate. The shortage of waste delivered in the facilities is further aggravated by the fact that the wastes delivered are becoming dirtier, the so-called "Bavarian syndrome". The high costs of treatment and incineration is prompting firms to find their own uses for the cleaner wastes and to utilize more efficient recycling technologies.

From the waste-reduction perspective, a measure of success of a high-priced facility is how quickly it manages to put itself out of business. But this strategy presents an obvious dilemma to the public authorities and underscores the conflicting institutional objectives and rationalities. From the point of view of a government trying to raise funds for a large capital investor, the prospect of middle- or long-term bankruptcy of the operation is less than helpful. It is not surprising that in the Netherlands, where the authorities are

trying to promote privately-financed, integrated facilities, there is a great deal of ministerial interest in creating *and sustaining* a "waste industry", in direct conflict with the stated aims of environmental groups for reducing wastes. On the other hand, in Hesse the Environmental Agency has taken direct measures to reduce pollution at the source by making it a condition for permitting that new industrial facilities or modifications, incorporate the best available technologies to reduce pollution and wastes.* Yet, a continuing problem in the F.R.G. is the overcapacity of the existing facilities which is further frustrated by the operation of marginally qualified plants, mostly in other states, which operate at lower costs. According to the prestigious Council of Environmental Advisors, the granting of operating licences for new plant is strictly dependent on their meeting costly environmental standards, which many of the other operators do not meet. This has led to a significant difference in price structure between the older and newer facilities, which is one reason, according to the Council, why highly qualified installations are underused, while a "special waste traffic" to inadequate waste disposal facilities is in full swing [31].

A pricing policy that encourages the environmental objective of reducing hazardous wastes thus conflicts with the economic objective of maintaining a reasonable return on the large capital investment in waste facilities. This creates a fundamental dilemma between those institutional interests charged with reducing environmental risks and those charged with monitoring a viable technological waste management system. Yet, there are effective stop-gap measures to this dilemma, as are illustrated by the following measures taken by Hesse and Bavaria in the face of decreasing supplies of hazardous wastes:

* This policy has been challenged by Hessian industries as being beyond the State's legal authority.

- Expansion of the universe of hazardous wastes by adding wastes to the list.
- Restriction of the amount of wastes that are exported by requiring all wastes, unless officially exempted, to be brought to the public facilities ("Benutzungszwang" or "compulsory use").
- Increasing the amount of wastes delivered by restricting on-site disposal.
- Importing wastes from other states and countries.

These measures, apparently motivated both by the need to maintain a supply of wastes to the state facilities and by a genuine distrust of the private sector in handling wastes, represent a compromise between the conflicting objectives of reducing wastes and sustaining the capital-intensive facilities. Yet, they will not suffice in the long-run if the costs to the waste producers remain high.* Lowering these costs, as was done by Hesse and Bavaria by not passing the full amount of the government subsidies onto the facility users, *does* contradict the government's stated aim of reducing or recycling wastes. Opponents of this policy of subsidizing the disposal of wastes also object on economic grounds in that it distorts prices and creates an unfair comparative advantage for certain firms. They are fueled in their arguments by the directive set out by the European Economic Community, the "polluter pays" principle, which obliges the government to charge polluters the full cost of their pollution [32]. Despite being subsidized, the Hesse costs especially are still high, and higher costs still would not only perhaps reach a limit of waste reduction innovation, but also encourage illegal disposal.

Thus the opposing institutional rationalities prescribed by sustaining highly qualified facilities and reducing hazardous waste generation are further complicated. A double dilemma arises since any price incentive for reducing

* In the long-run, this dilemma might resolve itself if the facilities became obsolete. Indeed, Bavaria plans to phase out slowly these investments.

wastes is at the same time an incentive to dispose illegally of wastes. Inevitably, high prices for waste disposal encourage both activities; the success of a costly environmentally attractive disposal system depends ultimately on whether it encourages more legitimate recycling and reduction measures while controlling illegitimate dumping, burning, or exporting.

The Enforcement Gap

The public is becoming increasingly sensitized to the problems involved in managing hazardous waste by the multitude of publicized disasters or near disasters, for example, Love Canal in the U.S., Lekkerkerk in the Netherlands, and Nievenheim in the F.R.G. The episode of the lost Seveso dioxin barrels, which, fortunately for German officials, were found in France, has further undermined the public's faith in the ability of regulators to cope with the hazardous waste problem. With thousands of diffuse firms producing and transporting hazardous wastes and easily accessible opportunities for them to evade the system, their full control is close to impossible, especially considering the limited funds available in state budgets for this purpose.* A serious disparity thus arises then between the legislative efforts to control hazardous wastes and the implementation of this legislation, what has been referred to alternatively as the "enforcement gap" [33] and "executive deficit" [34].

The most important regulatory "stick" for enforcing compliance with the hazardous waste laws are fines which can be as high as DM 100,000 (US\$44,000), however, this may not be high enough to dissuade some generators from

* In Bavaria, there are only four inspectors to control the many hazardous waste generators, allowing them, in effect, to inspect each firm only once per year.

profitably abusing the law. There are no criminal penalties. The Waste Disposal Act does not explicitly address questions of liability for environmental damages resulting from improper waste disposal practices. Violation of the waste regulations is, however, a violation of civil law which may result in liability for damages. Special regulations apply to accidents during the transport of waste which assign strict liability, i.e., it is not necessary to prove the fault of the driver. In addition, the law requires that transporters and disposers be insured against possible accidents [35].

Because of the weak economic sanctions and the difficulties in policing so complex a system, regulators have repeatedly stressed the importance of information dissemination and moral persuasion in encouraging industry to comply with the Waste Disposal Act.* Given the limited financial resources for enforcement, at most, the regulators can inspect and monitor the large generators.** But this may be where efforts are least needed since, as a regulator at the UBA points out, the large firms are nowadays highly sensitive to hazardous waste problems, having made substantial investments in their management, and can generally be trusted to comply with regulations [39]. The director of the ZVSM makes a similar point. The economic incentive created by high prices tends to encourage large companies to invest in low-waste technologies and recycling; however, this economic lever is not so effective for small business, such as paint shops or gas stations, which have the (illegal) option of mixing their toxic waste with household waste [40].

* Diver [36] argues that voluntary compliance is a crucial ingredient for most areas of regulation.

** Figures exist that show the expense of operating a comprehensive control system can be a significant portion (20-40%) of overall disposal costs [37]. In the U.S., the large generators are responsible for a disproportionately large percentage of total hazardous waste production. The largest 5% of hazardous waste generators produce approximately 98% of the wastes [38].

Ultimately the success of Bavaria's and Hesse's strategy of charging relatively high prices for technically and environmentally efficient waste practices hinges on the extent to which this strategy has not, in turn, increased the amount of illegal or semi-legal disposal practices. As might be expected, there are opposing opinions on this. Officials in Hesse and Bavaria at the state and local levels have expressed the opinion that illegal disposal practices, as opposed to semi-legal practices, are no longer a significant concern; the problem of midnight dumping, they claim, is a problem of the past [41,42]. Alternatively, civil servants at the Federal Environment Ministry (UBA) are not so sanguine about state practices, in general, stating that the extent of illegal practices could be anywhere from 10 to 90 percent, or highly uncertain [43].* But the general perception on the part of most officials is that the high disposal prices in Hesse and Bavaria have not increased the amount of illegal, "midnight" dumping, though the extent of these practices remains highly uncertain.

The more serious problem, it seems, is the transport of hazardous wastes over the state or national borders to less-qualified facilities. In theory, a waste management firm in another state should not accept wastes that are transported without permission from Hesse or Bavaria; however, officials state that, in practice, it is not difficult for generators to find out-of-state firms willing to take their wastes. There is also a lucrative waste traffic to the G.D.R.

Waste experts at the state and federal level are also in agreement that there is a large "grey area" which is not strictly illegal, yet is not entirely in the spirit of the law. Schenkel, from the UBA, compares hazardous waste regulations in the F.R.G. with tax regulation where, in both cases, elaborate formal

* An opposing opinion was offered by an expert at the Ministry for the Interior in Bonn, who states that, in contrast to the EC countries, where on the average only about 50% of hazardous wastes is disposed of correctly, in the F.R.G. this percentage is closer to 75 or 80% [44].

rules and bureaucracy exist, but because these rules are systematically scrutinized for loopholes, the regulations are only partially effective [45]. One such problem is the declaration of a waste as an economic good, relieving the entrepreneur of his obligation to register the waste, which may eventually be sold or burned in facilities lacking the necessary environmental equipment.* This practice does not come under the direct control of the state. Generators may also mix their wastes with used oil or they can discharge their wastes as waste water. Additionally, it is important to recall that a large amount of hazardous wastes are disposed of on-site, which, for reasons other than intentional abuses, may be insufficiently controlled and result in environmental pollution. For this reason, Hessian and Bavarian authorities are attempting to curtail on-site disposal of hazardous wastes.

Hucke [47] has shown, in connection with enforcing air pollution controls, that under the surface of relatively clear regulatory standards the actual practice of implementation involves a significant amount of bargaining between regulators and firms, rather than the command and compliance usually assumed. One important reason for this is the separation of function between state officials, who have the better technical knowledge, and local officials, who, in the case of air pollution, are charged with issuing the licenses and sanctions for non-compliance. Waste management officials have the same, if not more, discretionary powers as regulators of air emissions. There exist precise lists of hazardous wastes; yet, officials have to use their judgement in determining whether a firm's waste is equivalent to the waste listed with respect to chemical

* Rückel attributes environmental problems from recycling hazardous wastes by the producers to result more from the technical wear out of the recycling technologies than from the "bad" intentions of the producers. He suggests that these firms be periodically re-licensed for recycling [46].

composition, concentration levels, and so forth (see Wynne, Chapters 2 and 3). Similarly, judgement comes to bear in the process of licensing public facilities and transporters, in approving on-site facilities, and even in allocating the time of the limited number of inspectors, e.g., four inspectors for the whole of Bavaria. As in other areas of environmental regulation, the process of bargaining between regulators and firms in the F.R.G. is ever present, and significantly extends the "grey area" of hazardous waste practices.

VII. LESSONS FOR OTHER STATES AND COUNTRIES: NORTH RHINE-WESTFALIA AND THE UNITED STATES AS COMPARATIVE EXAMPLES

The viability of a hazardous waste management system will depend ultimately on its compatibility with the economic, institutional and political culture in which it is expected to work. Even seemingly independent parts of the system, for example the technologies employed, cannot be assumed transferable to other countries without sometimes substantial changes in the technology itself or the institutions which have responsibility for its operation. In this section, we examine the more important aspects of the Hessian and Bavarian hazardous waste management systems within the economic and political context of the F.R.G. Because of the different management philosophy in the state of North Rhine-Westfalia and generally in the United States, we will highlight these systems as comparative examples.

Public Ownership

The system in Bavaria and Hesse stands in sharp contrast to the United States, where the strong tradition of private ownership has led to a

predominant "stick" philosophy of government regulation. Almost without exception, hazardous wastes are collected and handled by private entrepreneurs, and a large percentage of wastes are handled on-site. The network of generators, transporters, and facility operators are regulated under the 1976 Resource Conservation and Recovery Act (RCRA) and its accompanying Administrative Orders. RCRA lays out a broad framework for the comprehensive control of hazardous wastes with five major elements [48]:

1. a federal classification system;
2. a trip ticket control system;
3. federal standards for generators, transporters, and disposal facilities;
4. a permitting program;
5. the authorization of state programs to substitute for the federal program.

The details of the framework were developed within the EPA and promulgated as regulations on May 19, 1980.

The "sticks" available to the EPA and the states to enforce compliance with the regulations are of two types--punishment and liability. RCRA provides rather stringent civil and criminal penalties for violations of the regulations. For instance, a company or individual found to be criminally violating the regulations is subject to penalties of up to \$50,000 per day and imprisonment for up to two years. But more effective than the threat of civil or criminal punishment is the possibility of financial liability for the damage from the improper management of hazardous wastes. Recent actions taken by the government in cleaning up past dumping sites has alerted the business community to the large sums of money required, and the possibility of their liability. In addition, large established firms are concerned about the damage that a civil or criminal law suit would do to their public image. Many observers of the implementation of RCRA feel that these sanctions, particularly the possibility of generator liability, are

motivating firms, especially the larger operations, to comply with the regulations [49].

The F.R.G., in contrast, has relatively less severe sanctions for non-compliance with the hazardous waste regulations and virtually no concept of generator liability for environmental or public health damages. The stronger emphasis in the F.R.G. on the "carrots" versus the U.S. emphasis on the "sticks" is firmly rooted in the political cultures of these two countries. In the F.R.G., and even more strongly in many other European countries, there is a tradition of government-industry cooperation in formulating and implementing standards and regulations (for a discussion of this point in the context of the preparation of the hazardous waste lists, see Dowling and Linnerooth, Chapter 4). In general, the government has a relatively large role in supporting and sometimes subsidizing industrial development. In contrast, U.S. government-industry relations are far more adversarial, especially with regard to environmental issues, as seen most strongly by the lack of industry consultation in the early stages of developing environmental standards and regulations. Consistent with this spirit of noncooperation, the U.S. relies far more extensively on legal sanctions as incentives for compliance.

Irrespective of this contrast in government-industry relations, the F.R.G. and the U.S. share a common "market" ideology, and the respective governments are reluctant to provide services that can be accommodated by private enterprise. Not to curtail private initiatives in the area of waste disposal, the F.R.G. Council of Environmental Advisors advises against the substitution of private waste disposal firms by municipal projects in government programs encouraging the construction of new waste disposal plants [50]. Thus, in some respects the development of public or quasi-public hazardous waste facilities in

Bavaria and Hesse is as much an anomaly in the F.R.G. as such a development would be in the U.S. Their present existence can be better understood by looking at the historical conditions in which they were created.

The HIM facilities in Hesse began wholly as a private venture on the part of Hessian industries to exploit a market for waste disposal; similarly, the GSB facilities in Bavaria were created by the initiative of private industry with only a small amount of government financial support. Since there did not exist at that time a well-defined or well-organized group of smaller private firms handling wastes in these states, the state governments did not meet with political opposition from a waste-handling industry when they increased subsidies to, and effectively took over, the HIM and GSB operations. In fact, the government was supporting the interests of private enterprise, not of the waste disposers, but of the waste generators. The ZVSMM, alternatively, has a different history in that it was from the start a fully public enterprise and, for this reason, is an exceptional case even in the F.R.G. Yet again, in the the case of the ZVSMM, there did not exist a well-developed and politically powerful network of private waste disposal firms.

Experience in North Rhine-Westfalia

The German state of North Rhine-Westfalia (NRW) offers a useful contrast to its neighboring states, Hesse and Bavaria, in that it has attempted a mixture of private and state-financed facilities for hazardous waste management. North Rhine-Westfalia is the F.R.G.'s major hazardous waste producing state, generating nearly twice as much hazardous wastes as the other ten states combined [51]. The highly industrialized and densely populated Ruhr region is located in this state, which administratively is organized into autonomous cities and

counties that, in turn, have instituted a regional structure, the Kommunalverband Ruhrgebiet (KVR), to deal with common problems such as hazardous waste management. Recognizing a need for facilities with higher environmental standards than those offered by private entrepreneurs, the KVR has planned and partially carried out the construction of a central incineration facility (Herten), central multi-component and special-waste land disposal facilities, and four collection centers. This system is fully financed by the KVR.

This plan for an independent public system to supplement the private waste handling sector has not been fully successful. The incineration facility at Herten, for instance, has serious financial problems due partly to unanticipated technical problems, but, more importantly, to a lack of state financial or regulatory assistance. The highly priced services offered at Herten cannot compete with environmentally less attractive alternatives offered by the state and out-of-state private market. For example, a generator of varnish residue can legally choose whether he pays DM450/ton for its incineration, DM200/ton for its storage at the Herfa-Neuroda underground deposit, DM80/ton for its deposit in a special waste land disposal facility, or, after mixing it with sand, DM5/ton for its deposit in a construction rubble landfill [52]. Even strict standardization and regulation on the state level would not prevent generators from taking advantage of laxer regulations in other states, unless an export ban were also imposed.

Compulsory Use (Benutzungszwang)

The crucial difference between the Herten operation and those in Hesse and Bavaria is the lack of legislation requiring compulsory use (Benutzungszwang) of the public or semi-public facilities. The problem is

partly administrative in that the KVR has no legal authority to impose restrictions, and state authorities have not passed legislation effectively creating a public monopoly at the expense of the many smaller handlers. State subsidies that reduce the Herten prices to competitive levels is the only remaining option to keep the facility in operation, but this option will undoubtedly also meet with opposition from the private sector [53].

The experience in NRW underscores the importance of the historical conditions in which the relatively successful waste disposal systems in Hesse and Bavaria were put into place. A desire on the part of public authorities to finance an environmentally comprehensive system of disposal facilities, combined with the explicit cooperation of waste generators and little political opposition from a private waste disposal industry, was important, though not entirely sufficient. In addition, the state regulators needed the legal authority to assure a market for their facilities. In the absence of standardized regulations across the German states, as was the explicit goal of the U.S. Congress in passing the RCRA legislation, it is essential for a state system to exclude the possibility of waste exports as competition for its facilities. The legal power of Hesse and Bavaria in establishing compulsory use, though controversial in the F.R.G., and now Europe generally, reflects the greater powers of the German states compared to their American counterparts, where a compulsory-use clause would be likely to be considered unconstitutional. The European Community, consistent with its free trade philosophy, has proposed a directive prohibiting restrictions on cross-border transfers of hazardous wastes. This proposal is understandably of considerable concern to Hessian and Bavarian authorities [54].

Central versus Decentralized Facilities

An important choice facing many regional or state authorities is whether they should encourage the construction of regional, integrated facilities serving a diverse clientele of hazardous waste generators or whether, instead, they should encourage a greater number of more specialized facilities. The distinction between the two is not entirely clear-cut, however, since specialized facilities may serve a large number of generators and regional facilities may not be integrated but consist of several more specialized handlers. Nor is the choice unrelated to the question of public financing and ownership since, as we have pointed out above, the large capital investment in regional facilities will likely, though not inevitably, require public financial support.

The advantages of a large, centralized operation is that it offers increased opportunities for resource recovery and economies of scale with respect to applying advanced and environmentally safe technologies, e.g. stack scrubbers, leachate collectors, and so forth. In fact, high-temperature rotary-kiln incineration is only practical on a large scale. Also, it is far easier for the authorities to oversee the operation of a small number of facilities, which operate with a staff large enough to include environmental experts, than a multitude of smaller operations. The technical staff may also be better equipped to cope with any novel problems that may arise.

While central facilities may be better equipped and easier to monitor, they have some drawbacks. One important problem concerns the distances that transporters must haul wastes, with the consequent increase in transportation costs and risks*, as facilities become concentrated in certain areas.

* According to Furmaier in the Bavarian Bureau of Environmental Protection, the transport costs are usually insignificant compared to the disposal costs. He recommends a system like the GSB with central facilities and a network of collection centers [55]. HIM, and also

Furthermore, the surveillance of waste transfers is perhaps the most difficult element to manage with regard to the requisite manpower and individual checks. Increasing the hazardous waste traffic will undoubtedly raise significant administrative difficulties. A second disadvantage regarding larger facilities is the potential dangers from dealing with wastes in large quantities. The bureaucracy of the facility becomes more meshed in administrative detail as waste traffic increases, especially at that point where there is no longer an identifiable and stable relationship between the handler and his clientele. In other words, small specialized firms have the advantage of a relatively constant stream of wastes which they are experienced in handling and for which they are generally clear about the composition. This experience and specialization becomes especially relevant for an industry structure of mostly large firms which treat their own wastes. For this reason, many experts have expressed the opinion that large, integrated facilities are sensible only for a region with an industry structure characterized by small- or middle-sized firms, such as in Bavaria, but are not so well suited for a region such as North Rhine-Westfalia, characterized by larger waste producing industries.

Experience in the U.S.

In 1974, the Environmental Protection Agency prepared a report to the U.S. Congress which advocates regional, centralized processing facilities for hazardous wastes [56]. No suggestion was made that the government might actually build or run these facilities, but it might give assistance by creating a franchise

Danish municipalities, are experimenting with a scheme whereby the publicly-owned collection centers pick up the wastes for the generators. This does not reduce the transportation distances, but it does give government authorities more control over the transport of wastes.

system with territorial limits. Although hazardous waste legislation was subsequently passed and is now being implemented, there exist to date no integrated facilities of a kind similar to those existing in Hesse and Bavaria. The hazardous waste industry remains in private hands, and neither private entrepreneurs nor public officials have sensed a market for large, regional facilities sufficient to justify the substantial capital investments necessary. This does not mean that there are no large operations, however. By 1980, four major firms had nearly half the sales revenue of the entire industry [57]. Chemical Waste Management, Inc., for instance, has an estimated 40% of the U.S. market and provides a variety of treatment, disposal and storage facilities; yet, it largely offers land disposal and consequently has not invested the large sums of capital necessary for more incineration and treatment technologies. There also exist large-scale, rotary-kiln incinerators, but these usually serve a fixed and identifiable number of industries requiring, specifically, this service.

There have been, and continue to be, however, attempts at establishing privately-financed, regional facilities. Rollins Environmental Services, which began operations in 1989 in New Jersey, planned in the early 1970's a national network of twenty-five integrated facilities as well as extensive on-site efforts to reduce waste stream volumes at the source. From the start, RES favored incineration, though it offered, and offers, other methods. Its ambitious plans for comprehensive and environmentally safe facilities, however, were not realized since it became apparent that there was not a market for expensive treatment and incineration of hazardous wastes, and there did not exist sufficient effective government regulation to create the market.

More recently, the IT Corporation, which began operating in California, has applied for the necessary permits to build a major integrated (land disposal,

treatment and rotary-kiln incineration) facility in Louisiana, with a large initial capital investment (approximately \$100 million). IT recognizes that this is a high risk venture, but believes the relatively strict hazardous waste regulations in Louisiana will create a market for its comprehensive and expensive services, including advisory services to industries to help them reduce their wastes.

Experience from Bavaria, Hesse, and North Rhine-Westfalia gives reason to be pessimistic about IT's commercial chances unless the state government offers strong regulatory (or financial) support. It may prove necessary to give franchise rights, creating a private monopoly, and effectively restricting the entry of smaller firms that may capture specialized niches of the Louisiana market. A ban on landfill for priority wastes would assure a certain market for IT's incineration facility. Yet, in the absence of standardized practices in neighboring states, these measures will be of little help if the state cannot restrict exports of wastes. IT's long-term prospects also appear limited by the capacity shown in Hesse and Bavaria for waste reduction as an alternative to expensive disposal, which IT plans to exploit in the short run by serving as a consulting service but which, in the long run, may reduce its overall commercial chances.

The future of comprehensive, regional facilities in the U.S., such as those found in Hesse and Bavaria, will depend on the developing role of government regulation. Since it is unlikely that state or local officials will provide large subsidies, there must be a market for private investors to exploit. Furthermore, the market must be stable enough in the location or catchment of each plant, not merely overall. The proposed ammendments to RCRA presently considered in its reauthorization would ban land disposal for a signifiant number of hazardous wastes, and would thus promote more expensive technologies with

decreased environmental risks. The new regulations, if enforced uniformly across states, coupled with an industry structure characterized by many smaller heterogeneous generators, may provide such a market. For other industry structures, we can expect increased investment in on-site facilities as well as smaller entrepreneurs capturing the market offered by the many developing niches of hazardous waste streams [58].

Siting Hazardous Waste Facilities

Finally, the problems that industrialized countries are experiencing in *siting* hazardous waste facilities cannot be ignored. According to many observers, the siting of new disposal facilities is the most urgent problem in the area of hazardous waste management. Even in the F.R.G., with present over-capacity in some states, projections of hazardous waste generation and the lead time necessary for capital-intensive facilities continue to make the siting problem important. Obtaining public approval to site waste facilities may be the most difficult obstacle in implementing a regional or state hazardous waste plan.

Spurred by controversies over nuclear power plants, the public is becoming increasingly sensitive to chemical waste facilities, especially if these facilities are to be located in their neighborhoods. Construction of the early facilities in Hesse and Bavaria went virtually unopposed by the public. Yet, recently, a great deal of protest has arisen on the part of residents near the Biebesheim facility in Hesse, although this facility is considered by experts to be technically advanced and, from an environmental point of view, far preferable to past operations. Similarly, citizen action groups are heatedly opposing the construction of a landfill by the ZVSMM in Bavaria. Other countries are facing equally difficult obstacles in siting facilities. In the U.S., for instance,

Massachusetts has passed novel siting legislation that involves all the interested parties, including the public, in the siting process by requiring mediation. In spite of this new siting law hazardous waste authorities continue to have problems in gaining permission to build facilities.

It is beyond the scope of this paper to delve into the many social and economic issues involved in siting hazardous facilities (for a comprehensive discussion of experience in the U.S., see [59]). It is worth noting that state officials in the F.R.G., reversing their usual regard for autonomy, are turning to the federal government to set out standards for hazardous waste facilities in the hope that this higher authority will increase public confidence in the safe operation of facilities. There appears, however, to be little difference in the public acceptability of facilities operated by the state or private entrepreneurs.

Price Subsidies

At the core of any hazardous waste management system is the question of who pays the costs. Despite directives by the EEC to force polluters, or industry, to pay the full costs of their pollution, in Europe there is a strong tradition of the government picking up the tab for pollution in contrast to the U.S. where the government hesitates to aid industry directly. In Holland, for example, government officials generally agree that it would be politically impossible to institute a "superfund" tax on industry as a way of paying the clean up costs for past dump sites; rather, it is expected that the national and local governments will pay the costs.

The mixed ideologies in the F.R.G. of *laissez faire*, on the one hand, and government-industry cooperation, on the other, explain the early reluctance,

but later support, for public subsidies on the part of the Hessian and Bavarian authorities. But these subsidies were clearly not in the spirit of allowing industry a "free ride" since prices remain relatively high in these two states. An option not considered in the paper, but discussed elsewhere [60] is that of the government paying a large portion, or even the full costs of hazardous waste management, by offering low-cost or even free facilities.

Opponents of government subsidies are concerned both about the equity of passing on the costs to the general public as well as the resulting distortions in the prices resulting in misplaced incentives for producing wastes. Lower handling costs for wastes, as discussed in Section VI, encourage their generation and discourage waste reduction and recycling.

Cost or price incentives, though proven effective, are not the only option for promoting the reduction or recycling of hazardous wastes. For instance, the government might tie tax advantages or low-cost financing to firms which take initiatives in reducing wastes. Or, the government might reduce the costs to firms for investing in new capital equipment by offering low-cost financing, higher depreciation allowances, and direct government assistance and advice. The UBA in the F.R.G., for instance, finances research for this purpose and directly advises firms about the technical possibilities for recycling or waste reduction.* As another example mentioned earlier, the Hessian government is tying construction permits for new facilities to a demonstration that the firm is using the best available technology for waste reduction.

* According to a waste expert from the federal Environment Ministry (UBA), there have been numerous successes in encouraging waste reduction and recycling: Acids from the production of titanium oxide pigment are now treated within the factory; chlorinated solvents for metal treatment are now recycled; residues from sulfur filters on power plants are now used in the production of plaster; the improvement in production processes has reduced the loss of varnish from around 50% to 5% [81].

The U.S., alternatively, relies almost exclusively on price incentives to promote waste reduction and recycling, whereby these incentives may be in the form of artificially high prices or taxes. A private initiative in this respect was taken by Dow Chemicals in the middle 1960's when it began charging its plant managers \$100 for each drum of hazardous waste buried in a landfill, resulting in increased recycling efforts. An important initiative being considered by the federal government and already initiated by eleven states is the waste-end tax or a tax placed directly on waste generators. This tax may be used as a way of replacing or supplementing the feedstock tax that presently finances state and federal "superfunds" with the argument that the tax serves the second purpose of reducing wastes [62]. It is too early to judge fully the experience of the states with this tax, but there appears to be a major drawback. In most of the states, the tax failed to raise the funds anticipated, and there was a dramatic drop in reported waste volumes (28% decline in California within one year). This decline came too quickly to be explained by increased recycling but rather appears to be largely the result of under-reporting and possibly midnight dumping [63].

VIII. SUMMARY AND CONCLUDING REMARKS

Given the difficulties most western, industrialized countries are encountering in implementing their hazardous waste legislation, the concept of public or joint public-industry ownership and control of the hazardous waste disposal facilities has a great deal of appeal. As experience in Hesse and Bavaria has shown, public ownership (full or partial) permits the authorities to choose consciously between the amount of capital investment in treatment and disposal

facilities, the environmental measures taken, the location and centralization of the facilities, the collection system employed, as well as the amount of costs passed on to industry or the taxpayer. The strategy of Hesse and Bavaria is to minimize the direct land disposal of hazardous wastes, substituting this method with more expensive incineration and treatment technologies, and to share the costs between the waste generators and the general public. The authorities have intentionally maintained relatively high disposal prices to encourage the reduction and recycling of wastes, with apparent success, as witnessed by the decreased volume of wastes delivered to the facilities.

This pricing policy creates a dilemma for the authorities in that high prices also encourage illegal disposal. But the general perception of waste experts is that waste reduction in Hesse and Bavaria is for the most part genuine and cannot be attributed to decreased reporting and "midnight dumping". However, the authorities do acknowledge that an unknown quantity of wastes are being illegally transported to other states or countries and that some "recycled wastes" are incinerated without adequate environmental controls.

The pricing decision presents yet another dilemma to the authorities in that a decreased volume of wastes reduces revenues for the facilities and places an ever increasing burden in the state to subsidize the disposal system. The economic objective of maintaining a return on the large capital investment in facilities conflicts, then, with the environmental objective of reducing wastes, resulting in further conflicting institutional rationalities and perceptions of the hazardous waste problem. The authorities in Hesse and Bavaria have responded to this dilemma by lowering prices somewhat beneath costs, and thus sharing the burden of waste disposal with the public, and taking a

variety of measures to increase the flow of wastes to the state facilities. These measures include restricting exports of wastes with the important "Benutzungszwang" or compulsory use of state/industry facilities and effectively legislating a state/industry monopoly, expanding the list of hazardous wastes that require the facilities services, and restricting on-site disposal.

To assess the appropriateness of public ownership and centralized facilities, the Hessian and Bavarian disposal systems must be viewed in their full economic, political, and historical context. The emergence of a publicly-financed monopoly to accommodate a market that is generally in private hands is as much an anomaly in the F.R.G., which stands committed to competitive enterprise, as in other capitalist, market economies. Historically, the Hessian and Bavarian systems (with the exception of Mittelfranken) were set up by a consortium of private industries with little competition from the almost non-existent private waste handling sector. The financial failure of these early initiatives led to government intervention with the full support of the waste generating industry. With the recent emergence of many small waste handlers in those countries or states having passed strong legislation, these conditions for government intervention and ownership may not repeat themselves.

Experience in Hesse and Bavaria highlights other conditions to the success of public or semi-public, centralized systems. The importance of restricting exports of waste and on-site disposal cannot be over-emphasized, as the near failure of the Herten incineration facility in North Rhine-Westfalia illustrates. A market for the facilities is only fully secure when its exclusive use is guaranteed by eliminating competitors, possibly by stricter regulations governing licensing, and even then the market is not fully secure in the long run if wastes are reduced by changing production processes.

Integrated, comprehensive facilities that offer a range of disposal and treatment technologies have many advantages for environmental controls, but appear to be most appropriate for regions with a heterogeneous industrial structure including many middle-sized or smaller generators and less appropriate for regions with larger firms which are better prepared to treat their own wastes. The success of private ownership of large, integrated facilities, such as proposed by IT for Louisiana in the U.S., will depend on the extent of government regulation that channels wastes to the more expensive treatment and disposal facilities, and also on the extent to which out-of-state transfers of wastes can be controlled. Experience in Hesse and Bavaria sheds doubt on the commercial chances of private firms undertaking the large capital investment necessary for comprehensive facilities. The consequent uncertainties in the viability of such initiatives imposes brittleness upon the regulatory system which needs such a treatment and disposal infrastructure.

In this paper, we have examined one type of organizational system for handling a regions hazardous waste problems that appears to have been successful relative to other states and countries. Although the legal, economic, and political conditions under which this type of system emerged in Hesse and Bavaria may not be present in other states and countries, the underlying philosophy of shifting more of the burden of hazardous waste disposal, at least in the short run, onto the public sector (with a strong element of generator-participation too) may be desirable and could take different forms to suit local or national conditions.

Any country or region seriously intent upon shifting disposal practices from land disposal to the more expensive, and safer, treatment and incineration methods, should give serious consideration to different forms of public

involvement, including public subsidies. The compelling reason for this, shown throughout this paper, is the strong probability of failure of the private market in providing the more expensive disposal and treatment technologies. The approach of imposing strict regulations to channel wastes away from land disposal, and thus creating a market for other technologies, relies on the ability of governments to enforce compliance with the regulations which, at the present, appears constrained by the limited state budgets for this purpose, the difficulties in standardizing practices across regions, states, or countries, the diversity of waste generators that must be controlled, and the multitude of channels open to evade the system. It appears almost inevitable that the authorities provide incentives for compliance, or "carrots", along with the sanctions for non-compliance, or "sticks". In doing so the responsible public authorities will have to move significantly towards direct "absorption" of the risks involved.

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