Institutional Arrangements for Municipal Solid Waste Combustion Projects

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vorgelegt von

Dipl.-Ing. Torsten Kleiss

aus: Rostock

Gutachter:

Prof. Dr. Hans Wilhelm Alfen

Prof. Dr. Michael Beckmann

Prof. Dr. Ashwin Mahalingam

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Univ.-Prof. Dr.-Ing. Dipl.-Wirtsch.-Ing. Hans Wilhelm Alfen

Marienstr. 7A

D-99423 Weimar

Tel.: (+49) 03643 584592

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Autor

Dr.-Ing. Torsten Kleiss

Email: torsten.kleiss@gmail.com

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Foreword

Throughout the world, traditional ways of delivering physical infrastructure and public services are reassessed to find new ways of providing them more efficiently. These assessments do not merely focus on technical and economic aspects, but also address legislative frameworks and organizational aspects to improve incentive structures among the different stakeholders. Furthermore, research is conducted to examine whether and to which extent public infrastructure can be provided in cooperation with or by the private sector.

The overall research goal of the doctoral thesis of Mr. Kleiss is to categorize and analyze institutional arrangements for the provision of municipal solid waste combustion projects (MSWC). Institutional arrangements describe the nature and structure of formal and informal relationships between the various public and private stakeholders involved. The theoretical framework is built upon microeconomics and new institutional economics, combining economics, law, psychology as well as organization theory for better understanding of complex economic realities and phenomena.

Obviously, research in this context has to be transdisciplinary, integrating theories, methods and instruments of the different associated disciplines. Accordingly, this doctoral thesis provides a very comprehensive theoretical and empirical analysis of the MSWC sector and covers various technical, environmental, economic and organizational aspects. The market survey and nine representative case studies from Germany in Singapore are presented to validate the elaborated institutional arrangements.

The theoretical and empirical findings of this thesis are of utmost importance to both research and practice. Various useful implications are given for the technical and economic development of MSWC projects and the formation of institutional arrangements. The doctoral thesis of Mr. Kleiss does not only lay foundations for further research in the MSWC sector, but is also highly relevant to other infrastructure sectors.

Weimar, November 2008 Prof. Dr.-Ing. Hans Wilhelm Alfen

Am Strande

Vorüber die Flut.
Noch braust es fern.
Wild Wasser und oben
Stern an Stern.

Wer sah es wohl,
O selig Land,
Wie dich die Welle
Überwand.

Noch braust es fern.
Der Nachtwind bringt
Erinnerung und eine Welle
Verlief im Sand.

Rainer Maria Rilke (1875-1926)

Now I stand at the beach and look out to the sea. Time already feels so distant when everything around me was flooded and I struggled trough the rough waters of writing a doctoral thesis. Obviously, I would not have survived without the help of so many people. I am grateful to all of them.

First of all, I would like to thank my parents. They taught me how to swim and supported me in all my aspirations. My partner Tiina was my lifejacket throughout the past years. Even though she worked on her own doctoral thesis, she was a motivator, discussion partner and editor at the same time.

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There are also many other professors and senior researchers who kept me afloat with their advice and guidance. I would especially like to thank Prof. Dr. Renate Fruchter (Stanford University), Prof. Dr. Satyanarayana N. Kalidindi (IIT Madras), Prof. Dr. Stephen Wearne and Prof. Dr. David Ling (University of Manchester), Prof. Dr. Gerhard Girmscheid (ETH Zürich), Prof. Dr. Robert Tiong (NTU Singapore), Prof. Dr. Ryo Hiraga (Nagoya University), Prof. Dr. Stephen Ogunlana (AIT Bangkok), Prof. Dr. Wang ShouQing (Tsinghua University), Prof. Dr. Werner Bidlingmeier (Bauhaus-Univeristät Weimar), and Dr. Mushtaq Memon (UNEP).

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Finally I am grateful to Dr. Madhumati M. Kulkarni for proof reading this work so thoroughly.

Zürich, November 2008 Torsten Kleiss

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Abbreviations

AbfAblV	AbfallAblagerungsVerdordnung (Waste storage ordinance)
APC	Air Pollution Control
AWA	Abfallwirtschaft Stadt und Kreis Aachen (Waste management City and County of Aachen)
BGB	Bürgerliches Gesetzbuch (German Civil Code)
BKB	Braunschweigische Kohlen-Bergwerke AG
BImSchG	BundesImmissionsSchutzGesetz (German federal immission law)
BImSchV	BundesImmissionsschutzVerordnung (German federal immission regulation)
BSR	Berliner Stadtreinigungsbetriebe (Berlin municipal cleaning companies)
CAC	Command And Control
CPI	Consumer Price Index
DU	City of Duisburg
EBIT	Earnings Before Interest and Tax
EC	European Commission
EPA	(US) Environmental Protection Agency
EPD	(Singaporean) Environmental Protection Division
ESP	ElectroStatic Precipitator
EU	European Union
EURIBOR	European InterBank Offered Rate
GDP	Gross Domestic Product
GDR	German Democratic Republic
GG	Grundgesetz (German Constitution)
GHG	Greenhouse Gas
GMVA	Gemeinschaftsmüllverbrennungsanlage (Joint waste combustion plant)
IMA	Inter-Municipal Associations
KIE	Keppel Integrated Engineering Ltd.
KR	City of Krefeld
KrW-/AbfG	Kreislaufwirtschaft- und Abfallgesetz (Circular Economy and Waste Management Act)
KVV	Kasseler Verkehrs- und Versorgungs-GmbH
LVwASA	Landesverwaltungsamt Sachsen-Anhalt (Regional Administrative Department Saxon-Anhalt)
LIBOR	London InterBank Offered Rate
MACT	Most Achievable Control Technology
MEWR	(Singaporean) Ministry of the Environment and Water Resources
MBT	Mechanical-Biological Treatment
MD	City of Magdeburg

MoU	Memorandum of Understanding
MSWC	Municipal Solid Waste Combustion
MT	Mechanical Treatment
NCV	Net Calorific Value
NEA	(Singaporean) National Environment Agency
NGO	Non Governmental Organization
NIE	New Institutional Economics
NUM	Niedersächsisches Umweltministerium (Environmental Ministry Lower-Saxony)
OECD	Organization for Economic Cooperation and Development
OB	City of Oberhausen
PAH	Polycyclic Aromatic Hydrocarbons
PAP	(Singaporean) People's Action Party
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
PSP	Private Sector Participation
RDF	Refuse Derived Fuel
RUW	RWE Umwelt West GmbH
SCR	Selective Catalytic Reduction
SNCR	Selective Non-Catalytic Reduction
SWK	Stadtwerke Krefeld AG
SWM	Städtische Werke Magdeburg GmbH
TASi	Technische Anleitung Siedlungsabfall (technical regulation for waste storage of municipal waste)
TCE	Transaction Cost Economics
TEHG	TreibHausgas-EmissionsHandelsgesetz (Greenhouse gas emission trading act)
UBA	Umweltbundesamt ((German) Federal Environment Agency)
UHG	UmweltHaftungs-Gesetz (Environmental liability act)
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
VerpackV	Verpackungsverordnung (Packaging Ordinance)
VAT	Value Added Tax
VPöA	Verordnung über die Preise bei öffentlichen Aufträgen (Regulation on prices for public ordering)
WBP	Wirtschaftsbetriebe Oberhausen GmbH
ZAK	Zweckverband Abfallwirtschaft Kaiserslautern
ZAS	Zweckverband Abfallwirtschaft Südwestpfalz

1 Introduction

1.1 Research context

The provision of municipal solid waste management infrastructure is a service of general public interest that is characterized by market failure, mainly caused by negative environmental externalities. As a consequence, the public sector has to assure that reliable and environmentally friendly waste management infrastructure and services are available (Paschlau, 2002; Rahmeyer, 2006; Thärichen, 2004). In order to conserve natural resources, waste management activities must be embedded in a general environmental policy framework[1] that defines the waste hierarchy as shown in the following Figure 1-1.

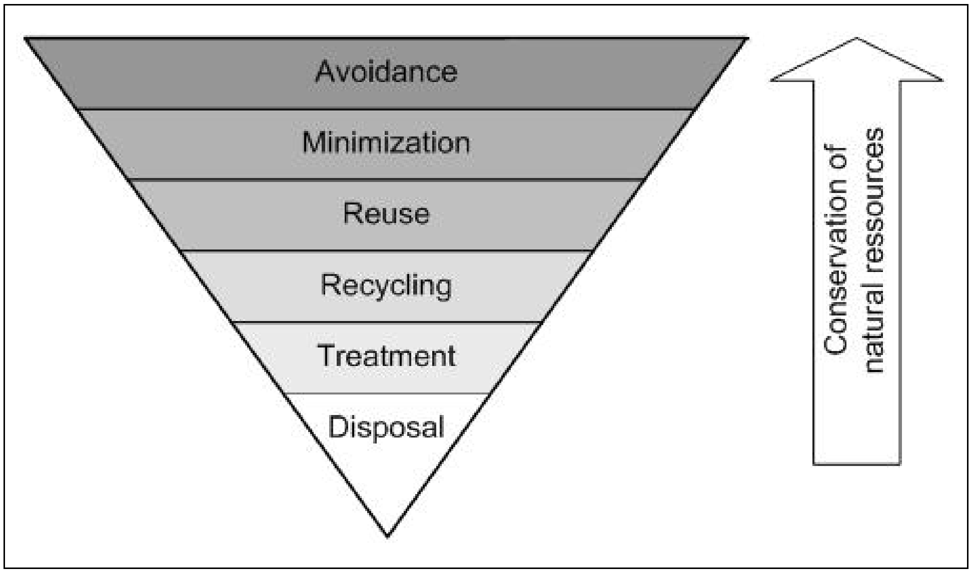

Figure 1-1: Waste hierarchy
Source: own

Today, most economists agree that market failure in the infrastructure sector of municipal waste management does not automatically require a public provision of waste management services. Instead, the public sector is primarily responsible for the coordination and monitoring that required services, such as waste collection, treatment and disposal, are implemented (Mühlenkamp, 2002). In practice, municipal authorities aggregate the demand for residual municipal waste management services[2] and make the classical make-or-buy decision as principals of the transaction, i.e. they can decide whether to provide waste management services themselves or to engage external organizations.

[1] See e.g. Agenda 21 - Rio Declaration on Environment and Development (UN, 1992)

[2] Vice versa households and commercial entities that generate household like waste are usually required by law to use the publicly coordinated and controlled waste management system.

Historically, municipal solid waste management infrastructure was provided by the public sector throughout the world. Similar to other infrastructure sectors, this slowly started to change in the 1970s when private sector began to participate in delivering municipal solid waste management service (Eggerth, 2005). In the recent past however, a partly reverse trend can also be observed. For example, in Germany, some waste management services are again provided by the public sector after temporarily being supplied by private companies (Christmann, 2004, p. 113; Keppler, 2007).

While initially private sector participation focused on short-term outsourcing of waste collection services or the operation of landfill sites, private stakeholders nowadays also play a vital role at technically and economically complex residual municipal waste treatment facilities. Especially in developed countries and fast growing urban centers, residual waste treatment has become a crucial activity in pursuing the waste management hierarchy. Here, municipal solid waste combustion (MSWC) has evolved as an environmentally friendly and reliable treatment technology that minimizes the negative environmental impacts of waste.

This research is settled within the context of (i) the technical and economic complexity of MSWC and (ii) the wide spectrum between public and private infrastructure delivery. The following sections present the research objectives, scope, state, methodology and structure. All of them have evolved as a result of dynamic and iterative processes involving numerous presentations and valuable discussions with different researchers, policy makers and practitioners in the field of municipal waste management.

1.2 Research objectives

The main objective of this research is to theoretically and empirically analyze institutional arrangements for the provision of municipal solid waste combustion (MSWC) infrastructure on the basis of a profound understanding of its complex technical and economic characteristics. Within the research context, *institutional arrangements* describe the nature and structure of relationships between the various stakeholders that are involved in specific municipal solid waste management projects. Institutional arrangements are governed by formal and informal institutions and can vary between the two extremes of (i) hierarchy and (ii) market, whereas several hybrid forms exist between them.

To approach the overall research objective, five more detailed research objectives have been isolated. These objectives are:

1. To gain a purposeful understanding of technical and economic aspects of MSWC.
2. To analyze the microeconomic characteristics of market for MSWC and to identify possible deviations from the model of perfect competition.
3. To elaborate on a theoretical framework to be used for categorizing and describing institutional arrangements for MSWC.

4. To verify these institutional arrangements in the two developed markets for MSWC of Germany and Singapore.
5. To explain the reasons for the emergence of institutional arrangements for MSWC in these two markets.

The findings of this research will contribute to existing theories. Furthermore, practical implications are derived from the theoretical and empirical findings to support the development of institutional arrangements for new MSWC projects.

The research does not aim at evaluating or comparing the performance of different institutional arrangements for MSWC. Such comparative analysis would certainly have to rely on quantitative data, which is impossible to collect with the constraint resources of a doctoral research project. Due to confidentiality reasons it is almost impossible to gain access to private information about prices, price adjustment mechanisms, contract durations, detailed risk sharing, as well as the internal transaction costs of public and private stakeholders.

1.3 Research scope

Already narrowed by the research objectives, the research scope is limited within the municipal solid waste management value system by (i) the waste stream and (ii) the waste treatment technology. Only residual municipal solid waste stream is relevant and waste combustion is considered as the treatment technology. Other waste streams (e.g. recyclables or biological waste) and other waste treatment options (e.g. mechanical biological treatment) are not examined. This limitation has different reasons and was only done after thorough considerations and discussions with senior researchers. An extension of analysis to other waste streams would have created too broad a scope with a high probability of delivering mixed results for different waste streams. The research study was limited to MSWC, because the major treatment alternative mechanical biological treatment continues to suffer from severe technical and economic problems (see e.g. Bilitewski, 2007).

Another important limitation of the research scope is related to the characterization and description of institutional arrangements. Here, the institutional environment, which encompasses of formal and informal rules on the macro-level that are non transaction specific, is treated as exogenously given. This is a necessary and logical confinement, as the research objectives target at explaining the emergence of institutional arrangements.

The research scope combines technical, economic and institutional theories with quantitative and qualitative analyses. This transdisciplinary scope is necessary, because so far there does not exist a fundamental and comprehensive overview for institutional arrangements for MSWC that takes into account its unique technical, economic and institutional characteristics (see next chapter).

Even though the research scope is limited to MSWC, the generic characteristics of the methodological approach as well as some of the theoretical and empirical findings are likely to be translatable to other areas outside the defined research scope. Furthermore, this thesis aims to trigger and support similar research endeavors for other activities within the municipal solid waste value system.

1.4 State of the research

In comparison with other infrastructure sectors, the number of existing research studies on economic and institutional aspects of municipal waste management, especially municipal waste treatment, is rather limited. Recent studies on private sector participation in infrastructure development have focused on general subjects such as risk management (Akintoye, Beck, & Hardcastle, 2003; Elbing, 2006; B. Weber, Alfen, & Maser, 2006) or financing (Boll, 2007; Merna & Njiru, 2002) and were mostly applied to public real estate development (K. Fischer, 2007; Littwin & Schöne, 2006) or road infrastructure (Abednego, 2007; Beckers, 2005; Thomas, 2005).

Cantner (1997) has conducted a comprehensive analysis of the Germany municipal waste management including economic, legal and cost calculation aspects. Even though some of his theoretical assumptions and findings can be disputed, it can nevertheless be considered as a pioneering work in the sector.

There also exists a small number of scientific works about institutional and organizational aspects of municipal waste management in Germany, most of which focus on private sector participation. Their major constrain however, is their broad scope covering the entire waste management value system, whereby the specific characteristics of individual elements in the value system are only marginally analyzed and discussed (e.g. Höftmann, 2001; Wagner, 2000; Winkler, 1999). Another constraint of existing research in Germany is the often regional focus onto individual federal states (Baum, Cantner, Ilg, & Sprinkart, 2003; Wagner, 2000)[3].

Yet, there exist two empirical studies focusing on the infrastructure sector of MSWC that are worth mentioning explicitly. The first one was conducted by Gaube (2006) who quantitatively analyzed treatment prizes of the German MSWC market and the impacts of possible regulatory measures onto them. The other is done by Berenyi (2006) who compiled statistical data including organizational aspects of MSWC in the USA.

Furthermore, numerous theoretical studies on institutional arrangements for general infrastructure development with special focus on private sector participation in Germany have

[3] Most of the work is the output of a research program that was sponsored by the Bavarian Ministry of Environment.

been conducted e.g. by Eggers (2004), Mühlenkamp (2005), Waffler (2002).. But as Reichard (2005) points out, the number of empirical studies is very limited.

To the knowledge of the author, there exists no scientific work, where theoretical and empirical aspects of institutional arrangements for MSWC plants are combined and thoroughly analyzed. An empirical overview as well as two representative exploratory case studies from Japanese market can be found at Kleiss & Imura (2006).

Thus, the presented research state highlights the relevance of the research objectives. There is a strong demand to fill in the gap in describing institutional arrangements for the provision of MSWC infrastructure on the basis of theoretical and empirical analysis while embracing the transdisciplinary complexity of technical and economic aspects.

1.5 Research methodology

The applied research methodology has to follow the nature of defined research objectives (Dunleavy, 2004). Due to the transdisciplinary characteristics of these research objectives and recommendations of senior researchers, a combination of qualitative and quantitative methods is applied (Bryman & Bell, 2003; Creswell, 2006; R. W. Scholz & Tietje, 2002; Tashakkori & Teddlie, 2000).

The achievement of the first three research objectives mostly relies mainly on a critical review and application of accepted theories and existing studies. For this purpose an extended literature review and theory analysis were conducted. In order to attain the first research objective, i.e. the understanding technical and economic aspects of MSWC infrastructure, primary data was also collected from developers and manufacturers to support the theoretical findings.

For the forth research objective, i.e. for the verification of the theoretically derived institutional arrangements used the markets in Germany and Singapore, quantitative research methods are applied. Given the size of the German market for MSWC, a survey was carried out to gather cross-sectional data on applied institutional arrangements at a single point in time. Since the market for MSWC is much smaller in Singapore, the required data and information was collected through personal interviews and secondary sources.

A qualitative case study methodology is used to meet the fifth research objective. Here, each identified institutional arrangement forms a case for which a representative case study is undertaken to understand the rationale for the emergence of the particular institutional arrangements. For achieving a greater generalization of research findings, only case studies with a strong representative character are selected. The multiple case study methodology is selected due to its potential strength of identifying and understanding complex processes and interactions between various issues that must be addressed within the research context (Yin, 2003). Such multiple case study approach is a recognized research methodology and has successfully been applied to interdisciplinary doctoral research studies (see e.g. K. Fischer, 2007; Leiringer, 2003; Mahalingam, 2005).

As Menard (2001) points out, case studies "*are particularly relevant in New Institutional Economics because of the need to deal with a limited number of discrete modes of organizing transactions, both at the micro-level and at the level of the set of institutions that characterize a society. Such comparative approaches have been extremely fruitful in other disciplines* ".

Therefore, the case studies are conducted to describe and explore representative institutional arrangements for MSWC in the two developed MSWC markets of Germany and Singapore. The descriptive nature of the case studies is well suited to portray the different institutional arrangements and to exemplify the intrinsic differences between them. The exploratory nature of case studies is very helpful to understand decision making, implementation and change processes that have led to the emergence of individual institutional arrangements (Gummesson, 2000, p. 3). Further, the exploratory case study approach can better identify informal institutions that shape institutional arrangements.

Even though the case study research is an accepted methodology in social sciences, not only many researches from natural sciences but also economics and business administration[4] are prejudiced against this qualitative research methodology (Bryman & Bell, 2003; Saunders, Lewis, & Thornhill, 2003). Especially in terms of exploratory case studies, they mostly criticize the limitations in generalizing the findings and the potential threat of subjectivity (Gummesson, 2000). These are considered serious threats and hence will be taken into account in the specific design of case studies as well as the formulation of conclusions. These potential shortcomings can be minimized by analyzing multiple cases and collecting data from different sources within each case study.

Altogether, taken into account the defined research objectives and limited resources available, descriptive and exploratory case study research is the appropriate methodology. To conclude in the words of R.W. Scholz & Tietje (2002, p. 25): "Case studies are good for problems where truth is relative, reality is realistic and a structural relationship is contingent".

1.6 Structure of the thesis

The thesis is divided into seven chapters. The opening chapter includes the research context, the research objectives and scope, the review of research state as well as the applied methodology.

Chapter two briefly presents the general aspects of the waste management sector into which this research integrates. It explains the characteristics of residual municipal waste, the mu-

[4] Especially with Anglo-American or Asian background

nicipal waste management value system as well as the economics of residual waste from a microeconomic and macroeconomic perspective.

In chapter three a profound understanding of the technical and economic characteristics of MSWC infrastructure is developed. Special attention is given to positive and negative externalities as well as costs and revenues that occur throughout the entire life-cycle.

Chapter four explores the specific aspects of the market for MSWC. Based on the standard economic model of perfect competition, different forms of market failures and applicable measures are briefly presented in general and are applied to MSWC infrastructure thereafter.

Chapter five develops the theoretical framework for institutional arrangements for MSWC. Attention is drawn to transaction costs economics and its application to the public sector in general and MSWC infrastructure in specific. Further, an analysis of involved stakeholders and their specific objectives is carried out.

Chapter six and seven constitute the empirical part of the research. Beginning with a short description of the specific institutional environments and historical developments, quantitative evidence for applied institutional arrangements for MSWC in Germany and Singapore is presented. Each type of institutional arrangement is elaborated by means of at least one representative case study to describe its main characteristics and explore the reasons for their particular emergence.

The final chapter summarizes and discusses the major research findings and ends with an identification of further research demand.

The following Figure 1-2 illustrates the logical sequencing of chapters:

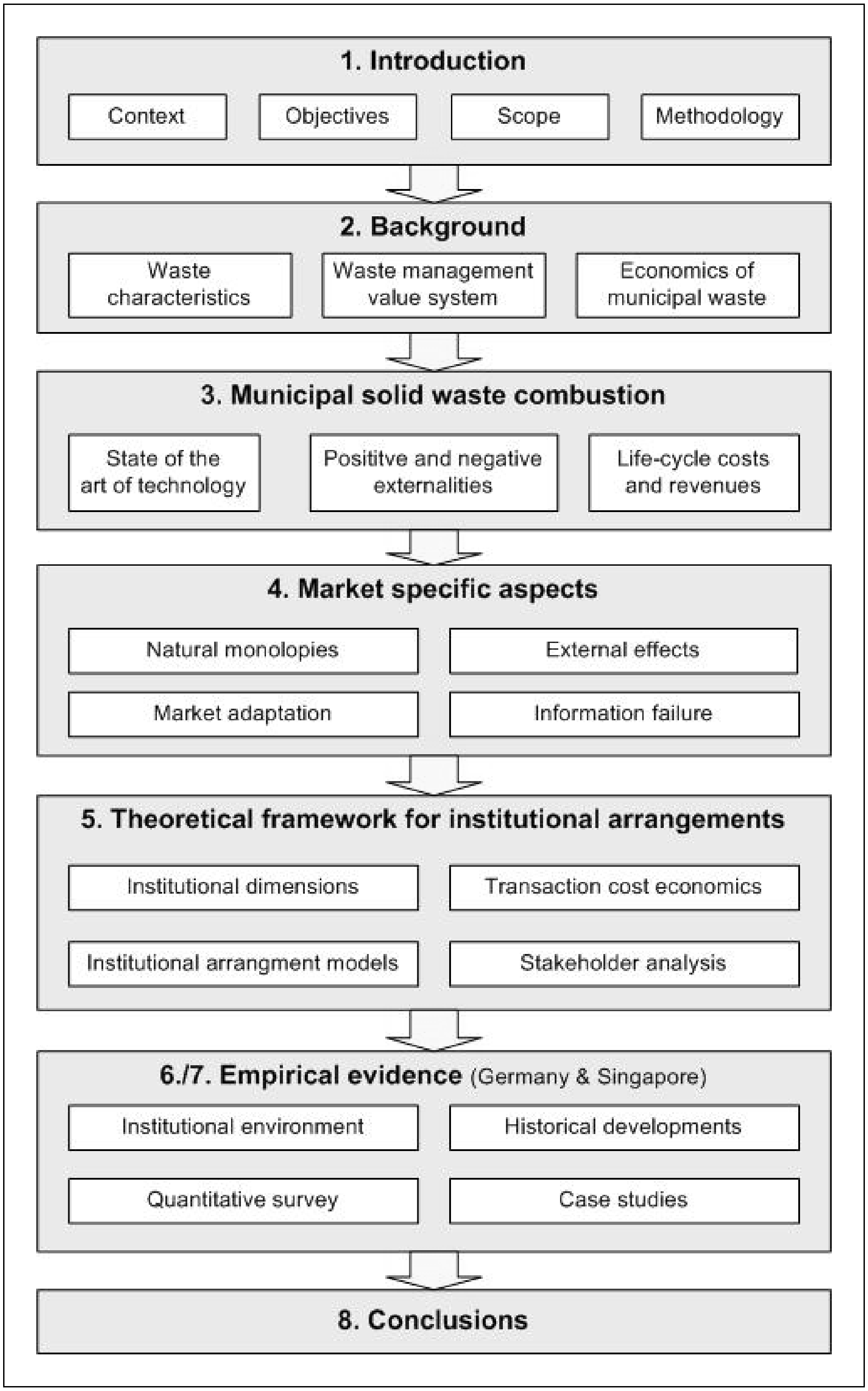

Figure 1-2: Research structure

2 Background

2.1 Waste classification

Solid waste can be classified by the source of its generation into industrial, municipal, construction and demolition as well as mining waste. Municipal solid waste encompasses waste from households as well as waste from other, mainly commercial sources that has similar characteristics and composition. Besides recyclable, kitchen and residual waste from residential and commercial sources, municipal solid waste includes bulky waste and waste from different municipal services, such as park and garden maintenance or street cleaning services. Municipal solid waste excludes fluid waste, e.g. from sewage collection and treatment (see e.g. UN (1997), 1999/31/EC). The following Figure 2-1 roughly structures the major sources and types of municipal solid waste:

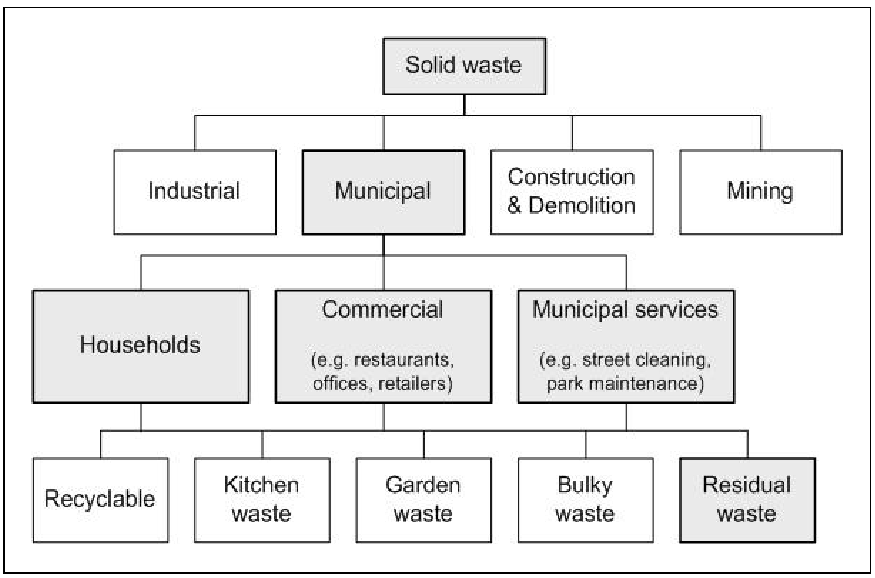

Figure 2-1: Major sources and types of waste
Source: own

As elaborated in chapter 1.3, the research scope encompasses primarily residual waste from municipal sources and its thermal treatment in MSWC plants (see gray boxes in Figure 2-1).

2.2 Characteristics of residual municipal waste

Residual municipal waste consists mainly of waste that households do not convey to recycling or composting schemes. A considerable portion is also contributed by curbside collection as well as leftovers from the separation of recyclables and bulky waste. The composition and characteristics of residual waste depend on a variety of interrelated factors that differ considerably in accordance with the institutional environment. The three major factors are: (i) the consumption patterns of residential households and commercial businesses, (ii) the availability of waste separation and recycling schemes and (iii) willingness of waste generators to separate and recycle.

A representative example of the composition of residual solid waste from households in Germany is given in the following Figure 2-2:

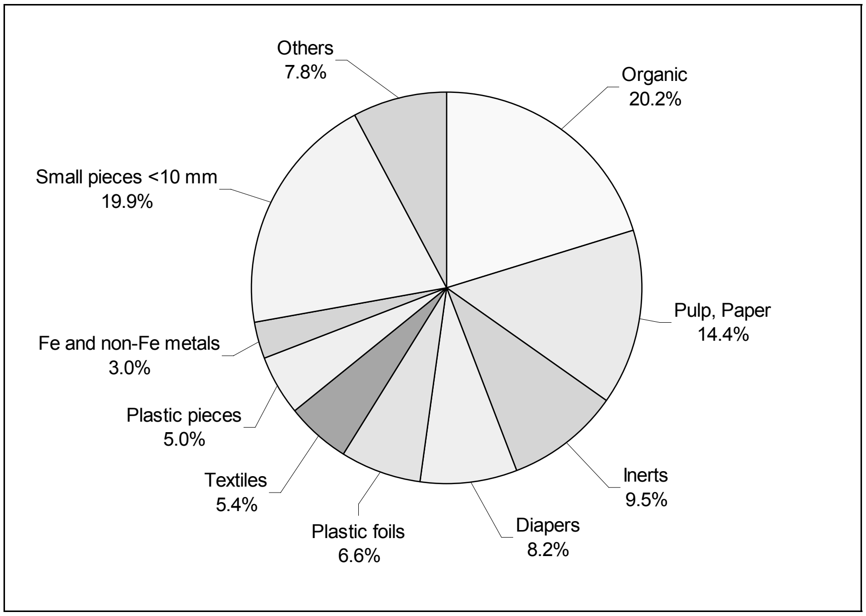

Figure 2-2: Typical composition of residual waste from households in Germany

Source: Pretz & Uepping (2007)

The composition of waste determines its physical and chemical characteristics. Major variables include net caloric value (NCV), total organic content (TOC), moisture content, chlorine concentration and particle size. The NCV usually ranges between 7,000-11,000 kJ/kg and correlates strongly with the content of paper and plastics not being recycled (Winterstein, Hilbert, Pflüger, Sabrowski, & Kahle, 2004). The TOC and moisture content are mainly effected by the separation rates of kitchen and garden waste.

2.3 Waste management value system

The waste management value system can be interpreted as the string of all activities between the generation of waste and the final disposal of its end products[5]. These different activities are separable from each other and could be delivered by different organizations. In practice, some or all value system activities are vertically integrated and delivered by a single organization.

[5] The presented model of the waste management value system is derived from Porter's (1985) generic model of a value system, which is formed by interconnected organizations that are jointly involved in the delivery of goods and services. Hereby, each organization possesses its own individual value chain consisting of primary and support activities (Porter, 1985).

The following Figure 2-3 presents the value system for municipal waste management and different options and elements for each activity:

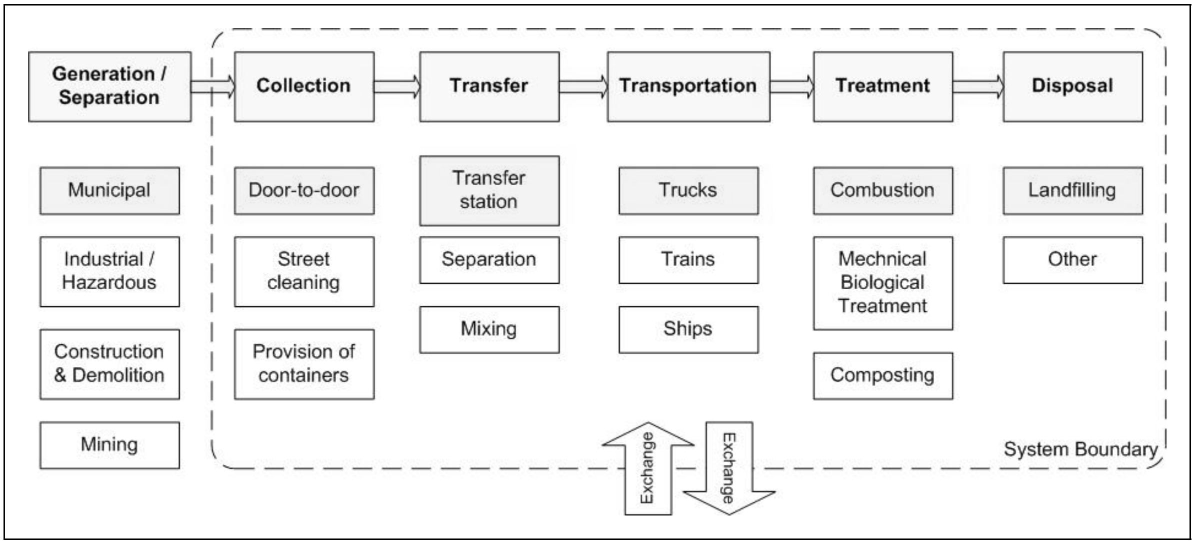

Figure 2-3: Waste management value system

Source: own, based on Eriksson et al. (2005)

The different activities of the waste management value system are briefly described below. Please note that not all of these elements must necessarily be provided as part of municipal waste management infrastructure and services. A simple scenario, as found in many economically developing or transition countries, often consists of waste collection, transportation and disposal only.

2.3.1 Waste collection

There exist different methods for collecting municipal waste. The three most commonly applied methods are (i) simple emptying of small scale waste containers, (ii) collection of waste which is put into one-way plastic bags or (iii) the exchange of filled large-scale containers by identical empty containers (Bilitewski, Härdtle, & Marek, 1996, pp. 64-70). While the first two methods are applied for the collection of municipal waste from households and commercial sources, the last is mostly used for commercial sources only[6].

Waste collection includes the local transportation from the source of waste to the transfer station. Other value creating elements at the level of waste collection include street sweeping and the provision of waste containers. Waste collection is comparatively labor intensive and less capital intensive (Rinschede & Wehking, 1991).

[6] In economically developing environments the method exchanging large-scale containers can also be found at household waste collection, if waste containers are provided for larger neighborhoods.

2.3.2 Transfer

Because it is often too costly to transport municipal waste over long distances in waste collection vehicles, special waste transfer stations can be established in the vicinity of the waste generation. Thereby, the waste collection vehicles unload their waste, which is transferred after a short period of time onto larger units. Due to the proximity of waste transfer stations to residential areas, they are normally constructed in encapsulated buildings to control noise, odor or dust emissions. In densely populated urban areas with high municipal waste generation rates and long transportation durations due to traffic congestion, transfer stations can be advantageous even if transport distances to waste treatment or disposal facilities are comparatively short.

Besides waste compacting machinery, waste transfer stations can also comprise equipment for mechanical separation or mixing of waste. Thus, valuable recyclables (e.g. ferrous or non-ferrous metals) can be separated and the waste be homogenized.

From a logistic point of view, waste transfer stations also function as a storage and buffer for leveling out short fluctuations in waste generation. From here, the waste can be transported in a continuous and controlled manner to waste treatment facilities.

2.3.3 Waste transportation

Long distance waste transportation is an important waste management activity whenever a transfer station exists between waste collection and treatment. Hereby, the compacted waste is usually reloaded into containers and transported either by trucks, trains or ships to the waste treatment facility.

Most commonly the municipal waste is transported by trucks, because it allows the highest logistical flexibility and least fixed assets. However, for the frequent transportation of high waste quantities over long distances, the transportation by trains can provide a less costly and environmentally friendly alternative. Waste transportation by ships is relatively uncommon, even though waste treatment facilities are frequently located nearby inland water ways.

2.3.4 Waste treatment

2.3.4.1 General

The principal objective of all waste treatment methods is to eliminate or minimize the negative impacts of waste on humans and the natural environment during its final disposal or utilization. Ideally, waste treatment also creates material or energetic products that can be used for other purposes.

Today, the major options for waste treatment are (i) thermal treatment, (ii) mechanical-biological treatment and (iii) composting. While the first two methods are applied to residual municipal waste, composting requires the separation of kitchen and garden waste at its source.

As shown in the following Figure 2-4, all treatment methods for residual municipal waste involve a combustion stage at some point:

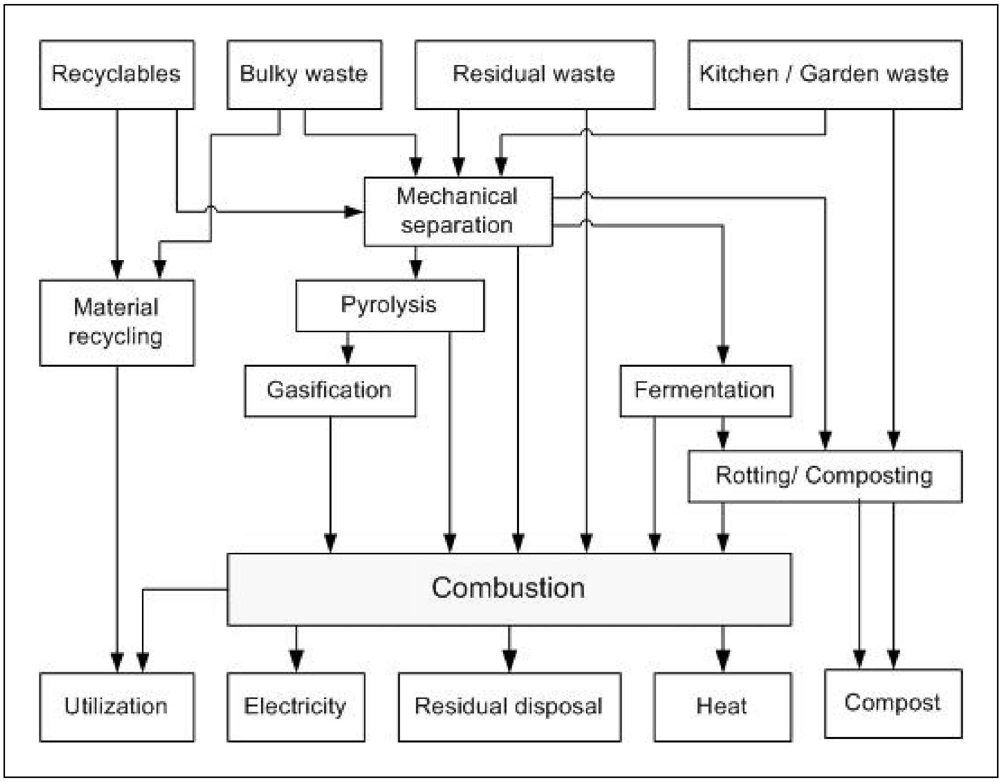

Figure 2-4: Options for mechanical, biological and thermal residual waste treatment
Source: own, after Thomé-Kozmiensky (2006, p. 14)

2.3.4.2 Thermal waste treatment

In many developed countries, thermal waste treatment is the dominant technology for residual municipal waste treatment. As shown in the following Figure 2-5, the share of thermally treated residual waste is often close to the technically applicable maximum value of 80-85% (Vaccani, 2007, p. 227). Due to the accentuation of environmental legislation, land scarcity in fast urbanizing regions and increasing transportation and energy costs it can be expected that the importance of thermal waste treatment will continue to grow around the world.

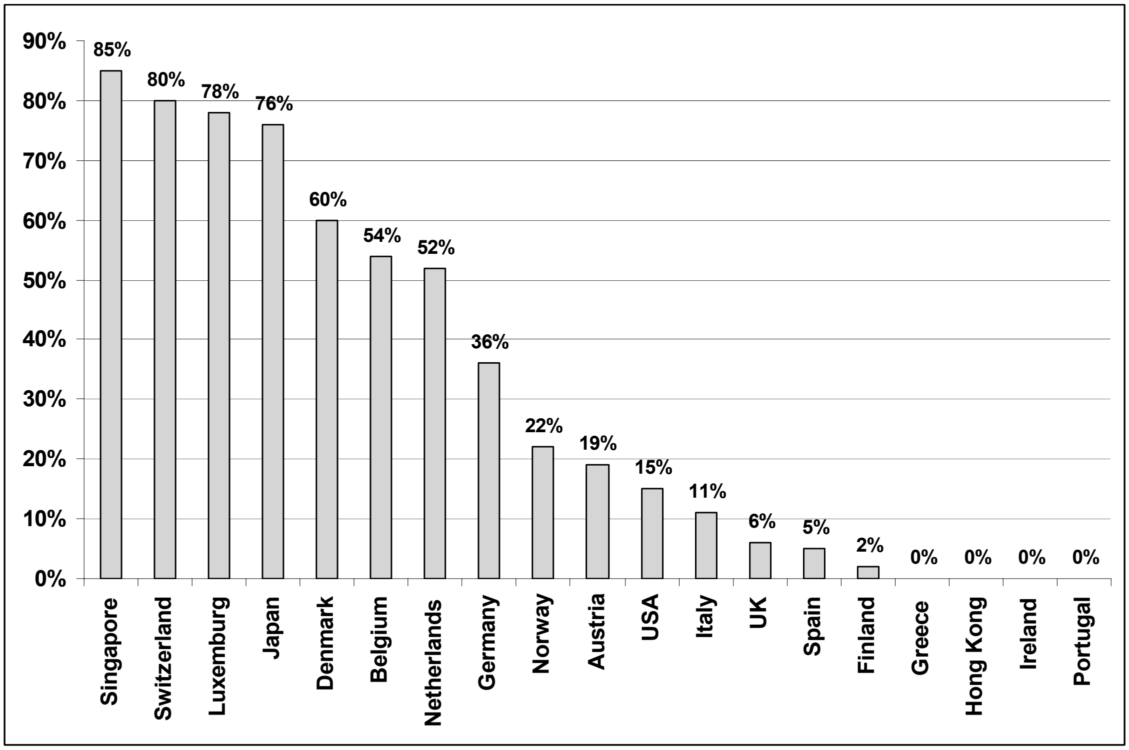

Figure 2-5: Share of thermal waste treatment for municipal waste in 2005

Source: Berenyi (2006), Vaccani (2007), own data

The major technological options for waste treatment through thermal processes encompass (i) waste combustion (mass burning), (ii) pyrolysis and (iii) gasification. The most frequently applied option is waste combustion, where residual municipal waste is burned on grates in industrialized facilities without prior treatment or separation. The technical, financial and economic aspects of MSWC will be described and analyzed in detail in the following chapters 3 and 4.

Apart from a few demonstration projects, pyrolysis and gasification play virtually no role at the current municipal waste management industry in Europe (Faulstich, 2006). However, in Asia, mainly in Japan and South Korea, gasification has gained remarkable importance (Themelis, 2007).

2.3.4.3 Mechanical biological waste treatment

Especially in Europe and starting in the late 1990s, mechanical biological treatment (MBT) has evolved as an alternative method for municipal solid waste treatment. In a typical MBT plant, the residual waste is mechanically separated into high-caloric and low-caloric fractions. The high-caloric waste (also: refuse derived fuel) is combusted in specialized plants[7], while

[7] Depending on quality of refuse derived fuel, co-combustion in coal burning plants or cement kilns is also technically possible.

the low-caloric waste is biologically treated trough rotting or anaerobic digestion and afterwards disposed in sanitary landfill sites[8].

In Germany and other European countries, many operators of MBT plants currently face serious technical and economic problems. Reasons include difficulties to meet target values for total organic content (TOC) at the biological treatment stage and the often unexpected high costs for the thermal treatment of the high-caloric waste fraction (Bilitewski, 2007).

2.3.4.4 Composting

Composting is the classical method for treating biological waste. A pre-requisite is that biological waste, i.e. kitchen and garden waste, is separated from other municipal waste at the source and collected by separate vehicles. In a composting plant the biological waste is screened for unwanted materials, homogenized and afterwards stocked for a certain period of time, during which the biodegradation takes place under aerobic conditions. The final compost products can be used for agricultural or landscaping purposes. Compared to thermal or mechanical-biological waste treatment, the negative environmental effects from composting are only few[9].

Please note that composting should not be considered as an alternative to thermal or mechanical-biological waste treatment, but considered as a complementary treatment technology for a different waste stream.

2.3.5 Disposal

The last element of the municipal waste management value system is the final disposal of treated or untreated waste. Sanitary landfill sites are the most frequently applied form of final above ground disposal. Their design can be very complex and has to reflect the chemical and physical waste characteristics as well as regional, hydrological and climatic conditions of its location. After a landfill site is being filled, it is capped to avoid penetration of rainwater and to allow the development of vegetation. The slag from MSWC is frequently used as the first layer for such capping.

Underground waste disposal facilities are engineered in salt or rock caverns. Because of their separation from the biosphere and groundwater, they are especially suitable for hazardous waste. Underground waste disposal facilities are therefore commonly used for the storage of residues from the flue-gas cleaning systems of MSWCs.

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[8] For a comprehensive overview on technical aspect of mechanical biological treatment see e.g. Soyez (2001). For recent development trends in Germany refer to Fricke, Bahr, Münnich, & Santen (2006).

[9] For comprehensive overview on biological waste treatment see e.g. Bidlingmaier (2000).

To control and minimize negative environmental impacts, waste disposal facilities require monitoring and maintenance (e.g. collection and treatment of leachate) over long periods of time after their closure. The costs for these after-closure activities should already be collected during operation of these facilities and be included in the disposal fees[10].

The major conceptual difference between waste treatment and disposal facilities is that treatment facilities have a maximum (constant) throughput capacity, while disposal facilities are characterized by a maximum volume capacity.

2.4 Economics of municipal waste generation

2.4.1 General

From an economic perspective, municipal waste can bee considered as a by-product of commercial production and private household consumption. It differs from “normal” economic goods in two important ways. Firstly, the marginal utility for its owner is lower than the marginal private cost for its further use (Holm-Müller, 1997, p. 24). Secondly, negative externalities are created if the waste is disposed in an uncontrolled way (Choe & Fraser, 1998)[11].

However, both municipal solid waste and “normal” economic goods have one thing in common: they are transportable. Therefore, unlike other infrastructure sectors, such as water supply or road networks, waste management does not possess the characteristics of a network industry.

2.4.2 Macroeconomic perspective

As shown in the following Figure 2-6, municipal waste generation rates per capita differ considerably between various countries[12]:

[10] For a comprehensive overview on design, construction and monitoring of sanitary landfill sites see e.g. Bagchi (2004) or Salvato, Nemerow & Agardy (2003, pp. 820-856)

[11] For externalities see also chapter 4.3.

[12] Please note that municipal waste generation rates can also vary strongly within countries.

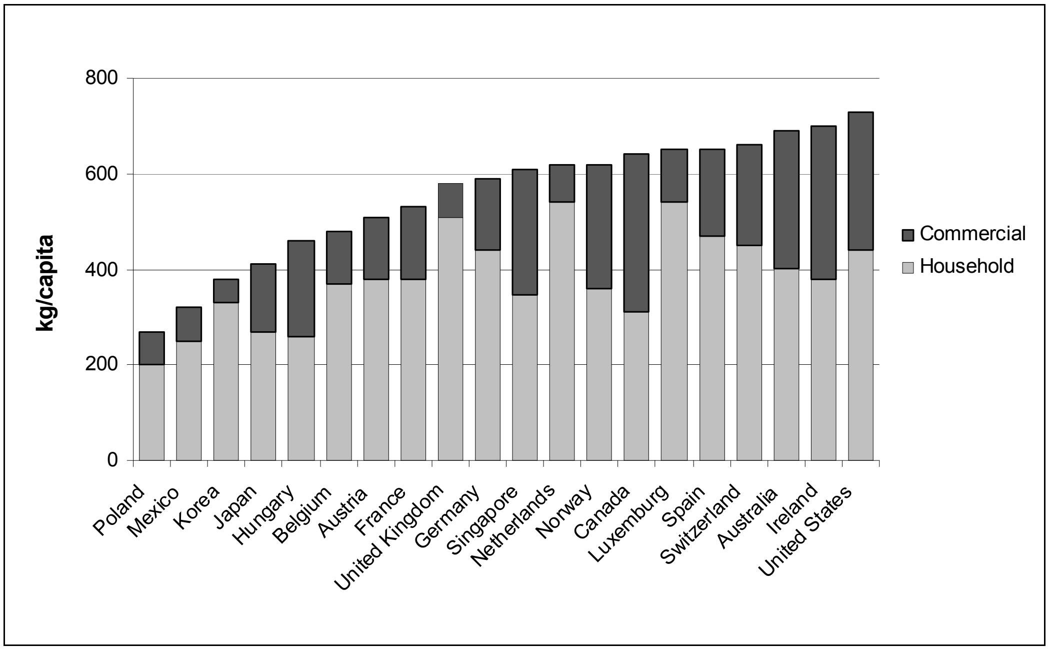

Figure 2-6: Generation of municipal waste in selected countries

Source: OECD (2007), NEA (2007)

Based on a comprehensive analysis of historical data on waste generation rates from different OECD countries, Johnstone and Labonne (2004) have identified three key economic and demographic determinants that can explain the generation of total and household municipal waste at national levels:

1. *Household income* has positive impact on waste generation rates. Depending on saving rates, an increase in real household income directly increases consumption and hence waste generation. However, marginal waste generation rates normally decrease with increasing household income.
2. *Average household size* and proportion of children in households have a significant negative correlation with household waste generation. This could be explained by the assumption that larger families jointly share meals and consume products in larger sizes with relatively less packaging material.
3. *Degree of urbanization* or population density have positive impacts on municipal waste generation rates, because consumption behavior changes towards increasing usage of packed goods and food.

Other surveys and studies have confirmed these three determinants and identified additional minor factors, such as infant mortality or education of people, both these correlate negatively with municipal waste generation rates (Beede & Bloom, 1995; Gellynck & Verhelst, 2007; Hong, 1999; Iseley & Lowen, 2007; Podolsky & Spiegel, 1999).

2.4.3 Microeconomic model for waste separation

Based on the outlined macroeconomic determinants of total municipal waste generation it is interesting to analyze how households separate recyclables and residual waste. A microeconomic model for this purpose is presented by Kinnaman & Fullerton (1996; 2001) and makes following assumptions[13]:

Households produce municipal waste m as a result of their consumption c:

$$m = (1/\alpha)c \tag{1}$$

, where 1/α is the portion of waste from consumed goods.

The municipal waste is either recycled r or collected as residual waste w:

$$m = w + r \tag{2}$$

Households maximize their utility $u = u(c)$, where $u_c > 0$ and $u_{cc}<0$. The disposal cost per unit of residual waste p_w is positive and constant, while direct recycling costs p_r are zero. However, the recycling of waste consumes time k^r , which multiplied by the wage p_k causes the opportunity costs $p_k k^r$. For simplification k^r can be assumed as:

$$k^r = \frac{1}{n+1}\delta r^{n+1} \tag{3}$$

Thus the marginal costs of recycling MC_r are calculated:

$$MC_r = p_k k_r = p_k \delta r^n \tag{4}$$

The variable δ can be interpreted as the efforts that different recycling schemes cause to the households.

In contrast with Kinnaman & Fullerton (2001) it is assumed that MC_r is not only a linear, but a concave curve depending on the exponent n, because the efforts for recycling increase exponentially with growing recycling rate[14].

The following Figure 2-7 illustrates the model and shows how the price of residual waste disposal p_w and the marginal cost of recycling MC_r determine the recycling rate r.

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[13] For an extended mathematical model see Kinnaman & Fullerton (2001). The model is widely applied in different forms by various studies on municipal waste and policy development (see e.g. OECD, 2004, pp. 44-47; Palmer, Sigman, & Walls, 1997).

[14] For example it is easier and less time consuming to separate larger newspapers (high volumes) than smaller packaging paper materials (lower volumes).

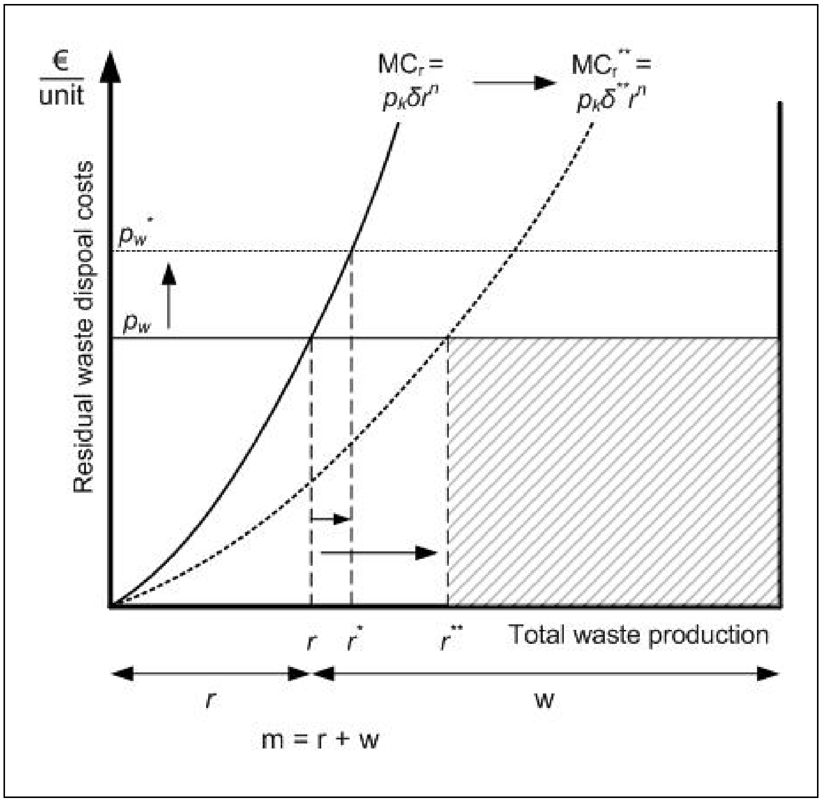

Figure 2-7: Choice of recycling and residual waste generation

Source: own, based on Kinnaman & Fullerton (2001)

As shown by the relationships in the above figure, an increase of residual waste disposal fees to p_w^* also increases recycling rate to r^*. This increase, however, greatly depends on marginal cost for recycling, i.e. the opportunity costs of households $p_k k^r$.

According to this model it can be expected that a simplification of waste recycling schemes from δ to δ^{**} has a greater impact on the recycling rate. It must however be noted that households benefit from reduced residual waste disposal costs (hatched area) only if a full unit based pricing is applied[15].

Empirical studies on household behavior support the presented model. Price elasticity for municipal residual waste generation is relatively low and decreases further with increasing income (Stehling, 1999, p. 23). For high income countries, such as Germany, the price elasticity can even be assumed as zero (Gaube, 2006).

In comparison with residual waste generation from households, surprisingly little theoretical or empirical research has been done on municipal waste from commercial sources. However, it can be assumed that the presented model is equally valid for this source of waste

[15] The reduced disposal costs are less likely to affect individual households wherever multiple households share waste collection containers due to the existing freerider problems.

generation[16]. Commercial enterprises are likely to behave even more rationally than households and therefore the opportunity costs and the ease to recycle determine price elasticity.

2.5 Summary

This chapter provided a brief background on general aspects of municipal waste management. The treatment of residual waste is an important waste management activity in most developed countries, because it minimizes the waste's negative environmental externalities. Waste treatment is a part of a broader waste management value system, which additionally consists of waste collection, transfer, transportation and disposal. Today, municipal solid waste combustion (MSWC) has evolved as the preferred treatment technology in many countries and its importance is likely to increase in other countries and densely populated areas as well.

Municipal waste possesses unique characteristics from macroeconomic and microeconomic perspectives. The main macroeconomic factors that determine the demand for municipal waste management infrastructure and services are household income, average household size and the degree of urbanization. The presented microeconomic model shows that the separation of residual and recyclable waste largely depends on waste disposal costs and households' opportunity costs which depend on wages and efforts for implementing available recycling schemes. Supported by empirical studies the model also shows that the price elasticity for residual waste generation is comparatively small in high income countries with a recycling scheme in place.

[16] This assumption is based on personal communication with Thomas C. Kinnaman.

3 Technical and economic characteristics of municipal solid waste combustion

This chapter aims at providing a short introduction to technical and economic aspects of municipal solid waste combustion (MSWC), such as applied technologies, externalities and life-cycle costs.

3.1 Introduction

Waste combustion is currently the most widely applied form of thermal waste treatment and can be done by applying and combining different specific technologies. Its major objectives are (see e.g. Bilitewski et al., 1996; EIPPCB, 2005):

1. To convert the heterogeneous mixture of harmful substances within the waste into substances that can be easily fractionated and captured as inert materials in the flue-gas cleaning system and slag;
2. To reduce the volume of waste in order to minimize the required disposal spaces;
3. To recover energy that is generated during the thermal treatment processes; and
4. To capture metals and other marketable secondary products.

During the past two decades, technological developments for MSWC plants have undergone rapid developments that were triggered by stricter environmental regulation, public pressure and growing demand in a supplier's market with fierce international competition. As a result, the state-of-the-art MSWC plants nowadays have low air emission and become more and more accepted as an efficient way for treating residual waste.

The terms combustion and incineration are often used as synonyms and technically describe the oxidation of waste materials. However, a combustion plant[17] is a complex facility where the actual waste combustion (or incineration) is only one step within a chain of physical and chemical processes. The following Figure 3-1 gives a simplified overview of the processes in a typical combustion plant:

[17] The term waste-to-energy (WTE) plant is also commonly used for waste combustion plants emphasizing the recovery of thermal energy as it sounds more environmentally friendly thus provoking less public concerns.

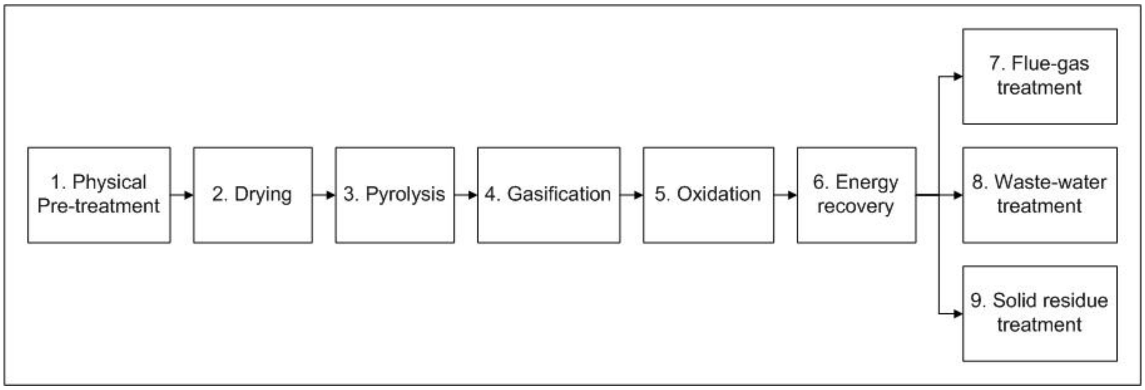

Figure 3-1: Simplified process diagram for typical waste combustion plant
Source: own

For special waste, such as bulky waste, the delivered waste is prepared prior to the thermal treatment. This usually includes physical treatment, such as shredding and separation of larger recyclables (e.g. scrap metal). The next four stages of drying, pyrolysis, gasification and oxidation are the actual processes of thermal waste treatment, where most volume and weight reduction take place. After the recovery of thermal energy from excess flue-gas, the treatment of process residues, such as flue-gas, waste-water and solid components is required to minimize environmental impacts.

3.2 Solid waste combustion technology

A typical MSWC plant consists of the following elements (Bilitewski et al., 1996; EIPPCB, 2005; R. Scholz, Beckmann, & Schulenburg, 2001; Thomé-Kozmiensky, 2006; VDI, 2002):

1. Waste receiving, storage, pre-treatment and charging,
2. Firing unit,
3. Energy recovery,
4. Flue-gas cleaning,
5. Storages and transfer stations for residues,
6. Stack including emission control and monitoring system and
7. Auxiliary infrastructure.

These functional areas are designed by combining components from various manufacturers and suppliers. Some of them, e.g. firing grades, are specifically designed for MSWC plants, while others, e.g. charging units, are designed for wider range of application in the design of power plants.

The layout of a typical municipal MSWC plant with its most important components is shown in the following Figure 3-2 and will be described shortly.

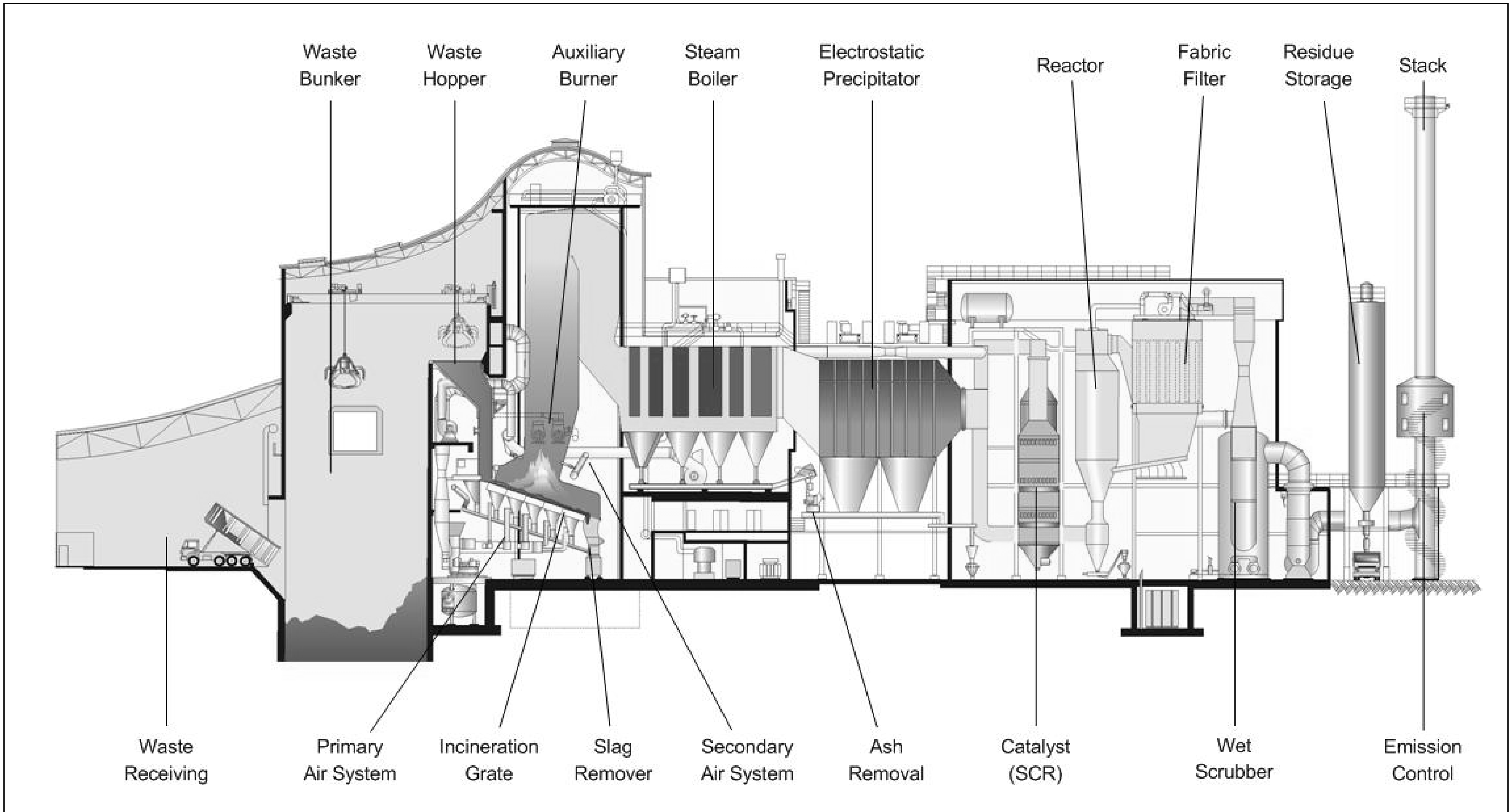

Figure 3-2: Layout and typical components of a municipal solid waste combustion plant

Source: vonRoll Inova (2007)

3.2.1 Waste receiving, storage, pre-treatment and charging

At the waste receiving area, the delivered waste is weighted, documented and offloaded into the waste bunker. The waste bunker should be dimensioned to ensure the off-taking of waste and its storage functions as a buffer-zone for continued firing. Its volume should be large enough to store waste for at least five to seven days to ensure continuous 24/7 combustion.

Many MSWC plants have separate areas for receiving special waste such as bulky waste. The preprocessing of waste usually encompasses the shredding of combustible bulky waste and removing of the waste disrupting the combustion processes. The mixing and homogenization of waste (materials, NCV) are important functions done manually by the crane within the bunker. Combustion plants that process waste from municipalities without waste recycling policies can integrate more sophisticated waste separation units at this stage to extract marketable product (see also chapter 3.4.3.3).

The off-loading and intermediate storage of waste can cause unwanted odor, dust and noise. Therefore, the waste receiving and storage facilities should be installed in closed buildings with slight atmospheric under-pressure. The storage of municipal waste outside the bunker should be avoided to minimize health and odor problems. A waste packaging station is in place to bale waste for outside storage in case the bunker is full due to excessive waste deliveries or longer operational shutdown due to planned or unplanned maintenance work.

Most of the delivered waste is only visually inspected requiring experienced and motivated operating staff. Randomly, the waste quality might be tested in a laboratory for its compliance with contractual requirements and plants' permission criteria. For operation, most crucial mechanical and physical characteristics of the waste are the net calorific value, density, size and the content of hazardous substances.

The waste charging unit must be designed to ensure continued and controlled waste streaming into the combustion unit. Stationary cranes that are usually operated semi-automatically or manually from a cabin above the bunker fill the waste into the hopper. An automatic interlock mechanism must prevent backfiring into the hopper. The entire charging unit must be very robust to resist heavy mechanic and thermal stresses.

3.2.2 Firing unit

A vast majority of MSWC plants use grate firing systems consisting of (1) feeding table, (2) firing grate, (3) furnace, (4) combustion air system, (5) after-burning zone, (6) auxiliary burner, (7) slag remover (see e.g. Thomé-Kozmiensky, 2006, p. 57; VDI, 2002, p. 32). A typical arrangement of them is shown in Figure 3-3.

The feeding table distributes waste from the chute onto the firing grates depending on measured parameters, such as steam production rate, oxygen content in the raw gas and temperature. In some MSWC plants (e.g. in Bamberg, Germany), an additional feeder is attached to the system for co-combustion of dried sewage sludge or collected leachate from landfill sites.

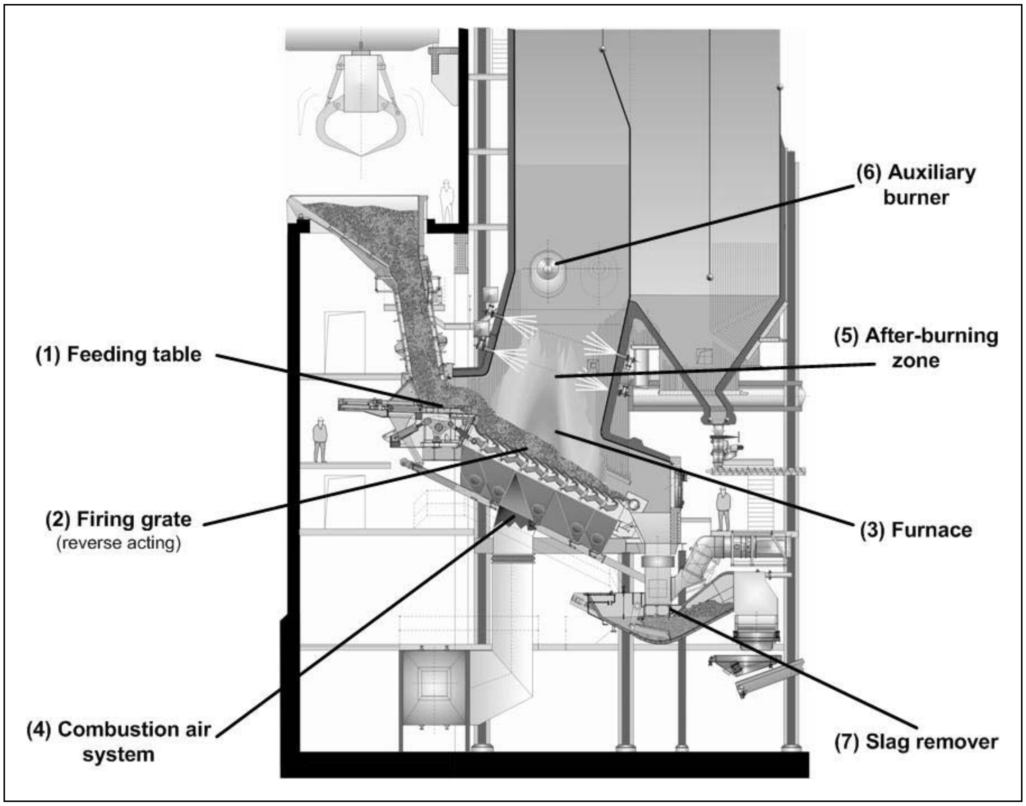

Figure 3-3: Firing unit

Source: Martin GmbH (2007)

The firing grate transports the waste through the furnace and ensures a continuous stoking of the fire on the basis of information from the combustion process control system (CCS). Among others, the major types of grates are: roller grates, forward feeding grates, reverse-acting grates or traveling grates. Depending on the various design characteristics of the MSWC plant, they are either cooled by only air or by air and water together. Instead of grate systems, rotary kiln or fluidized-bed can also be used for waste combustion. However, these two alternatives are mostly applied for treatment of hazardous waste, sewage sludge or refuse-derived fuels (RDF).

The combustion of waste takes place in the bed on the grate (solid conversion) and in the after-burning zone above the grate (conversion). Depending on the desired combustion gas flow, parallel-flow, counter-flow and centre-flow current systems are available. The primary air for oxidation processes is added from below the grates by the combustion air system (4) that also controls air flow rate and distribution of air in the grate zones. A secondary air system creates additional turbulences and fosters maximum burnout of combustion gases.

The transition region between the boiler and the furnace is regarded as the after-burning zone. At high temperature above 850°C, minimum residence time of 2 seconds and sufficient oxygen concentration a maximum burn-out of combustion gases like carbon-monoxide, furans, dioxins and others is ensured (17. BImSchV; Directive 2000/76/EC).

An auxiliary burner using oil or natural gas is installed for controlled heating and cooling of facilities (especially the boiler) during run-up and shut-down of operation. If the net calorific value of the waste is too low, the auxiliary burner should be activated automatically to ensure that the minimum required temperature in the furnace and after-burning zone is reached.

The slag[18] remover collects and cools the residues accumulated during the combustion processes. It is designed according to the grate system and must ensure air sealing against the furnace as well as a prevention of blockage during the removal processes. In grate firing systems, the slag falls due to gravity into a remover or conveyor where water is usually used as the medium for cooling. The slag mainly contains minerals, metals and glass of which some could be recovered by the operator of the MSWC plant or by an external firm (e.g. extraction of iron could be done with magnets). The slag is stored within the combustion plant until it is transported for disposal at a landfill site or for further treatment.

The total capacity of an MSWC plant correlates strongly with size of the firing unit and the net calorific value of waste. A combustion performance diagram can be drawn for every MSWC plant showing the relationship between thermal capacity, NCV and mass flow rate of waste (see appendix 2 for an example).

3.2.3 Energy recovery

Modern MSWC plants recover the thermal energy that is released as part of the combustion processes. For example, the German emission law (BImSchG) requires energy recovery and therefore all German MSWC plants possess a heat recovery system.

The thermal energy from the hot flue-gas has a temperature between approx. 850-1,000°C can either be transformed into steam or water. Steam can be used on the other hand for further transformation into electricity by turbines and generators or as a process steam for adjacent industrial off-takers. On the other hand, heated water can be supplied into a local heating system.

There are different types of boilers, depending on the output, the heat transfer system and the throughput capacity. The simplest categorization is done by its output, where three major types of boilers exist: (i) hot water boiler; (ii) low pressure (LP) steam boiler[19]; (iii) steam boiler. Hot water boilers produce hot water under pressure at a temperature between 110-

[18] Also named: bottom-ash

[19] Also-called: saturated steam boiler

200°C that can be used for heating purposes. Low-pressure steam boilers produce process steam with a pressure of up to 20bar and a temperature between approx. 120-250°C. As compared to the last two types of boilers, steam boilers have a more complex design.

The total energy efficiency of an MSWC plant depends mostly on the following three factors:

1. *Location*: Hot water or process steam generation recovers more energy than pure electricity generation. The highest efficiency rate can be achieved with co-generation of hot water (or process steam) and electricity. Therefore the location of the MSWC plant and the existence of off-takers for hot water (district heating system) or process steam (industrial application) has a decisive impact on energy efficiency.
2. *Steam parameters*: The selection of steam parameters[20] influence the efficiency of the boiler. Higher parameters increase the efficiency.
3. *Flue-gas cleaning system*: The components of the flue-gas cleaning (e.g. ventilators, pumps) require electrical energy themselves. Therefore the design of the flue-gas cleaning system has an impact on the total energy efficiency of an MSWC plant.

Due to the physical and chemical contents in the flue-gas, corrosion, erosion and fouling are serious problems that reduce the durability and reliability of boilers, especially steam boilers. Therefore, their design, integration into the overall system, operation and maintenance must be optimized to reduce unwanted interruption of the combustion schedule.

3.2.4 Flue-gas cleaning

Due to the various chemical components in the waste, large volumes of flue-gas containing various unwanted pollutants are generated during the waste combustion processes. Therefore, minimizing the generation and cleaning of flue-gases are the most important emission reduction processes in MSWC plants. While the pollutants are distributed heterogeneously in the solid waste[21], the flue-gas cleaning system fractions the flue-gas and treats them at different steps.

In contrast with primary measures, such as ensuring high temperatures in the after-burning zone, which target at impeding the creation of pollutants, the flue-gas cleaning system is a secondary measure for precipitating, reducing and destroying unwanted and hazardous pollutants, such as carbon monoxide, hydrogen chloride, dust, mercury and dioxins (see also 3.3).

[20] Standard steam parameters for MSWC plant are 40bar/400°C

[21] Prior sorting can do only little to reduce the heterogeneous distribution of pollutants in the waste.

Several different physical and chemical processes can be employed in flue-gas cleaning system by combining different process components that are offered by numerous suppliers. Major process components for flue-gas cleaning are (R. Scholz et al., 2001, p. 261):

1. Filter systems (fabric filter or electrostatic precipitator (ESP)),
2. Dry systems,
3. Semi-dry (or semi-wet) systems,
4. Wet systems,
5. SCR (Selective Catalytic Reduction),
6. SNCR (Selective Non-Catalytic Reduction),
7. Activated-carbon filters systems.

According to EIPPCB (2005, p. 102), these elements can be combined to 408 different options for flue-gas cleaning. The following Figure 3-4 shows three common combinations for wet, semi-wet and semi-dry flue-gas cleaning systems.

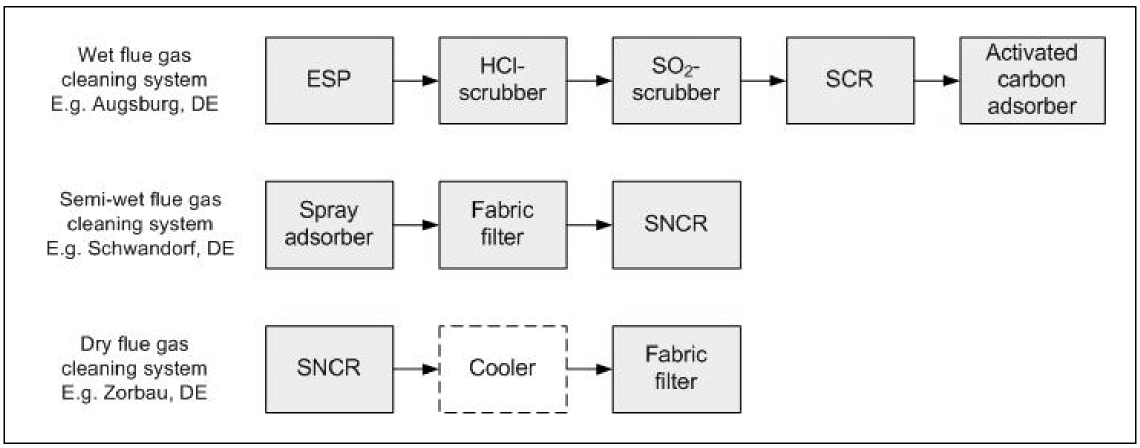

Figure 3-4: Flue-gas cleaning systems

Source: adapted from Fuchs (2006)

The choice of flue-gas cleaning system largely depends on legal requirements for air pollutants (e.g. 17. BImSchV). In many countries, such as Germany, public authorities frequently reduce the standard emission limits to a much lower level as a result of the planning permission processes.

For example, the MSWC plant shown in Figure 3-2 corresponds with the wet flue-gas cleaning system and utilizes an electrostatic precipitator (ESP), two-stage wet scrubber, SCR and a bag filter (Sotec, 2007). In all wet systems, a waste-water treatment facility is necessary to clean the effluent from the wet scrubber in a closed circle.

At the final stage, the cleaned flue-gas is released through the stack into the atmosphere. The ducts and stack must be resistant to corrosion, as the exhaust gas has a fairly high content of moisture at a temperature of 60°C or higher.

3.2.5 Process control and monitoring system

In comparison with gas or coal firing plants, the combustion of municipal solid waste is a rather discontinuous process due to the comparative inhomogeneity of the input material. A sophisticated control and monitoring system[22] is therefore needed to ensure (i) a full burnout in the firing unit, (ii) an efficient transformation of thermal energy and (iii) a reliable functioning of the flue-gas cleaning systems. While these three systems can function independently, their superordinated integration into a central control and monitoring system is required for taking into account their interdependencies.

Some pollutants (dust, HCl, SO_2, NO_2, total-C, CO, NH_3) are continuously measured, while others (Hg, dioxin, furan, HF, PAH) are measured discontinuously. The public authorities that are in charge of supervising emission levels must get access to the data. In modern MSWC plants therefore the authorities have an online access to the measurement instruments in the stack.

3.2.6 Auxiliary facilities

Various supporting facilities are required for developing and operating the MSWC plant. They include:

1. Civil structure for plant (foundation, construction cover)
2. Storages and transfer station for operating materials and residues (especially for slag and residues from flue-gas cleaning)
3. Connection to public infrastructure (road, railway, water supply, drainage, waste water disposal, electricity)
4. Office building, control rooms, social rooms for workers (incl. showers, kitchen), visitor's centre
5. Waste packing station and suitable area for intermediate storage of waste.
6. Parking spaces

In some cases, MSWC plants are built in urban industrial zone that are close to commercial or residential areas. These locations have the advantage of short transportation distances and an easy access to the municipal district heating system. In contrast to construction in non-urban industrial areas, these facilities require higher architectural and civil design standards to integrate themselves into the environment and therefore increase public awareness[23].

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[22] also: continuous monitoring system (CMS)

[23] The plant in Vienna, designed by the architect Hundertwasser, is a famous example. The plant has become a popular tourist destination and a plant at Osaka, Japan, has followed a similar design. Another plant, famous for its civil works, is the new MWCP in the City of Issy-les-Moulineaux, near Paris.

3.3 Externalities of municipal solid waste combustion

Every society produces waste. MSWC, like all waste treatment methods, aims at minimizing the environmental impacts of residual waste. It is therefore important to remember that the environmental impacts of MSWC are much lower in comparison to the environmental impacts of a non-existing municipal waste management. As compared to other waste treatment technologies, MSWC has rather little environmental impacts[24].

The classification of negative and positive environmental impacts correlates with the distinguishing between negative and positive externalities. Their economic analysis will be done in chapter 4.3.

3.3.1 Negative environmental impacts

During the waste combustion processes, various pollutants are produced with potential negative environmental impacts. Without adequate measures implemented in the flue-gas cleaning system (see chapter 3.2.4) the highest potential pollution could come from the flue-gas. Therefore a large amount of regulatory and policy efforts are focusing on the issue of minimizing airborne pollution (see chapter 4.3.2).

At the beginning of large scale commercial applications in the 1970s and ‘80s, MSWC caused severe air pollution and became known for their hazardous dioxin emission. The following public pressure and advanced environmental regulation triggered the development and implementation of improved technology. A study of Germany shows that the emission of dioxin could be reduced between the years 1990 and 2000 by 99.9% and is nowadays a negligible source of total national dioxin production (BMU, 2005)[25].

The slag (or bottom ash), which is by quantity the largest residue of the combustion does not cause major environmental impacts. Marketable ferrous and non-ferrous metal is usually extracted and used in industry. Depending on the quality of slag, it might either be disposed without further treatment at landfill sites or can be used as construction material (e.g. road construction). In the year 2001, about 84% of all slag from MSWC was utilized for road construction or other underground work (Krass, Brüggemann, & Görener, 2004). In countries like Japan or Singapore, the slag is even used for off-shore land reclamation.

The plant is only a few kilometers away from the Eifel Tower and directly near the river Seine. Two third of the plant is located below the ground level to limit the maximum height to 21m.

[24] A comparison with other waste management strategies or technologies is very complex and is out of scope for this research. A comparative study can be found for example in (Murphy & McKeogh, 2004).

[25] Surveys in the USA show similar reduction, while backyard waste burning remains the largest source of dioxin (IWSA, 2007b).

However, the fly ash that is collected in the boiler or through physical treatment (e.g. ESP) has high contents of minerals and heavy metals. To prevent ground water pollution, the fly ash is usually disposed underground as filling material in old salt mines.

The quality of residues as a result from chemical processes in the flue-gas cleaning largely depends on the chosen treatment system (dry, semi-dry, wet). The quantity depends on the process conditions, waste characteristics (e.g. chlorine content) and the required emission levels (e.g. HCl). For most of the residues from the flue-gas treatment no commercial use has been found. As such, they must be disposed in special landfills for hazardous waste or also underground sites. In wet treatment systems, gypsum and liquid hydrochloric acid are those end products that can be used as input material for further industrial application. Wet flue-gas treatment requires a wastewater treatment system that is usually designed in a closed circuit, therefore imposing no pollution to the environment.

Also noise and odor can cause unwanted environmental impacts, especially if the MSWC plant is located in the vicinity of residential or office areas. Noise can be reduced through proper sound isolation of the building and the muffling of ventilator. Appalling odor frequently causes sever problems in the immediate surrounding of MSWC plants. To reduce the impacts, the waste receiving could be built in a closed hall where trucks unload the waste into the bunker. An atmospheric low-pressure in the waste receiving hall, the waste bunker and all other closed buildings leads the air into the primary air system of the firing unit and ensures that the odor is not spreading uncontrolled.

3.3.2 Positive environmental impacts

It remains common consensus that the waste hierarchy of reduction, re-use and recycling should be pursued before the residual waste is treated and finally disposed. In many countries, MSWC is nowadays recognized as one of the most environmental friendly technologies for large-scale residual waste treatment.

In the recent past, the thermal energy utilization of waste has come into the focus of political and technical discussion. The drivers for these developments are (i) the search of alternative energy sources as demand for fossil fuel is growing due to rapid economic growth in developing countries such as VR China or India and (ii) the need to reduce the emission of greenhouse gases that are accounted responsible for global warming (IPCC, 2007).

Empirical studies from different countries have shown that the production of thermal energy in MSWC plants reduces the emission of CO_2 (Bilitewski & Schirmer, 2006; Thorneloe, Weitz, Nishtala, Yarkosky, & Zannes, 2002; UBA, 2002). In Germany it is estimated that MSWC will reduce greenhouse gas emissions between 2005 and 2020 by 2.95 Mio. CO_2-equiviants (Dehoust et al., 2005). The total reduction of CO_2-emssions is a result of the fossil energy content in the waste[26] and has to be calculated in comparison with CO_2-emissions and fossil carbon content of the substituted energy production (e.g. coal, oil)

A pre-requisite for these positive environmental effects is a high efficiency of thermal energy utilization which depends strongly on the location of the plant and its local circumstances. Details on the calculation and comparability of energy efficiency of MSWC plants that are required for potential categorizations remain disputed (Beckmann & Scholz, 2007; VDI, 2006).

Whether MSWC should be categorized as a renewable form of energy production remains disputed in many countries around the world. As compared to other forms of renewable energy, like wind, photovoltaic or hydro-power, the environmental impacts from MSWC are considerably lower (BUWAL, 2005, p. 21). For example in the USA, 23 states regard MSWC as renewable energy under various laws and statues (IWSA, 2007a).

Another important positive environmental effect from MSWC in comparison to other waste management options is the reduction of land use. Because the volume of waste is reduced by around 90%, much less space is required for landfill site. The land use which can be reduced even further if the residues are utilized by other industries, plays a very important role in densely populated countries and urban areas.

3.4 Financial analysis of MSWC plants

3.4.1 Overview

The financial analysis of any infrastructure project should be based on all costs and revenues being occurred during the life-cycle of a project (Wübbenhorst, 1984)[27].

In order to do so, it is crucial to define the duration of the life-cycle. As compared to infrastructure projects like roads or harbors that are usually designed to exist indefinitely, MSWC plants usually have a rather defined life-cycle at the project development stage. It starts with the project planning including the identification of demand and the preparation of a feasibility study; and ends with its demolition or dismantling. The machinery equipment of MSWC is often designed for an expected operational period of 25 to 30 years.

In practice, however, it is common that MSWC facilities are not demolished at the end of their designed technical life expectancy and will rather get a refurbishment. The refurbishment might affect the entire plant or just a separated overhauling of diverse components, such as

[26] The fossil, i.e. biological, carbon content of municipal waste correlates negatively with the NCV. In Germany, it is around 65% for municipal waste with an NCV of 9 MJ/kg (Beckmann, 2007a).

[27] The life-cycle of a project is to be distinguished from an industry life-cycle. For example Stigler (1951) exemplifies at the cotton industry, how an industry undergoes different levels of vertical integration at different life-cycle stages, such as expansionary, mature or declining phase.

firing unit, boilers or flue-gas treatment systems. Such refurbishments could also be triggered by change in law (e.g. air emission regulation), an adaptation to changed waste composition or they could be a measure to accommodate growing or decreasing demand.

The most important cost and revenue items occurring during the total life-cycle of MSWC plants are listed below:

Life-cycle costs	Life-cycle revenues
1. Planning costs 2. Capital costs 3. Maintenance costs 4. Operational costs 5. Financing costs 6. Disposal fees 7. Costs for demolition 8. Others	1. Gate fees or availability payments 2. Sale of energy 3. Sale of recovered materials 4. Subsidies

Table 3-1: Life-cycle costs and revenues for MSWC plants

Source: own

The following figure Figure 3-5 is part of technical guidelines developed by VDI (2002) and indicates how the costs for an MSWC plant could be distributed during operation. Other calculations and statistics from Europe show similar numbers (Kaufhold, Kaufmann, & Goedecke, 2005; Kaufmann, 2006; RenoSam, 2006).

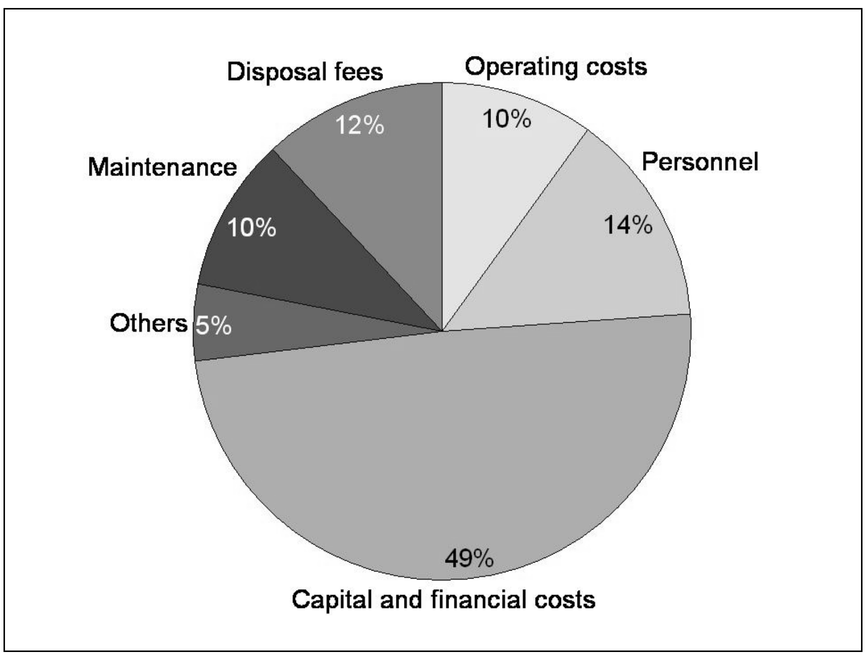

Figure 3-5: Typical life-cycle cost distribution for MSWC

Source: VDI (2002)

A cost structure analysis of all MSWC plants in Germany by Gaube & Weigand (2005) calculated that fixed capital and fixed operational costs together account for up to 85% of total costs (without disposal fees). This high percentage illustrates the importance of plant dimensioning and selection of technology.

Theoretical calculations by AFEA (2002) and Auksutat & Löffler (1998) for MSWC plants under comparable boundary conditions reveal that the total treatment capacity has the highest impact on total life-cycle costs. Therefore, the total life-cycle costs must always be seen in relation to the net capacity (actual treatment capacity), which is the product of gross capacity and plant availability. It is calculated as:

$$\text{Unit costs [€/Mg]} = \frac{\text{total life-cycle costs [€]}}{\text{gross capacity [Mg] x availability [\%/100\%]}}$$

The net calorific value (NCV) of the delivered waste can differ considerably during operation and strongly influences the net capacity of MSWC plant and the generated thermal energy. The interdependencies between an NCV, hourly throughput and energy generation are shown the combustion performance diagram (See appendix 2 for an example).

As shown in the following Figure 3-6, unit costs decrease with growing treatment capacity. But the effect of decreasing unit costs is declining as well and increase of capacities over 250.000Mg/a does show only small decreases in average costs.

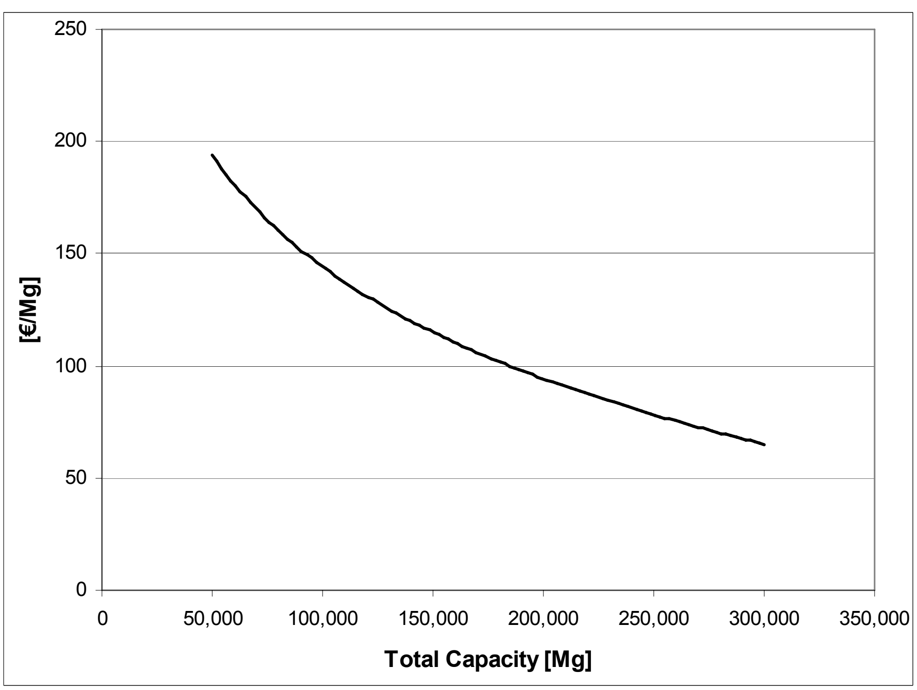

Figure 3-6: Relationship between unit costs and capacity

Source: own and data from AFEA (2002), Auksutat & Löffler (1998)

Formally the production function can be written as:

$C(x) = f(x)$ with $f(x)/d(x) < 0$; $f(x)/d^2(x) < 0$

The comparison of life-cycle costs between different facilities and applied technologies is a very difficult and complex task, because they are influenced by various project specific variables that are changing over time. There has been extensive research on benchmarking models for MWC facilities by Przybilla (2002) and Stegmann (2002), and the developed methodology can be a useful tool for specific plant owners or operators to identify and compare their comparative strengths and weaknesses. Their applicability, however, as an up-front decision making tool for optimization of life-cycle costs is very limited due to (i) restricted data availability and (ii) inadequate inclusion of cost changes over time.

In some countries, there exist standardized procedures for the public sector to calculate the occurring costs during the operation of the project. In Germany, the so-called LSP[28] includes various fixed and variable cost items, including margins and risk premiums.

The objective of the next chapters is to identify and illustrate the most important categories and their variations for life-cycle costs and revenues.

3.4.2 Elements of life-cycle costs

3.4.2.1 Planning costs

The planning processes for MSWC project are very complex and require expertise in various fields. The planning costs can account for 2.5% – 6.0% of capital costs (VDI, 2002). Major planning activities include project management, planning for technical installations, preparation and implementation for procedures to obtain necessary permits, preparation and implementation of tendering procedure, supervision of construction works as well as claim management (Claus, 2000).

The cost for preparing and obtaining planning permission largely depends on legal requirements and the social acceptance of the project. The fees for technical, financial and legal advisory services can increase dramatically in case of extensive public hearings procedures and legal disputes with project opponents. Also the fees charged by the public authorities to grant the required permissions are relatively high and can easily sum up to more than €1m (Claus, 2000).

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[28] LSP is the German abbreviation for „Leitsätze für die Preisermittlung auf Grund von Selbstkosten“ PR 30/53. See also: (Ebisch & Gottschalk, 1994; Winkler, 1999, p. 100)

3.4.2.2 Capital costs

As explained earlier, MSWC plants are large-scale waste treatment facilities that employ sophisticated and complex technologies. Like large power plants, they are very capital intensive and require solid financing capacities and structures.

There exist various factors influencing the design and thus the capital costs of an MSWC plant. As shown in the following figure Figure 3-7, these influences can be clustered into project specific and global factors. Project specific factors are determined individually for every single project and differ strongly from case to case. Global factors, however, are given on a supra-level and are usually identical to all projects within a country.

The most important global factors influencing capital costs of MSWC projects are (i) legal requirements; (ii) public acceptance of the technology; (iii) macroeconomic situation and (iv) competition of suppliers. Within a country, these global factors change rather over a time than from project to project.

The most significant project specific factors determining the capital costs are (Brunner, 2006; Rand, Haukohl, & Maxen, 2000a): (i) capacity and waste characteristics; (ii) flue-gas cleaning requirements; (iii) energy utilization; (iv) civil works and architecture; (v) redundancy; (vi) local site conditions.

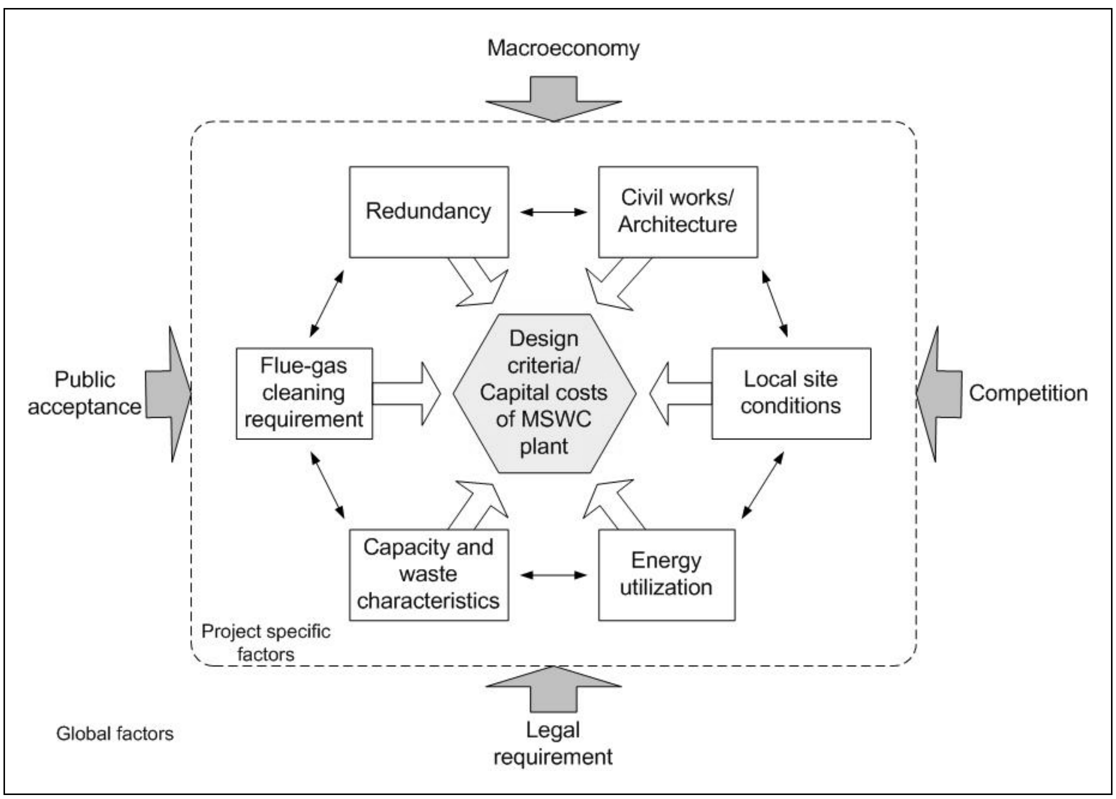

Figure 3-7: Factors influencing capital costs
Source: Own

These project specific factors are not independent variables. They are affected by the global factors and also influence one another. For example the total capacity of the MSWC plant and the characteristics of the treated waste determine the size and design of flue-gas cleaning and energy recovery system.

The capital costs for larger MSWC plants are normally distributed among the following items:

<table>
<tr><th>Components</th><th colspan="3">Percentage of total capital costs [%]</th></tr>
<tr><td>Source</td><td>(Vaccani, 2007)</td><td>Manufacturer A</td><td>Manufacturer B</td></tr>
<tr><td>Planning/Engineering</td><td>-</td><td>10 – 12</td><td rowspan="3">45</td></tr>
<tr><td>Firing unit and boiler</td><td>20 – 25</td><td>18 – 22</td></tr>
<tr><td>Flue-gas treatment</td><td>18 – 22</td><td>9 - 12</td></tr>
<tr><td>Electricity generation</td><td>10 – 12</td><td>20 - 22</td><td>15</td></tr>
<tr><td>Control and monitoring system</td><td>6 – 8</td><td>5 – 6</td><td>5</td></tr>
<tr><td>Slag and ash removal systems</td><td>4 – 6</td><td>-</td><td>5</td></tr>
<tr><td>Balance of plant</td><td>4 – 5</td><td>8 - 10</td><td>10</td></tr>
<tr><td>Civil structures</td><td>18 – 22</td><td>17 – 21</td><td>20</td></tr>
</table>

Table 3-2: Distribution of capital costs

Source: Vaccani (2007) and two manufacturers

The costs for firing unit and boiler together account for the largest share of total capital costs. The design capacity (throughput) and waste characteristics (net calorific value, water content) are the most important factors that influence their design and thus the capital costs.

The investment costs for flue-gas treatment system depend on the expected flue-gas characteristics and the desired level of emission reduction. Dry flue-gas cleaning systems are less capital intensive than semi-wet and wet systems (LUA, 2001).

Because of the complexities and interactions between the various parts of an MSWC plant, examinations of capital costs must either be in the form of sensitivity or scenario analyzes (see e.g. AFEA, 2002; Auksutat & Löffler, 1998; Doedens & Kühle-Weidemeier, 2004; Rand, Haukohl, & Maxen, 2000b; VDI, 2002). In a sensitivity analysis, individual parameters (e.g. design of flue-gas cleaning system) are changed to assess the level of change to the total costs. The scenario analysis can be utilized to compare different set of changes among one another.

3.4.2.3 Operating costs

Operating costs are the costs incurred by running the MSWC plant and they comprise of fixed and variable cost elements. Fixed costs occur independently of the operational performance whereas variable costs represent expenses that strongly correlate with the actual quantity and quality of treated waste.

Labor and administrative costs are usually fixed and together they account for a large portion of operational costs. The salaries depend strongly on national and local levels, as well as on additional surcharges for shift works, weekends and holidays. Even if the MSWC plant runs at low capacity, there is little flexibility in labor costs, because the facilities must run continuously 24 hours per day and 7 days per week.

The operating costs for the flue-gas treatment system include costs for chemicals and filters. They are mostly variable operating costs, because their consumption largely depends on the volume and load of -as. Operating costs for dry flue-gas cleaning systems are higher than for wet systems, due to higher costs for filter bags.

Usually there are no direct costs incurred for electricity required for the machinery, especially for the flue-gas treatment system and buildings because the electricity is mostly taken from its own generation. The amount of electricity used, however, has an indirect financial impact as it affects the revenues from sale of excess quantities.

The cost for fuel that is required during start-up and shuot down of the plant also adds up to the operational costs. In case the net calorific value of waste is too low[29], an additional fuel has to be added permanently during operation to ensure minimum temperatures in the combustion chamber, thus substantially increasing the variable operational costs.

3.4.2.4 Maintenance costs

The equipment and buildings of the MSWC plants require frequent maintenance. Whether the maintenance is done by own personal or subcontractor depends on strategic considerations of the operator which might be influenced by the plant size, technical experience and the possibility of sharing maintenance resources among several facilities operated.

Smaller maintenance is usually done twice per year for 48 to 96 hours, whereas once a year a larger maintenance interruption is scheduled up to 500 hours. During the initial guarantee period, which is usually agreed between 16.000 and 32.000 hours, maintenance must be done by the suppliers as part of their contractual obligations.

The calculation of maintenance costs should not only consider the cost for technical works, but it must also incorporate the opportunity costs for not operating the plant. These are primarily the costs for balling and storing the waste that is continuously delivered on the basis of long-term contracts. Also revenues will be lost by not offering excess capacities on the spot market and not selling generated energy.

[29] Lower than 7,000 kJ/kg

3.4.2.5 Costs for disposal of residues

Major residues from the combustion processes that must normally be disposed off at a charge are (i) the slag (bottom ash); the (ii) fly ash; (iii) flue-gas cleaning residues.

The weight of slag amounts to approximately 25 to 30% of the combusted waste and the volume is reduced to 5-10% of its original baseline. Considering these large amounts, the costs for disposing the slag have a significant impact on life-cycle costs. These costs are mostly variable, since quantities depend on actual throughput.

There exist two options for handling the slag. In the first option, which is mostly commonly applied (Krass et al., 2004), a specialized external company takes the residual slag from the MSWC plant and charges a fee that is lower than the tipping fees at landfill sites. This company then extracts ferrous and non-ferrous metals in its own facility, imposes further treatment and markets the material. The fees depend greatly on the price of scrap metal (see appendix 1 for change of prices since 2002), the quality of slag and the existence of a market for utilization of the slag as construction material or other purposes[30].

In the second option, the MSWC plant owns and operates its own slag treatment facility for the recovery of marketable recourses and possible further treatment of slag. In this case, the operator must search for ways of utilizing and disposing the residual slag. Currently, the slag has a negative market value and a fee must be paid to the recipient.

Fly ash from the boiler, electrostatic precipitator or filter system amounts for approximately two to three percent of the original waste weight. Due to the content of minerals and heavy metal, a utilization or recycling is very difficult and the fly ash is almost exclusively disposed in special landfill sites or as a filling material in underground mines (Rand et al., 2000b). The fees for disposal of fly ash are much higher than for residual slag.

Many countries such as United Kingdom or Denmark impose a landfill tax. They were initially introduced to stimulate recycling schemes at times when all municipal waste was disposed in landfill sites without prior treatment. Because in most countries the landfill tax continues to exist even if the treatment of waste is legally required, it increases total variable operating cost if the slag or other residues are disposed in landfill sites.

3.4.2.6 Financing costs

As shown above, MSWC plants are very capital intensive and even at medium size easily reach investment costs of more than 100m Euros. Therefore the sources of funding and consequently the financing costs are of utmost importance to total life-cycle costs.

[30] Currently, many landfill sites are closed in the EU and the slag can be used as a cheap material for surface sealing or for strengthening of roads on the landfill site.

The available sources of funding depend on the institutional arrangement (see chapter 6) and could include bank loans, off-balance sheet project finance, forfeiting, municipal bonds or leasing.

The financing costs depend on the financing structure and consist of debt payback, interest payments, bridge funding costs, arrangement fees and commitment fees.

3.4.2.7 Other costs

In addition to the costs described above, life-cycle costs also include (i) land lease fee or land acquisition; (ii) insurances; (iii) fees for public authorities; (iv) general business taxes.

3.4.3 Revenues

3.4.3.1 Gate fees

The gate fee is the charge to be paid by the customers (waste generator) for treating the delivered waste at the MSWC plant. In most MSWC markets they account for the largest share of total revenues.

Plant operators often strongly rely on long-term contracts with public or private customers. These contracts have a duration of at least five years and often include a spectrum of waste treatment quantities with minimum guaranteed waste deliveries as well as a maximum available capacity for off-take. Usually, a baseline for the gate fee and a price escalation mechanism are fixed for the entire contractual period. The baseline is often identical to the gate fee at the beginning of the contractual period, whereas the price escalation mechanism defines adjustments to the gate fee and could relate to unforeseen price changes such as change in inflation, consumer price indexes, financing costs (e.g. EURIBOR), energy prices, waste characteristics, labor costs or others. These price escalation mechanisms can be either very simple with only a single key indicator or they can be very complex on the basis of an extensive mathematical formula with various indicators. Because of their large time horizon, gate fees in long-term contracts often do not reflect actual market conditions governed by supply and demand. Therefore the gate fees in long-term contract can divert positively and negatively from actual market prices.

In comparison with long-term contracts, short-term contracts are usually agreed with a fixed price and without price escalation mechanisms. The prices are more likely to reflect market conditions of which available spare capacities in the market are most significant.

Price differentiation (also: price discrimination) is commonly applied to the market for MSWC and describes the fact that the same production or service, i.e. the combustion of waste, is sold at different prices in the market. Reasons for price differentiation are different competitive situation, waste treatment quantities, different contract durations as well as costumer relationships.

3.4.3.2 Energy revenues

As compared to other waste treatment technologies, energy production in MSWC plants is relatively expensive and revenues, other than derived from electricity, depend strongly on the existence of local markets for thermal products such as process steam or heating water (Murphy & McKeogh, 2004).

There exist various possibilities to sell generated energy. Process steam or heating water are usually sold on the basis of long-term contracts to local industrial off-takers or operators of the district heating systems. Similar to long-term waste treatment contracts, these contracts can be based on complex price escalation mechanisms.

From a technical point of view, the transmission of electrical energy is less restricted than steam or heated water. As such, there are much more options for sale of electricity if the energy market is liberalized. Besides long-term contracts with individual companies, electricity could be sold on spot, future or option markets that are traded on platforms provided by energy exchanges (see e.g. EEX, 2007).

In recent years, the energy prices have increased significantly (see appendix 1 for change of electricity prices since 2002). At the same time the price level has also fluctuated more strongly and as a result the risks and opportunities have increased in the market. Depending on their risk acceptance, operators of the MSWC might prefer a mixture of contracts and sign long-term agreements for a larger share of generated electricity and sell the remaining share on the market. Such structures also have the advantage of more flexibility with respect to quantities of generated electricity that change frequently depending on the operational performances of the MSWC plant.

In countries, where energy from the MSWC is legally classified as renewable energy, regulatory schemes might be in place to guarantee minimum prices level for energy sale. In these cases, operators often sign long-term energy sale contracts with net providers with prices above market level (see case studies from USA). The revenues from energy sale might thus even become the most important share of total revenues.

3.4.3.3 Sale of recovered materials

The MSWC plant can extract ferrous and non-ferrous metals from the slag if it owns and operates a slag treatment facility (see also chapter 3.4.2.5). Revenues from the sale of scrap metal correlate powerfully with world market prices for raw materials and prices can fluctuate tremendously (see appendix 2 for change of prices since 2002).

Depending on the applied technology, marketable products, such as hydrochloric acid or gypsum, can be retrieved from the flue-gas treatment system. Quantities, however, of these products are rather low, so that the total revenues from their sale are marginal in comparison to other cost and revenue items.

3.4.3.4 Subsidies

Many infrastructure projects, independent of the institutional arrangement, receive direct or indirect subsidies for capital investments or for operational expenditures and are usually granted to pursue political objectives. Direct subsidies are payments to the project owners, usually in the form of cash, whereas indirect subsidies are given as tax exemptions, lower interest rates, guaranties or other public support affecting the project in a positive financial way.

Case studies from various countries[31] show, that MSWC plants have often received direct or indirect subsidies. These subsidies were often given to encourage improved emission reduction, advanced resource recovery or efficient energy utilization (see e.g. (Amsterdam, 2006). In many cases, this financial support has been a decisive source of funding and without the direct or indirect subsidies some MSWC projects would not have been bankable (see e.g. EIB, 2002).

3.4.3.5 Availability payments

Every MSWC plant must interrupt operations for scheduled or unscheduled maintenance work, during which no waste can be treated. The total period of interruptions is comparatively extensive, because the ramp-up and shut-down of the plant consumes additional time. The availability describes to what extend an MSWC plant is working according to the defined technical specifications. The availability can be calculated as the total annual net capacity or as a daily average net capacity and must be put in relationship to waste characteristics (mainly NCV). Through various measures, the availability of an MSWC can be maximized and modern MSWC plants achieve an average operational availability of up to 92% - 95%.

Payments that are based on the net capacity of the MSWC plant are the so-called availability payments. Here the operator receives a fixed payment based on the actual availability of treatment capacities that is independent of the actually amount of treated waste. Other operational values, such as energy efficiency rates or emissions could also be included in the compensation mechanisms. The payments are usually connected with a bonus-malus-system to reflect reduced or increase availability. Price adjustment mechanisms can be agreed upon to reflect changes in various cost items (e.g. operational material).

The advantage of this payment model is that the demand risk, which the operator often cannot influence, is carried by the client, which is usually by public sector.

Even though availability payments are common methods for compensations in PPP road projects (Alfen, Elbing, & Leupold, 2005), they have found few application projects for the

[31] In Japan MSWC plants, like all other infrastructure in this country, receive subsidies from the central government (Kleiss & Imura, 2006).

MSWC project with total life-cycle integration. A case study from Singapore, where this payment model is applied, is presented in chapter 7.4.

3.4.3.6 Discussion

As elaborated in the previous chapters, innumerable complex factors have an impact on the costs and revenues of an MSWC plant. As shown in the following Figure 3-8, capital investments, operational costs and revenues are directly interlinked with one another.

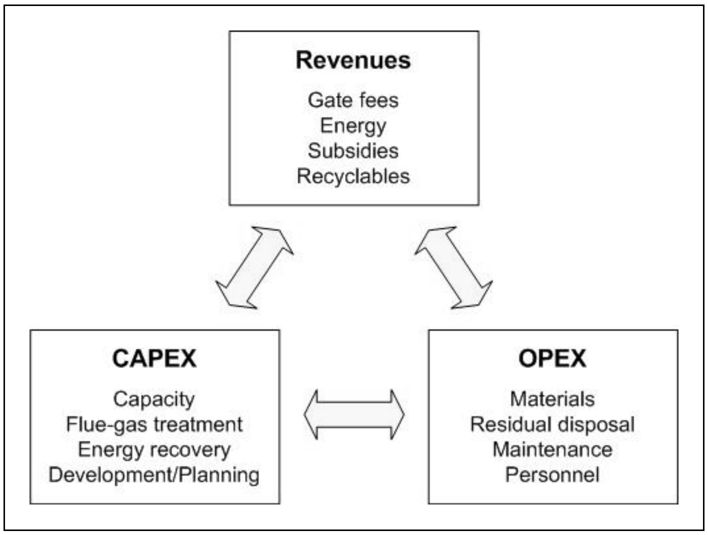

Figure 3-8: Leverage of capital costs, operational costs and revenues

Source: own

In practice, the optimization between capital investments, operational costs and revenues require experience over a long period of time throughout all life-cycle phases and across diverse MSWC plants that use different technologies and operational strategies. The following list gives a glimpse of important interrelationships:

1. *Capital investment vs. maintenance costs*: For example, more costly materials for boiler or grate system might result in a reduction of operational/maintenance costs or in an increase of plant availability, vice versa.
2. *Flue-gas cleaning system*: While older calculations strongly favor a dry flue-gas cleaning system over a wet and semi-wet system, experience of the MSWC operators suggest that wet systems might have lower total life-cycle costs if high volumes of flue-gas with high pollution content (e.g. chlorine) must be treated.
3. *Energy efficiency vs. capacity*: If the operation is optimized to maximize the capacity, i.e. throughput, then the energy efficiency rate is below its maximum. Therefore possible higher revenues from gate fees must be leverage against lower revenues from energy sale.

4. *Location*: The location of an MSWC plant close to an urban area can reduce transportation costs and can possibly allow the connection to a central heating system city, thus increasing energy efficiency (Beckmann, 2007b). Such a location, however, might increase costs and time during the permission procedures (due to increased public objections). Often additional investments for changes in the architectural design or flue-gas treatment system might be required, even though they are not justified from a technically objective point of view.
5. *Slag disposal vs. capacity*: The costs for disposal of slag depend on its quality (e.g. organic content). An increase of throughput, i.e. net capacity, can be achieved by reducing the time for waste travelling on the grate. This measure, however, reduces the quality of the slag.
6. *Capital investments vs. recyclable revenues*: Investment on facilities to extract recyclables should justify the achievable revenues from the sale.
7. *Availability and redundancy*: A high availability rate of the facility requires higher investments in redundant electronic and machinery components.

3.5 Summary

This chapter presented a brief overview of the technical and economic aspects of MSWC. The most important components of a typical MSWC plant are waste receiving and charging facilities, firing unit, energy recovery, flue-gas cleaning, emission control and monitoring system and auxiliary facilities. Depending on the project specific design requirements, various combinations of these different components are applicable.

Even though the MSWC considerably decreases the negative environmental impacts of residual waste, it can be a potential source of negative environmental impacts by itself. However, due to improved technological development, most negative impacts are reduced to a minimum at the state-of-the-art MSWC plants. E.g. in Germany, dioxin emissions from MSWC are nowadays negligible. On the other hand, MSWC provides also additional positive environmental impacts which include reduction of greenhouse gas emissions and a reduction in land use.

The financial analysis of the MSWC infrastructure assessed the costs and revenues that occur through the life-cycle. It was shown that capital investments are by far the largest share of total life-cycle costs for the MSWC plants and that they are influenced by various global and project specific factors. Other costs include planning, operation, maintenance, residual disposal and financing costs. The gate fees that are received for waste treatment are the most important share of the total life-cycle revenues, which also include income from energy generation, sale of recovered materials or subsidies.

4 Market specific aspects of MSWC

4.1 Introduction

4.1.1 The model of perfect competition

The theory of paretian welfare economics (also: new welfare economics) is a widely accepted framework that uses various microeconomic instruments to analyze how social welfare is to be maximized. A central objective of paretian welfare economics is the achievement of Pareto efficiency[32] which describes a situation as optimal if no individuals can be made better off without making someone else worse off. If this condition is fulfilled, then all goods and resources are distributed within the economy to those individuals who derive the biggest utility from them (Feldman & Serrano, 2006).

Economists believe that the model of perfect competition leads to a Pareto efficient outcome and therefore many economists choose this model as their principle foundation of economic theory and analysis (Fritsch, Wein, & Ewers, 2003, p. 26). The model of perfect competition is characterized by a number of extreme conditions and assumptions (Hernberg, 1986, p. 299):

1. A very large number of small producers and consumers are acting in an atomistic market where no individual producer or consumer can influence prices. The supply is determined by the production cost function and the demand is determined by the utility function of consumers.
2. All goods and production factors can be divided into any small number without technological or other restrictions.
3. All consumers want to maximize their utility, whereas producers want to maximize their profits[33].
4. All goods are homogeneous and can therefore substitute one another.
5. The market is totally transparent and all participants receive complete and costless information about all goods and prices.
6. All costs of individual consumption or production are included in the transaction processes, i.e. there exist no technical externalities. All transactions are done voluntarily.
7. Changes in demand or supply of goods will immediately lead to new market equilibrium without delay.

[32] This concept was developed by and named after the Italian engineer and economist V. F. Pareto [1848-1923]

[33] It must be noted that profits of producers are zero in the model of perfect competition because at market equilibrium the market price equals marginal costs of production.

Similar to every model, the concept of perfect competition as the standard model for economic analysis has its limitations. It is, however, a suitable starting point for elaborating the principles of price determination from which further analysis can emanate (Makowski & Ostroy, 2001).

It is important to distinguish two aspects of social welfare: economic efficiency and the distribution of income. Economic efficiency is concerned with the allocation of goods and resources whereas the distribution of income deals with the way the goods and resources are distributed among individuals. A Pareto efficient allocation of resources does not necessarily require that the income is distributed more or less equally among market participants.

The desirable distribution of income depends on various normative preferences that are influenced by individual norms, beliefs and culture. In the context of this research, the effects of institutional arrangements for the MSWC infrastructure on the distribution of individual incomes play only a subordinated role[34]. It can be constituted that the waste management in general and especially the MSWC, is not a suitable object to influence the distribution of income among individuals within the society according to given normative targets. Rather the most efficient provision of the MSWC infrastructure should become the central focus of analysis.

4.1.2 The Problem of market failure

As explained in the previous chapter, perfect competition in the market would lead to a Pareto efficient allocation of goods and resources in the economy. In reality, however, the requirements for perfect competition are often not met or limited due to social and technological constraints. Deviation from the various conditions for perfect competition can lead to distortions of the market which fails to produce an efficient allocation of resources (Mankiw, 2004, p. 99).

Economic theory discusses mainly four phenomena of market failures (see e.g. Fritsch et al., 2003; Stiglitz, 2000). These are:

1. *Natural monopolies*: due to a subadditive production function and non-contestability, aggregate production costs are lowest if only one producer satisfies total market demand.
2. *Externalities*: not all costs or benefits of a transaction are borne by the contractual parties directly involved.
3. *Information failures*: producers and consumers do not possess equal or all necessary information about prices, utilities or relevant future developments.
4. *Inadequate market adaptation*: the market equilibrium of supply and demand either does not exist, is unstable or fails to adapt adequately to changes.

[34] This aspect will be taken up at the analysis of stakeholders. See chapter 5.5.

The following sub-chapters analyze the causes and implications of these deviations from the model of perfect competition and apply them to the MSWC infrastructure. Further, the discussion incorporates an identification of and elaboration on measures to solve the problems associated with each form of market failure. As it will be shown, these different forms of market failures are often interrelated and can be based on similar causes.

The so-called *public goods* are frequently added to the list of market failures, referring to goods for which the unregulated market fails to produce the optimum output, because consumers do not reveal their right preferences due to non-rivalry and non-excludability of consumption. As Fritsch et. al (2003, p. 354) elucidate, public goods are merely a special form of positive externalities and therefore do not need to be analyzed separately.

The phenomena of macroeconomic disturbances, such as unemployment, inflation and disequilibrium, that Stiglitz (2000, p. 85) also groups as a form of market failure is not discussed here, because they are concerned only with macroeconomic issues that have little relevance to physical infrastructure provision of the MSWC.

The analysis of market failures is an appropriate tool to identify the normative functions and limitations of the state in the economy (Mühlenkamp, 2002). Many fundamentals are based on microeconomic theory.

4.1.3 Constraints of market failure concept

There exists also some criticism against the theory of market failure and its suitability as an economic model for analysis. One rejection is derived from the claim that different forms of market failures are ubiquitous and that the theory of market failure itself is merely a failure of the theoretical model of perfect competition. Even though this argument is very strong, it must be admitted that the methodological strength and logical persuasiveness of starting with Pareto optimality under conditions of perfect competition and elaborating on the deviations as well as their impacts, is very powerful. So far, no serious alternatives have evolved and therefore the application of the market failure concept as one tool for economic analysis is justified[35].

There exist two more causes of serious reasons concern while applying the concept of market failure. The first one was presented e.g. by Zerbe & McCurdy (1999) who argue that the conceptual shortcoming of the market failure theory is the negligence of the transaction

[35] One complementary school of theory is New Institutional Economics, whose roots are derived from microeconomic analysis. This theory, especially transaction cost economics, will be dealt with in the next chapter.

costs, which they identify as the major reason for imperfect competition[36]. It is argued that technical externalities, natural monopolies and information asymmetries are several types of externalities that reflect monetary effects not taken into the account by market participants as part of the production functions or utility functions. The reason is that in these cases the net value of externalities might be lower than the transaction costs associated with their inclusion into the decision making process.

The second criticism to the market failure concept is not related to its analytical approach itself, but rather to the conclusions and implications drawn from it. As criticized for instance by Nelson (1987), many economists and especially policy makers use the occurrence of market failures automatically as a justification for governmental intervention. However, as explained by Mühlenkamp (2002), further conditions, in addition to the existence of a market failure, must be fulfilled for right actions of the government or the public sector to improve economic efficiency. First, the public sector must possess suitable means or instruments to overcome the particular problem of market failure and second, it must also be willing to implement these instruments. These conditions, however, are again related to the transaction cost problem, because from an economic point of view, interventions from the public sector only lead to a Pareto optimum if all transaction costs associated with the interventions are lower than the benefits of improved allocation of goods.

Both these constraints of the market failure concept, i.e. the transaction cost problem and the following limitations of government intervention to overcome the negative impacts of market failures must be taken very seriously. Therefore, both of them are incorporated into the theoretical framework for institutional arrangements in chapter 5.

4.2 Natural monopolies

4.2.1 Characteristics of natural monopolies

The model of perfect competition assumes that all goods and production factors can be divided into any small number. Technical restrictions, however, often constrain this assumption and in extreme situations, goods or production functions might not be dividable at all[37]. As a result of such indivisibilities the so-called natural monopoly might develop, which means that a single producer is able to produce at the lowest costs (Fritsch et al., 2003, p. 179).

Baumol (1977) was the first to elaborate that a strict and global subadditivity of the production cost function is the only and sufficient requirement for the development of a natural mo-

[36] A very simplified definition describes transaction costs as the recourses required for exchanging goods. A more detailed definition and discussion of transaction costs is given in chapter 5.3.

[37] Examples can be found in network industries, such as gas pipelines, telecom networks, etc.

nopoly. Defined in a formal mathematical way, the cost function C(y) is subadditive if for any output vector $y^1,\dots,y^m$ there is

$C(y^1+\dots+y^m) < C(y^1) + C(y^2) + \dots + C(y^m)$.

In other words, subadditivity exists if the aggregated costs for the separated production of goods are higher than the costs of production of all goods by a single producer. This definition for subadditivity of production costs is identical to the definition of natural monopolies.

Decreasing average costs or economies of scale[38], that many studies on microeconomic theory (Stiglitz, 2000, p. 191; Varian, 1996, pp. 416-421) present as sufficient reasons for the occurrence of natural monopolies are implied in the concept of subadditivity. Both are sufficient, but not required for subadditivity. The following Figure 4-1 illustrates the deficiency problem in natural monopolies with monotonic decreasing of average production costs:

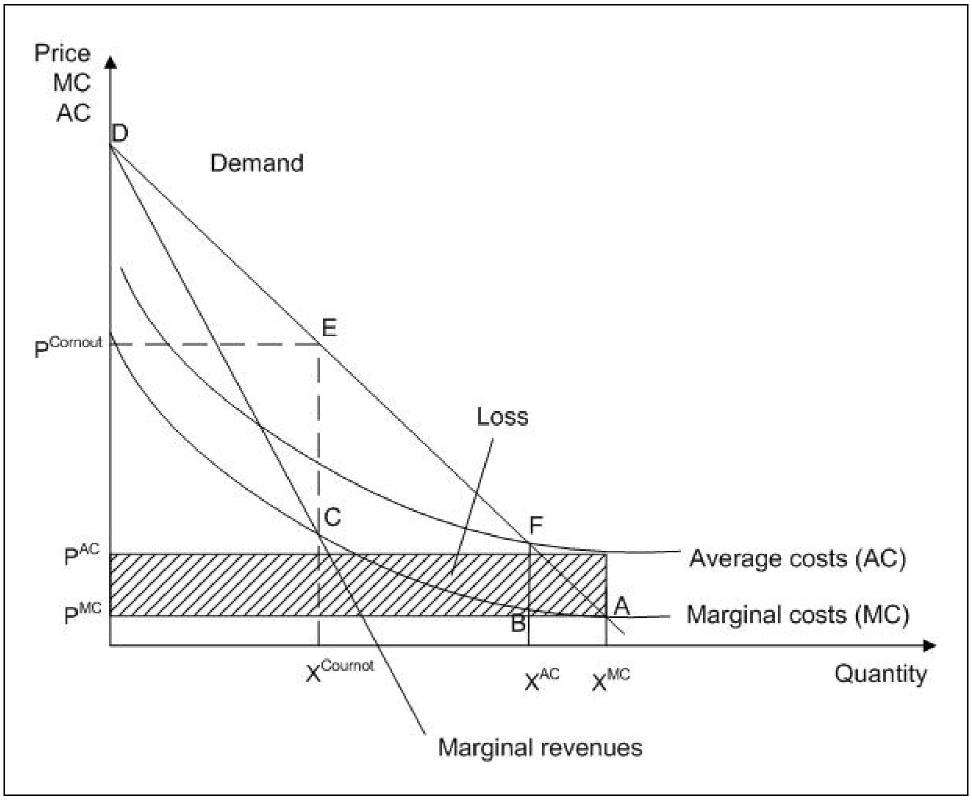

Figure 4-1: Deficiency problem with decreasing average costs

Source: (Fritsch et al., 2003, pp. 192-195)

The development of a natural monopoly implies the deviation from another assumption of the perfect competition model of an atomistic market structure. Because now only one producer

[38] According to Baumol (1977) *decreasing average costs* occur if: $C(vy_1,\dots,vy_n)/v < C(wy_1,\dots,wy_m)/w$ with v>w and for a given output vector: $y_1+ \dots +y_n$

Economies of scale are present for any input-output vector $(x_1,\dots,x_r;y_1,\dots,y_n)$ where there exits another input-output vector with $(wx_1,\dots,wx_r;v_1y_1,\dots,v_ny_n)$ with w>1 and all $v_i \geq w + \delta$, $\delta > 0$

satisfies the demand of a large number of consumers, it is not a price-taker anymore, it can influence the prices itself.

In the model of perfect competition, the goods are offered and produced at the price of marginal costs. In a natural monopoly, however, such a condition would cause a deficit because marginal costs are always below the average costs (see hatched area in Figure 4-1). To prevent such losses, a natural monopolist could easily increase prices from marginal costs (P^{MC}) to average costs (P^{AC}), where he would make no profit or losses[39].

However, a natural monopolist, like every other monopolist, would be motivated to increase the prices even further to the profit maximizing Cournot-price where marginal revenues equal marginal costs (Cournot, 1938). From a welfare economic point of view, this situation is not optimal, because a welfare loss with the value of the amount EAC exists (Figure 4-1, Fritsch et al., 2003, p. 195).

Another negative effect of the production in a natural monopoly is an increased and long-term survival of the so-called X-inefficiencies[40]. According to Leibenstein (1966) such X-inefficiencies are the result of non-minimization of production costs and exist with different peculiarities in most industries and markets. In natural monopolies these X-inefficiencies can survive, whereas in competitive markets producers with higher X-inefficiencies would be pushed out by competitors in the long run.

A further disadvantage associated with the lack of competition in natural monopolies is that there exists limited motivation for product or service improvements. There are still incentives to develop innovations that increase profits due to lower production costs, but they are not as essential for survival as they are in competitive markets (Posner, 1969).

4.2.2 Measures for natural monopolies

As explained earlier, natural monopolies can result in a welfare loss if the producer is able to set prices above average costs. But whether a monopolist is really able to enforce such prices depends on the contestability of the market. The model of contestable markets was developed by Baumol, Panzer & Willig (1982) who elaborated that the irreversible part of the market entry costs that are lost when exiting the same market, are decisive for the price setting power of a monopolist. These irreversible costs are called *sunk costs* and must not be mixed up with fixed costs, because often the assets that are part of fixed costs can be sold at market exit[41].

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[39] It is important to remember that in microeconomics, return on equity is part of the production costs.

[40] The model of X-efficiencies or X-inefficiencies is concerned with production costs within a firm and must not be mixed up with the concept of efficient allocating of good and resource within a market.

[41] See also asset specificity later in chapter 5.3.2.1.

In a perfectly contestable market there are no cost discriminations against new entrants and any profit earned by the incumbent would motivate a competitor to enter the market. The phenomenon is also transferable to perfectly contestable natural monopolies: in a contestable natural monopoly there would not exist any economic profits nor any X-inefficiencies in production, and the price for the goods would equal average costs.

In reality, however, markets are often not fully contestable and market barriers exist for new entrants. These market barriers depend largely not only on sunk costs but also on access to suppliers and resources, availability of technology and knowledge (Baumol, Panzar, & Willig, 1988, p. 290; Fritsch et al., 2003, p. 204).

The question whether to intervene exogenously into a natural market to prevent monopoly price settings as well as the creation and survival of X-inefficiencies therefore strongly depends on the contestability of the market. As a general conclusion, it can be claimed that an exogenous intervention into the market should only be considered if both subadditivity and high sunk costs exist together.

There exist different measures to overcome or reduce the explained problems associated with natural monopolies. If it is impossible to reduce the subadditivity of production costs or to increase the contestability of market, the most promising measures will be (Fritsch et al., 2003):

1. Price regulation,
2. Timely limited auctioning of monopoly, and
3. Public monopoly production.

Examples of price regulation include direct price setting, rate of return regulation or price-cap regulation. It might also be possible to oblige the natural monopolist to set prices at marginal costs and pay subsidies for compensating losses (Stiglitz, 2000, p. 195). A major problem for effective price regulation is the lack of information about the production costs of the monopolies. Whether it is possible to get access to correct information decides upon the success of such measures (Fritsch et al., 2003, pp. 227-239).

Granting the monopoly for a limited period of time to a private firm in an auction is also often suggested for regulation of natural monopolies. In these so-called monopoly franchises, a competition among private companies is implemented and the right to produce the monopoly goods is granted to the bidder with the highest price (Riordan & Sappington, 1987). The duration of the franchise should be aligned with the required sunk costs to ensure their payback.

In addition to a regulated or timely limited private monopoly, Mühlenkamp (2002) also elaborated the possibility of a public company producing the monopoly goods. The public company would then be obliged to offer the goods at a price equal to average production costs without making profit. A major disadvantage of public monopoly production might be that public companies tend to have higher production costs in comparison to private companies. Stiglitz (2000, pp. 200-202) explains that lower incentives and higher restrictions at individual and organizational levels are the causes for such X-inefficiencies in public companies, even though many exceptions do exist.

A comparison of price setting in an unregulated private monopoly in the Cournot-point with the price settings in a public monopoly at average costs is exemplified in the following Figure 4-2. If a public producer made no profits, he would offer more goods for a lower price, although his average production costs were higher than that of a private monopolist. In reality however, it is questionable whether public companies also would not have incentives to abuse their monopolistic power to gain profits, which in turn could be used for cross-subsidizing other loss making public services and infrastructure (e.g. public transportation).

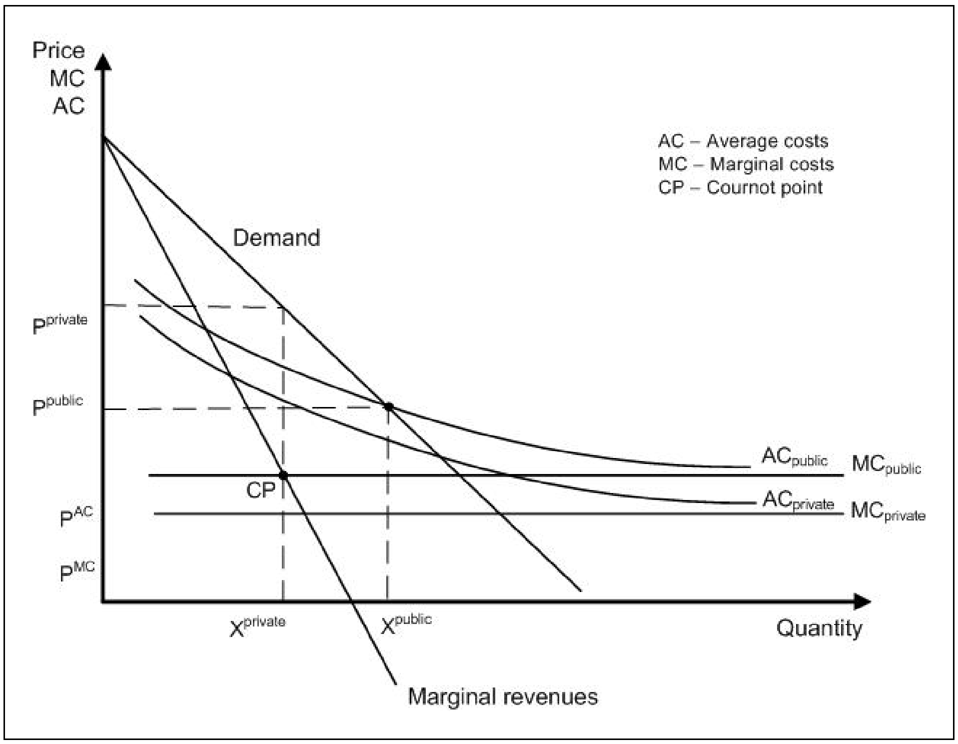

Figure 4-2: Pricing in unregulated private monopoly and profit-free public monopoly
Source: (after Mühlenkamp, 2002)

Mühlenkamp (2002) concludes that from a welfare perspective, both a regulated private monopoly and the public monopoly are better choices than an unregulated private monopoly. However, neither option has a decisive advantage over others to overcome the explained problems.

Another important aspect to reduce welfare losses is to prevent the monopolist abusing his market power onto upstream or downstream activities that are in direct connection to the product, for which cost subadditivity and market barriers exist. The monopolist could extend his power either by (i) setting of predatory prices in the up- or downstream markets that are subsidized by the monopolies' profit or by (ii) exacerbating the access for up- or downstream competitors to the monopoly goods, the so-called essential facility (Bolton, Brodley, & Riordan, 2000; Eckert, 2002; Gómez-Ibáñez, 2006). On the other hand, such bundling of the essential facility with connected markets could also create synergies that reduce production costs. The extent to which a monopolist can abuse his power, depends strongly on the contestability of the up- and downstream markets.

Some economists, particularly the representatives of the 'Chicago School', express strong criticism against regulatory measures for natural monopolies. They argue that regulation often lacks the necessary information, that it is ill-directed through influential interest groups, and that it reduces incentives for efficient production. Regulatory failures that overweight the effects of the addressed market failures might be the result and could altogether cause more damage than good (Demsetz, 1968; Gaube, 2006; Ross, 2004).

4.2.3 Application to the MSWC

To identify the existence of natural monopolies in the MSWC infrastructure, it is necessary to look first at specific production functions of the MSWC plants. Based on empirical data it is shown in chapter 3.4, that the production functions of the MSWC plants are subadditive. Major reasons are the decreasing investment costs per capacity that show discontinuity only at the point where a new firing unit is added to a plant. Therefore, the production function has no continuously decreasing average costs or decreasing marginal costs, but global subadditivity that is a sufficient evidence for the existence of a natural monopoly. To simplify further analysis, monotonously decreasing costs are assumed.

Up to this point, only the internal production costs for the MSWC were considered without looking at all the costs that are part of the waste management value system (see chapter 2.3). The inclusion of all these costs, however, is necessary in order to figure out whether the natural monopoly encroaches in connection with the MSWC.

The major cost elements (activities) of the value system that are not included in the internal production functions of the MSWC are the costs for (i) waste collection; (ii) waste transfer; (iii) waste transportation; (iv) residual disposal (see chapter 2.3 and 3.4). Thereof, the waste transportation costs are the most significant[42]. The costs for waste collection and combustion residual disposal (incl. combustion residual transportation) can be assumed as constant and therefore do not have a direct impact on the subadditivity of the local natural monopoly of an

[42] Among theorists it remains disputed whether transportation costs are part of production (transformation) cost or whether they should be treated as transaction costs (Blum, Dudley, Leibbrand, & Weiske, 2005, p. 57).

MSWC plant. These assumptions are realistic because waste collection costs depend largely on the density of waste generation and not on the distance between waste generation source and the MSWC plant. Therefore, only waste transportation costs per unit increase with total treatment quantity (i.e. used capacity of MSWC plant), because the collected waste has to be transported within an increased catchment area.

The waste transportation costs mainly depend on the distance between waste generation and the MSWC plant as well as on the unit costs that are different for specific transportation modes, such as roads, railways or inland waterways. The usage of waste transfer stations and optimization of logistic systems can effectively reduce waste transportation costs. Nowadays, most of the waste is transported by trucks to the MSWC plants (see chapter 2.3.3).

The share of transportation costs in relation to total costs grows monotonously with increasing distance from the waste generation source to the location of the MSWC plants. The following Figure 4-3 shows how total costs are affected in case of high transportation costs:

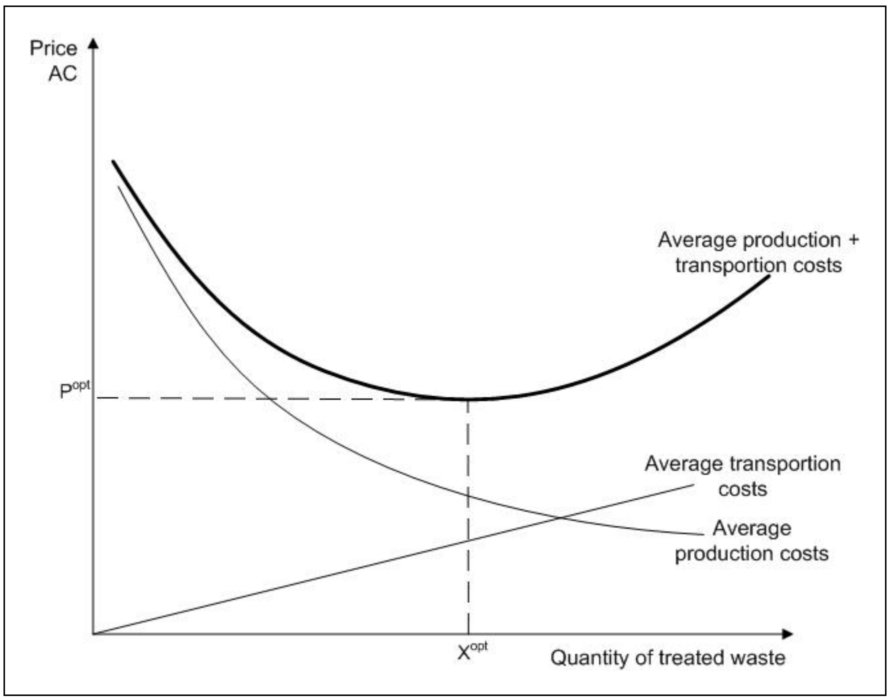

Figure 4-3: Local natural monopoly for the MSWC with high transportation costs
Source: own

It obvious that starting from point X^{opt}, the marginal transportation costs exceed the subadditive effects of waste combustion costs and that the sum of costs for transportation and combustion starts to increase again. The result is a local natural monopoly, the size of which is not only dependent on the production costs of the MSWC but also on the cost function of the waste transportation to the MSWC plant. In cases of high transportation costs the geographic location of the MSWC plant will thus become increasingly important[43]. Because the transportation costs are expected to rise in the future (mainly due to higher fuel prices and toll fees), their impact on the total cost function will gain importance[44].

In reality, the MSWC plants are often located relatively close to one another. As shown in the following Figure 4-4 for the MSWC plant in Zorbau (see also case study in chapter 6.3.8) an intensive competition among facilities is likely to take place because of its geographical vicinity to multiple plants.

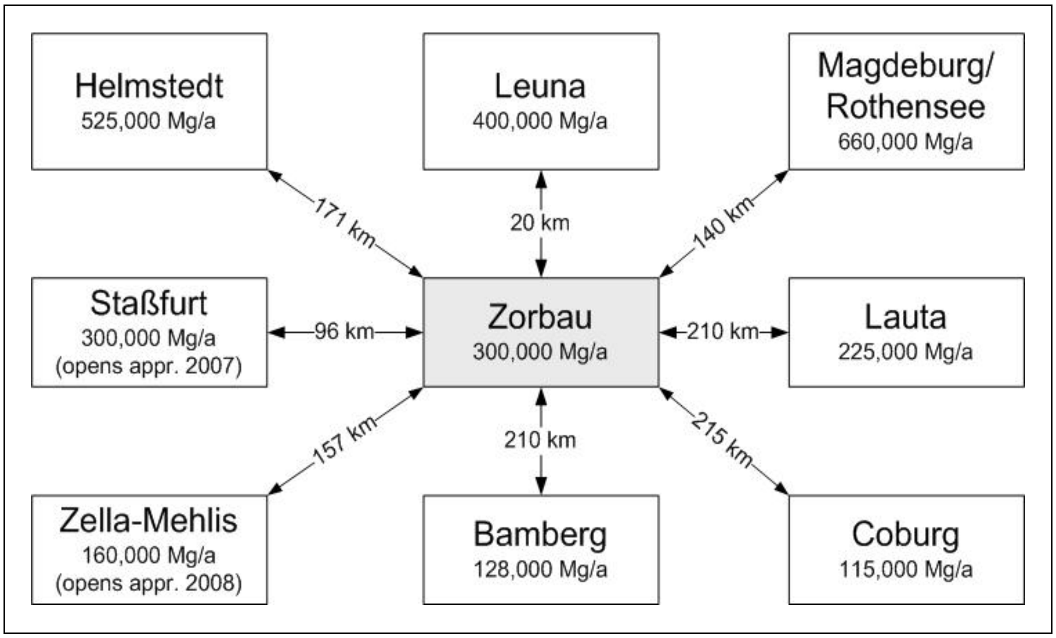

Figure 4-4: Nearest competitors to the MSWC plant Zorbau
Source: own, distances from http://maps.google.de

Depending on local circumstances, most importantly, the population density and available transportation infrastructure to the MSWC plant, the size of a local natural monopoly can still be very large. In extreme cases (such as large and densely populated areas), the transportation costs do not lead to suppression of subadditivity in the total cost function. As shown in the following Figure 4-5, in such cases the economies of scale can be exploited over the entire cost function and a natural monopoly exists without spatial limitations. The result is an extended natural monopoly. However, technical restrictions limited the maximum size of

[43] Spatial competition and the economics of location are a separate field of research and are analyzed in more depth as part of the industrial economics (Blum et al., 2005, pp. 99-138; Tirole, 2003, pp. 279-287)

[44] The calculation of transportation costs and their impact on determining optimum size of the MSWC plant can be found for a simple hypothetical case study in Höhr (1988).

MSWC plants (see chapter 3.2) and therefore also an extended natural monopoly has a maximum technical size.

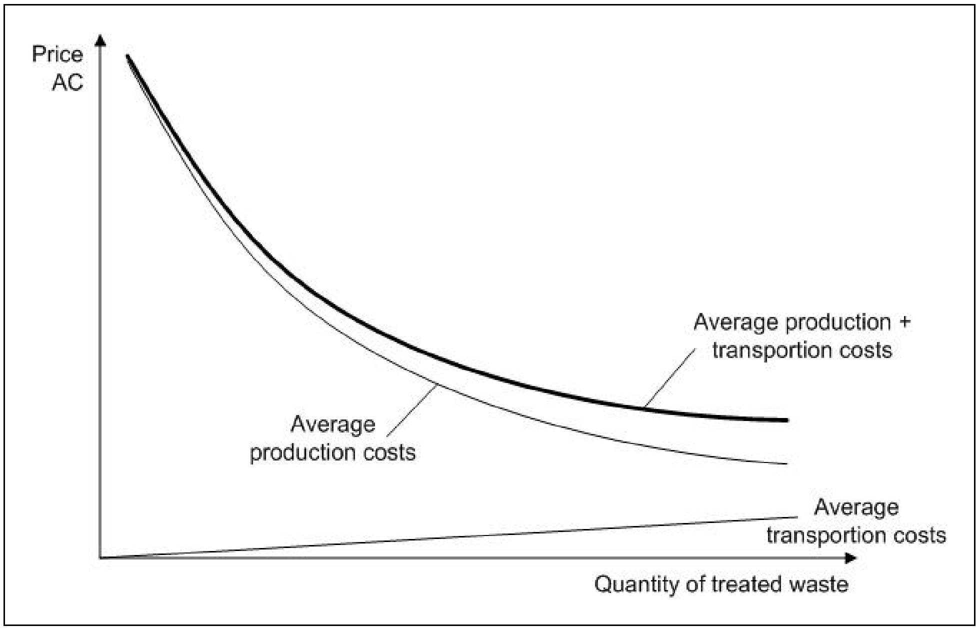

Figure 4-5: Extended natural monopoly for the MSWC with low transportation costs
Source: own

In both cases of a local or an extended natural monopoly, the attention must now be drawn to the contestability of the MSWC market to analyze whether a monopolist is able to abuse his potential market power.

In larger metropolitan areas (e.g. megacities with more than five to ten million inhabitants), technical restrictions limit exploitations of economies of scale in a single MSWC plant (see chapter 3.2). Here, several MSWC plants would be required to meet the demand for thermal waste treatment and they are often built at diverse places to further reduce transportation costs and to have separated access points to district heating systems. If MSWC were owned by different parties, they could compete with one another and therefore monopoly pricing would be impossible. If these MSWC plants were owned by one company, the described regulative measures might be required.

Apart from any legal restrictions[45], the most important market entry barriers that limit the contestability of a natural monopoly are high sunk costs. As shown in chapter 3.4.2, the development and construction of the MSWC plants require large capital investments and it is very difficult to use all the assets or a share of it in another market (e.g. coal firing power plant). Also the costs for planning and obtaining the required permission form a large share of sunk

[45] Possible justifications of legal restrictions are elaborated in the next chapter.

costs. Therefore, it has to be constituted that a large portion of the investments are sunk in case a firm wants to leave the market for MSWC.

The classification of the MSWC including transportation costs in relation to sunk cost and subadditivity is shown in the following Figure 4-6:

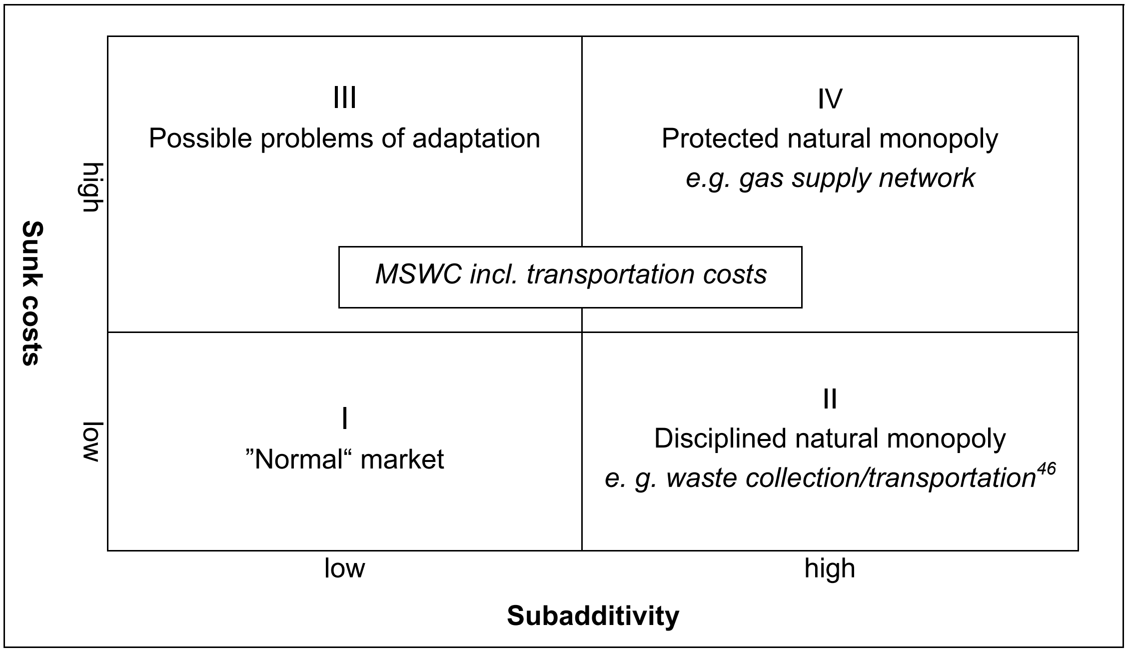

Figure 4-6: Sunk costs and subadditivity in the municipal waste management sector
Source: (after Fritsch et al., 2003)

As a result of the analysis, it can be constituted that the MSWC infrastructure has the characteristics of a natural monopoly with a limited geographic extension depending on transportation cost characteristics as well as with a limited contestability due to high sunk costs. Whether regulative measures might be required to prevent Cournot pricing cannot be disputed and depends on the described local circumstances. Any regulative measures must take into account the spatial extension of the local natural monopoly and also local modes of transportation. Furthermore, they should be implemented very carefully to ensure that negative impacts of regulation do not offset the anticipated welfare gains.

Additionally, it must also be noted that Cournot pricing is usually limited in the MSWC market due to existing demand aggregation. In municipal waste management, the public sector ag-

[46] The sunk costs for waste collection services are comparatively low. If a waste collector wants or needs to exit a (local) market, it can easily transfer most of the assets, i.e. the waste transportation vehicles, to another market or sell the vehicles within a functioning second-hand market (Saboe, 2007).

gregates the demand of households and commerce (partly) and has therefore bargaining power in price negotiation.

Wherever a natural monopoly for the MSWC exists, the effects of extending the monopolists' activities on other markets must be thoroughly analyzed. Possible exploitation of market power has to be thoroughly analyzed if vertical integration exists between waste collection and MSWC. Such a combined ownership to bundle up activities is not necessarily undesirable as it can create synergies and lead to cost reduction. Yet, it is important to guarantee that rivaling waste collection companies will not be discriminated in their access to the MSWC plants (e.g. Bundeskartellamt, 2006; Monopolkommission, 2003).

4.3 Externalities

According to Kolstadt (2000, p. 91) an externality *"exists when the consumption or production choices of one person or firm enters the utility or production function of another entity without that entity's permission or compensation*".

For the case, that the utility function of a household U_h is directly influenced by the external production function of the producer y the utility function takes the following form:

$$U_h = U_h(x,y),$$

with consumption $x = [x^1,\ldots,x^i]$ and production $y = [y^1,\ldots,y^i]$.

Depending on the impact of the externality, positive and negative externalities are distinguished. In case of positive externalities, one market participant benefits without costs from the action of the other, whereas in case of negative externalities, the action of one market participant imposes costs to the other.

There exist three forms of externalities (Fritsch et al., 2003, p. 89):

1. Technological externalities,
2. Pecuniary externalities, and
3. Psychological externalities.

Only technological externalities can lead to a non-Pareto optimal market equilibrium of supply and demand. Due to their high relevance to the object of this research, the occurrence and effects of technological externalities on MSWC and applicable policy instruments are discussed in detail. Afterwards, pecuniary and psychological externalities are briefly presented.

4.3.1 Technological externalities

Technological externalities exist if there is a direct physical linkage between the consumption, production or utility functions of the market participants that does not reflect all market transactions. As a result, the aggregated private costs/utilities of the consumer or producer deviate from the total social costs/utilities. The difference between the two is regarded as additional social cost/utility (Fritsch et al., 2003, pp. 90-91).

The problems of technological externalities and their implications have long been a central focus of theoretical and empirical analysis in the fields of environmental economics and environmental policy development (see e.g. Endres, 1994; Kolstad, 2000; Wiesmeth, 2003). As shown in chapter 3.3, the MSWC plants have potential impacts on the environment that cause negative as well as positive technological externalities. The following table provides examples for externalities from the MSWC on other consumers and producers.

Form of externality	**Example for MSWC infrastructure**
Negative MSWC/Consumer	The construction of an MSWC plant reduces property values in the neighborhood, because it spoils the previously nice views from gardens.
Positive MSWC/Consumer	AN MSWC plant generates electricity with lower green house gas emissions than electricity generation from fossil fuels. The price for sale of electricity is the same.
Negative MSWC/Producer	The flue-gas of an MSWC plant with a simple flue-gas treatment system increases the emission of particulate matter. A plant for waver production in its vicinity needs to install additional filters for their cleanrooms.
Positive MSWC/Producer	The manufacturer of MSWC plants invests into R&D for the development of a new method to reduce flue-gas emissions. The same innovation is copied free of charge by manufacturers of coal firing plants.

Table 4-1: Examples for externalities at MSWC plants

As proven for example by Myles (1995, pp. 315-317), externalities can lead to a non Pareto optimal equilibrium of the market, as incorrect quantities of goods will be produced and consumed. Because welfare will not be maximized under these conditions, the implementations of economic policies could be justified. The following Figure 4-7 shows that the quantity of produced goods with negative external effects at market equilibrium (X^M) would be higher than the efficient quantity level (X^E) that includes the social costs.

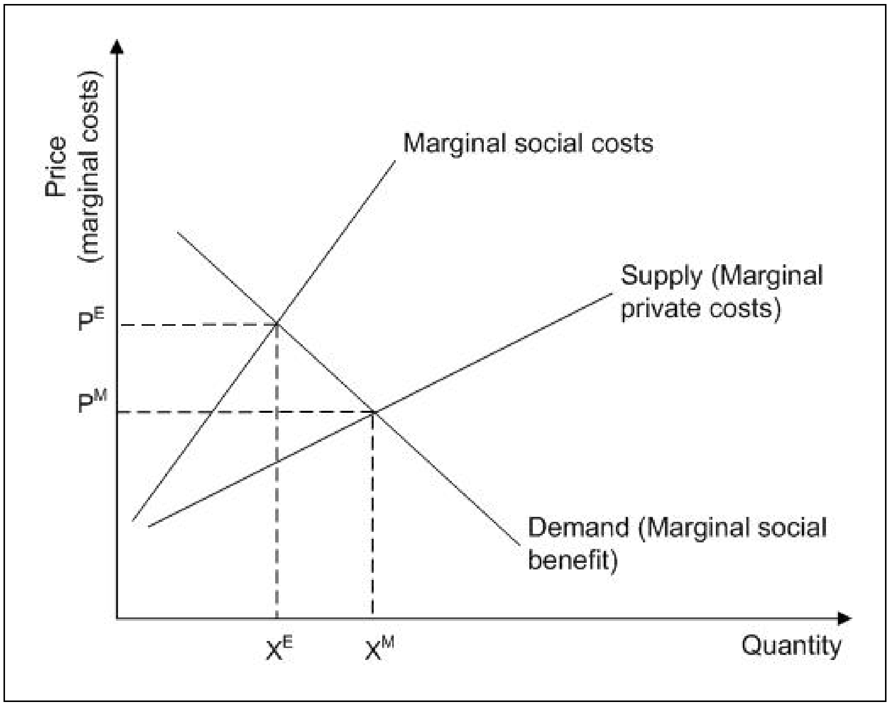

Figure 4-7: Effects of negative technological externalities

Source: after Stiglitz (2000, p. 216)

The problem of technologic0al externalities is closely related to the problem of property rights. Where property rights for goods are not sufficiently defined (or are impossible to define) it is possible for a producer or consumer to use or benefit from those goods without paying adequate compensation (Baumol & Oates, 1988, pp. 26-28).

4.3.2 Measures for technological externalities

The objective of economic policy making is to reduce the undesired effects of technological externalities by internalizing them into the production, consumption or utility functions of the market participants. The following sections provide an overview of available measures, followed by an elaboration of their applicability to the research object MSWC

4.3.2.1 Education and ethical appeal

Politicians often believe that educating people by increasing their awareness for the consequences of their consumption and by appealing to the ethical standards of the producers result in the reduction of negative externalities. Motivating voluntary internalization of negative externalities through education and ethical appeals could also be interpreted as increasing positive psychological externalities (see chapter 4.3.5). The costs associated with the reduction of the negative externality would be offset by its psychological benefit.

According to Fritsch et al. (2003, p. 111) the potential to overcome market failure problems due to technological externalities is very limited, especially in case where the costs for reducing the externality has to be paid by only a small group while the number of beneficiaries is much larger.

4.3.2.2 Taxes and subsidies

An attempt to reduce the effects of negative externalities is to impose taxes and fees. Uniform taxes that are levied based on the level of externalities are named Pigouvian taxes, after the influential work of Pigou (1932). As shown in the following Figure 4-8, the height of taxes would be optimal if they leveraged the difference between marginal private costs and marginal social costs.

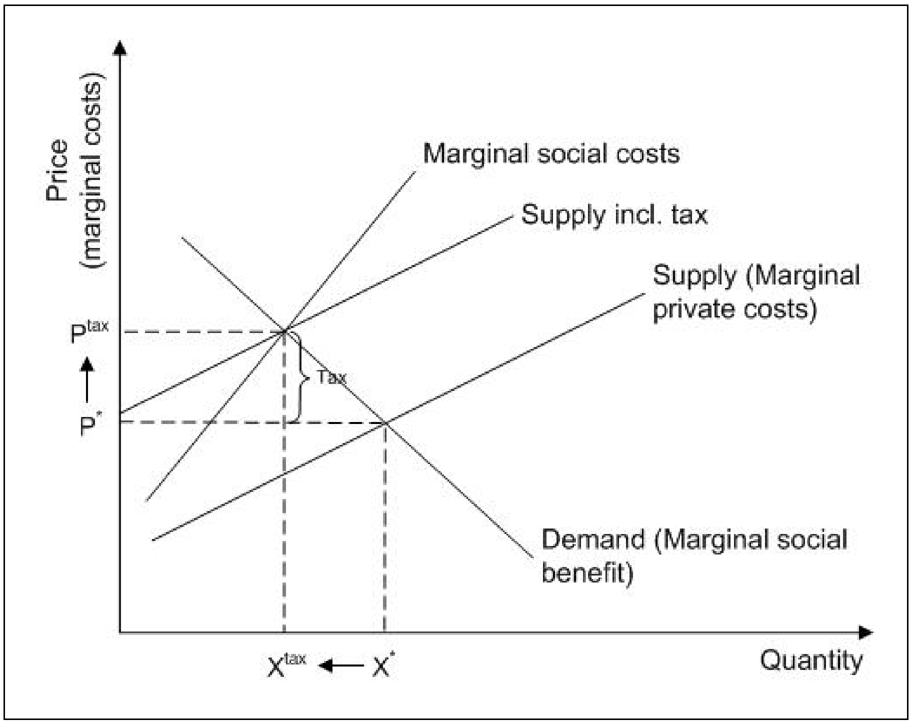

Figure 4-8: Pigou Tax
Source: after Endres (1994, p. 94)

An accurately calculated tax would therefore represent the external costs associated with the production of the goods and correct level of production and consumption. To collect all necessary data and information to determine the optimal level of tax is very difficult in practice and every solution is most likely an approximation of the Pareto-optimum (Baumol & Oates, 1971).

The Pigouvian tax would only overcome the market failure problem associated with negative technological externalities if it not only led to a reduction of the produced goods but the collected tax also compensated for the cost of the externality. In reality, the payment of tax revenues to the parties that suffer from the negative externality might not be very realistic, because it is either very difficult to identify the claimant or the government uses the tax for other purposes.

Another problem with the Pigouvian tax is the requirement that the tax should to be adjusted to changing levels of externality. In case the negative technological externality is eliminated, the tax should be abolished as well. In reality however, the government might have little incentives to do so[47].

The Pigouvian solution for internalization would also be applicable for positive technological externalities. In such cases, subsidies (which are nothing else than negative taxes) are paid to the producer of the positive externality to compensate for market prices that do not reflect all benefits. The problem with such subsidies is that the money must first be collected from the beneficiaries and the prices do not reveal the true costs for the goods anymore (Kolstad, 2000, p. 128).

4.3.2.3 Coase theorem

In a market economy, it should be the central focus of policy development to find market based solutions for problems associated with technological externalities. The most prominent approach in this context was proposed by Coase (1960) who argued that the allocation of property rights and their trading with the market participants would eventually internalize technological externalities. The so-called Coase-theorem implies that it is irrelevant to the externality equilibrium to whom the property rights are assigned. In theory, the negotiation of property rights is a very efficient way to internalize externalities and would provide incentives for right technology application. The model is based on a number of assumptions, such as, no information failure, no transaction costs, free contract rights and equal utility functions for all participants

The chief problem of the Coase theorem is the correct allocation of property rights. In many cases, for example, unpolluted air, it is technically impossible or too expensive to allocate the property rights. It is therefore debatable whether the Coase theorem is a solution at all for the problem of externalities, because the non-existence or high transaction costs for property right allocation are often the causal reason for the technical externality (see chapter 4.3.1).

Based on the problems to correctly allocate property rights and the various unrealistic assumptions of the model, the application of the Coase theorem to overcome problems with externalities in a real world is very limited and has found little application in history so far (Fritsch et al., 2003).

[47] It is very rare that governments abolish any taxes. A prominent example is the introduction of a tax on Champagne in Germany by the emperor Wilhelm II the year 1902 to finance the building up of the navy. Even today the tax is still paid, although its original purpose has vanished a long ago.

Yet, the ideas of the Coase theorem are still very valuable. In case of existing externalities, it should be examined whether property rights could be allocated or whether other policies cause the non-allocation of property rights.

4.3.2.4 Tradable permits

Another market based solution to internalize externalities originates from the creation of tradable permits. The principal ideas are derived from the elements of the Coase theorem to trade property rights for negative externalities. But instead of exchanging the rights between the parties that produce the externality and are affected by them, here the government defines the total amount of externalities. The permits (property rights) are then allocated or sold to the producers who can use them themselves or trade them in the market. If the marginal costs for reducing the negative externality are lower than the market price for the permits, the producer will be willing to reduce the externality.

To prevent punishment for producers with less negative externalities, the initial allocation of tradable permits should be based on the level of production and not on the initial amount of externality (Stiglitz, 2000, pp. 229-230).

Tradable permits are well suited for limiting the total amount of negative externalities. They also induce the development and application of more cost-effective technology with less externalities (Fritsch et al., 2003, p. 139). However, similarly to Pigouvian taxes, the concept of tradable permits usually does not compensate the party that still pays a price for the negative externality (whose amount is now only limited).

4.3.2.5 Command-and-control

In practice, legal obligations are the most common form of regulating negative technological externalities. These legal obligations are referred to as command-and-control (CAC) and could be either (i) technology restrictions or (ii) emission restrictions. Under *technology restrictions* the individual polluters must take legally specified physical steps to reduce or solve the causes of negative externalities (Kolstad, 2000, p. 139). Such a regulation requires a very costly collection of information about various industries and production processes.

The second option of *emission restriction* either forbids or sets standards for different forms of externalities with which the producers have to comply. Such standards could (i) limit the total amount of permissible externalities in a certain period of time, (ii) limit the externality per output unit or (iii) limit the externality per input unit (Helfand, 1981). In contrast to technology restrictions, such standards do not define the technology that has to be applied by the producer and therefore leaves more freedom for innovations.

Both types of CAC should be combined with appropriate fines and penalties in case of non-compliance, which rely on the enforcement in a strong and non-corruptive regulatory regime.

Such fines are different from Pigouvian taxes, because they should be much higher than the marginal social costs of the produced negative externality.

The greatest advantage of CAC measures is their high certainty in how much of the negative externality will be generated. Therefore they are very well suited for reducing negative externalities where a monetary evaluation of an externality as a starting point for a market based abatement is very difficult or impossible. From a technical point of view, the enforcement of CAC can easily be monitored. The total transaction costs for reducing the negative externality are comparatively low in contrast to market based incentives where numerous producers and consumers are involved (Kolstad, 2000, p. 141).

A major disadvantage of CAC is that they do not ensure equal marginal costs for reducing the negative externality among different producers. In contrast to the Coase theorem or tradable permissions, the legal obligations do not ensure the abatement of negative technological externalities at the lowest costs.

4.3.2.6 Liability for damages

The principal idea of liabilities is that the generator (either consumer or producer) is legally responsible for the effects of negative technological externalities caused by his actions. It means that the party that is harmed through the externality should be compensated for the damage.

There exist two basic forms of liability: (i) strict liability and (ii) negligence rule. Under the system of *strict liability*, the producer is liable for all negative externalities regardless of any precautionary measures implemented. He, therefore, has to pay for all internal abatements to reduce the external costs as well as for the external costs that he has not internalized. As shown in the following Figure 4-9, the producer would then set the level of precaution where the costs of precaution and the expected damage are at their minimum (C^*). Under the system of *negligence rule*, however, the producer will only be liable for the negative externality if he has not complied with a defined standard (which should be equal to C^*). Instead of paying fines for not meeting defined standards, the producer will have to pay for actual external costs he has caused (see e.g. Bohm & Russell, 1985; Endres, 1994, pp. 55-89).

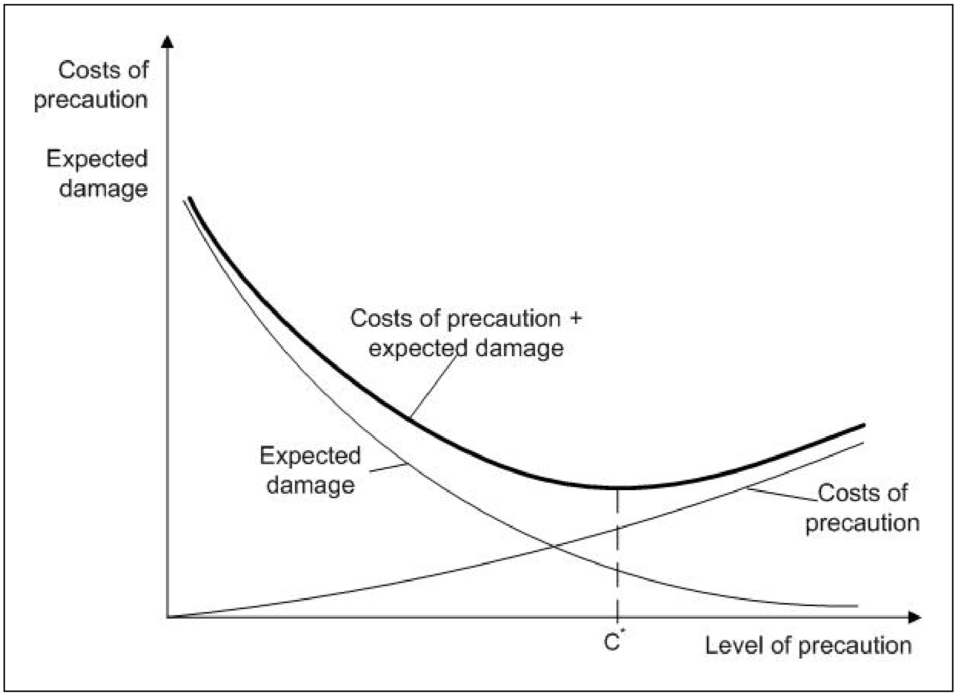

Figure 4-9: Optimum level of precaution

Source: after Endres (1994, p. 65)

In practice, however, the appropriateness of legal liabilities to provide correct incentives for internalizing externalities is limited. The first constraint is the difficulty to measure and legally prove the external costs that are often monitored long after their production. Another reason is that the negative technological externalities can be larger than producers' wealth and bankruptcy would then limit the volume of compensation (Larson, 1996). The mitigation of liability costs to insurances might not necessarily lead to an optimum level of precaution (C^*) due to problems of moral hazard and asymmetric distribution of information (Zweifel & Tyran, 1994).

4.3.2.7 Public provision

A measure to reduce allocative inefficiencies caused by positive or negative technological externalities is often seen in the public sector providing the goods. The proponents argue that public provision is suitable for goods where nobody can be excluded from consumption. Such non-excludability is prevailing for goods from the consumption of which nobody can be excluded due to technical restrictions or too high transaction costs (Fritsch et al., 2003, p. 113). In these cases, the elaborated market based solutions for internalizing externalities, i.e. Coase theorem, tradable permits and liability, are not applicable, because they require the assignment of property rights.

Where consumers cannot be excluded, the government could provide the right amount of the good and internalize the positive or negative costs of the technological externality. Such a measure obviously requires the government to aim at maximizing the welfare and possessing sufficient information about the market, especially about the utilities of consumers.

4.3.3 Application to MSWC

The previous chapter presented a number of policy instruments that are available to address the effects of technological externalities. In theory and practice, there exists a widespread discourse about the appropriateness of these instruments and the degree to which positive and negative externalities are to be eliminated.

The following Table 4-2 lists the presented policy instruments and indicates their applicability in cases of positive and negative externalities:

Measure/ Policy instrument	Applicability to externality	
	Positive	Negative
1. Education and ethical appeal	(X)	X
2. Taxes		X
3. Subsidies	X	
4. Coase theorem	X	X
5. Tradable permits		X
6. Command and control	(X)	X
7. Liability for damages		X
8. Public provision	X	X

Table 4-2: Measures for negative and positive technological externalities

As shown in chapter 3.3, the treatment of waste in the MSWC plants causes positive as well as negative externalities. Even though *education and ethical appeal* are important measures to reduce the waste generation rates and increase recycling rates (e.g. school public programs), they can be considered as rather ineffective means for the voluntary internalization of the MSWC's externalities. While producers of commodities might gain a competitive advantage from better than the required environmental performance (Reinhardt, 1999), the developers and operators of the MSWC plants are most unlikely to be able to benefit from such a strategy on a local level. The power of business ethics, however, should not be underestimated on a global scale. Especially multinational waste management or utility companies show little willingness to own and operate the MSWC plants with high negative externalities in their portfolio due to their social corporate responsibility codex and the potential pressure from the international media and NGO activists, even though such facilities would comply with local standards.

Taxes are considered to have only limited impact on reducing the waste generation rates because of low price elasticity (see also chapter 2.4.3). In the absence of legal requirements, they could be used to influence waste streams. For example, high landfill taxes would support the thermal treatment of waste in the MSWC plants prior to its disposal and therefore reduce considerably the negative externalities (e.g. land use, methane emission and ground water pollution). The waste combustion taxes that are based either on weight or greenhouse gas emissions have virtually no potential to reduce other negative externalities, because the thermal treatment of waste with the CO_2 as the final production of complex chemical reactions is desirable in order to reduce overall impacts of municipal waste generation. The unwanted emissions (e.g. CO, NO_x) could be reduced by taxes, even though the described restrictions apply (see chapter 4.3.2.2). In some countries[48], there exist taxes on both landfilling and on the MSWC. Here, the assumption is inevitable that the state primarily uses the tax to increase is budget.

Direct or indirect *subsidies* are found in various countries to address positive technological externalities from the MSWC (see also chapter 3.4.3.4). They are often provided as an incentive for efficient energy recovery with reduced greenhouse gas emission from fossil fuels. Similar to taxes, the determination of subsidy level is practically impossible.

Applying the ideas of the *Coase theorem* to allocate and trade property rights as a measure to internalize most externalities from the MSWC is also practically impossible due to high technical and administrative transaction costs. During the planning approval procedures, however, certain trade activities between the developer of the MSWC plant and local citizens are thinkable. For example, in one Japanese project, the citizens accepted the construction of a thermal waste treatment plant in its municipality after the operator promised to support financially the construction and operation of a local spa.

Recently, *tradable permits* are adopted in various developed countries to limit or decrease the total emission of greenhouse gases from industrial sources[49]. Inclusion of the MSWC plants into any such emission trading program would internalize these positive technological externalities and certainly provide a dynamic incentive to increase their energy efficiency. In Germany, however, as in many other countries, the MSWC plants are explicitly excluded from national emission trading laws (see e.g. §2(5) TEHG for Germany)[50].

Due to the explained shortcomings of the other policy instruments, *command-and-control* measures dominate the limitation of negative externalities from the MSWC. In most countries air emission limits are legally set without restricting any technology. The following table provides an overview of emission thresholds for the most important MSWC air pollutants in se-

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[48] E.g. in Denmark there is a landfill tax of 375 DKK/Mg (50€/Mg) and a waste combustion tax of 330 DKK/Mg (44€/Mg).

[49] See e.g. Annex I countries in the Kyoto protocol to the UNFCCC.

[50] The current exclusion of the MSWC plants from emission trading is much disputed. The discussion seems to be based rather on political than on economic or environmental terms.

lected industrial countries as well as an example for further reduction by local authorities in Germany[51].

Contaminant [mg/Nm³]	USA	Japan[a]	Singapore	European Union	Example for planning permission in Germany
Source of information	MACT	National law	(NEA, 2001)	2000/76/ EC	(ZV-TAD, 2007)
Total carbon				10	10
Carbon monoxide (CO)	100	100ppm	625	50	50
Hydrogen chloride (HCl)	29	700	200	10	2
Hydrogen fluoride (HF)				1	0,1
Sulphur dioxide (SO2)	29	7.247**		50	5
Nitrogen oxides (NOx)	160-250	250	700	200	70
Particulate matter (dust)	27	40	100	10	10
Mercury (Hg)	0,08	4.571	3	0,03	0,01
Dioxins in ng/TEQ		0.1	0,1*	0,1	0,1
a Depending on flue-gas volume and location of MSWC plant. Here: Maishima Osaka Plant * 1.0 ng TEQ/Nm 3 for MSWC plants commissioned before 1st January 2001 ** SO_x for 1 hour					

Table 4-3: Comparison of daily-average emission limits for MSWC

In many countries such emission limits are set by policy makers with the support of technical experts. The US EPA, for example, applied a process called MACT (most achievable control technology) to define emission limits based on the best available technology. Besides command-and-control measures for air emissions, there also exist limits for other negative externalities, such as odor, noise and vibration.

On the other hand, command-and-control measures could also increase externalities. For example in Germany, all MSWC plants are required by law to utilize thermal energy from the waste. A compensation for positive externalities due to reduced CO_2-emission, however, is currently not in place.

Liabilities for damages are commonly applied to technical facilities, including the MSWC plants. The German environmental liability act, for example, includes the MSWC plants in the list of facilities that are liable for any damages caused by them (see UmweltHG §1 attachment 1(76))[52]. For the compensation, it is irrelevant whether the MSWC plant complied with existing laws and regulations. As part of their insurance package, owners and operators are

[51] In the past, it had been common practice in Germany to reduce emission well below the legal limit during approval procedures.

[52] A new USchadG will be added in 2007 to cover liabilities for damages in ground, water bodies or biodiversity. Here the authorities can make the claims, if no legal or natural person has been damaged.

usually insured against claims from these liabilities. In practice, however, the law has so far little relevance due to problems in legal enforcement (Schwarze, 2004).

It is often argued that *public provision* of the MSWC infrastructure is better suited to address problems of technological externalities. They purport that especially negative externalities are better reduced through public provision, because private companies merely want to maximize profits without caring about any externalities. Such statements have little justification if other measures to reduce externalities are implemented and enforced. Therefore, a general justification for public provision of the MSWC infrastructure cannot be derived. On the contrary, there might even exist persuasive reasons for private provision, because it could be argued that the separation of interests between the public sector and private MSWC infrastructure provision is a precondition for transparent and effective application of command-and-control measures. Even in countries with a weak law enforcement regime, public provision might not be a better choice, because here the weak authority would control itself.

If an individual municipality wishes to increase further the positive externalities (e.g. increased energy efficiency or advanced architectural design) or to further reduce negative externalities (e.g. emissions reduction) then it could either technically specify them in the tendering documentations or incorporate them into the payment mechanism. The application of availability payments would especially be suitable if emissions are to be measured over a longer period of time.

4.3.4 Pecuniary externalities

The effects of pecuniary externalities are of indirect nature and occur if the prices of one producer influence the prices of the other (see e.g. Kolstad, 2000, p. 93; Viner, 1932). These effects are not regarded as market failures, but they are actually desirable means of effective resource allocation in a market based economy. In contrast to technical externalities, pecuniary externalities do not justify any policy interference with the market because they do not cause an inefficient allocation of resources (Holcombe & Sobel, 2001).

Pecuniary externalities accumulate wherever ideal substitutes for a product exist. In Germany, the existence of pecuniary externalities in the waste sector could very well be observed with the introduction of TASi that required the treatment of municipal waste prior to their final disposal by June 1, 2005. Many landfill sites considerably reduced their prices to sell capacities that would not be needed anymore after the deadline. Before June 1, 2005, the low prices for landfilling reduced incentives for waste recycling or treatment in more environmentally friendly facilities.

After the introduction of the TASi regulation, pecuniary externalities continue to exist in the market for the MSWC. Because commercial waste generators can more easily choose between alternative waste treatment technologies (which are perfect substitutes for them), the consumption and therefore the prices between MSWC and M(B)T in combination with RDFC strongly influence each other.

4.3.5 Psychological externalities

Psychological externalities describe the relation between the utility function of two parties that are dependent on each other, but can exist without a direct physical connection or market transaction. This phenomenon implies that individuals do not always act selfishly, i.e. they do not aim exclusively at maximizing their own utility. Psychological externalities are used to explain altruistic behavior which decreases with the size of groups or markets (Becker, 1981). Classic examples of psychological externalities are voluntary donations to people in need in the wake of a natural hazard or the consumption of the so-called “fair trade” products.

The concept of psychological externalities can well be observed in the municipal waste sector. Suppose the households or consumers pay a fixed fee for waste services[53], thus they have no monetary incentives for reusing or separating their waste. Still, many households might reuse plastic bags for shopping or separate paper and take them to special collection systems. By acting in an environmentally friendly way they receive a higher psychological utility and furthermore affect the waste recycling and treatment industry.

Psychological externalities can be an important aspect to explain the behavior in environmental issues. They depend on normative attitudes that are influenced by education, culture, income level or religion. Under certain circumstances, psychological externalities can cause market failure (Fritsch et al., 2003, pp. 106-108).

4.4 Inadequate market adaptation

One fundamental assumption of perfect markets is that supply and demand are always in equilibrium. There exist, however, various situations where an equilibrium is not developed at all or where the market does not adapt adequately to establish a new equilibrium. Such deviations from the model of perfect competition could be referred to as a market failure, because perfect markets always produce these goods without time constraints (Stiglitz, 2000, p. 81).

The phenomenon of inadequate market adaptation can have three different forms (Fritsch et al., 2003, p. 351):

1. Incomplete markets,
2. Markets with unstable equilibrium, and

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[53] In many countries, households pay nothing or only fixed fees or taxes for waste services (e.g. council tax in the UK).

3. Inflexible markets.

Early economic theorists have focused on agricultural and financial markets to analyze the phenomenon of incomplete markets. But as it is shown later, the problem has also relevance to other markets, such as municipal solid waste management.

4.4.1 Incomplete markets

There exists the possibility that demand and supply for goods are not in equilibrium at all. In theory, this could happen, if supply and demand were totally price-inelastic, so that the price mechanism would not be working anymore. An incomplete market is an extreme case, where goods are not produced at all, even though the willingness to pay is higher than production costs. In reality, however, such a market failure probably only exists in timely or spatially restricted markets or if no substitutes for the goods exist (Fritsch et al., 2003, p. 331).

Another explanation can be the absence of certain complementary markets. If the supply of products from these complementary markets is not available, the market that requires the input will not function. The development of complementary markets can sometimes require extensive coordination efforts, which could be very challenging, especially in developing or transition countries (Stiglitz, 2000, p. 83) [54].

4.4.2 Markets with unstable equilibrium

The cobweb theorem is a popular model to explain the development of an unstable equilibrium in an isolated market. The theoretical explanation for the existence of such an instability is that producers frequently assume prices in their current time period *t* to continue to be unchanged in the future *t+1*. Their production decision in *t+1* is then based on the cost in the previous period *t*, which might result in an over- or undersupply. If the elasticity of prices and supply are of a certain magnitude, a change in supply or demand will result in a continuous fluctuation of both and no static equilibrium will be reached. This phenomenon is also known as a ‘pig cycle’. In addition to the mentioned price elasticity, the fluctuation of prices and the timely extension of a cycle depends strongly on the ability to store the goods (R. H. Coase & Fowler, 1935).

An extreme case of the cobweb theorem is shown in the following Figure 4-10. If the absolute price elasticity of supply is higher than the price elasticity of demand, a change in demand or supply caused by an exogenous event will lead to an unstable market with exploding prices (Ezekiel, 1938).

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[54] Consider the market for composting: If there does not exist a market for separation, collection and transportation of biodegradable waste, no market for composting will be developed, even if there exists a demand for compost.

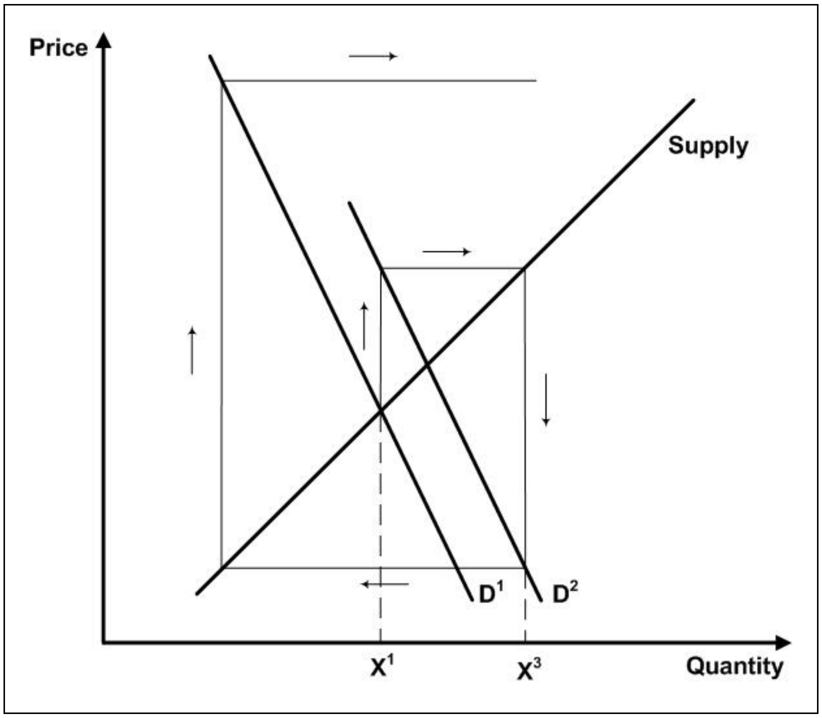

Figure 4-10: Cobweb theorem with exploding market equilibrium
Source: Hernberg (1986)

In the long run, it is rather unrealistic that a distortion of the market equilibrium may lead to an "explosion" of prices and quantities for goods or that the 'pig cycle' may continue to exist perpetually. The reason is that market participants learn from their experiences and nowadays there is often plenty of information available upon which producers can make their decisions (Fritsch et al., 2003, p. 341).

4.4.3 Inflexible markets

An important assumption of the perfect market model is that changes in demand or supply of goods will lead to a new market equilibrium without delay (see chapter 4.1.1). In many markets, however, especially if they require high sunk costs, such a flexible development of a new equilibrium is not always possible. Problems arising from inflexible markets can be observed in both directions: either when the demand is growing or when the demand is falling.

In the first case it might be possible that inflexible markets do not produce a Pareto-efficient amount of certain goods. This can be due to the growth in demand for the goods, the production of which requires stepwise investments in irreversible production facilities leading to sunk costs (Kruse, 1985, p. 54). In case the demand only slightly exceeds current production capacities, the producers might be reluctant to invest into a new production unit and therefore the growing demand will not be met.

In the second case of falling demand, the inflexibility of markets with high sunk costs could lead to the so-called 'cutthroat' competition, if the decreasing demand resulted in prices below average production costs. If, however, the average prices are still higher than the share of irreversible costs per output, the individual producers will not leave the market. If in this 'cutthroat' competition prices fall further and below the irreversible costs of some producers, these producers will quit the market. As shown by Fritsch et al. (2003, p. 349), not necessarily the producer with highest average costs will be the first to quit the market. Such inefficient sequencing of producers leaving the market would therefore result in allocative inefficiencies during market adaptation processes.

The occurrence of these two problems of inadequate adaptation certainly depends on the total size of the market. If the number of producers is very high, the adaptation processes will be rather fast and the effects of high sunk costs less important. If, however, the size of the market with high sunk costs is smaller, the allocative inefficiencies due to inadequate adaptation will exist for a longer period of time and can cause severe problems within these markets.

4.4.4 Measures for inadequate market adaptation

The options to decrease or eliminate market failure due to inadequate market adaptation are limited. The most effective way to reduce unstable markets is through extensive information policy. If it is too costly for individuals to collect data and information about the market, public authorities will collect, analyze and provide them (see e.g. statistical bureaus or private market research institutes).

In cases of incomplete markets without equilibrium in supply and demand for essential goods and products, the government could intervene into the market by setting maximum prices (e.g. for food crises) or by setting minimum prices (e.g. minimum wages).

The occurrence of inefficient sequencing of producers leaving the market in a 'cutthroat' competition could be reduced by providing financial incentives to producers with higher average costs to leave the market. Such a measure, however, will only be justified if average costs can be verified easily by outsiders and if the financial support is limited in time. Long-term subsidies, such as given by the EU to farmers for not producing, should be avoided.

Other available measures to reduce undersupply in case of inadequate market adaptation includes storing of goods (e.g. governmental storages for vaccines and medicines) or the support for developing substitute products (e.g. financing of R&D).

4.4.5 Application to MSWC

As shown in chapter 2.4.3 the price elasticity for residual municipal waste management is comparatively low and changes in waste quantities are often based on exogenous factors. In a simplified model it can be assumed, that the production of the MSWC takes demand as given and that municipal waste generators are price takers. Thus, it is realistic to suppose that supply reacts to changes in demand, not vice versa.

The occurrence of a market failure due to incomplete markets is rather unlikely for in case of the MSWC, because at least the supply side shows certain price elasticity, even though with rather high inflexibility (see below for the problem of inflexibility). One can also assume that complementary markets will be in place before demand in the MSWC exists, because the complementary markets (e.g. waste collection and slag disposal) require less technical expertise and less sunk costs.

The existence of an unstable market equilibrium as one form of market failure is rather unlikely, mainly because price elasticity in demand is very low. Also, one can assume that there is enough information available in the market, so that the 'pig-cycle' would not be developed (see also Kaufmann & Heinemann, 2007). Short-term fluctuations in demand and supply, which are the characteristics of an unstable market equilibrium, can be leveraged to a certain extent through storing of waste in waste transfer stations and large temporary storages[55].

There are, however, two significant reasons, why the market for the MSWC is comparatively inflexible in coping with significant long-term changes in demand that cannot be leveraged by short time storing. First, the MSWC requires high sunk costs and secondly, the development of new capacities is very time consuming. The expansion of existing facilities or the development of new ones can sometimes take two to three years[56] and involves various time related risks. Such inflexibility could lead to inadequate market adaptation (undersupply) if demand for the MSWC changes rapidly, e.g. due to changes in law[57].

In case of increasing demand for the MSWC, one important measure is timely, transparent and open information policies. Public waste management strategies should be accurately timed and waste disposal contracts have to be structured adequately to address issues of sunk costs (see chapter 5). Another valuable measure is to explore opportunities for reducing the time that is required for project development and implementation. One option is that public policy makers and authorities could ease legal requirements for project approval processes. Another option is applied by professional project developers and operators of the MSWC plants who sign umbrella contracts with important suppliers to reduce order times.

If demand for the MSWC is falling[58], the distribution of life-cycle costs will play an important role in the adaptation of the market. The impact of such changes in demand is much lower

[55] Many MSWC plants own or borrow baling equipment in case they cannot threat the delivered waste (either because too much is delivered during high waste generation seasons or during maintenance periods).

[56] Even longer development phases of five and more years are known.

[57] E.g. 1999/31/EC requires that practically all municipal waste must be treated prior to disposal.

[58] If for example changes in law require mandatory recycling of certain material (e.g. plastic bottles).

on the MSWC plants with comparatively lower sunk costs and higher flexible costs (see chapter 3.4.2). To choose such flexibility might therefore be a desirable design criterion for new facilities, if high fluctuation or decrease in demand were expected in the future, even though average costs will be higher for these plants, if capacities are fully used. Although such different cost structures would support the theoretical concept of wrong sequencing of producers leaving the market, one should not conclude that a market failure exists justifying external intervention. Here, the participants in the free market should make their own decisions and balance the structure of life-cycle costs to address falling demand against comparative average costs.

If baling must be extensively used due to insufficiently available waste treatment capacities, further market failures caused by negative externalities will be the consequence[59].

4.5 Information failures

There exist two forms of information failures that could cause Pareto inefficient markets. These are (ii) incomplete information and (ii) uncertainty (Fritsch et al., 2003, p. 279). At this point it is important to re-emphasize that the level of analysis is the market and not a specific transaction within the market. The latter is the domain of other economic theories, such as new institutional economics.

4.5.1 Incomplete Information

Often the producers or consumers are not fully informed about the goods that are exchanged in the market. Such incomplete information will exist, if either (i) prices are unknown, (ii) utilities are unknown, (iii) or if information is distributed asymmetrically between the market actors (Fritsch et al., 2003, p. 321).

Sometimes, consumers do not possess complete information about the full price of the goods and therefore the allocation in the market is not efficient[60]. If the utility of the goods is not fully known by the consumers, it will be possible that too little or too much of the goods will be consumed. This might especially be the case, if the utility of the goods can be seen long after its consumption[61].

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[59] The new TASi law for Germany required that all waste must be treated prior to disposal since June 1st 2005. Even though the new regulation was well known in advance, there was an undersupply for waste treatment of 2.5 million Mg/a at that time (see appendix 3). Due to inadequately slow market adaptation it is estimated that a total amount of 12 million Mg of untreated or pre-treated waste must be baled and stored (Alwast, 2006). The environmental impacts remain unknown.

[60] Examples could be door-to-door sales or subscription contracts.

[61] Examples could be education or health precaution.

A more severe form of incomplete information is asymmetry of information among market participants, which could cause inefficient market allocation due to (i) adverse selection, (ii) moral hazard or (ii) opportunistic hold-up. As shown in a landmark publication of Akerlof (1970), ex-ante asymmetric information about the quality of goods can lead to adverse selection in markets where only goods with low quality will be exchanged. In an extreme case, such an adverse selection could result into the non-development or total breakdown of a market due insufficient demand or supply for the particular goods (Rothschild & Stiglitz, 1976).

The problem of moral hazard is yet another result of information asymmetry. It describes the situation in which one party is unable to observe the activities or behavior of the other party after the contract is signed. Here, the transaction might not happen at all due to the potential threat that one party does not enter the contractual relationship in good faith[62].

Opportunistic hold-up can occur in long-term contracts if two conditions are fulfilled. First, at least one party must undertake irreversible investments in order to prepare for the transaction. Second, the future demand and quality of the goods cannot be specified in the contract with sufficient certainty (Rogerson, 1992). Due to the risk that one contractual party abuses its position ex-post, the Pareto efficient level of investments might not be achieved or the transactions might not happen at all.

4.5.2 Uncertainty

Uncertainty differs from incomplete information by being concerned with future developments that no party in the market is able to foresee. Because, any market activity involves risks and opportunities as a resulting in an unpredictable world, uncertainty should not be made responsible for Pareto inefficient allocations. The time that markets need for reacting on uncertain developments is rather a question of adaptability (see chapter 4.4).

It might be possible that a market for certain goods will not be developed at all, if market participants are very risk adverse and uncertainties are high. Such an extreme non-development of a market will more easily be observed, if sunk costs are high and the opportunistic hold-up likely. In reality, however, many transactions might just not take place because one contractual party is unwilling to accept the allocation of risks at a given price level[63]. Such situations are normal in a competitive market and should not be referred to as a market failure.

[62] Insurance industry is a popular example.

[63] This situation is similar to the characteristics of incomplete markets.

A special case of a market failure due to uncertainty is recognized by economists in the field of research and development (Stiglitz & Wallenstein, 2000). Especially in fundamental research, the market might not be willing to provide sufficient quantity of the good R&D[64].

4.5.3 Measures for information failures

As explained above, there exist only extreme situations, in which incomplete information or uncertainty lead to market failure. In most cases of incomplete information, the market participants can acquire necessary information through screening or spread information in the market through signaling. If the transaction costs for screening and signaling by individual market participants are higher than the benefit, actions by organizations within the market or by the government will be desirable. Such activities could include the compulsory introduction of minimum quality standards, obligation to disclose certain product information, external quality controls, occupational licensing or certification (Tirole, 2003, p. 113).

Governmental intervention into the market could be justified in extreme cases of market failure. For example, the state guarantees could be provided to overcome problems of moral hazard in the financial sector (e.g. provision of student loans). Also the financial support for fundamental research is a suitable measure.

4.5.4 Application to MSWC

In developed countries, market failure due to incomplete information and uncertainty is very unlikely for the market of MSWC. Although the problem of information failure exists at a transaction specific level for the MSWC, it can be assumed that the market is functioning. The variety of policy instruments that are usually already in place to address problems of external effects also reduce the occurrence of information failures. These instruments include, for example minimum quality standards (emission limits), public disclosure of information (mandatory publishing of actual emissions) and licensing.

In developing and transition countries, high uncertainty about waste generation rates, waste composition as well as legal developments are said to be the reason for the non-development of the market. Here, the development of a sound institutional environment must be fostered. In addition to that, the provision of guarantees by the government or external third-party organizations can prove to be helpful. In most cases, however, markets are more likely not to develop due to insufficient profitability rather than uncertainty[65].

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[64] One could also argue that fundamental research is good with very big positive externalities, where the internalization of positive externalities (e.g. through patents) is not desirable.

[65] Projects in other infrastructure with higher profitability (e.g. airports) are often developed even though uncertainties are high too.

4.6 Summary

This chapter discussed four relevant forms of market failures: natural monopolies, externalities, inadequate market adaptation and information failures. Further, it analyzed their occurrence in and implications for the market of MSWC

An isolated view of the MSWC plants assumes the existence of natural monopolies due to subadditivity of the cost function. The natural monopoly also possesses limited contestability which is caused by high sunk costs. However, an inclusion of transportation costs into the total cost calculation shapes natural monopolies in two different ways. In case of comparatively high transportation costs a local natural monopoly with spatial limitations evolves. If the transportation costs are lower, the subadditivity of total cost function will continue to exist. However, the size of this so-called extended natural monopoly is also technically limited. To reduce welfare losses within natural monopolies, price regulation, competition for the market, public provision and aggregation of demand are available policy measures.

Different positive and negative technological externalities occur in the infrastructure sector of the MSWC. It is shown that command-and-control measures are best suitable to internalize negative environmental externalities. Other measures such as taxes, subsidies, education and ethical appeal, liability for damages and tradable permits could also help to reduce positive and negative externalities and might be applied in addition to command and control measures. The applicability of the Coase theorem must mostly be denied due to practical impossibilities of allocating property rights.

With respect to the possible inadequacy of market adaptation, the analysis has shown that incomplete markets or unstable market equilibriums are unlikely to exist for the MSWC infrastructure. However, due to high sunk costs and long development phases for the MSWC plants, there is reason to believe that the market is comparatively inflexible in coping with the significant long-term demand changes caused by exogenous factors.

The two forms of information failures that could cause market failures are incomplete information and uncertainty. In developed economies or densely urbanized areas, where the MSWC has the highest relevance, such information failure is unlikely to cause a malfunctioning of the market, because signaling and screening mechanisms are usually in place.

In the next chapter the theoretical framework for applicable institutional arrangements for MSWC will be developed. It will employ theories of new institutional economics, the historic roots of which can actually be found in the analysis of the market competition.

5 Theoretical framework for institutional arrangements

5.1 Introduction

New institutional economics is an interdisciplinary theory building that joins economics, law, psychology and organization theory for better understanding and analyzing complex economic realities and phenomena. In contrast with frictionless neoclassical economics, its central assumption is that institutions do matter for economic performance (Furubotn & Richter, 2005, p. 1).

The following Figure 5-1 provides an overview of distinct branches that evolved under the umbrella of an institutional view of economics. The three theoretical concepts of (i) property right economics; (ii) agency theory and (iii) transaction cost economics form the most significant components of new institutional economics (Dollery, 2001).

The fourth branch of public choice theory is frequently allocated to the research field of new political economics as part of political sciences (Johnson, 1991). Nevertheless, there exists a variety of interrelationships and overlaps between the new institutional economics and new political economics that have resulted into new powerful analytical tools[66].

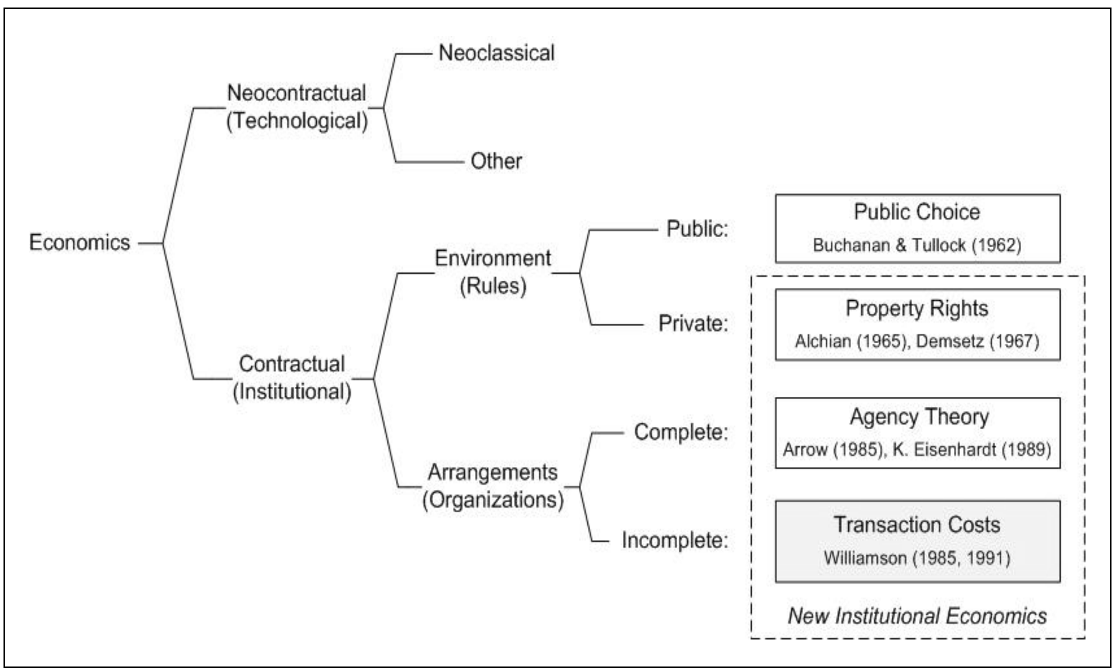

Figure 5-1: Transaction cost economics and alternative theories to economic institutions
Source: Adapted from Williamson (1990)

There exist various different definitions of institutions, which are applied in the field of economics, sociology and political science (Scott, 2001, pp. 1-16). A very generic and widely accepted definition is done by North (1990), who describes institutions as “the rules of the

[66] See e.g. budget maximizing model of bureaucracy in chapter 5.5.3.

game in a society or, more formally, [they] are the humanly devised constraints that shape human interaction”. They structure the incentives and constraints of political, social and economic exchange. Institutions can be of formal as well as informal kind and also include their enforcement arrangements. Their major purpose, i.e., cause for their evolvement, is to provide a framework for human interaction that reduces uncertainties.

Formal institutions are evidently written documents as well as rules which can be executed through a formal position, such as authority or ownership. They are usually created with a special purpose and might exist for a limited time only. Informal institutions, on the other hand, are based on implicit understanding among human beings and include social norms, routines, culture and behavior. They are socially driven and do not change instantly, because they often evolve over a longer period of time (Zenger, Lazzarini, & Poppo, 2002).

With respect to the research object of municipal solid waste combustion (MSWC), formal institutions are for example short- or long-term waste treatment contracts as well as written environmental laws or public procurement regulations. Informal institutions are, for example, social networks among different stakeholders or public acceptance of MSWC plants.

It is important to distinguish organizations from institutions. While the latter ones are the rules of the game, organizations must be understood as the players (North, 1990, pp. 4-5). In the field of waste management, these could be for example public bureaus, private waste management companies, investors, advisors or diverse interest groups. Obviously, the differentiation between institutions and organizations is not always razor sharp and the boundaries of a firm (and of other organizations) have long been the subject for various theories.

5.2 Institutional dimensions

New institutional economics differentiates between the two dimensions (or levels) of (i) institutional environment and (ii) institutional arrangement.

The *institutional environment*[67] defines the formal and informal rules on the macro-level limiting permitted and accepted actions and behavior (norms) within the society (North, 1990). The institutional environment is not specific about a transaction or an institutional arrangement as it rather concerns the general definition and enforcement of property rights and contract laws, which are of course rudimentary for economic activities and transactions. Secure property rights ensure that people are able to keep the returns of their entrepreneurial activities. In addition, well defined property rights and contract enforcement decrease the transaction costs associated with doing business (Ronald H. Coase, 1937). The institutional environment includes both the functions of the government as well as the power distribution between the different levels of government (Williamson, 2000).

[67] Also: institutional framework (North, 1990) or institutional atmosphere.

The *institutional arrangement*[68] encompasses the institutions, i.e. the formal or informal rules, on a micro level that structure *specific* transactions between organizations in a particular way (North, 1990). This terminology is frequently used in similar research contexts. For example, Mühlenkamp (1999, p. 23) uses the term institutional arrangement to describe the relationships between public and private stakeholders in the public infrastructure delivery.

Within the context of this research, the term *institutional arrangement* is used to describe the design of relationships between most relevant stakeholders of the MSWC projects. It is important to bear in mind that there exist formal as well as informal institutions that govern institutional arrangements.

5.3 Transaction cost economic approach towards institutional arrangements

5.3.1 General

What later evolved as the field of transaction cost economics was initiated by Coase's (1937) influential article "The Nature of Firm", in which he posed the question, why individual firms emerge at all in the economy. As a result, transaction and institutions became the nucleus of the economic analysis in which transaction costs have a crucial impact on institutional arrangements.

Transaction cost economics looks at how the nature of specific transactions, referred to as attributes of transactions, influences the choice of an institutional arrangement. Hereby, the institutional environment is treated as exogenously given. Therefore, the transaction costs that arise to the stakeholders of the institutional arrangements in a defined institutional environment are of primary concern to transaction cost economics.

Already at this point it is important to distinguish between transactions and contracts. According to Williamson (1985b, p. 1) a "*transaction* occurs when a good or service is transferred across a technologically transferable interface". A *contract* can be understood as "a formal, legal commitment to which each party expresses approval and to which a particular body of law applies" (Masten, 1988). A contract can therefore include a single transaction or as in the case of a long-term contract, numerous transactions. It is important to bear in mind that not all transactions necessarily require a contract[69].

The transaction cost economics stresses the importance of human behavior for any economic analysis of transactions. Based on the insights of cognitive psychology the traditional

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[68] Williamson (1985b) uses the term "governance structure".

[69] In practice, however, most transactions are carried out on the legal basis of explicit or implicit contracts, such as buyer-seller agreements or employment contracts. Transactions without contracts are for example gifts or robbery.

neoclassical model of the 'homo economicus' is transformed to the model of a 'homo psychologicus' who acts opportunistic and with bounded rationality (Simon, 1985).

Opportunistic behavior is the human "self interest seeking with guile" (Williamson, 1985b). It refers to incomplete or distorted distribution of information that leads ultimately to information asymmetries in both ex ante as well as ex post situations. Opportunism can embrace obvious forms, such as lying, cheating and stealing or it can involve more subtle forms of active or passive behavior, such as negligence or the intentional ignoring of certain things and developments. Bounded rationality must be clearly distinguished from opportunistic behavior. It assumes that even if economic actors want to behave rationally their ability to do so is only limited (Simon, 1978). The cognitive abilities of humans are restricted and therefore not everybody has the competence required to act in a way that is objectively seen as rational.

The theoretical concept of transaction costs economics was predominately developed by Williamson (1971; 1985b) and is rooted on the perception that the costs for a transaction in a market (transaction costs) are decisive for the institutional arrangements of a specific transaction. Originally defined by Coase (1937) as the "cost of using the price mechanism", market transaction costs are nowadays distinguished into four components (Furubotn & Richter, 2005, pp. 52-54):

1. *Search and information costs* are the costs for searching suitable contractual parties (e.g. firms, individual customers and employers) as well as for collecting information about prices and quality of goods in the market.
2. *Bargaining and decision costs* are the costs that are arise from writing and negotiating contracts.
3. *Supervision and enforcement costs* are the costs for monitoring and measuring the contractual obligation, especially timely delivery, quality and quantities. They also include costs for enforcing the contract in case disputes arise between the parties due to perceived deviations from the contract.
4. *Investments in social relations* are the costs to build up social networks within the market to reduce information complexity, personal uncertainty and bounded rationality.

The behavioral assumptions of bounded rationality and opportunism are the causes for these transaction costs. As a result, all complex contracts are unavoidably incomplete due to high transaction costs (Williamson, 1985b)[70]. The theory of incomplete contracts was strongly

[70] In contrast with transaction cost economics, the agency theory (also: principal agent theory) assumes implicit contracts and investigates the different relationships between the principal and another agent. It focuses primarily on the problem of economic incentives for each economic actor and how the incentives are created and defined *ex ante* (see e.g. Eisenhardt, 1989a; Sappington, 1991).

influenced by the work of Hart & Moore (1988; 1999) who analyzed the effect of contractual parties' inability to formulate contracts that would cover all contingencies. Even if the parties were willing to specify contingent clauses ex ante, they could not do so completely because (i) it is either too expensive to describe them ex ante or (ii) it is impossible or too expensive to verify them ex post.

The main purpose of transaction cost economics is to solve the paradigm problem of vertical integration, i.e. to give reasons for the make-or-buy decision (Williamson, 2005). It tries to determine and analyze the factors (attributes of transaction) that are decisive for the emergence of distinctive institutional arrangements. According to the transaction cost economics, the institutional arrangement is chosen on the basis of the lowest total cost of transaction, which is the sum of transaction and production costs, and it could entail either a hierarchical structure (internal production), a market structure (external production) or any hybrid mode between these two extremes.

Many researchers, especially at doctoral level, are tempted to apply transaction cost economics to all kinds of problems. But the warning of David & Han (2004) must be taken seriously, who note "[…] *that many classic works are said to be frequently cited, yet rarely read.* […] *Transaction cost economics, it seems, is often appropriated to serve as a basic for analogues and a source of insight. And, more than occasionally, it is loosely interpreted and used as a metaphor, or even just as a ritual marker.*" Bearing this in mind, the concept of transaction cost economics will be presented and critically assessed as a theoretical framework to explain the evolvement of institutional arrangements. Subsequently, it will be applied to the public sector and to the MSWC infrastructure.

5.3.2 Attributes of a transaction

The height of transaction costs depends mainly on three attributes (or dimensions) of transactions. The first and most significant attribute of a transaction is *asset specificity*, while *uncertainty* and *frequency* play an important role as well (Williamson, 1984).

5.3.2.1 Asset specificity

Asset specificity refers to durable investments that are done as part of a distinct transaction and the value of which is much lower if used in the best alternative way. The excess value of an asset over its value to the second highest valuing user is called a *quasi-rent* (B. Klein, Crawford, & Alchian, 1978). As a result of asset specificity, the identities of the parties in the transaction matter and therefore contractual as well as organizational safeguards are put in place to secure continuity of the relationship (Williamson, 1985b, p. 55).

There is an important difference between the two related concepts of asset specificity and sunk costs. The latter is concerned with the consequences of asset specificity in specific markets and whether they cause a potential threat to allocative efficiency. The transaction cost economics extends this concept of asset specificity and analyzes how idiosyncratic attributes of a specific transaction govern the institutional arrangement (Williamson, 1984).

Four types of asset specificity can be distinguished (Joskow, 1985, 1988)[71]:

1. *Site asset specificity* refers to investments in highly immobile assets at an ex-ante specified location that is chosen mutually by the contractual parties.
2. *Physical asset specificity* refers to investments in machinery or equipment that are specifically designed and built in accordance with the requirements of the transaction. An alternative use outside the initial transaction has much lower value.
3. *Human asset specificity* refers to investments in unique human capital as part of the transaction specific relationship. People develop trust and specific knowledge as the result of continuous learning processes. These transaction specific relationships are of little use to transactions in other institutional arrangements.
4. *Dedicated assets* refer to general investments by the agent to serve a specific principal. The agent will be left with considerable access capacity in case the relationship is terminated prematurely.

Assets that are specific to a transaction are also-called 'idiosyncratic' investments and they will create dependencies of at least one or both contractual parties if they concur with opportunistic behavior and bounded rationality. As shown in the following Table 5-1, asset specificity alone would not become the source for potential disputes without occurrence of bounded rationality and opportunistic behavior at the same time.

Behavioral assumptions		*Asset specificity*	*Implied contracting process*
Bounded rationality	*Opportunism*		
not existing	high	high	Planning
high	not existing	high	Promise
high	high	zero	Market
high	high	high	Governance

Table 5-1: Contracting models
Source: Adapted from Williamson (1985a)

[71] A wider classification of asset specificity also includes (5) brand name capital (B. Klein & Leffler, 1981), and (6) temporal specificity which refers to the timely constraints in identifying and arranging alternative transactions with new contractual parties (Masten, James W. Meehan, & Snyder, 1991). See also Williamson (1991).

Transaction costs correlate with quasi-rents of assets, because increasing asset specificity encourages opportunistic behavior that the transactional parties need to mitigate through extensive contracts as well as control and enforcement mechanisms.

5.3.2.2 Frequency

Frequency is a further important attribute of transactions that impacts institutional arrangements. For the analysis, two different kinds of frequencies are distinguished. The first one refers to the frequency of transactions between two specific market actors. Here, a higher number of anticipated transactions reduces the motivation and benefits of opportunistic behavior for both actors (Heide & Miner, 1992).

The second kind of frequency refers to the frequency of transactions for specific goods among many trading partners (P. G. Klein, 2006)[72]. Williamsons (1984) argues that specialized institutional arrangements are more sensitively accustomed to the requirements of non-standard transactions requiring idiosyncratic investments than unspecialized arrangements. However, the transaction costs for the development and set-up of specialized institutional arrangements are very high. Therefore, the frequency of a transaction is important for the selection of institutional arrangements, because the number of transactions must be sufficient to leverage these high transaction costs.

The transaction costs to set up specialized institutional arrangements can be reduced through the adaptation of institutional arrangements to similar markets. If such institutional adaptation with lower transaction costs is possible, specialized institutional arrangement will become beneficial even at a lower number of transactions (Mamadouh, Jong, & Lalenis, 2002).

5.3.2.3 Uncertainty

Uncertainty has already been recognized by neoclassical microeconomics as a potential source of a market failure (see chapter 4.5.2). But the analysis of its impact on institutional arrangements for specific transactions and its interrelationship with asset specificity and frequency is new within the domain of transaction cost economics.

Uncertainty can be conceptualized one-dimensionally as ‘imperfect foresight’ (Furubotn & Richter, 2005, p. 81) or as a mixture of ‘volatility and ambiguity’, whereby volatility refers to the impossibility to predict changes in an environment over time and ambiguity describes the degree of uncertainty regarding the changes in perceptions of the environment irrespective of its change over time (Carson, Madhok, & Wu, 2006).

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[72] Klein (2006) also lists ‘frequency of disturbances’ as a third form of frequency. This concept, however, is incorporated into the third transaction attribute of uncertainty (compare also Williamson, 1991).

In order to elaborate the impact of uncertainty onto institutional arrangements in production, Walker & Weber (1984) suggest to distinguish between (i) *volume* and (ii) *technological* uncertainty. Volume uncertainty refers to the fluctuation in demand and the confidence in the estimated demand. Technological uncertainty refers to the adaptation to required technology to meet changes in demand. Obviously, both these types of uncertainties are not necessarily independent of each other. This classification of volume and technological uncertainty has been frequently used to characterize transactions (Geyskens, Steenkamp, & Kumar, 2006).

High degrees of uncertainty will make transactions more conducive to opportunistic behavior in case the transactions require idiosyncratic investments[73]. An analysis of institutional arrangements must therefore incorporate the interactions between uncertainty and asset specificity, which are indeed difficult to measure in empirical analyses (Williamson, 1985b, p. 60).

5.3.3 The contract law perspective of transactions

The behavioral assumptions and attributes of transactions have an impact on the design of institutional arrangements, including the legal design of contracts for a specific transaction. The classical categorization of contracts has been introduced by Macneil (1978), who distinguishes between: (i) classical contracts, (ii) neoclassical contracts and (iii) relational contracts. Williamson (1985b) has adopted this categorization in his development of transaction cost economics, even though he admits that a discrete distinguishing between these forms is not always possible as several overlaps exist in practice.

Classical contracts are designed for a singular transaction between two parties that is timely limited and takes place in high numbers within the market between other parties. Classical contracts are complete contracts in the sense that both contractual parties negotiate with symmetric information and ex-ante define the transaction. Legal enforcement, that is non-transaction specific as part of the institutional environment, guarantees the fulfillment of contractual obligations, because the characteristics of the transaction and each party's obligation have been described completely, i.e. for every possible ex-post eventuality (Furubotn & Richter, 2005, p. 156)[74].

Neoclassical contracts are applied for more complex and long-term relationships involving a high number of transactions. Here, both contractual parties intentionally negotiate an incom-

[73] If the investments would be non-specific it would be easier to renegotiate the transaction in case of unforeseen ex-post changes.

[74] A further development of the classical contract theory is the agency-contract theory, where information is taken to be asymmetric after contract conclusion. The agency or principal-agent theory is a distinct theoretical branch within the New Institutional Economics and will not be elaborated within in the context of the present research objectives.

plete contract which enables them to react flexibly upon uncertain circumstances. Due to the uncertainty and bounded rationality, it would be too expansive to formulate, control and enforce a complete contract. Third parties can observe the execution of the contract and are therefore able to solve any disputes. Arbitration rather than legal courts are used to settle disputes, because they are faster, less expensive and allow continuity of the contractual relationship. These contracts are therefore also referred to as trilateral contracts (Williamson, 1985b, p. 75).

Relational contracts, similar to neoclassical contracts, are intentionally incomplete and therefore allow gaps in the contract. Relational contracts are used in arrangements that exceed discrete singular transactions, whereby the contractual parties recognize that it is impossible or prohibitively expensive to agree ex-ante on all future contingencies and/or to verify them ex-post by third parties in case of disputes. A relational contract is based on the outcome that is only observable ex-post by the contractual parties directly involved. It therefore allows the parties to utilize their detailed knowledge of their specific situation and adapt to new information as it becomes available (Baker, Gibbons, & Murphy, 2002). Because relational contracts, unlike neoclassical contracts, cannot rely on third parties for dispute resolution, they are also referred to as bilateral contracts (Williamson, 1985b, p. 76). Due to the explained characteristics, relational contracts are also described as implicit, informal or self-enforcing (Furubotn & Richter, 2005, p. 173) [75].

The threefold framework of classical, neoclassical and relational contracts has later been extended by Williamson (1991), who added *forbearance* as the implicit contract law for internal organization. Here, firms (hierarchies) are their own court of ultimate appeal and able to exercise fiat, which markets cannot.

As shown in the following Figure 5-2, Williamson (1985b, pp. 72-79) argues that the transactional attributes of asset specificity and frequency are decisive for firms whether to use classical, neoclassical, relational contracts or forbearance in arranging their business relationships. In this concept, a sufficient degree of uncertainty exists throughout all contractual forms.

[75] A special case of relational contracts are symbiotic contracts, whereby both parties pursue the same objective, but where a power imbalance exists. The imbalance is leveraged through a system of control, information and enforcement (Schanze, 1991).

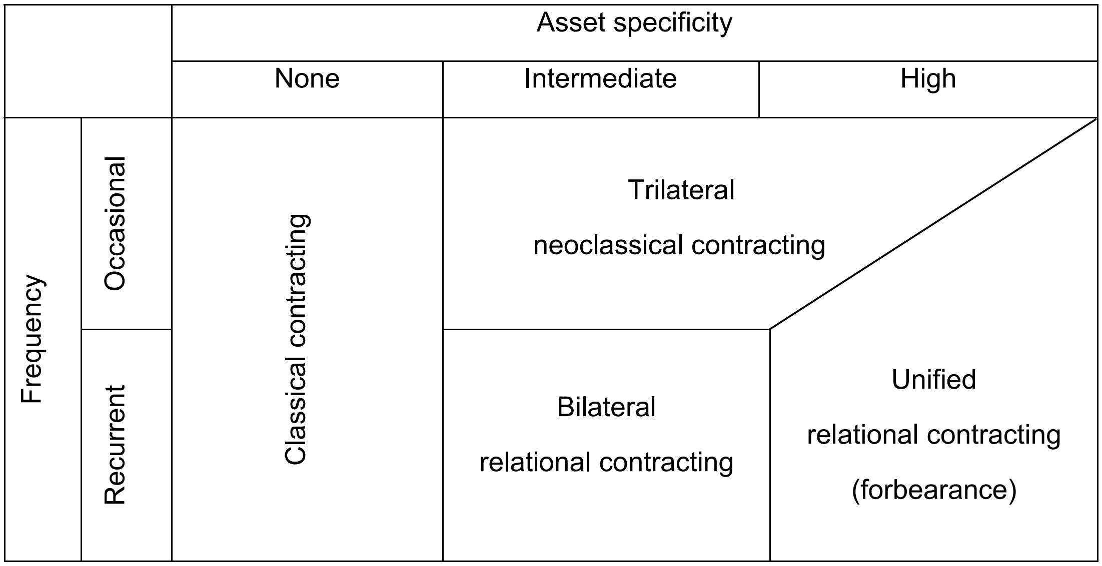

Figure 5-2: Efficient contractual governance

Source: Adopted from Williamson (1985b, p. 79)

Transactions with non-specific investments can be governed by the market in which classical contracts are used for both occasional and recurrent exchange (Williamson, 1985b, p. 73). The classical contracts are more or less standardized and experience or advisory of outsiders (e.g. rating agencies, consultants) can be used by everybody. Parties cannot benefit from opportunistic behavior, because contracts can easily be enforced and the threat of a hold-up problem does not exist.

Transactions with low frequency that require intermediate or high asset specificity are suitable for trilateral governance using neoclassical contracts (Williamson, 1985b, p. 75). The limitations of classical contract law associated with the hold-up problem for transactions with idiosyncratic investments on the one hand and the high transaction costs for relational contracting on the other hand are given as the reasons for the emergence of trilateral governance.

If the frequency of transactions with intermediate or high asset specificity is high enough, the higher transaction costs for using relational contracts in bilateral or unified governance will be justified. The limited potential of opportunistic behavior in transactions with intermediate asset specificity favors bilateral governance with autonomous partners under a strong control and incentive regime. Unified governance is a vertical integration of formerly two individual parties giving up their autonomy and should be preferred for recurrent transaction involving large idiosyncratic investments. Hereby, the high threat of opportunistic behavior is better mitigated in a unified system, especially if economies of scale can be utilized to reduce production costs (Williamson, 1985b, pp. 76-78).

5.3.4 Transaction cost economic approach towards institutional arrangements

As elaborated in chapter 5.2, an institutional arrangement encompasses the formal or informal rules that structure specific transactions between economic actors (North, 1990). The two extreme forms of institutional arrangements are *markets* on the one side and *hierarchy* on the other. Between these two there exist various hybrid institutional arrangements, such as long-term contracting, reciprocal trading, regulation or franchising (see next chapter).

The analysis of institutional arrangements within the theory framework of transaction cost economics treats the institutional environment as exogenously given and neglects their impact on the choice of an institutional environment. The key characteristics for describing institutional arrangements are given by Williamson (1991) as:

1. *Contract law regime* refers to application of classical, neoclassical or forbearance contract law.
2. *Incentive intensity* describes the motivation to use assets and revenue streams efficiently.
3. *Administrative support (*also *administrative control*) refers to the extent to which internal administrative instruments of the organization support (or control) the transaction.
4. *Performance*: With reference to Hayek (1945) and Barnard (1938), two forms of adaptation are distinguished. Autonomous adaptation refers to the neoclassical price mechanisms for changes in demand and supply, whereas cooperative adaptation refers to the conscious, deliberate and purposeful efforts to adapt internally to the changes in demand, supply or technology.

In later publications, Williamson (2005) reduces the importance of performance as a transaction characteristics of institutional arrangements, because it is a result of the first three.

The following Table 5-2 gives an overview of the way these attributes characterize the bipolar institutional arrangements of market and hierarchy as well as the hybrids located in between.

	Institutional Arrangement		
Characteristics	**Hierarchy (Vertical Integration)**	**Hybrid Forms**	**(Spot) Market**
Contract law regime	Forbearance	Neoclassical/ relational	Classical
Instruments Incentive intensity Administrative support	Low High	Intermediate Intermediate	High Low
Performance Autonomous Adaptation Cooperative Adaptation	Low High	Intermediate Intermediate	High Low
Duration	Perpetual	Enduring with limitations	Momentary

Table 5-2: Characteristics of institutional arrangements

Source: Adopted and expanded from Williamson (1991)

The institutional arrangement of (spot) markets relies on classical contract law and combines high incentives with low administrative control. The performance of markets is characterized by high autonomous and low cooperative adaptation.

In contrast, the institutional arrangement of hierarchy is governed by internal dispute resolution mechanisms through forbearance contract law, whereby incentive intensity is low and administrative control is high. Hierarchy is also referred to as vertical integration, because here the firm undertakes production internally by integrating all property rights. The autonomous adaptability of hierarchies is low, whereas cooperative adaptability is high. The attributes of a hybrid institutional arrangement are in between the two extremes and favor neoclassical or relational contract law.

A further attribute of an institutional arrangement is introduced by Ruiter (2005) who draws the attention to the *duration* of exchange as a significant attribute and puts it into relationship with the applied contract law. He describes the market as an institutional arrangement where a classical contract coincides with the exchange to yield a *momentary* exchange regime. In hybrid institutional arrangements, a neoclassical or relational contract support exchange in a more recurrent or enduring exchange regime that often has a *timely limitation*. A hierarchy is characterized by the replacement of an externally enforceable contract through internal assignment to yield a *perpetual* authority regime.

5.3.5 Hybrid institutional arrangements

While the dichotomous types of market and hierarchy can be described more precisely, because they are the two extreme boundaries of institutional arrangements in which transaction can take place, the taxonomy of hybrids as alternative institutional arrangements has to be presented more openly.

A flexible definition is given by Ménard (2004; 2005) who describes hybrids as “all forms of inter-firm collaboration in which property rights remain distinct while joint decisions are made, requiring specific modes of coordination”. They are characterized by (i) pooled resources, (ii) relational contracting and (iii) reduced competition due to combination of autonomy and interdependency.

Hybrid institutional arrangements include equity joint venture, long-term contracting (including employment contracts), networks, alliances, franchises, strategic alliances, other long-term business relationships and even clusters or joint trademarks (Furubotn & Richter, 2005, pp. 295, 303; P. G. Klein, 2005; Ménard, 2005; Noorderhaven, 1995).

Hybrid institutional arrangements will emerge for specific transactions whenever required resources and capabilities cannot be bundled efficiently in the market, while vertical integration within a firm reduces flexibility or incentives (see next chapter).

Different types of hybrid institutional arrangements can be distinguished by three dimensions: (i) number of partners, (ii) scope and (iii) specifications of neoclassical/relational contract law regime (Bruce & Jordan, 2007; Child & Faulkner, 2002). The first two dimensions look at whether two or several parties are part of the arrangement and whether the scope of joint actions is focused (single purpose) or complex. As shown in the following Figure 5-3, the latter dimension specifies applied contractual relationships.

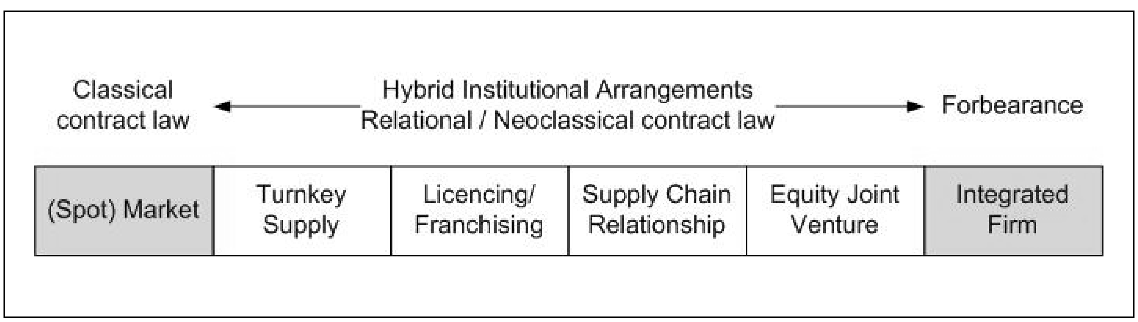

Figure 5-3: Contractual dimension of selected hybrid institutional arrangements
Source: own

Even though the presented illustrations of hybrid arrangements might be unsatisfying due to the lack of a precise definition, the obtained flexibility and vagueness must be accepted as new hybrids frequently emerge as a mixture of various ideal types (Noorderhaven, 1995).

5.3.6 Heuristic model of institutional arrangements

Based on the theoretical findings of applying contract law regimes to transactions (see chapter 5.3.3), a core prediction of transaction cost economics is that the institutional arrangements of spot market (M), hybrid arrangements (X) and hierarchies (H) are applied depending on the asset specificity (k). The following Figure 5-4 abstracts anticipated transaction costs for the institutional arrangements market, hybrids and hierarchy as a function of asset specificity.

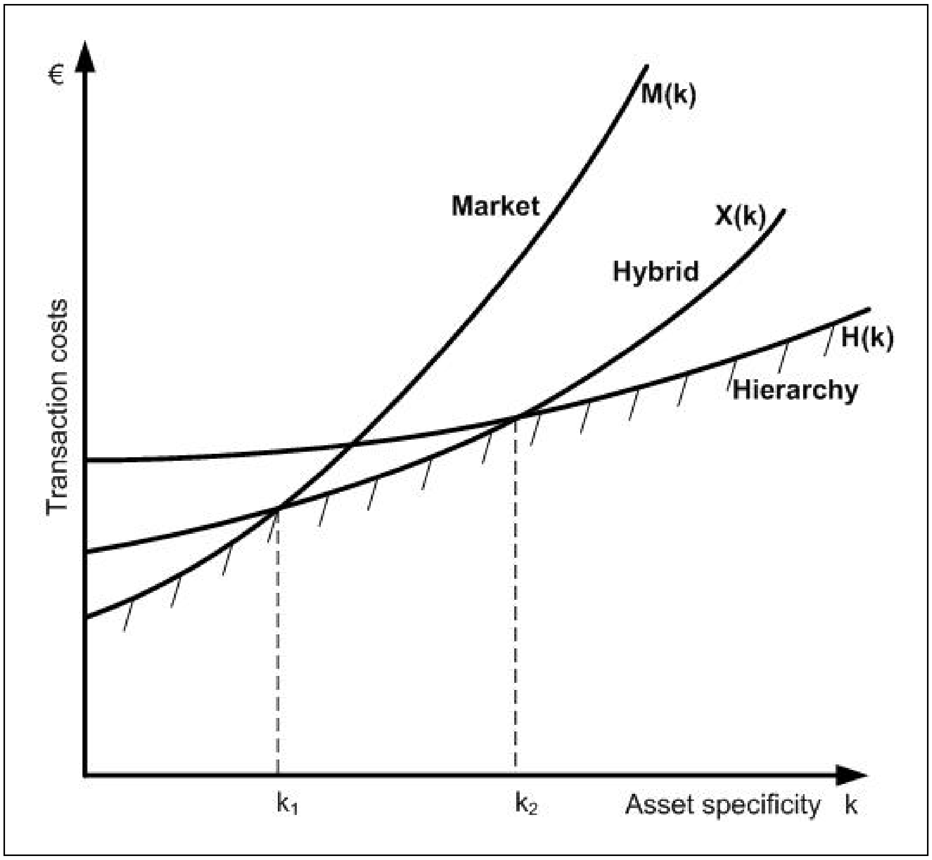

Figure 5-4: Institutional arrangements, transaction costs and asset specificity
Source: Williamson (1991)

Formally, the transaction cost functions can be written as M = M(k)+ α for markets, X = X(k) + β for hybrid institutional arrangements and H = H(k) + γ for hierarchies. If a transaction does not require investments in specific assets (k=0), the institutional arrangement of market will be preferred due to least transaction costs[76]:

$$M(0)=\alpha < X(0)=\beta < H(0)=\gamma$$

Due to their different ability to implement coordinative adaptation that is required for asset specificity (k), the marginal growth of transaction costs in relationship to asset specificity is

[76] Williamson also uses the terms 'governance costs' (1991) and 'bureaucratic costs' (2005).

the highest for markets (M), medium for hybrid institutional arrangements (X) and the lowest for hierarchies (H): $\frac{\partial M}{\partial k} > \frac{\partial H}{\partial k} > \frac{\partial H}{\partial k}$

As a result, the transaction costs for hybrid institutional arrangements are the lowest with intermediate asset specificity between k_1 and k_2 (compare with Figure 5-4). With asset specificity higher than k_2, the hierarchy provides the least transaction costs[77].

So far the presented theoretical framework only attempted to economize transaction costs to align institutional arrangements with respect to asset specificity. The other two attributes of transaction, i.e. uncertainty and frequency, have so far been left unconsidered. As part of a static comparative analysis, Williamson (1991) investigated the impacts of uncertainty, especially the frequency of disturbances, on institutional arrangements. It is argued that hybrid institutional arrangements meet sever problems with increasing uncertainty, because increasing adaptation requirements are costly and time consuming under neoclassical or relational law regime. As shown in the following Figure 5-5, hybrid institutional arrangements might not be appropriate anymore for enduring exchange regimes with high uncertainty, due to their failure to adapt adequately.

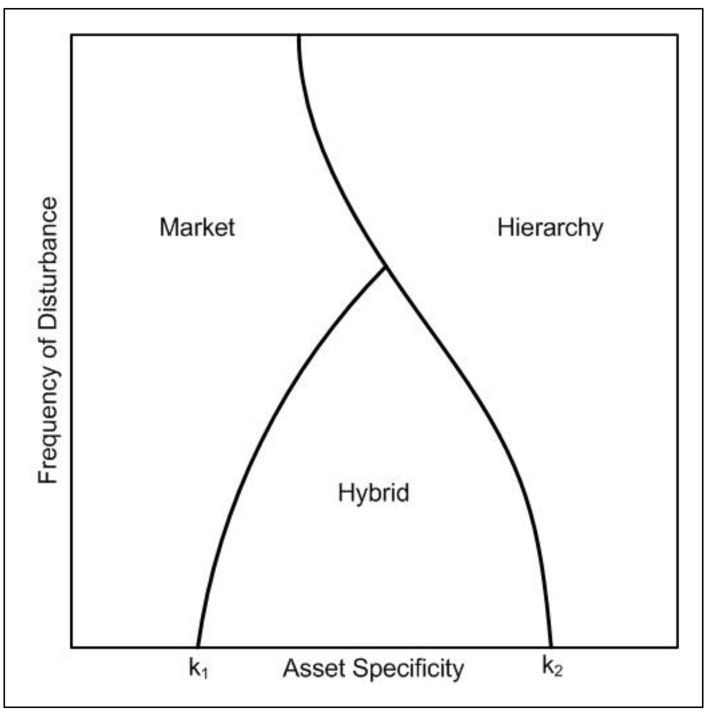

Figure 5-5: Transaction cost economizing of institutional arrangements with respect to uncertainty

Source: Williamson (1991)

[77] For a more formalized theory of vertical integration and transaction cost economics, see e.g. Grossman & Hart (1986).

The following Figure 5-6 was developed by Williamson (1999) and it displays a heuristic contracting scheme that is based on the attributes of a transaction. If the transaction involves no idiosyncratic investments to a non-trivial degree, the spot market will be chosen. If the transaction requires idiosyncratic investments and no contractual safeguards are provided, an unrelieved contractual hazard will be expected, whereby a farsighted contractual party will charge a price with a high risk premium. It may also be possible that no contractual party can be found at all due to anticipated high uncertainty. If the transaction requires idiosyncratic investments and contractual safeguards (neoclassical contracts, relational contracts or forbearance) are in place, the transaction will use either hybrid institutional arrangements or internal organization.

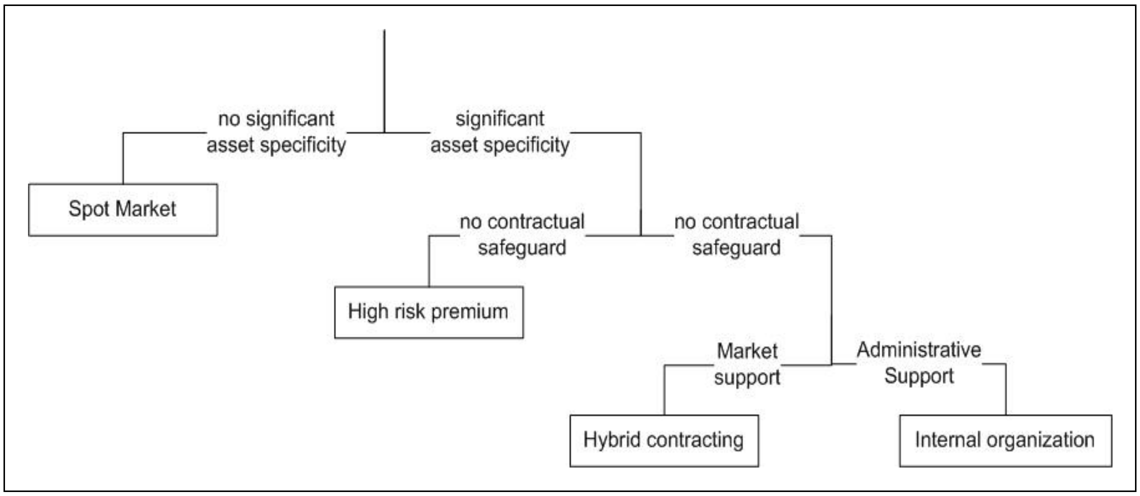

Figure 5-6: Heuristic contracting scheme
Source: Adopted from Williamson (1999)

Due to high transaction costs[78] for internal organization, Williamson (1999) argues that "internal organization is usefully thought of as the organization form of last resort: try markets, try hybrids, and have recourse to the firm only when all else fails".

5.3.7 Existing empirical support for transaction cost economics

In comparison to industrial organization or the theory of the firm, the theoretical framework of transaction cost economics has been subject to extensive empirical analyses. Today, there exits a vast number of empirical studies to support the basic tenets of transaction cost economics. Early empirical work was carried out in specific industry sectors, e.g., coal burning power plants (Joskow, 1985, 1988, 1990), natural gas supply (Masten & Crocker, 1985) or shipbuilding (Masten et al., 1991).

[78] Williamson uses the term 'bureaucratic costs', thus emphasizing that the transaction costs accrue within the firm.

An influential survey on empirical research in transaction cost economics was conducted by Shelanski & Klein (1995). More recent aggregations of empirical studies can be found for example at David & Han (2004), Klein (2005), Geyskens et al. (2006) and Carter & Hodgson (2007).

Given the strong empirical support, it is very persuasive to use transaction cost economics as the theoretical framework for analyzing institutional arrangements of the MSWC plants. For that purpose, its application to (i) public ordering in general and (ii) the unique characteristics of the MSWC infrastructure will be discussed in the next two chapters.

5.3.8 Application to public ordering

5.3.8.1 General

Although not explicitly said, the standard theoretical framework of transaction cost economics, as presented so far, is primarily concerned with transactions between private firms. The question is now whether or under what conditions, the concept can be expanded to transactions involving the public sector and the political systems. Looking back at the historical evolution of transaction cost economics, the necessity to raise this question is rather surprising, because much of the theoretical foundations are the result of the public policy analysis of market failure problems (Williamson, 1971).

In comparison with the vast number of theoretical studies on transaction cost economics regarding institutional arrangements in the private sphere, there are only very few theoretical approaches to extend the model to public procurement (Genugten, 2005; Glachant & Saussier, 2006).

As stated early, there exist thematic linkages between public choice theory and transaction cost economics, and Furubotn & Richter (2005, p. 477) argue that Williamson's transaction cost economic approach also applies to institutional arrangements for political relationships.

One expansion of transaction cost economics to public bureaucracies and policies has been done by Williamson (1999). Hereby, in addition to the transactional attributes of asset specificity, uncertainty, frequency and duration (see chapter 5.3.2), public transactions are further ascribed by the attribute of *probity*, referring to the need for acting with strong moral principles and honesty. This extension of Williamson has only very limited applicability to the analysis of institutional arrangements for the MSWC projects, because it focuses on sovereign public transactions such as redistribution, regulation, foreign policy or judiciary. Transactions for the procurement of public infrastructure and service delivery are explicitly excluded (Williamson, 1999).

5.3.8.2 Applying the heuristic model

Two important constraints have to be considered when applying the transaction cost economic framework to the public sector. The first constraint concerns the application of contract law theory to transactions where one party is from the public sector. In many countries, formalized public procurement law is very stringent and restricts the selection of contractual partners[79]. Therefore, the informal institutions as part of institutional arrangements might play a smaller role. In addition, public procurement law might restrict the application of relational contracting for transactions. Also, the private parties might not have the same incentives to apply relational contracts, because no advantage will result from “informal good behavior”, if the transaction partners are chosen purely on formal aspects. As a result of public procurement restrictions, hybrid institutional arrangements that include public partners will more likely rely on neoclassical contracts than on relational contracts, therefore leading to higher transaction costs.

The second constraint concerns transaction costs for hierarchical production within the public sector. In case the incentives are lower within the public sector (for example because higher efficiencies are less rewarded internally than in the private sector), the transaction costs will be comparatively higher.

The following Figure 5-7 shows the impact of higher transaction costs on hybrid arrangements and hierarchy in the public sector.

[79] Such restrictions are e.g. (i) required open tendering, (ii) contract award to lowest price or (iii) prohibition or limitations in negotiating ex ante or ex post.

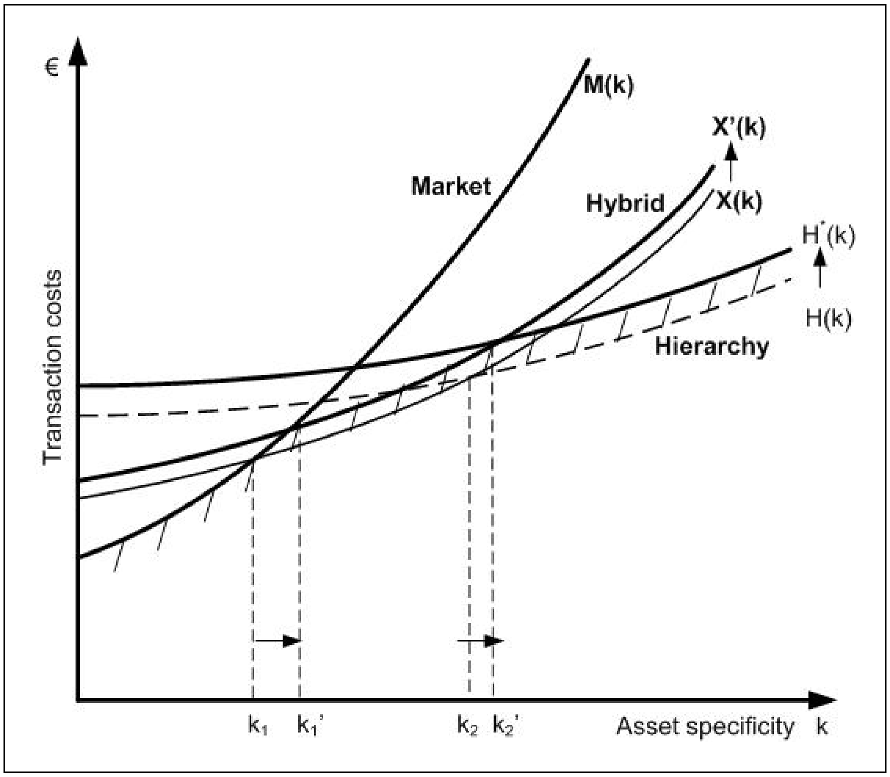

Figure 5-7: Change of transaction costs for institutional arrangements in the public sector
Source: Own, based on Williamson (1991)

The model indicates that the order of selecting institutional arrangements remains the same in relation to asset specificity. The major difference is that lower transaction costs for (i) hybrid arrangements in comparison to market and (ii) hierarchy in comparison to hybrid arrangements will come into effect with higher asset specificity (the points move to k_1' and k_2' respectively). It is interesting to observe in this theoretical model, that the distance between k_1 and k_1', representing the change in asset specificity, is larger than the distance between k_2 and k_2'. Depending on the increase of transaction costs for public hybrids (X') it is even possible that the point k_2 does not move at all or that it moves to the left (see appendix 4).

For other attempts to apply the theoretical concept of transaction cost economics to the public sector (especially policy aspects) see e.g. Bryson & Ring (1990), Hart (2003), Dollery (2001), Obermann (2007) and M. A. Nelson (1997).

5.3.8.3 Privatization taxonomy and institutional arrangements

As elaborated in chapter 5.3.5, there exists a wide range of applicable institutional arrangements to structure transactional exchange between different parties. The terminology usually changes when institutional arrangements are discussed with a public organization acting as the principal of the transaction. Here, the various forms of privatization are used to describe institutional arrangements for public ordering.

The following Figure 5-8 shows the taxonomy of different privatization forms and their allocation to the institutional arrangements of hierarchy, hybrid and market. Public administration[80] and formal privatization are referred to as the institutional arrangement of hierarchy, whereas functional privatization and partial material privatization are hybrid institutional arrangements. Depending on the contract duration, full material privatization is either a hybrid institutional arrangement (using long-term contracts) or a market arrangement (using short-term contracts in a spot market)[81].

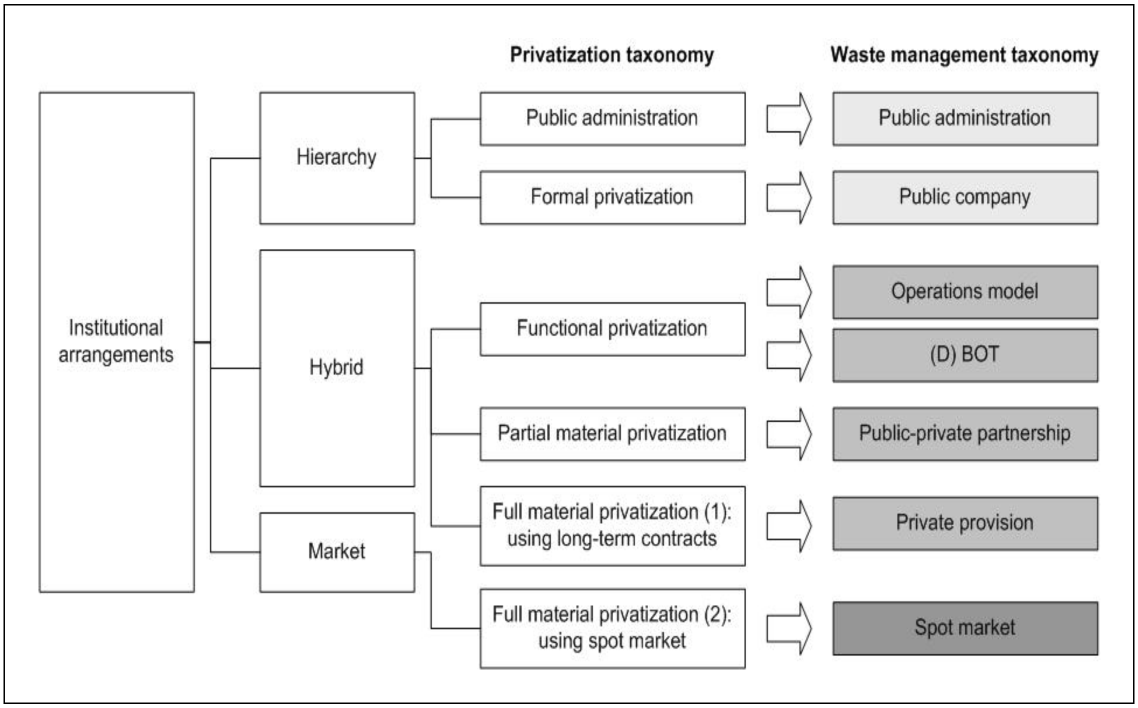

Figure 5-8: Privatization taxonomy and institutional arrangements

Source: own

Public administration

An internal production (vertical integration) by the public sector within its own bureaucratic and administrative organization is called *public administration*. Often a discrete unit (e.g. cost centre, bureau of public works) is established to separate the production from other public entities. The legal system in some countries (e.g. Germany) even allows the outsourcing of production into a public company which operates under public law.

[80] Also: public bureaucracy

[81] It should be that the presented taxonomy of institutional arrangements and privatization forms applies only to transactions, in which the public sector remains the principal of contracted tasks and services.

Public administration is often also-called “internal outsourcing” or “commercialization”, because here various functions are usually reorganized and restructured in a separate unit with the adaptation of management techniques from the private sector (see e.g. Kessides, 1993, p. 24).

Formal privatization

Formal privatization describes the transfer of production from the public administration to a legally independent entity under private law which remains under 100% public ownership. This institutional arrangement is still considered a hierarchy, because production continues to be done within the public domain (principal and agent are within the same extended public sphere). The objectives of a formal privatization often comprise fiscal and labor-related issues, improved commercial management structures as well as reduced (but by far not abolished) political influences. Formal privatization is often implemented before creating another hybrid institutional arrangement (see B. Weber et al., 2006, pp. 57-59).

Functional privatization

Functional privatization is understood as the timely limited transfer of formerly public production by a public administration or formally privatized public company to an independent company under 100% private ownership. Basically, all forms of contractual relationships between a public principal and a private agent, where the responsibility of production returns to the public sector after the completion of the contract, fall under this category. For such functional privatization it is irrelevant whether only single goods and services (e.g. construction works) or complex and integrated tasks (e.g. Design-Build-Finance-Operate) are transferred (Alfen & Kleiss, 2003). Due to the relational characteristics of the timely limited contract and the bilateral dependencies between public principal and private agent such functional privatization is categorized as a hybrid institutional arrangement.

Partial material privatization

The permanent formation of a joint venture company under shared public and private ownership is called partial material privatization. The respective distribution of ownership can range between the two extremes of 1% to 99% (Alfen, 2007). In this hybrid institutional arrangement, which is often also-called horizontal partnership, both parties pool their resources for an unlimited period of time to jointly produce the publicly ordered goods and services.

Full material privatization

Full material privatization describes the permanent transfer of production to a 100% privately owned company. Hereby, all assets that are required for the production are owned by the private agent. These assets are either newly developed by the private sector or they have been initially under public ownership and were transferred to the private company at a later stage.

The full material privatization can be categorized as a hybrid arrangement whenever a long-term contract for a high number of transactions exists between the public principal and the private agent (enduring exchange regime)[82]. In case of short-term contracts for each individual transaction in a spot market, such institutional arrangement can be classified as a market arrangement.

5.3.9 Critical comments on the transaction cost economic approach

In the past two decades, the body of theory that is embraced by new institutional economics became a distinct school of economics and received strong followings (Ménard & Shirley, 2005). Especially the discipline of transaction cost economics has been used by a vast number of scientists for analyzing a wide range of institutional and organizational aspects in the economy.

No theory, however, exists without shortcomings and one must also be aware of the limitations imposed by transaction cost economics (for a review of criticism see Furubotn & Richter, 2005, p. 195). The most severe criticism is formulated by the assertion that economic actors rather aim at minimizing only their own transaction costs, whereas the total transaction costs are only of subordinate interest to them. Therefore, the individuals might often search for the institutional arrangement that shift transaction costs to the other party without necessarily implementing the most efficient one (Dollery, 2001).

It is important to bear in mind the criticism to transaction cost economics when applying the economic concept to exploring institutional arrangements in real-world environments. Transaction cost economics provides however a very valuable framework for a positive analysis of transactions that involve idiosyncratic investments (Mühlenkamp, 1999), and therefore it can be regarded as one pillar to pursue the objectives of the present research.

Many concepts that have been developed to measure and model transaction costs and their effects to institutional arrangements are truncated because they leave out the interrelationships with production costs and revenues (see e.g. Williamson, 1991). Therefore, a further comparative analysis of institutional arrangements for the MSWC must not only focus on transaction costs, but also on production costs. Hereby, the aspects of unit costs in relation to plant size (economies of scale) and location of production must be considered (see chapter 3.4).

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[82] Such arrangements are similar to long-term supply contracts between private parties. An analysis of such hybrid institutional arrangements can be found e.g. at Joskow (1985) or Masten & Crocker (1985).

Another criticism is related to behavioral aspects. Although the impacts of bounded rationality and opportunistic behavior are fundamental elements of transaction cost economics, the theory widely disregards other aspects of human nature. Ghoshal & Moran (1996) argue that transaction cost economics is not suitable as a normative theory, because highly relevant issues of culture, learning and trust within organizations are generally neglected (see also Dyer, 1997). However, they acknowledge the potential strengths as a positive theory if carefully applied within specific contexts[83]. This criticism is taken very seriously for this research and therefore an elaboration on different stakeholders in the MSWC projects is done in the next chapter (see below).

5.4 Application of transaction cost economic approach to MSWC

Williamson (1985b, p. 41) argues that "any problem that can be posed directly or indirectly as a contracting problem is usefully investigated in transaction cost economizing term". Based on this insight, the theoretical framework of transaction cost economics is now applied to the MSWC by (i) determining the attributes of the transaction *municipal solid waste combustion* and by (ii) elaborating on the characteristics of applicable institutional arrangements.

Before applying the theoretical framework, it is important to define the single transaction for the analysis within the MSWC. Based on the general definition of an individual transaction as a transfer of a good or service across a technological interface (see chapter 5.3.1), a single transaction within the MSWC is defined as a single unit of municipal waste to be treated at an MSWC plant. The smallest transactional unit is usually a container (e.g. 20Mg) that is delivered by a truck or other vehicle. The physical transfer across the technological interface takes place when the waste is unloaded from the truck into the waste bunker. The accurate size of the transaction, i.e. the weight of the bulk waste, is determined by weighing machines at the gate of an MSWC plant[84].

5.4.1 Attributes of the transaction MSWC

5.4.1.1 Asset specificity

The asset specificity of the MSWC plants is comparatively high in two respects: First, site asset specificity is very high, because it is very expensive to dismantle existing facilities and to rebuild them at another location. Also the planning approvals restrict the location of the plant. Secondly, the physical asset specificity is also comparatively high. The MSWC plants are usually built to treat residual waste from households or commercial sources with specific

[83] Williamson (1996) directly responded to their critique: "Transaction cost economics is an empirical success story. Ghoshal and Moran should come to terms with that."

[84] A long-term waste treatment contract could therefore easily include tens of thousands of transactions.

characteristic (e.g. NPV, moisture content, chlorine concentration, etc.). The redesigning for thermal treatment of other waste types (e.g. RDF, industrial waste or medical waste) or for burning other fuels (e.g. coal or biofuel) would be very costly and time consuming.

The other two types of asset specificity, i.e. human asset specificity and dedicated assets, are evaluated as low to medium. Human resources that are required for operating an MSWC plant need special training and experience. In the medium run, however, it is likely that new employees will be found to replace former staff if necessary. From a technical point of view, assets of the MSWC plant are not dedicated to a specific principal, because the characteristics of waste from different municipalities are very similar.

5.4.1.2 Frequency

Two different forms of frequency are differentiated: First, the frequency of transactions can be interpreted as the number of transactions between the public principal and the client (owner of an MSWC plant). This frequency depends on the municipal waste generation rates within the municipality, which in turn depends largely on the number of households and commercial organizations (see also chapter 2.4.2). Obviously, the transaction frequency for smaller municipalities is much lower than for larger municipalities. The frequency can be increased, if municipalities bundle their demand in the so-called inter-communal cooperations (see below).

The second form of frequency refers to the number of transactions among all partners within the boundary of an economy. In this context, it is very important to analyze the administrative, legal and geographic borders of the waste management system. In many countries, there are laws restricting the transportation of waste across regional or national levels.

5.4.1.3 Uncertainty

Uncertainty is differentiated between volume and technological uncertainty. The latter is comparatively high, if new technology has not been tested over longer periods of time. In the beginning of modern waste combustion in the 1960s and ‘70s, the technological uncertainty was relatively high. Nowadays, these uncertainties are much lower, especially if a supplier of machinery equipment possesses a track record or if operators have a larger number of horizontally integrated the MSWC plants, among which knowledge can be shared.

Volume uncertainty reflects changes in demand, i.e. anticipated changes in waste generation rates. Also uncertainty with respect to waste characteristics (e.g. NCV) must be considered in this context. A generalized proposition about the uncertainty in MSWC cannot be made as it depends on the specific institutional environment.

5.4.1.4 Conclusion

The attribute of asset specificity of the transaction the MSWC expects that hybrid institutional arrangements or hierarchy are preferred to the institutional arrangement of market. In theory, the preference between hybrids and hierarchy rather depends on the attributes of frequency and uncertainty than on degree of asset specificity (site and physical asset specificity are almost equal among different transactions). Based on the theoretical framework of transaction cost economics, comparatively high frequency of transaction (e.g. in large municipalities with high aggregated waste generation volumes) and high uncertainty (e.g. unpredictable changes in waste law or technological uncertainty) would support the institutional arrangement of hierarchy.

The next chapter will present an overview of theoretically applicable institutional arrangements for the MSWC projects.

5.4.2 Institutional arrangements for MSWC

The description and characterization of institutional arrangements for the MSWC can be derived from the classification of institutional arrangements within the privatization context (see chapter 5.3.8.3). This approach is appropriate, because the public sector is responsible for ensuring an integrated municipal waste management system and it is therefore the principal for the MSWC infrastructure and services (see chapter 1). In theory, the public sector (usually the municipality) can therefore choose between hierarchical institutional arrangements of internal production, various hybrid institutional arrangements and market arrangement.

Within the infrastructure sector of waste management[85] a sector-specific taxonomy has emerged and is widely used to describe the various applicable institutional arrangements (see e.g. Berenyi, 2006; Cointreau-Levine & Coad, 2000; Kusenbach, 2002; Lee, 1997; Wagner, 2000). This taxonomy will be adopted with only minor changes in the further analysis of this research. The following Figure 5-9 shows the seven most relevant institutional arrangements in the waste management sector and their allocation with respect to the privatization taxonomy.

[85] The taxonomy is very similar to the water sector, but differs partly to the sectors of public real estate and road infrastructure.

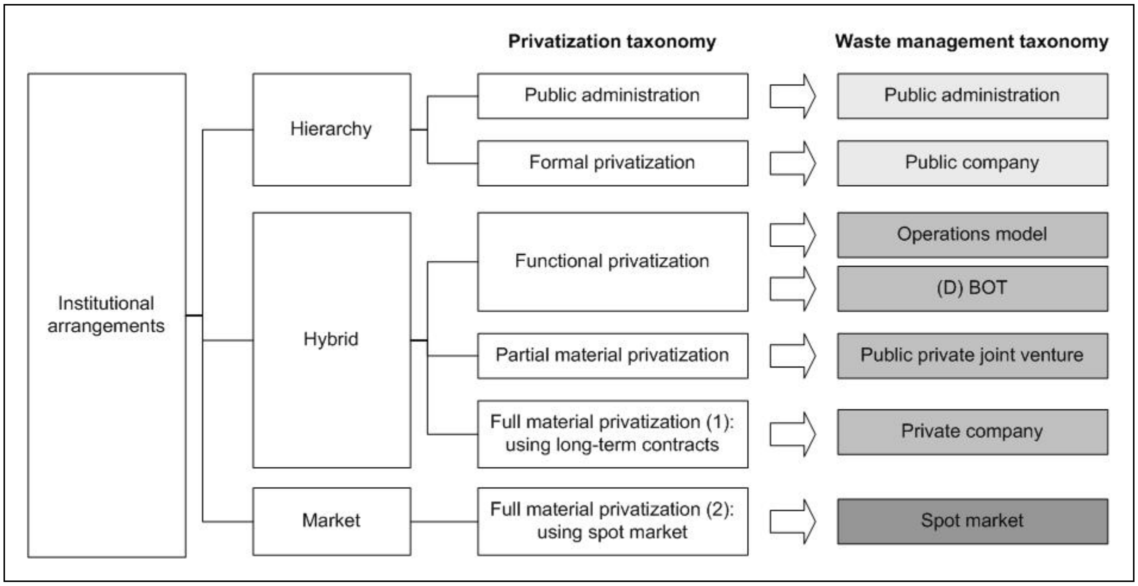

Figure 5-9: Institutional arrangements with waste management taxonomy
Source: own

Four important attributes have been identified to describe and characterize different institutional arrangements for the MSWC (see also chapter 5.4.1):

1. *Asset ownership* indicates whether the public principal or the private agent is the owner of assets. This issue is very important due to the high asset specificity of the MSWC plants.
2. *Duration* specifies the time frame of the institutional arrangement during which the transactional exchange takes place.
3. *Operation* defines the distribution of rights and responsibilities for technically operating the assets.
4. *Demand risk allocation* identifies which transactional partner assumes the volume uncertainty, i.e. who bears the positive and negative effects of changes in waste combustion quantities and qualities.

Based on these elaborated attributes, the most significant and theoretically applicable institutional arrangements for the MSWC can now be modeled and described below. Hereby, only the principal institutional arrangements for the MSWC are outlined. A further degree of details and separation is not necessary at this stage.

<u>Public administration</u>

Every hierarchical institutional arrangement within the public sector that operates under public law can be classified as *public administration*. Based on the institutional environment, i.e.

aspects of the public law, different organizational and legal forms of public administration might be available[86].

The institutional arrangement of public administration is characterized by public ownership and operation of assets for an unlimited period of time. All demand risks are borne by the public sector. An important feature of public administrations is the fact that they cannot go into bankruptcy.

Public company

The hierarchical institutional arrangement of *public company*[87] is identical to formal privatization (see chapter 5.3.8.3). Hereby, the public sector founds a legally independent company under private law which owns and operates the MSWC plant for an unlimited period of time. Similar to the institutional arrangement of public administration, all demand risks are internalized within the public sector. Even though the public company enjoys more operational autonomy than the public administration, production continues to be done within the sphere of the public sector and it is therefore classified as hierarchy.

Operations model

In the *operations model* the technical operation of the MSWC plant is outsourced to a private company for a longer, but limited period of time (usually 10-20 years). The assets remain under the ownership of the public principal, which also carries all demand risks. Due to the long-term mutual dependency between public principal and private client, any arrangement is referred to as a hybrid arrangement under which the technical operation of an MSWC plant is outsourced for a longer period of time[88].

A special form of the operations model exists if the same private company builds an MSWC plant and after transferring ownership of assets to the public principal, operates the facility over a longer period of time[89].

(Design)-Build-Operate-Transfer

As the name *Build-Operate-Transfer* (BOT) implies, this hybrid institutional arrangement encompasses the construction of an MSWC plant by a private company, which operates it for a

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[86] E.g. in Germany, there exist three different options. See chapter 6.1.4.

[87] Also referred to as *state-owned-enterprise*

[88] In case of an outsourcing of other value chain elements (i.e. design or construction), as done in the institutional arrangement of public administration or company, the same level of mutual dependencies doesn’t exist between public and private.

[89] Also-called: Build-Transfer-Operate (BTO)

limited period of time[90]. During the contractual period, which usually lasts for 15 to 25 years, the assets are owned by the private agent and will be transferred at the end of the contractual period to the public principal. The private agent also usually finances the assets and receives compensation during the operational phase that can be based on different applicable payment structures.

In case the entire MSWC life-cycle also including its design is transferred to the private agent, this institutional arrangement will be called *Design-Build-Operate-Transfer* (DBOT). In both cases, however, the public agent specifies the capacity of the MSWC plant and carries all demand risks.

Public-private joint venture

In the hybrid institutional arrangement of *public-private joint venture* the assets of the MSWC are jointly owned and operated for an unlimited period of time by a public and private entity[91]. The public entity could either be a municipality or a public company under private law. A typical characteristic of this institutional arrangement is that commercial and technical risks including demand risks are shared between both partners. Specific characteristics of the risk sharing mechanism are specified in the shareholder agreement.

There are two options for the creation of a public-private joint venture. First, the public and private partners can jointly found a special purpose company, which develops the MSWC plant. Another option for its formation is the sale of shares of a formerly publicly owned company to a private partner (Bognetti & Robotti, 2007).

Private company

In the hybrid institutional arrangement of *private company*, the assets of an MSWC plant are owned and operated by a private company for an unlimited period of time. Hereby, the private company owning the MSWC plant has signed one or multiple long-term waste treatment contracts with public municipalities that are usually tendered under open competition. The aggregate quantity of all waste treatment contracts guarantees a minimum capacity utilization of the MSWC plant to secure investments. The waste treatment contracts usually have a

[90] The transfer of the entire life-cycle to the private agent for a limited period of time is also-called "contractual public private partnership" (Alfen, 2007; European Commission, 2004). In the real estate sector, this institutional arrangement is called "public-private partnership".

[91] A public-private joint venture is also-called "institutional public-private partnership" (Alfen, 2007; European Commission, 2004). In the waste management sector, this institutional arrangement is called "public-private partnership".

duration of 10 to 20 years and normally guarantee minimum waste quantity and qualities[92]. In this institutional arrangement, the total capacity of the plant is specified by the private owner, which therefore bears overall demand risks. Due to the enduring exchange regime of the long-term waste treatment contracts, the private client and public principal remain mutually dependent on each others.

Spot market

The theoretical institutional arrangement of *spot market* is partly similar to private company, because the assets of an MSWC plant are fully owned and operated by a private company for an unlimited period of time. In contrast with private company, however no enduring exchange regime exists between the public principal and the private agent due to the lack of any long-term contract. The short-term (sometimes implicit) contracts embrace only single transactions and the contractual specifications change constantly. In a private spot market the public principal could constantly choose among different private MSWC plant for every single transaction. There exists no prior agreement concerning time, quantity, quality or price of waste deliveries.

[92] Another option is that the municipality obliges itself to deliver residual municipal exclusively to the contracted MSWC.

5.4.2.1 *Summary*

The following Table 5-3 provides a summary of the theoretically applicable institutional arrangements for MSWC infrastructure, their characteristics and applied contract theory:

	Hierarchy		Hybrid				Market
Privatization taxonomy	Public administration	Formal privatization	Functional privatization	Functional privatization	Partial material privatization	Full material privatization (1): long-term contracts	Full material privatization (2): spot market
Waste taxonomy	Public administration	Public company	Operations model	(D)BOT	Public-private joint venture	Private company	Spot market
Asset ownership	Public	Public	Public	Private	Shared	Private	Private
Duration	Perpetual	Perpetual	Enduring for limited period	Enduring for limited period	Perpetual	Enduring for limited period	Momentary
Demand risk	Public	Public	Public or shared	Public	Shared	Shared or private	Private
Operation	Public	Public	Shared	Private	Shared	Private	Private
Contract theory	Forbearance	Forbear-ance	Neoclassical	Neoclassical	Neoclassical/ relational	Neoclassical	Classical

Table 5-3: Institutional arrangements for MSWC

Source: own

5.5 Stakeholder Analysis

5.5.1 General

In order to analyze institutional arrangements, it is important to obtain a profound understanding of the stakeholders involved and their interests. According to the sociological concept of methodological individualism (Schumpeter, 1908; M. Weber, 1922) and the stakeholder approach (Freeman, 1984), it is emphasized that the objectives stakeholders matter. Within the research contexts, stakeholders are any organization or individuals that are affected by a MSWX project.

As shown in the following the following Figure 5-10, following major stakeholders have been identified and will be analyzed in the following section: citizens of households, politician, bureaucrats, public and private companies, financiers, manufacturers and suppliers, as well as consultants.

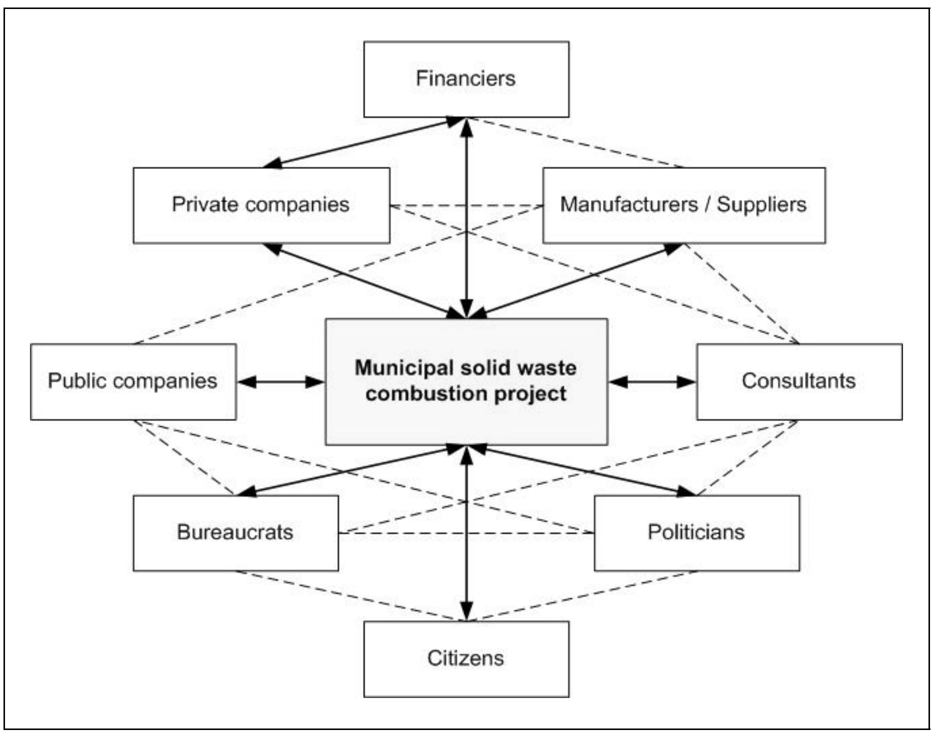

Figure 5-10: Stakeholders of MSWC projects and possible linkages

Source: own

5.5.2 Politicians

Politicians are elected and active members of the government. They have the decision making power to enact laws, regulations, enforcement rules or other formal elements of the institutional environment. With this power they shape the framework in which society and economy function. Because politicians are elected by all citizens, politicians aim at maximizing their votes (Downs, 1957).

Similar to other individuals, politicians behave mostly rationally and pursue personal pecuniary as well as non-pecuniary objectives[93]. Depending on personal preferences, they want to use their positions to maximize power, reputation, popularity as well as their income. Also the objective to shape society according to their personal normative believes (e.g. "creation of a better society and environment") is part of politician's utility functions.

Depending on the political structure of the state, politicians are usually present at three levels: (i) national, (ii) regional and (iii) municipal level. For each level there exist different elections, in which different issues can have an impact on voters' choices. Besides general environmental issues, more detailed aspects of municipal waste management usually only have an impact on municipal political level, where they could become an important "battlefield" for political struggle. Costs and fees for waste management frequently become a political issue, especially if prices for mandatory waste management are already comparatively high or if they are about to be increased.

There are frequent conflicts between political objectives at different government levels. Economic or environmental objectives could be different at national and municipal levels. For example, municipal politicians are often more interested in reducing the unemployment rate or in increasing tax revenues and purchasing power within their own municipality, regardless of their impacts at regional or national levels. They might therefore prefer local public waste management companies and might want to protect them against competition from outside.

The NIMTOO (not in my term of office) phenomenon can often be observed in politics and it also has relevance to municipal waste management. Hereby, politicians might want to delay decisions that, from an objective point of view, might be necessary or preferable within the legislative period. They might fear the loss of votes, if unpopular decisions were made, such to cut the budget, to increase waste management fees or to determine the location of an MSWC plant.

Informal networks and relationships with other stakeholders play an important role for politicians. Especially after politicians retire from official politics, these informal contacts are often used for personal benefit, such as obtaining a lucrative position in a public or private company. Therefore, it can be assumed that political decisions, such as the decision on the selection of an institutional arrangement for the MSWC, could be influenced by anticipated objectives after their term in power.

[93] Especially at municipal level often only leading positions (e.g. mayor) receive compensation for their work. Other politicians (e.g. members of municipal parliaments) receive only marginal financial compensation and therefore non-pecuniary objectives prevail.

Especially municipal politicians could have strong incentives to increase their influence on public waste management companies (see below). Their formal controlling power over companies as part of institutional arrangements as well as informal relationships could be used for assigning well paid positions or contracts to selected persons (Crounauge & Westermann, 2003, p. 77). Memberships of the board of larger companies are also very lucrative for politicians (as also for private persons), because they provide additional income.

5.5.3 Bureaucrats

Government bureaus are the organizations controlled and regulated by politicians through which political objectives can be implemented. Bureaucrats are the individuals who work in bureaus and unlike politicians they are not elected[94]. Government bureaus are usually characterized by a clear division of power among hierarchical offices in a formalized, rigid and linear career system. Formal and informal networks play an important role for bureaucrats within their organization as well as with other organizations and individuals in politics, and public or private companies.

In contrast with public and private companies, government bureaus are characterized by nonmarket and non-competitive nature of their output, which in turn shapes the output of the market. Bureaucrats are usually risk averse, because there usually are only limited rewards for possible profits from taking these risks.

Within the context of the municipal waste management, government bureaus include, for example, national and regional environmental ministries or municipal waste management authorities. Depending on the political assignments, their responsibilities include the development of environmental policies (see chapter 4.3.2), the design of waste management strategies, as well as their enforcement.

There are different theoretical approaches to understand and analyze bureaucracies. These theories are part of the public choice framework which has developed parallel to new institutional economics (see e.g. Buchanan, 2003; Mueller, 2003).

The *budget-maximizing model of bureaucracy* is an influential theory and was developed by Niskanen (1968; 1971) who argues that rational bureaucrats primarily aim at maximizing the total budget of the bureau. In this way they can increase their power. Under the assumption that (i) there exists a known demand for the output of the bureaus, (ii) only the bureaucrats know the true cost function of their output and (iii) the bureau makes a take or don't-take proposal to politicians, Niskanen (1975) formally showed that the result is an excess in output and required budget.

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[94] The head of a bureaucracy who is chosen for a specific legislative period is regarded as a politician and not as a bureaucrat.

The budget-maximizing model has been advanced by other theorists who made changes to the assumptions. Miller & Moe (1983) showed that the excess in output and budget will be lower or possibly even zero, if the demand for the output of the bureaus is only known to the politicians and thus the bureaucrats do not have the power to make take or don't-take proposals[95].

A more recent theory of bureaucracy was developed by Dunleavy (1991). His *bureau-shaping model of bureaucracy* can be understood as an enhancement of the budget-maximizing model and is based on the assumption that rationally acting bureaucrats primarily want to maximize their personal utility rather than that of the bureau. Their utility function is not only based on power (i.e. budget), but also on the nature of their work. Bureaucrats might prefer to do appealing work instead of running large agencies that involve extensive and rigid formalities. Also in this case, bureaucrats are risk averse and therefore often favor the outsourcing of different works. By this they can pursue careers in more exiting and newly structured bureaus, where they continue to enjoy employment securities in combination with decision making power and influence.

Some researchers have challenged the assumptions and conclusions from theoretical models of self-interest seeking bureaucrats. They argue that bureaucrats have professional motivations comparable to those in private companies and that their efforts might even lead to a better outcome than in profit-maximizing firms (Francois, 2000).

Waste management bureaus and their bureaucrats are often identified with the implemented waste management infrastructure or provided services, even if services are contracted out to private companies. Often households do not possess sufficient information about the institutional arrangement and will complain to the bureaucrats if they face problems (whether objectively justified or not). This bias might explain why many bureaucrats prefer public waste management provision, as it allows them to have a direct control and actively influence output levels.

5.5.4 Public service providers

Public service providers are entities owned by the public sector, the respective civil society. In municipal waste management, these entities are either public waste administrations that act under public law or they are public companies that provide services as legally independent entities under private law (see chapter 5.3.8.3).

It could be argued that public administrations (and to a certain extent also public companies) are some kind of bureaus as well, because they are controlled by politicians who employ

[95] See also Mueller (2003, pp. 365-368) for a review of extensions of Niskanen's budget-maximizing model.

them to implement their objectives. The decisive differentiation from bureaus is that these public service providers produce a physical output of specific goods in the market. These goods are often related, but not just constrained, to public infrastructure, such as waste management or public transportation[96].

Public service providers play an important role within the context of municipal waste management, as they can be found for example as public waste collectors, transportation companies or publicly owned and operated the MSWC plants (see chapter 5.4.2). Many public waste companies not only provide services for municipal waste management but also actively engage in the management of commercial waste (Bruch, 2004).

The dependence of public companies on political influences, which determines their degree of decision making freedom with respect to internal organization and management, differs according to the chosen legal form under which they operate. Formally, privatized public companies that are governed by private law usually enjoy more independence by political influences and public constraints, such as labor law or budgetary constraints.

Even though public entities are likely to be threatened by lower efficiency, i.e. higher production costs, compared to private companies, Benz & Frey (2007) argue that some characteristics of public governance have potential advantages in comparison to corporate governance. These include: (i) fixed compensation of management, (ii) division of power, (iii) rules of succession and (iv) institutionalization of competition for leadership within the organization.

Especially at municipal level, publicly owned entities are used as policy instruments (Bernier & Simard, 2007) and present important vehicles to implement political objectives. For example, public waste management companies create local jobs within and outside the organization and generate taxes. Even though public entities should primarily aim at maximizing the utility of a citizen[97], they could also earn profits as quasi-monopolistic producers if the demand were high. If the institutional environment allows, such profits will be frequently used to subsidize other loss-making but politically wanted activities and programs.

There exist frequently substantial information asymmetries between public service providers and politicians controlling them. Especially public companies can be very large and politicians possibly not have the adequate time, resources, capabilities or incentives to efficiently carry out the supervising responsibilities.

[96] In reality, public companies can be found in many more markets outside the physical infrastructure.

[97] Often referred to as a *citizen value*.

5.5.5 Citizens

Citizens live in households and generate different forms of waste as a result of their consumption. Because consumers wish to maximize their free available income and their utility, they are interested in low taxes and low waste management fees.

In addition to the role of waste generators, citizens are also affected by externalities of waste. Depending on the individual's impact, they are interested in the implementation of an environmentally friendly waste management system. Their attitude towards the environment can differ strongly across nations, cultures, traditions or development levels and plays an important role in determining the requirements of a waste management system.

The attention given by the public to issues of waste management and their awareness of such issues change with time and the infrastructure development level. The following Figure 5-11 is based on the issue-attention cycle model that was developed by Downs (1972). Hereby, the attention of the citizen is categorized into (i) pre-problem stage, (ii) alarmed discovery, (iii) euphoric enthusiasm, (iv) realizing the costs, (v) decline of interest and (vi) a final post-problem stage.

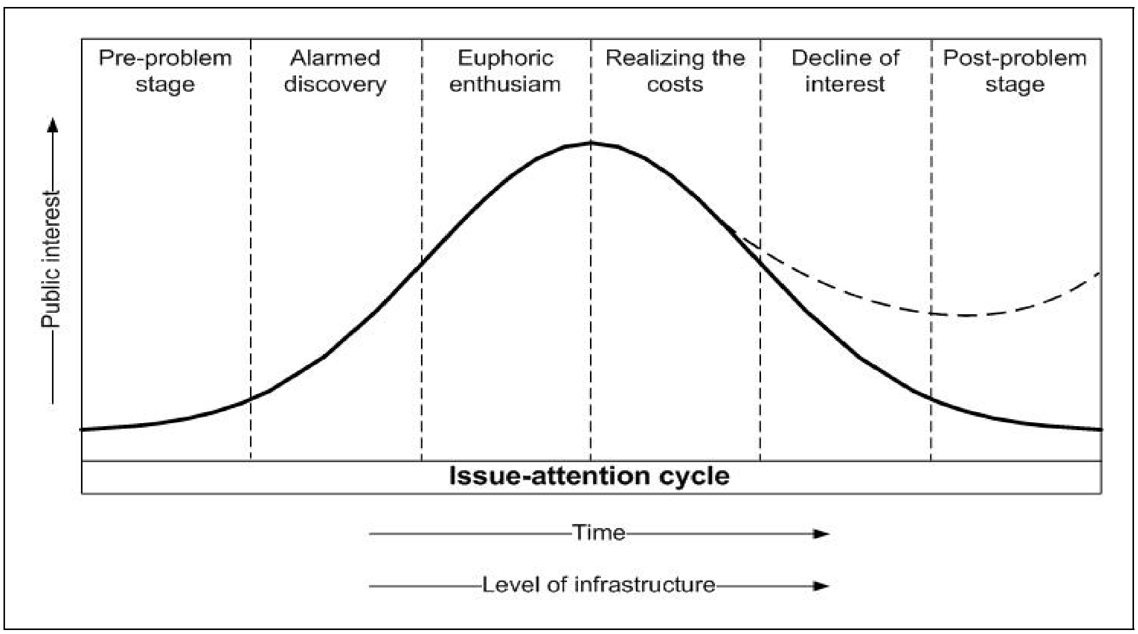

Figure 5-11: Issue-attention cycle for public interest

Source: adapted from Downs (1972)

In many countries with an advanced waste management infrastructure (e.g. Germany), the public interest has reduced in the recent past after an intense period of infrastructure development, followed by realization of the required costs (i.e. high waste management fees).

While most citizens agree on the necessity to implement a waste management system that reduces negative externalities resulting from waste generation, they often oppose the development and operation of waste management facilities, such as landfill-sites, MSWC plants or composting facilities, in their immediate vicinity. Such objectively justified or unjustified opposition is known as NIMBY (not in my backyard) effect and plays a major role in the development of MSWC plants[98].

Besides being waste generators, consumers of waste management services or otherwise affected by waste infrastructure, citizens are also individual voters in democratic societies[99] and elect politicians who define waste management policies (see above). Environmental subjects, including waste management, could have a significant impact on individual vote decisions. Especially at municipal elections, the satisfaction (or dissatisfaction) with waste management services, its costs or anticipated NIMBY projects can become a crucial issue during the election campaigns. It can, however, be expected that citizens possess only bounded rationality, because transaction costs are very high for collecting and analyzing the necessary data and information. If an individual is willing to bear these transaction costs, the personal utility will be very low and positive external effects very high.

While most citizens should be interested in a cost-effective waste management system, some individuals and groups will also benefit from high expenditures, e.g. advanced (expensive) technology, higher wages or continuous advisory contracts. These individuals hence prefer a more costly system and will try to influence politicians and bureaucrats in their decision making (see Olson Jr, 1965).

5.5.6 Private companies

There exist mainly two sorts of private companies, which frequently possess larger stakes in the development and operation of the MSWC plants. These are energy companies and waste management companies[100]. Similar to all private companies, they aim at maximizing the return on their investment and at increasing their shareholder value. But as elaborated below, both pursue different subordinate objectives, due to different core competencies and different abilities to generate added value through vertical or horizontal integration.

[98] See Elliot (1998), Groothuis & Miller (1994), and Inhabler (1992) for more about sociological aspects of waste management infrastructure implementation.

[99] Dictatorships are excluded from the analysis.

[100] There exist also large utility companies, e.g. Suez, that incorporate both, energy generation and waste management services. The German energy company RWE, in contrast, has sold most of its waste management business and only operates a few MSWC plants nowadays.

5.5.6.1 Energy companies

In many countries, energy companies[101] are strongly engaged in the market for MSWC[102]. While a majority of energy companies are completely privately owned, some are still partly or fully owned by the public sector.

The original competitive advantage of energy companies that motivated most of them to expand into the field of MSWC, was created by their expertise in the development and operation of other power plants, e.g. coal burning plants. The traditional technical and managerial competencies that exist within energy companies are outstanding and could be very beneficial if adequately adapted to the unique technical and operational requirements of the MSWC plants. Not all energy companies were successful in doing so and some of them have already exited the market (e.g. RWE).

Most energy companies participating in the MSWC own a portfolio of plants that are horizontally integrated and jointly managed within strategic business units. Energy companies often use existing locations of power plants with other input material to develop an MSWC plant in its direct neighborhood[103]. Thus they can capitalize on existing transport infrastructure, available operational personnel and energy distribution networks. Also, the public acceptance of the MSWC plants in the vicinity of existing industrial facilities tends to be higher.

The strong financial capacity of most energy companies makes it easy for them to finance new MSWC projects from their own balance sheets. Thus, transaction costs are reduced and the project development phase can be shortened in comparison to other modes of finance, such as structured project financing. Furthermore, the expected total return on investment (ROI) is much higher for balance sheet financing.

Energy companies also possess a wide range of social networks with a wide geographic coverage across various infrastructure fields. Such social networks are very helpful when entering new geographic markets (within a state or outside).

The positive external effects of the MSWC (see chapter 3.3.2) are also a strategic reason due to which energy companies have recently increased their activities in this market. Thus, they not only diversify the sources of energy production, but also increase their percentage of energy production from regenerative, i.e. non-fossil, sources.

A competitive disadvantage of energy companies as owners of the MSWC infrastructure in comparison with waste management companies is their reduced capacity and experience in marketing and optimizing waste stream management. They do not possess the same capaci-

[101] Also: utilities

[102] E.g. e.on, Vattenfall (Germany), Covanta (USA), Keppel (Singapore) and Veolia (France).

[103] See e.g. case study TRV Buschhaus in chapter 6.3.9.

ties to offer full waste management services that are often required for commercial, i.e. non municipal, clients. Also, they usually do not want to get involved in logistical activities and therefore will have to ally with waste collection and transportation companies in case a public or private client wishes to outsource the whole waste management value chain.

In markets, where networks of energy distribution (mainly electricity, district heating systems) are not unbundled from energy production, failure in competition can be a threat due to the natural monopoly of network industries and integration of downstream or upstream value chain elements (see chapter 4.2).

5.5.6.2 Waste management companies

As compared to the energy sector, there are a high number of private companies in the waste management market. While smaller waste management companies usually focus regionally and onto one element of the waste management value chain (e.g. waste collection and transportation), larger waste management companies often vertically integrate the entire value chain and operate in larger geographic markets. Thus they can better benefit from their professional expertise in all waste management aspects as well as from their formal and informal social networks. The customers of private waste management companies are municipalities and/or private commercial or industrial clients

Similar to all private companies, waste management companies also aim at maximizing shareholder value by increasing of market share and receiving adequate return on investment. In many developed countries, especially in Northern America and Europe, the market for private waste management has experienced an accelerating process of concentration since the 1990s. Nowadays, there exist many large companies, such as Onyx (Veolia, France), SITA (Suez, France), Remondis (Germany), Cleanaway (Australia) or Waste Management (USA). Also, private equity funds have recently showed increasing interest in waste management companies and add fresh capital into the market for new capital intensive projects and further support the market consolidation.

The macroeconomic impacts of these concentration processes are judged very differently by politicians, antitrust agencies, lobbying groups, as well as researches. On the one hand, it could be argued that only bigger companies are able to integrate the entire value chain, increasing efficiencies and adding value to customers. Also only these large companies have the organizational and financial capabilities to expand into new markets, increasing competition. Pessimists (see e.g. J. Fischer, 1999), on the other hand, focus on the negative macroeconomic effects due to regionally reduced competition and the potential threat of cartelization or setting of predatory prices.

Even bigger waste management companies do not possess the same financial capabilities as energy or utility companies. For larger capital investment, such as MSWC plant, they have to rely more often on bank loans or structured finance products. While external financing has a variety of advantages, it also increases the time required for project development and transaction costs.

5.5.7 Manufacturers and Suppliers

Manufacturers and suppliers design and produce the various components necessary for the MSWC plants. Their objective is to sell their products at highest prices. In the last decade, a consolidation of manufacturers and suppliers can be observed in the market for the MSWC. In Europe, the largest market for the MSWC equipment worldwide, numerous mergers and acquisitions have reduced their number, and by 2007, three large companies (AE&E incl. VonRoll, Martin and Lentjes) dominate the market. Through licensing, their market share is also high in other countries (e.g. Japan, Singapore and USA).

Unlike for example in the real estate sector, where large and medium size construction companies have started to provide the entire project life-cycle for commercial as well as for public buildings (see e.g. K. Fischer, 2007), most manufacturers and suppliers focus on their traditional core businesses of designing manufacturing. They can be categorized as comparatively risk averse as their exposure to the MSWC plants is usually timely limited to the legal guarantee period[104].

More recently, however, some manufacturers and suppliers in the MSWC started to access their strategies and tendencies for expansion into other elements of the value chain can slowly be observed. Larger manufacturers have introduced plans to expand by offering operational and maintenance services, and some are even eager to cover the whole project life-cycle including financing (see case study from Singapore in chapter 7). While their motivation is mostly driven by strategic and financial considerations to become more independent of cyclical changes in demand, they face problems in implementing their strategies. The main reasons are their weak financial capabilities to commit equity into long-term projects as well as their very limited experiences and capacities in the very complex business of operating MSWC plants.

5.5.8 Financiers

The development of MSWC projects is very capital intensive (see chapter 3.4.2.2) and therefore project developers (either public or private) rely on external financial resources. In the vast majority of MSWC projects, public or private banks provide debt in form of loans for fi-

[104] In Germany: two years for equipment and five years for civil works (see BGB).

nancing the capital costs. In some markets, e.g., in the USA, the bond market is also used to raise debt for financing capital costs [105].

As shown by Trescher (2007) for the German market, financiers have only limited impact on the evolvement and development of an institutional arrangement, because they usually become involved in the project after an institutional arrangement was initially shaped. Their investment decision is based on a thorough analysis of the project's risk profile that also depends on the institutional arrangement. In this respect, financiers can play an important role in analyzing and controlling the (contractual) rules between stakeholders within an institutional arrangement.

5.5.9 Consultants and researchers

Consultants are frequently hired by the other stakeholders to give advice on various technical, commercial or legal issues. Similar to politicians, bureaucrats and companies, consultants and advisors also have their own individual norms, beliefs and objectives. There is always the potential threat that consultants recommend what their clients wish (or that consultants are chosen on the basis of their likely output, which is effectively the same). The consultants may also favor institutional arrangements which create higher and continuous demand for advisory and planning services.

Researchers can be put into the same category as consultants. Even though their degree of freedom regarding objectives and neutral behavior is likely to be higher than that of consultants, researchers are not totally independent from other stakeholders and interest groups. As the public sector is a large sponsor of R&D projects, the bureaucrats who administer R&D budgets have incentives in preferring research projects that are not in contradiction to their own interests. Such preferences are likely to be observed at public and private companies as well that frequently sponsor research projects.

5.6 Summary

This chapter has elaborated the theoretical framework for institutional arrangements for MSWC. They are structured by a set of formal as well as informal rules and can take the shape of a hierarchy, various hybrid forms or a market.

Transaction cost economics enjoys extensive empirical support and can be used as a positive theory to explain the emergence of different institutional arrangements which possess different contract law regimes, incentive intensity, administrative support, performance and duration. According to the theoretical model, institutional arrangements are chosen by individuals with bounded rationality to minimize transaction costs that are the functions of asset

[105] A comprehensive overview of financiers and available financing forms for infrastructure development can be found e.g., at Merna & Njiru (2002) or Weber, Alfen & Maser (2006).

specificity, uncertainty and frequency. Among these, the alignment to asset specificity is most significant. One of the main conclusions is that hierarchies will most likely evolve if transactions require idiosyncratic investments, whereas market arrangements mostly emerge for transactions with low (or none) asset specificity. The various hybrid forms lie between these two extremes. High uncertainty in turn, supports the choice of hierarchies.

Later on, the theory of transaction cost economics was extended to the public ordering and it was shown that its main assertions are equally valid, even though minor restrictions concerning contract law regime and incentive intensity in public hierarchies exist. In this context, institutional arrangements were described by using the privatization taxonomy. Public administration and formal privatization are hierarchies, functional and partial material privatization are hybrid arrangements and full material privatization can either be a hybrid or market arrangement depending on the duration of contractual relationships.

By showing that transaction cost economics is also valid for the public ordering its further application to the MSWC is justified. It was shown that comparatively high site and physical asset specificity of MSWC transactions supports to the emergence of hybrid or hierarchical arrangements. The selection between them is likely to be based on the other two transaction attributes of frequency and uncertainty, which depend on project specific factors that cannot be generalized for the entire infrastructure sector. Based on the taxonomy of waste management industry and literature, the following institutional arrangements for the MSWC were modeled and described: public administration and public company (hierarchy); operations model, DBOT, public-private joint venture and private company (hybrid arrangements); and spot market.

The second corner stone of the theoretical framework was formed by an identifying and analyzing major stakeholders in MSWC projects. The stakeholders act opportunistically with bounded rationality and pursue different pecuniary and non-pecuniary objectives that influence the emergence of institutional arrangements. Politicians are important stakeholders to be found at several levels: at macro-level some strongly influence the institutional environment, while at municipal level others have an important impact on the selection of an institutional arrangement. Their decisions are steered by the aim to maximize votes in elections at their political level and in different terms. The political decisions are implemented by bureaucrats who act risk averse in a non-competitive environment. The budget-maximizing model and the bureau-shaping model of bureaucracies show that bureaucrats aim at maximizing their budget (i.e. power) as well as their personal utility. The citizens are important stakeholders as well and assume different roles as voters, waste generators and local residents being affected by externalities of MSWC. Their objectives of low waste management fees, environmentally friendly waste treatment and objections against MSWC in their vicinity (NIMBY) sometimes contradict each others.

Depending on the institutional arrangement, different public and private entities can also be stakeholders. Such public entities include public administrations or public companies, which operate under more or less strong political influence. While normatively aiming at maximizing the social welfare, they sometimes also earn considerable profits for the public budget or cross-subsidies. Private entities are primarily waste management companies and large energy companies that principally aim at maximizing return on investments and at increasing shareholder values. Other stakeholders in the MSWC projects include manufacturers and suppliers, financiers and consultants.

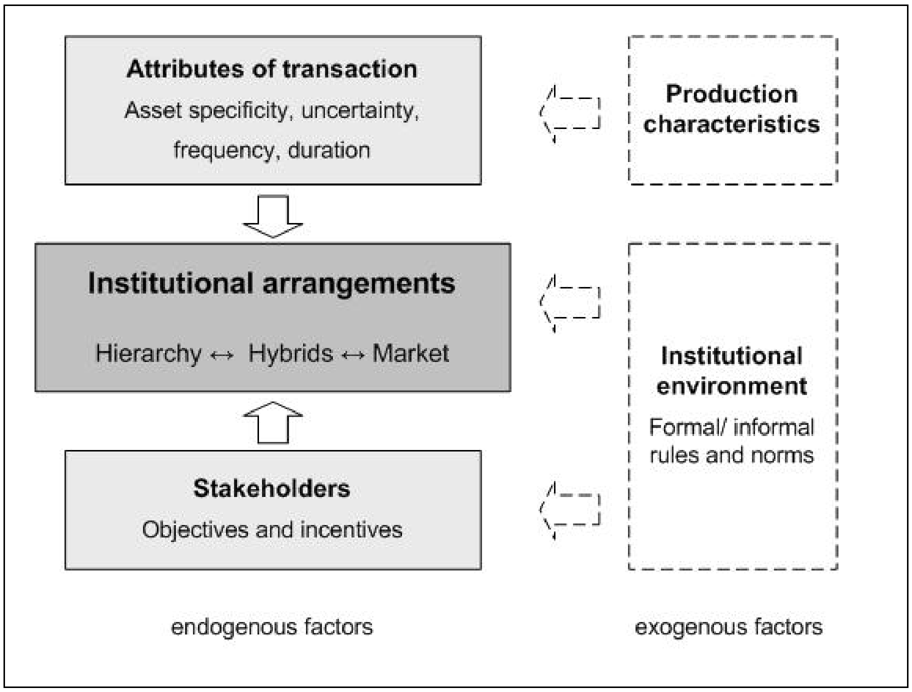

Figure 5-12: Determinants of institutional arrangements
Source: own

The above Figure 5-12 illustrates the key findings from the theoretical analysis: institutional arrangements align to the attributes of the transaction and are formed by stakeholders with different objectives and incentives. In the presented framework, the production characteristics and the institutional environment are treated as exogenous factors.

6 Empirical study in Germany

6.1 Background

6.1.1 Historical development of waste management in Germany[106]

Until the 1960s, most municipal waste was disposed of in one of the 40,000 small and simple dumps that were scattered all around Germany. The strong and continuous growth in industrial production and private consumption in post-war Germany resulted in a steady increase of waste volumes that demanded new solutions to overcome the chaotic situation (Knauer & Ooyen, 1979; Schenkel, 2003).

The first waste disposal act (AbfG) was passed in 1972 and had the objective to restructure and improve waste disposal. As a result, most small dumps were closed and replaced by larger landfills that fulfilled minimum environmental standards. By 1980 there existed around 530 landfills, 22 MSWC plants and 15 composting plants (Bilitewski et al., 1996, p. 4; UBA, 2005a).

The strategic change from simple waste disposal towards the waste hierarchy was initiated with the establishment of a new waste act in 1986. Hereby, waste avoidance became the primary objective on top of recycling and disposal (see also waste hierarchy in chapter 1.1). In 1991, the so-called “Green Dot System” was established on the basis of the Packing Ordinance (VerpackV), imposing a mandatory fee on all packaging materials depending on their type and weight. While the fee should primarily provide an incentive for the producers to avoid or reduce packaging materials, it is also collected to finance the private company “Dual System Germany GmbH” to run a collection and recycling system in parallel to the residual waste management system under public responsibility. The success of the Green Dot System remains disputed, mainly due to limited public participation and unsolved free rider problems.

In the beginning of 1990s, the fear of a “state of waste emergency”[107] was very much present in the political and public discussion. The major reasons were unchanged high volumes of generated waste and lack of sufficient treatment and disposal capacities. To solve the anticipated problems, many regional waste management plans were elaborated and advised the development of new treatment and disposal facilities. As a result, many new composting facilities, MSWC plants and sanitary landfill sites were constructed (Petersen, Malte, & Herrmann, 1999).

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[106] Unless specifically stated, the developments before 1990 reflect only the West German situation.

[107] German: *Müllnotstand*

In 1996, the so-called "Circular Economy and Waste Management Act " (KrW-/AbfG)[108] was legislated and had a far-reaching impact on the further development. Among others, one principal innovation was the extension of producer's responsibility for their waste, excluding most commercial and industrial waste from the responsibility of municipalities. The law also specifically allowed the transfer of municipal waste management tasks and services to private companies (see chapter 6.1.3.1).

Another important milestone in municipal waste management in Germany was the introduction of TASi regulation[109]. From June 1, 2005, this administrative regulation requires that all the municipal waste must be treated prior to its disposal in landfill sites. The regulation had two effects. The first one was the construction of new or the expansion of existing MSWC plants or MBT plants. The second (and unintended) effect was that many landfill sites considerably reduced their prices prior to June 2005 in order to sell as much available capacity as possible. This "price dumping" caused severe economic problems to many MSWC plants.

The year 2005, the total waste amount of 332m Mg was generated in Germany (see Figure 6-1). Most of the waste came from construction and demolition works, while municipal waste only contributed 14.0%.

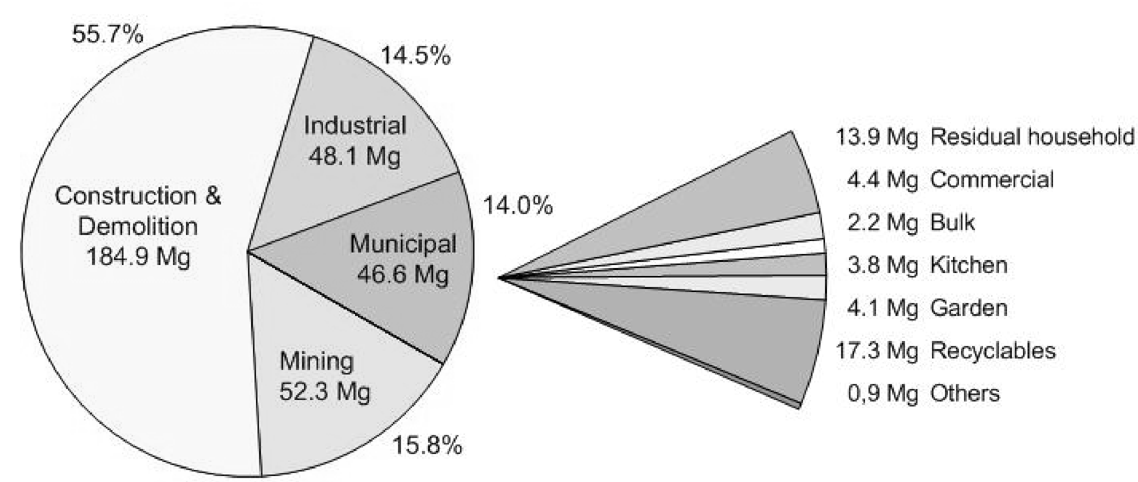

Figure 6-1: Waste composition in Germany by weight
Source: German federal statistical office (2005)

[108] Long title: Act for Promoting Closed Substance Cycle Waste Management and Ensuring Environmentally Compatible Waste Disposal

[109] In German: *Technische Anleitung Siedlungsabfall*

As shown in the following Figure 6-2, the total waste amount has almost remained constant during the last decade. It must be constituted that the avoidance of waste, which should enjoy the highest priority in the waste management pyramid, is not apparent (Bidlingmaier, 2007).

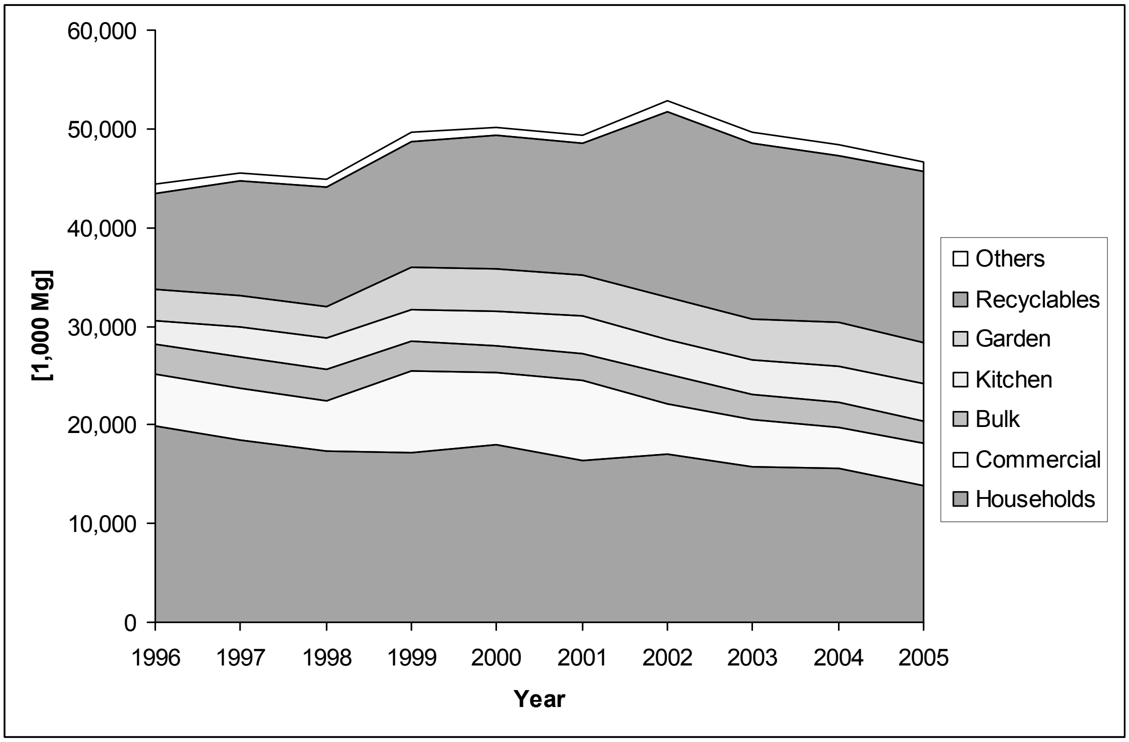

Figure 6-2: Municipal waste generation, 1996-2005

Source: German federal statistical office (2005)

By the year 2020, Germany aims at achieving a zero-landfilling policy by enhancing waste reduction, reuse, separation, recycling and treatment (UBA, 2005b). For MSWC this policy implies that the residuals (slag and fly ash) must be recycled (e.g. as construction material).

6.1.2 History of MSWC in Germany

There exists a long history for MSWC in Germany. The first simple MSWC facility on the European mainland was built in Hamburg in the year 1896 (Stadtreinigung Hamburg, 1996)[110]. The oldest MSWC plants that are still in operation were built in the 1960s and are mostly located in densely populated areas, such as Berlin, Essen or Stuttgart.

[110] At that time there was a cholera epidemic in Hamburg and the neighboring areas refused to take waste from the city to prevent a spread of the disease.

Ever since the number of MSWC plants grew steadily to a total number of 65 the year 2007. The following Figure 6-3 indicates when the existing plants commenced operation[111]. There has been only a small jump in the number of plants in 2005, the year since the TASi regulation requires the treatment of all the residual municipal waste prior to its disposal.

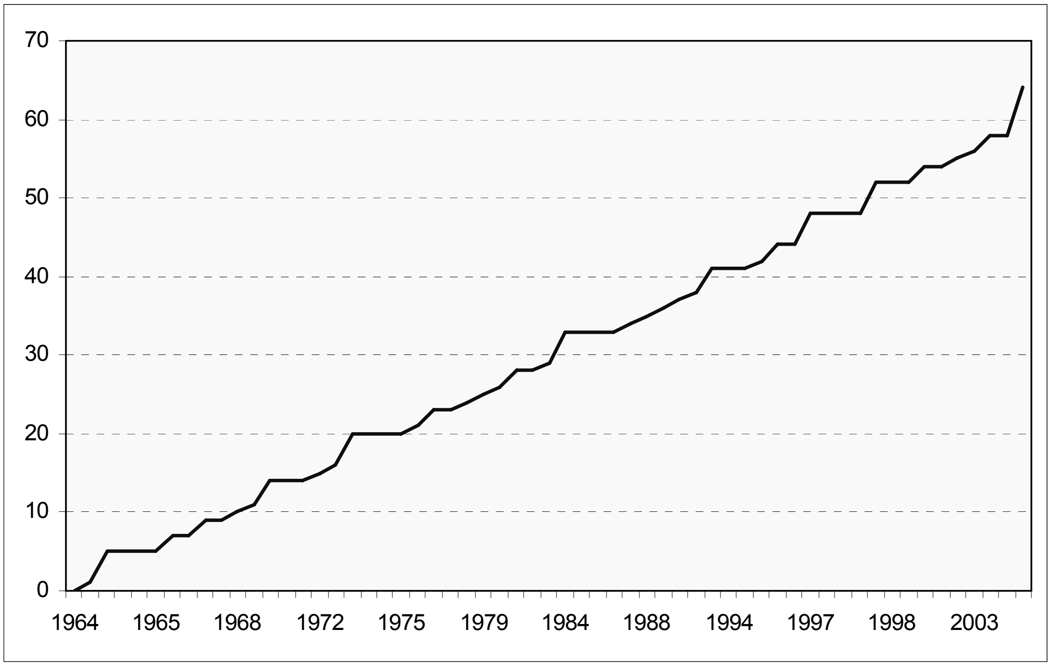

Figure 6-3: Accumulated number of MSWC plants in Germany
Source: Own survey (2007)

At an early stage, MSWC plants had only insufficient flue-gas treatment systems compared to modern standards and hence caused severe pollution in their vicinity due to high emissions of organic and inorganic substances[112]. Due to technological advances and new air pollution laws[113], all MSWC plants have later made high investments to upgrade and improve their flue-gas treatment systems. In comparison with other sources, toxic emissions from MSWC plants are nowadays negligible (see chapter 3.3.1). However, this history of MSWC remains present in the minds of the people leading often to a very low social acceptance, even though this is unjustified from an objective point of view. The development of new MSWC plants therefore often faces strong public objection.

[111] Data on cumulated MSWC capacities is not available, as dates of expansions were not recorded.

[112] Many pollutants, such as dioxins, were often unknown before.

[113] The latest air immission law was 17. BImSchV and came into effect in 1990.

6.1.3 Institutional environment

The following Figure 6-4 indicates informal as well as formal institutions that shape the institutional environment for MSWC in Germany:

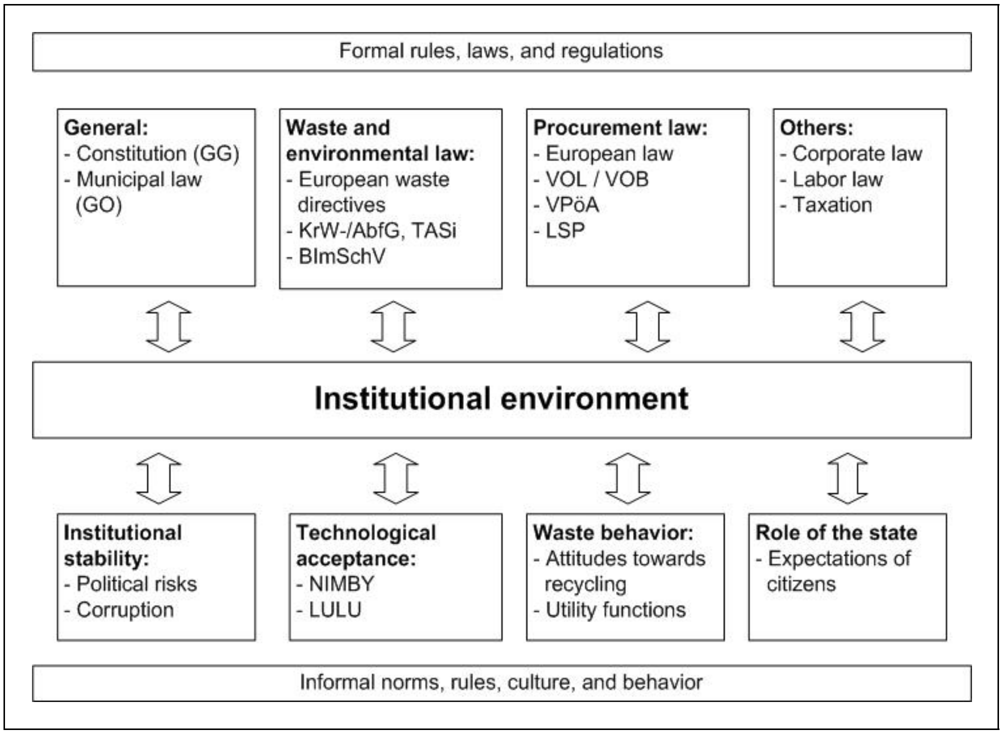

Figure 6-4: Institutional environment for MSWC in Germany
Source: own

The shear number of different institutions makes it practically impossible to reproduce them and present the complex interactions among them. Therefore, only the most decisive formal and informal institutions that influence the development of institutional arrangements for the MSWC in Germany are shortly presented below.

6.1.3.1 Formal institutions

<u>Waste legislation</u>

The waste legislation in Germany is composed of various laws, ordinances, regulations and statutes at different governance levels. The following Figure 6-5 illustrates the hierarchical structure of the legislation for municipal waste management in Germany:

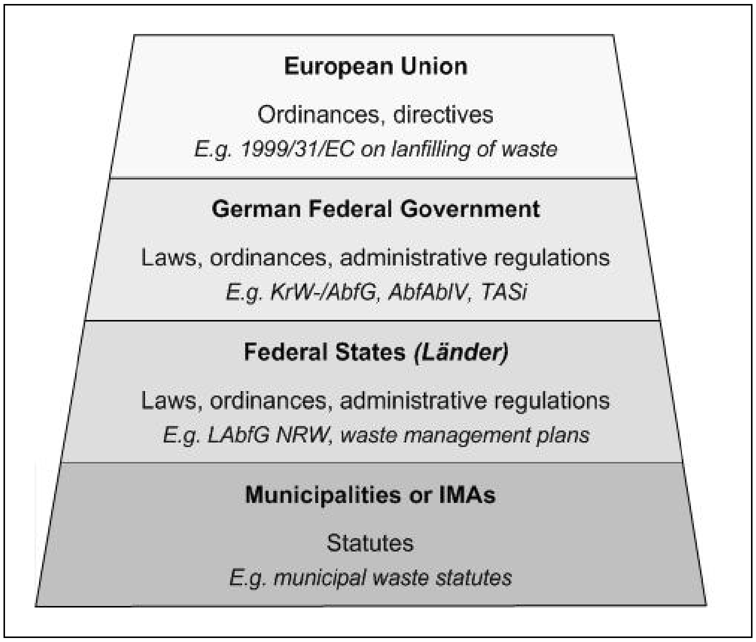

Figure 6-5: Legal framework for municipal waste management in Germany
Source: adapted from (Pschera, 2003, p. 79)

The European Union formulates the coordinative framework for circular economy and waste management in its Member States. Most important corner stones of municipal waste legislation at the European level are the waste directive (75/442/EWG[114]), the landfill directive (99/31/EC) and the waste incineration directive (2000/76/EC).

The EU law is translated at federal level into national laws that are supplemented by numerous ordinances and administrative regulations. The "Circular Economy and Waste Management Act" (KrW-/AbfG) forms the framework of German waste legislation since 1996 (see chapter 6.1.1). Most important supplements are the waste storage ordinance (AbfAblV), the packaging ordinance (VerpackV) and the technical regulation for waste storage of municipal waste (TASi).

Every federal state in Germany has to issue a state waste act (e.g. LAbfG NRW) which translates the KrW-/AbfG into state law. However, federal states (like municipalities) do not have the legal competence to enact any regulation or restrictions that specify the framework for waste avoidance or management of different waste streams.

Based on §29 KrW-/AbfG, federal states are obliged to develop regional waste management plans every five years. These are either planned for the entire federal state or for its individual administrative districts. The plans can determine the development of specific waste treatment and disposal facilities as well as assign municipalities to use them. The federal state is allowed (but not obliged) to enact the waste management plan so that its implemen-

[114] To be replaced soon by 2006/12/EC.

tation becomes mandatory. Only some states have actually enacted their waste management plans, which caused numerous legal disputes with municipalities. In future, it can be expected that waste management plans are developed for monitoring and information purposes rather than for centralized planning (Schink, 2001).

At the lowest level of communal law, municipalities (or inter-municipal associations – see chapter 6.1.4.1) issue statutes that are based on the relevant state law. The statutes reflect and define the local implementation of waste management services (collection, treatment and disposal) and the calculation of waste management fees.

Public responsibility for municipal waste

The German constitution (§28(2) GG) guarantees all municipalities[115] "the right to regulate all local affairs on their own responsibility". Because the municipal waste management is regarded as a local affair, it falls under municipal responsibility. Furthermore, §15(1) KrW-/AbfG assigns the municipalities to implement a waste management system within their jurisdiction. According to §16(1-2) KrW-/AbfG, municipalities can transfer the entire waste management value chain or different parts of (such as MSWC) to third parties under private ownership. Such transfer, however, does not free municipalities from their ultimate obligation to ensure a functioning waste management system (§16(1) KrW-/AbfG).

6.1.3.2 Informal institutions

As elaborated in chapter 5.1, informal institutions, such as social networks or bureaucratic norms, can have a decisive impact on the development of institutional arrangements. They are difficult to observe or to model and unlike formal institutions, differ among individual institutional arrangements and must not be generalized. Therefore, informal institutions within the research context can only be named or be described very abstractly[116].

With respect to municipal waste management, informal institutions include individuals' (and society's) willingness to follow voluntarily the waste hierarchy (see psychological externalities in chapter 4.3.5) or the acceptance of the construction of new waste treatment or disposal facilities.

One important impact of informal institutions onto institutional arrangements for the MSWC are normative attitudes towards public provision of infrastructure as well as the extent to which public companies should get engaged in economic activities. It can often be observed that politicians and citizens in Germany agree on enhanced public production. Initiatives or

[115] The term "municipalities" is used as a synonym for the two communal forms of county (*Landkreis*) and city (*kreisfreie Stadt*).

[116] See to case studies for examples of specific informal institutions.

strategies to privatize public companies are often heavily discussed in national and local media[117].

As compared to other developed countries, corruption levels are relatively high in Germany. Among developed countries, Germany ranks the lower half of the global corruption index (Transparency International, 2007). Unfortunately, the waste industry (under public as well as private provision) has not remained unaffected by corruption and one of the largest corruption scandals in the recent German history was disclosed after the development of the MSWC Cologne (Leyendecker, 2005).

6.1.4 Legal options for institutional arrangements in Germany

As shown in the following Figure 6-6, there exist different legal options under which institutional arrangements can be established in Germany. All options for the hierarchical institutional arrangement of public administration act under public law. The options for the hierarchical institutional arrangement of public company as well as hybrid and market institutional arrangements act under private law.

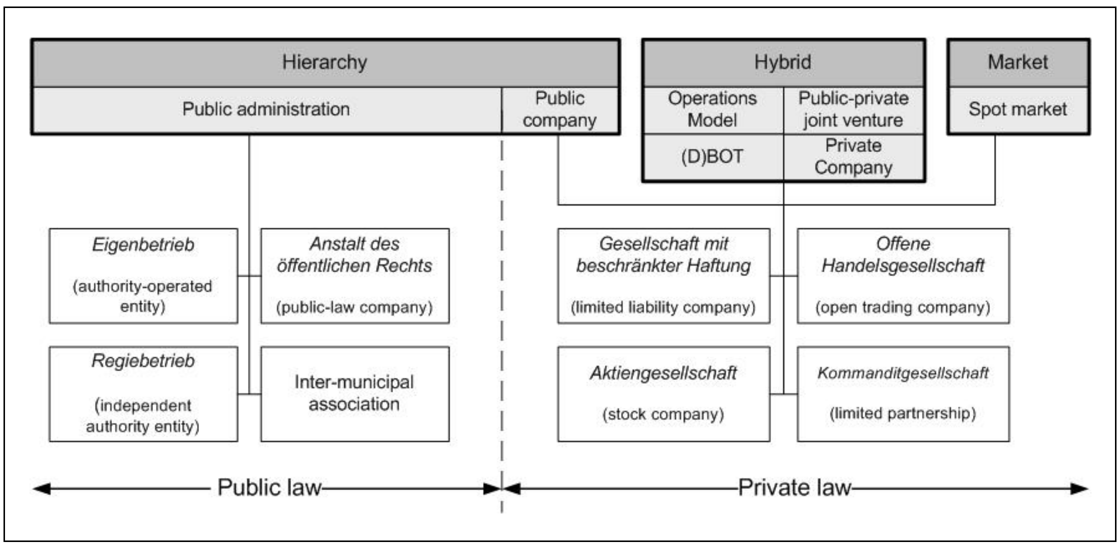

Figure 6-6: Legal options for institutional arrangements in Germany
Source: own

The institutional environment in Germany possesses a special attribute with respect to taxation. All legal entities under public law do not have to add value added tax (VAT)[118] to the fees that they charge their citizens. However, the effects on the competition with companies under operating under private law are rather low are therefore neglected during the further

[117] One recent example is this anticipated sale of 49.9% of Stadtwerke Leipzig to a strategic private partner.

[118] Currently at 19% (2007).

analysis due to two reasons. First, the MSWC plants are very capital intensive (only 14% are labor cost, see chapter 3.4) and private companies can balance the charged VAT for waste treatment against the VAT paid for capital investments, labor cost or disposal fees. Secondly, the exclusion of VAT applies only to the calculation of waste management fees for households. For the treatment of residual municipal waste from commercial sources, the MSWC plants that operate under public law have to charge VAT as well .

6.1.4.1 Legal options under public law

Regiebetrieb

At the *Regiebetrieb* (authority-operated entity) all tasks and services are provided within the public authority, e.g. municipal waste authority. It is neither organizationally, economically nor legally independent. The managerial responsibilities could be spread among diverse departments (e.g. waste management, finance, environment) or could be concentrated to one of them (Crounauge & Westermann, 2003, pp. 36-38). Because of the lack of financial independence, the *Regiebetrieb* is rarely found for any tasks or services requiring larger capital investments.

Eigenbetrieb

Also the *Eigenbetrieb* (independent authority-entity) has no legal sovereignty. In contrast with the *Regiebetrieb*, it enjoys economic and organizational independence from other bureaus or offices within the public sector, such as waste management bureaus. It has its own and separated management, personnel and accounting system (Crounauge & Westermann, 2003, pp. 99-116). An *Eigenbetrieb* for the MSWC could be established within every public authority responsible for household waste management, i.e., either within a municipality or inter-municipal association.

Anstalt des öffentlichen Rechts

Another hierarchical arrangement for internal provision of the MSWC infrastructure within the public sector is the establishment of an *Anstalt des öffentlichen Rechts* (public-law company). On the basis of the public municipal law[119] it is organizationally as well as legally independent from other public bureaus or administrations. However, the municipality is still fully liable for all its financial activities and therefore usually strongly involved in all decision making processes[120] (Kusenbach, 2002, pp. 27-28).

[119] In German: *Gemeindeordnung*

[120] In contrast, a municipality has only limited liability for a public company under private law.

The *Anstalt des öffentlichen Rechts* can be referred to as a commercialization of public activities, because it enjoys organizational freedom and often adopts strategic and operational processes known from the private sector. Usually, it also has to develop a publicly available annual report which contributes to improved transparency and control mechanisms.

<u>Inter-municipal associations</u>

Under German law, different independent municipalities have the possibility to cooperate for the provision of infrastructure or services by establishing an inter-municipal association (IMA). It is a legally independent body and its members agree on the IMA's rights and responsibilities in a formal statute (Hirschinger, 2002). The member municipalities are allowed to transfer their own legal obligations for infrastructure provision, such as waste management, to an IMA. However, the member municipalities remain fully liable for any financial losses and the shares of each member's liabilities are specified in the founding statute.

One has to distinguish between a single-purpose IMA, which is specifically established for bundling the demand in waste treatment, and a multiple-purpose IMA, which is established to provide several or all elements of the waste management value chain (e.g. collection, transportation, treatment and disposal). In both cases, however, the IMA has the same options as any municipality in choosing from the different institutional arrangements between hierarchy and market.

In the context of this research, only single-purpose IMAs that have hierarchically integrated the development and operation of an MSWC plant within their own organization are regarded as the institutional arrangement of public administration[121].

6.1.4.2 Legal options under private law

There exist four basic legal options under private law that can be used to structure institutional arrangements for MSWC[122]:

1. *Gesellschaft mit beschränkter Haftung* (limited liability company)
2. *Aktiengesellschaft* (stock company)
3. *Offene Handelsgesellschaft* (open trading company)
4. *Kommanditgesellschaft* (limited partnership)

Once a decision is made to found a company under private law, the selection among these options is mostly made based on tax reasons. However, there exist also differences in con-

[121] There are also cases in Germany, where municipalities jointly tendered the treatment of their waste without forming an IMA (see e.g. case studies Pirmasens or Rothensee).

[122] Combinations between them also exist, e.g. GmbH & KG, and KGaA

trol and reporting issues. Normally, the owners of companies under private law have only limited financial liability (see e.g. Hirschinger, 2002; Wagner, 2000, p. 200).

6.2 Quantitative study

6.2.1 Methodology

The objective of the quantitative survey is to get an empirical verification of theoretically elaborated institutional arrangements for developed market of MSWC in Germany. For that purpose, a self-completion questionnaire was developed to collect information in eight categories (see copy of the questionnaire in appendix 6):

(A) Personal information about respondent;

(B) General information about MSWC;

(C) Legal ownership structure;

(D) Separation of ownership and operation;

(E) Vertical and horizontal integration;

(F) Waste treatment contracts;

(G) Energy recovery;

(H) Financing.

The structure and contents of the questionnaire were discussed with two senior researchers and one representative of the industry associations. Before its distribution, the questionnaire was tested at two MSWC plants during personal interviews.

The three most relevant public and private associations within the German market of MSWC and waste management gave their formal support to the survey and content of the questionnaire. These associations are:

1. ITAD – Interessensgemeinschaft der thermischen Abfallbehandlungsanlagen in Deutschland (Interest Group of Thermal Waste Treatment Facilities in Germany)
2. VKS - Verband kommunale Abfallwirtschaft und Stadtreinigung (Association of municipal waste management and city cleaning)
3. BDE - Bundesverband der Deutschen Entsorgungswirtschaft (Federation of the German Waste Management Industry)

The survey was undertaken in Germany during the first half of the year 2007, covering all MSWC plants under operation at that time[123]. The self-completion questionnaire was filled in mostly by the commercial managers or CEOs of these MSWC plants, who also had the option to answer anonymously. The high response rate of 86% (answers from 56 out of 65

[123] Two MSWC plants under construction were not covered.

plants) could only be achieved through the formal support of the above mentioned interest groups and very time consuming follow-up through personal phone calls[124]. For those nine MSWC plants that did not participate in the survey, basic information (size, year of commencement, legal form and ownership) was gathered from secondary sources (e.g. internet presentations and annual reports).

6.2.2 Capacities

By June 2007, a total number of 65 MSWC plants were in operation in Germany with an aggregated annual nominal capacity of 17.5 Mg/a (for a list and location of all 65 MSWC plants, see appendix 5). As shown in the following Figure 6-7 their capacities range from 40,000 to 740,000 Mg/a with an average capacity being 269,000 Mg/a.

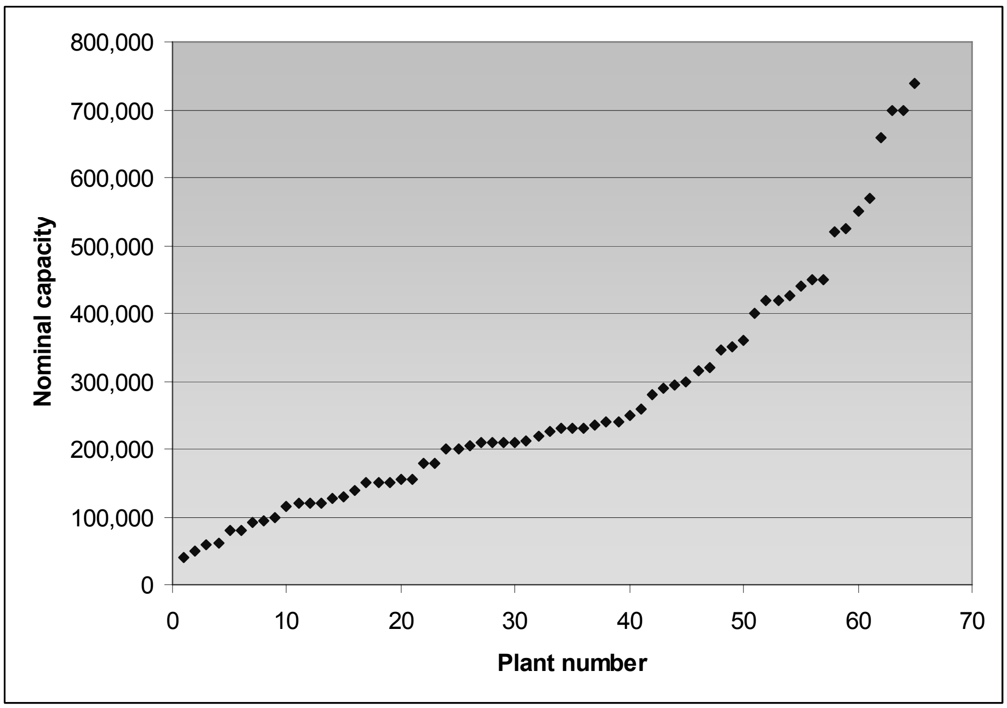

Figure 6-7: Nominal capacities of MSWC plants in Germany
Source: Own survey (2007)

6.2.3 Legal forms for asset ownership

The following Table 6-1 provides an overview of the legal forms under which the assets of MSWC plants in Germany are owned. Altogether 15 plants are owned by entities under public law, whereas 50 are owned by entities under private law.

[124] MSWC plants receive questionnaires or survey requests on a monthly basis.

		Number of plants	Aggregated capacities [Mg]	Mean capacity [Mg]	δ
Public law	Regiebetrieb	0	0	0	0
	Eigenbetrieb	6	1,760,000	293,333	237,227
	AöR	4	1,107,000	276,750	179,264
	IMA	5	732,500	146,500	47,618
Private law	GmbH	43	11,185,300	260,123	157,272
	AG	5	2,355,000	471,000	187,963
	KG	1	130,000	130,000	0
	OHG	1	225,000	225,000	0
Sum		**65**	**17,494,800**	**269,151**	**171,141**

Table 6-1: Legal forms for asset ownership

Source: Own survey (2007)

In case of the institutional arrangement "operations model", whereby asset ownership and operation are separated, the legal form of the operations company can differ from the legal form of the asset ownership. This is especially the case whenever the assets are owned by an entity under public law[125].

6.2.4 Quantitative overview of institutional arrangements for MSWC in Germany

The following Figure 6-8 illustrates the distribution of institutional arrangements with respect to their share of the total employed capacity of 17.5m in Germany. As it can be seen, the institutional arrangement of public-private joint venture has the largest capacity share with 22 plants (39.7%), followed by private company (9 plants, 16.6%), public administration (11 plants, 14.9%), public company (12 plants, 14.7%) and operations model (7 plants, 10.1%). The institutional arrangement of (D)BOT is only represented by 4 plants and a capacity share of 4.0%.

[125] Out of 14 MSWC with asset ownership under public law, 2 MSWC apply the institutional arrangement "operations model" (compare

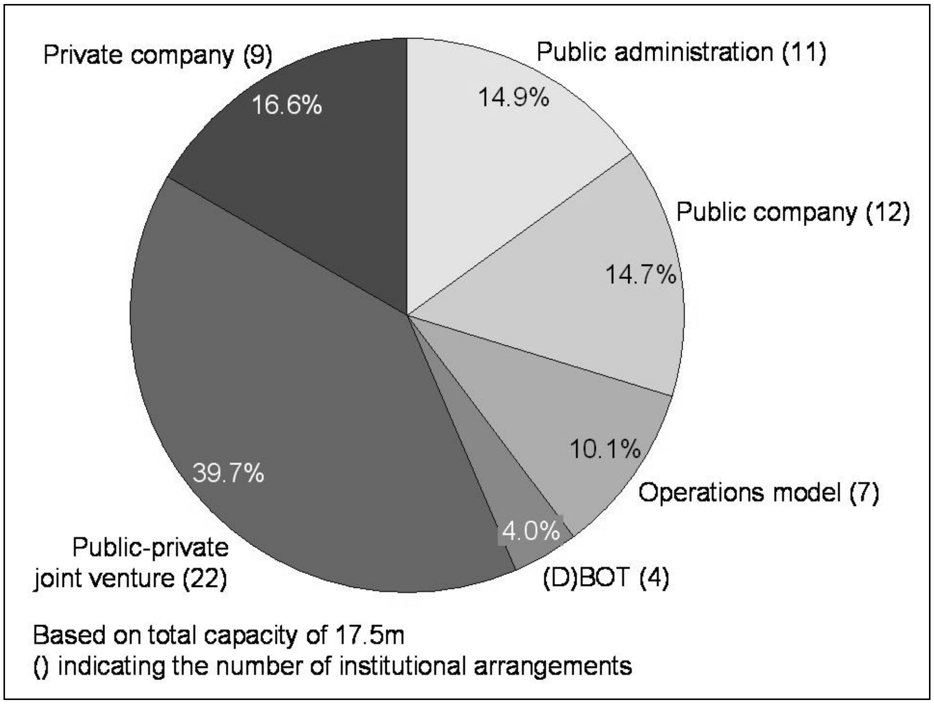

Figure 6-8: Distribution of institutional arrangements for MSWC in Germany

Source: Own survey (2007)

On an average each MSWC plant has three long-term contracts with public entities with an average duration of 16.9 years. The minimum waste guarantees secure the average usage of 73.3% (range: 30-90%) of the total capacities. In 2006, however, an average of 81% (range: 60-100%) of the total plant capacities had been used for treating municipal waste from long-term contractual partners.

A detailed qualitative analysis of all MSWC plants under the institutional arrangement of private company showed that they possess an average number of three long-term contracts (range: 1-8) with an average duration of 16.1 years and a minimum guaranteed capacity usage of 81.0% (range: 70-100). These statistics prove, that none of these MSWC plants operate under the institutional arrangement of sport market, in which no long-term contracts or minimum waste guarantees exist.

The following Table 6-2 provides a qualitative overview of institutional arrangements in Germany:

	Hierarchy					Hybrid				Market	Σ
Privatization taxonomy	Public administration				Formal privatization	Functional privatization		Partial material privatization	Full material privatization: long-term contracts	Full material privatization: short-term contracts	
MSWC taxonomy	Public administration				Public company	Operations model	(D)BOT	Public-private joint venture	Private company	Spot market	
	Eigenbetrieb	AöR	IMA	Σ							
Total number	4	3	4	11	12	7	4	22	9	0	65
% by number	6.2%	4.6%	6.2%	17.0%	18.5%	10.7%	6.2%	33.8%	13.8%	0	100%
Total capacity [T Mg]	1,097	895	613	2,605	2,570	1,762	705	6,945	2,905	0	17,492
% by capacity	6.3%	5.1%	3.5%	14.9%	14.7%	10.1%	4.0%	39.7%	16.6%	0	100%
Average capacity [T Mg/a]	274	298	153	255	214	252	176	315	323	0	269 (average)
Average duration [a]	∞	∞	∞	-	∞	15.3	20	∞	16.9	-	-
Range of duration [a]	∞	∞	∞	-	∞	11 – 20	(8) 22–25	∞	10 – 20	-	-

Table 6-2: Quantitative overview of institutional arrangements in Germany

Source: own survey (2007)

6.2.5 IMAs and institutional arrangements

As shown in the following Table 6-3, there exist 19 MSWC plants, in which an inter-municipal association (IMA) has a decisive influence on the development of institutional arrangement[126]:

Institutional arrangements with IMA		Number of MSWC plants
Hierarchy	Single-purpose IMA	4
	Public Company	5
Hybrid	Operations model	5
	(D)BOT	3
	Public-private joint venture	2
Sum		19

Table 6-3: IMAs and institutional arrangements
Source: Own survey (2007)

In four cases, a single purpose IMA was formed specifically for the development and operation of an MSWC plant (see also chapter 6.1.4.1 and Table 6-2). In five other cases, the IMA produces in the hierarchical arrangement of a public company.

In ten cases, the hybrid institutional arrangements of operations model, (D)BOT or public-private joint ventures are implemented. It is interesting to note that 71% (5 out of 7) of operations model and 75% (3 out of 4) of all (D)BOT models are institutional arrangements with an IMA as the principal for waste treatment services[127].

6.2.6 Horizontal integration

In case of 30 MSWC plants at least one shareholder is an owner of more than one MSWC plant. The cumulated capacity of these plants is 8.0m Mg which represents 45.9% of the national market. The largest shareholders are:

[126] The institutional arrangement of private company is not covered in this analysis. Here, IMAs (like any other public body) frequently sign long-term contracts with private MSWC plants.

[127] The reason for that is speculative. One reason might be, that IMAs usually have fewer resources than large public bureaucracies and therefore cannot operate an MSWC in a hierarchical arrangement.

Company	Number of MSWC plants owned	Capacity* [T Mg/a]	Total market share	Share of hybrid institutional arrangements
BKB AG (e.on)	8	1,750	10.0%	14.2%
Remondis	7	1,100	6.3%	8.9%
Sotec[128]	4	590	3.4%	4.8%
MVV	3	790	4.5%	6.4%
Vattenfall Energy Europe	3	600	3.4%	4.9%
*as per share of ownership in particular MSWC plants				

Table 6-4: Horizontal integration of MSWC plants in Germany

Source: Own

As shown in Table 6-4, there exist only two large private companies (BKB and Remondis) owning a relatively high number of MSWC plants in Germany. While BKB, a subsidiary of the energy company e.on, mostly owns the majority or all shares of these plants, the independent waste management company Remondis mostly owns only 49% of the shares of these plants as part of public-private joint ventures[129]. The accumulated capacities of Sotec, MVV and Vattenfall are relatively low in comparison to the largest MSWC plants (e.g. MSWC Ruhleben is owned by the City of Berlin and has a capacity of 520,000 Mg/a, see chapter 6.3.2).

In Germany, there is only one municipality owning shares of more than one MSWC plant. The Free and Hanseatic City of Hamburg owns 100% of MSWC "Stellinger Moor", which operates under public law, and also owns 25% of MSWC "Rugenberger Damm" as part of a public-private joint venture with Vattenfall and EWE.

The following Figure 6-9 indicates how the respondents evaluate the benefits of horizontal integration:

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[128] Sotec is already owned to 51% by BKB. In 2008 it will be under 100% ownership of BKB.

[129] The accumulated capacity of MSWC plants with BKB and Remondis as shareholder is 2,900T Mg/a and 2,200T Mg/a (16.6% and 12.6% market share), respectively.

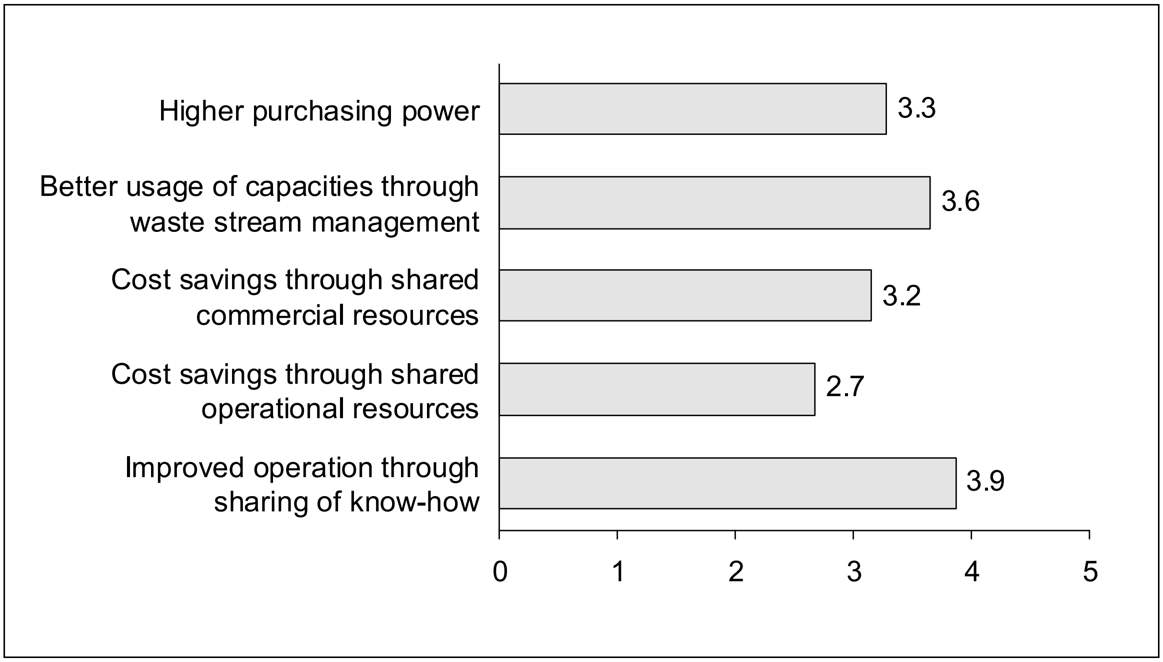

Figure 6-9: Evaluation of the benefits of horizontal integration (response rate: 25/30)

Source: Own survey (2007)

6.2.7 Vertical integration

There are 29 MSWC plants, which are vertically integrated through ownership with other activities of the waste management value system (see chapter 2.3). In these cases, at least one shareholder of the MSWC plant also owns a waste management company that offers services for waste collection, transportation or disposal. The following figure indicates the evaluation of vertical integration by the respondents with respect to generating possible competitive advantages:

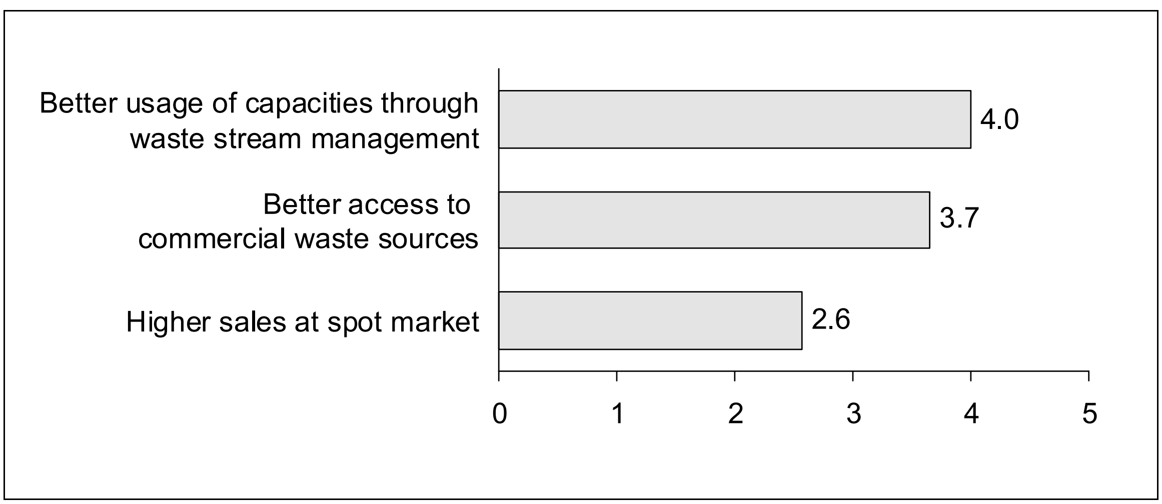

Figure 6-10: Evaluation of vertical integration (response rate: 23/29)

Source: Own survey (2007)

An analysis of the German waste management market by Fischer (1999) showed, that strong market concentration in the waste management activities of waste collection and transportation took place since the beginning of 1990s. Even though such market concentration is necessary to a certain extent in order to gain sufficient financial strength to invest in new or existing MSWC plants, a further market concentration through vertical integration should be observed very carefully by anti-trust agencies (compare also with chapter 4.2.3).

6.2.8 MSWC treatment prices

As shown in the following Figure 6-11, the prices for waste treatment at MSWC plants in 2006 had strong variations and ranged from 70 €/Mg in Lower Saxony to 340 €/Mg in Bavaria. These prices mostly reflect the prices paid according to long-term contracts, but not the price level for smaller quantities at the spot market.

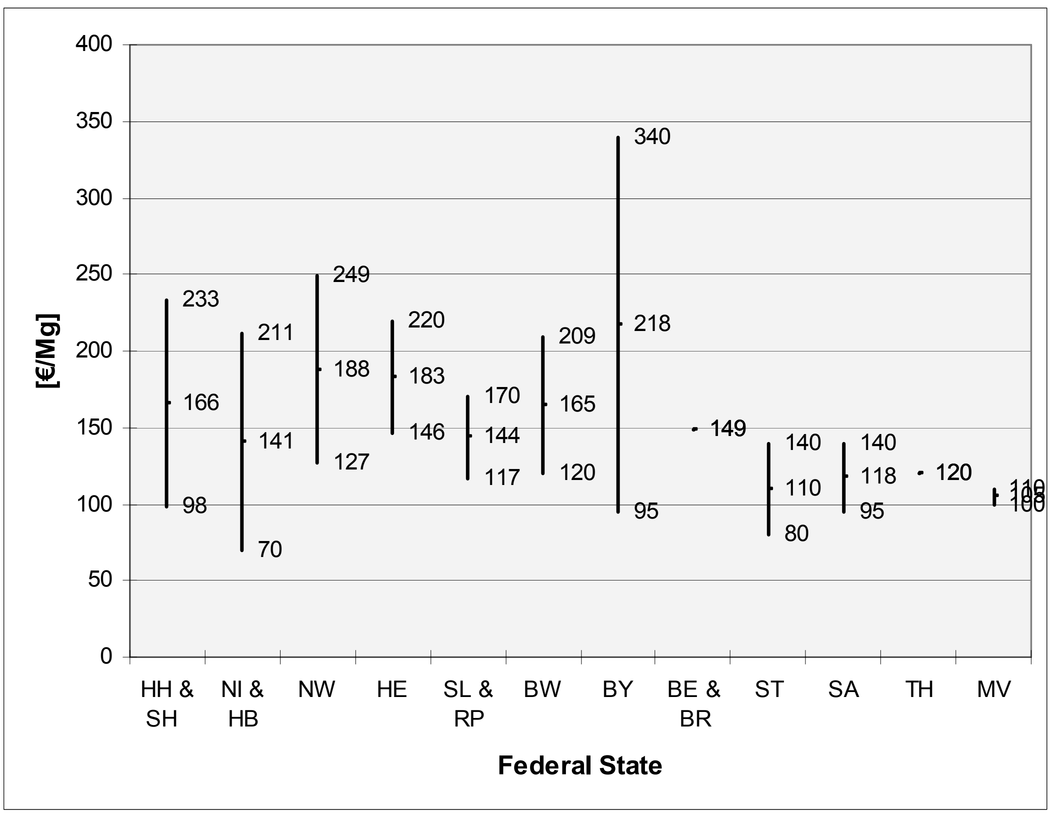

Figure 6-11: Prices for MSWC treatment in 2005 by federal states
Source: EUWID (2006)

The respondents of the annual survey conducted by the information service EUWID expect that the price for MSWC will be determined at around 120 to 130 €/Mg in the near future (EUWID, 2006). The price level will depend mostly on the development of additional capacities for MSWC as well as for substitute waste treatment technologies (see chapter 2.3.4).

6.3 Qualitative study

6.3.1 Methodology for data collection and analysis

As elaborated in chapter 1.5, multiple case studies were undertaken to illustrate institutional arrangements for MSWC and to explore the reasons for their development. The case studies are developed from quantitative and qualitative data that has been derived from personal interviews, statistics and publications.

The development of a standardized interview structure for all case studies was rejected, because the nature of the cases was expected to be very different. A more flexible approach with open questions was therefore applied to pursue the exploratory objectives.

In order to focus on the important characteristics, the illustrations must abstract the institutional arrangements to a certain degree. Minor details, such as the establishment of companies for tax purposes, will not be included in the discussion and visualization.

The data analysis was done iteratively and took place along with the quantitative and qualitative data collection. A descriptive framework based on narrative elements was chosen as the preferred strategy for analyzing the multiple case studies, because it helps to identify the causal links for the emergence of institutional arrangements (Bryman & Bell, 2003, pp. 440-442; Yin, 2003, pp. 114-116). The descriptive framework applied to each case study consists of three elements:

1. The *background* contains historical information about the MSCW, its technical characteristics, specific elements of the institutional environment and introduces the main stakeholders.
2. The *arrangement* describes the relationships between the most relevant stakeholders and their formal, and as much as possible informal, agreements. It also contains a organization diagram, which illustrates the main stakeholder and interdependencies.
3. The following *discussion* contains the explanation building for the emergence and categorization of the particular institutional arrangement. Reasons for the evolvement of the particular institutional arrangement are identified by examining at how the major stakeholders could achieve their objectives and by elaborating on the impacts of specific events or developments.

According to (Eisenhardt, 1989b) the chosen narrative analytic strategy is well suited to meet the defined research objectives, because it ensures in-depth familiarity with each case and therefore allows unique patters of each institutional arrangement to emerge.

There exist several constraints that influence the collection and validation of data in the conducted case study research. A major constraint is confidentiality. Many contracts and other formal or informal agreements are inaccessible to outsiders, because they contain information that must not be available for competitors. However, due to the high number of personal interviews and legally required information policies of the public sector it was possible to collect sufficient information for describing and exploring the case studies. Another constraint is the time lapse. Most institutional arrangements were established many years ago and the decision makers involved are not anymore available for interviews. Also the perception of stakeholders about the institutional arrangements might have changed over a period of time. Stakeholders might recall the development of a particular institutional arrangement differently today than before its establishment.

Based on the quantitative findings for MSWC in Germany and advisory by senior researchers, representative cases studies were selected for every institutional arrangements applied. For the institutional arrangement of public-private joint ventures altogether three cases were selected to illustrate different ownership structures and developments.

Following case studies from Germany have been chosen and presented:

Case study #	**Name, Location**	**Institutional arrangement**
Case study 1	Ruhleben, Berlin	Public administration
Case study 2	Kassel	Public company
Case study 3	Weisweiler, Eschweiler	Operations model
Case study 4	Pirmasens	(D)BOT
Case study 5	Niederrhein, Oberhausen	Public-private joint venture
Case study 6	Rothensee, Magdeburg	Public-private joint venture
Case study 7	Zorbau	Public-private joint venture
Case study 8	Buschhaus, Helmstedt	Private company

Table 6-5: List of case studies

The following Figure 6-12 indicates the location of the case studies:

Figure 6-12: Location of case studies in Germany

Source: own

The nature of institutional arrangements required the cases to be studied in different depths. Therefore, the data collection and case study design were done with a sufficient degree of flexibility, which allowed exploring particular issues that emerge during the analysis.

6.3.2 MSWC Ruhleben, Berlin

6.3.2.1 Background

With 3.4m inhabitants, the City of Berlin is the largest municipality in Germany, and similar to Hamburg and Bremen, has the legal status of a federal state. Thus, there is no differentiation between the municipality and the federal state concerning the responsibility for municipal waste management services[130]. The year 2005, a total amount of 966,000 Mg of residual municipal waste was generated and collected in Berlin (SLB, 2006).

In the year 1951, the public company "Berliner Stadtreiningungsbetriebe" (BSR) was founded in West-Berlin. It united with "Stadtreinigung Berlin" from East-Berlin in 1992 and has ever since served the entire city. BSR is owned by the City of Berlin, it operates under public law and since 1994 it has the legal status of the *Anstalt des öffentlichen Rechts* (see chapter 6.1.4.1). It is therefore legally and organizationally separated from other public companies and bureaus in Berlin (e.g. public transportation).

Within the City of Berlin, the operations and services of BSR encompass:

1. Waste collection and transportation,
2. Waste treatment and disposal,
3. Street cleaning incl. winter services, and
4. Cleaning and maintenance of public green areas and parks.

Due to severe land scarcity within formerly walled West-Berlin and the desire to become more independent from the GDR, the City of Berlin started very early the development of an MSWC plant within its own administration to treat growing amounts of municipal residual waste. In 1967, the MSWC plant with one line started to operate in the northern district of Ruhleben and was extended several times afterwards. To comply with advanced emission standards, the installation of a modern flue-gas treatment system was finalized in 1989 (Park, 2004, p. 184). Today, the MSWC Ruhleben has a nominal capacity of 520.000 Mg/a[131] and employs around 200 people for operation, maintenance work and administration. Currently, a modernization of the old machinery is planned and by the year 2011 four combustion lines will be replaced and upgraded.

6.3.2.2 Arrangement

The MSWC Ruhleben in Berlin is owned by the City of Berlin and its public company BSR, which operates under public law. Herein, it forms an independent business unit to allow an organizational separation from other activities of BSR. All capital and operational expenditures are accumulated in a cost centre and balanced by BSR along with the costs of all business units (BSR, 2005). The treatment costs at the MSWC Ruhleben are included in the calculation of the waste management fees that households have to pay to the City of Berlin.

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[130] Legal basis is the KrW-/AbfG Bln from 1999.

[131] The remaining municipal waste, generated in Berlin, is treated in other MT or MBT. Most of them are jointly owned and operated by the City of Berlin and private companies (e.g. ALBA).

A long-term power purchasing agreement (PPA) for transmitting process steam was signed with the adjacent private power plant “HKW Reuter West”, where the thermal energy is converted into electricity and heated water for the municipal district heating system.

The following Figure 6-13 illustrates the most important relationships among the relevant stakeholders of the MSWC Ruhleben:

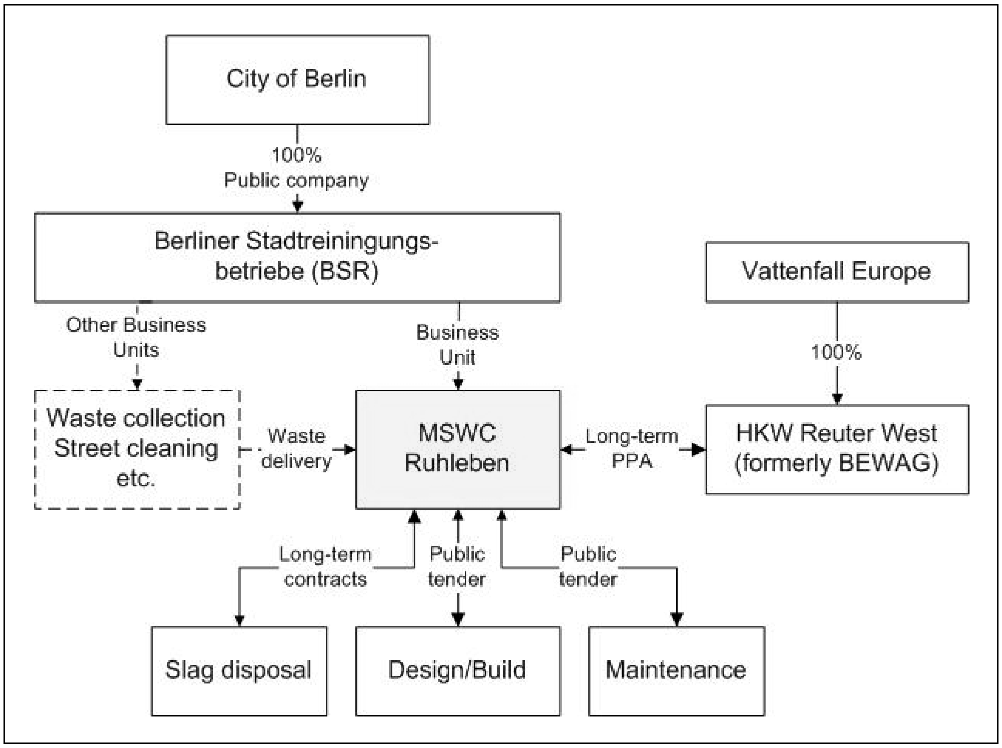

Figure 6-13: Stakeholders and their relationships at MSWC Ruhleben
Source: own, based on personal interviews (2007)

Because all investment and operation expenditures are included into the waste fee calculation for households in Berlin, there exist practically no commercial risks for BSR (Holthusen, 2002). In order to assess and improve commercial performances, several public and private management programs and tools have been applied, such as participating in benchmarking programs or the introduction of balanced scorecard (Kempin & Zahn, 2007).

6.3.2.3 Discussion

The MSWC Ruhleben in Berlin is a representative case study for the hierarchical arrangements of public administration. Its main characteristics include the ownership and operation within the administration of Berlin and the legal status based on public law. It was built as one of the first MSWC plants in Germany and has always been under public ownership and operation. Because of the continuous large amounts of municipal waste generated within the City of Berlin, there exist almost no demand risks for this large MSWC plant.

Due to the high demand for waste treatment in Berlin, the assets of MSWC Ruhleben are highly dedicated to one customer, i.e. the City of Berlin. Therefore the third dimension of asset specificity, i.e. dedicated assets, are comparatively high[132], favoring a hierarchical institutional arrangement. Transaction costs for this arrangement are comparatively low and the potential hazard of opportunistic hold-up does not exist. The realization of economies of scale in combination with high asset specificity therefore gives the reason for the development of a hierarchical arrangement.

The power among political parties has frequently changed in Berlin and none of them favored hybrid arrangements for the MSWC plant or other business units of BSR. Apart from transaction cost economic considerations, an additional reason for choosing a hierarchical institutional arrangement might be that the political influence can easily be exercised through the public administration. As Berlin continues to suffer from severe economic problems, any potential profits from the MSWC could be used at least to cross-subsidize different operations within BSR (e.g. winter service, park maintenance) that would not otherwise be possible at the background of Berlin’s weak financial situation.

There is always the potential threat that production costs for the production in hierarchical arrangements, especially under public ownership, are comparatively higher. In the presented case study, for example, no competition exists and commercial risks are in the end borne by the citizens due to the possible adjustment of waste management fees. On the other hand, politicians and the higher management of BSR have started different initiatives to improve the efficiency of the plant by introducing management methods from the private sector.

6.3.3 MSWC Kassel

6.3.3.1 Background

The MSWC Kassel was built by the City of Kassel (190,000 inhabitants) and is located adjacent to a closed coal burning power plant. At the time of commencement in 1968, it was organizationally integrated into the administration of the public municipal cleaning department and was operated by the municipal power company. With the introduction of a new air emission law in 1990 (17. BImSchV), an upgrading of the flue-gas cleaning system became legally mandatory. The required decision making processes within the different administrative and political levels in the City of Kassel were rather complicated and slow. The mandatory deadline of December 1, 1996 for meeting the new emission requirements neared and it seemed unlikely that the upgrading would be achievable within the existing hierarchical institutional arrangement of public administration.

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[132] Site asset specificity and physical asset specificity are always high for every MSWC plant. Compare chapters 5.3.2.1 and 5.4.1.1.

Therefore, in October 1995 the City of Kassel decided to formally privatize the MSWC Kassel and to bundle all existing assets into the special purpose company “MHKW Kassel GmbH”. With this transfer into a company under private law, the MSWC became more independent of the municipal budget and free from various administrative restrictions. After the formal privatization the investment decisions could be taken more rapidly and the flue-gas cleaning system was eventually upgraded before exceeding the legal deadline. Between the years 1997 and 1999 a total amount of 150m € was invested to renew large parts of the machinery (e.g. firing unit, boilers and energy recovery). Today, the MSWC plant has a rather small nominal capacity of 150,000 Mg/a (for NCV of 11,077 kJ/kg)[133] and generates electricity with its own steam turbine as well as hot water for the municipal district heating system.

6.3.3.2 Arrangement

The majority of 97.5% of “MHKW Kassel GmbH” is owned by Kasseler Verkehrs- und Versorgungs-GmbH (KVV), a holding company under private law that is fully owned by the City of Kassel. The remaining minority share of 2.5% belongs to the City Kassel itself. The commercial management is done by KVV, for which it receives financial compensation. The operational personnel is provided by “Städtische Werke Kassel GmbH”, a public utility company of the City of Kassel with which also a long-term power purchase agreement was signed.

There exists a long-term waste delivery contract between the MSWC Kassel and its owner, the City of Kassel. In addition to that, the two municipalities Marburg-Biedenkopf and Schwalm-Eder also signed long-term contracts for treating altogether 75,000 to 100,000 Mg/a of residual municipal waste after June 2005. None of these contracts required a public tendering, because the contractual relations exist between public entities or companies that are publicly owned[134]. The following Table 6-6 indicates how capacities were used in 2006:

Municipality or IMA	Capacity at MSWC [Mg/a]
Kassel	75,400
Marburg-Biedenkopf	36,300
Schwalm-Eder	54,700
Sum	*166,400*

Table 6-6: Capacities used at MSWC Kassel in 2005
Source: HMULV (2005)

[133] The NCV of delivered wastes is much lower. In the year 2005, 174,000 Mg could therefore be treated.

[134] In the future, such “in-house” contractual agreements might not been allowed under EU procurement law.

The contracts of the two municipalities Marburg-Biedenkopf and Schwalm-Eder with the MSWC Kassel to treat their waste after 2005 were already signed in the year 1998 and will run for 15 years until 2020. The prices were determined on the basis of cost calculations from the year 1998 and include price adjustment mechanisms for diverse parameters. In the central waste management plan of the Federal State of Hessen[135], the ministry of environment allocated the waste from the municipalities Marburg-Biedenkopf and Schwalm-Eder to be treated at MSWC Kassel. The two municipalities were therefore strongly urged by the administration to sign long-term contracts with the MSWC Kassel to ensure that legal requirements will be fulfilled by 2005. In exchange, the ministry gave permission to operate the existing landfill site “Oppermann” until 2005, which is jointly owned by the two municipalities in the form of an IMA.

The following Figure 6-14 illustrates the most important relationships among the stakeholders of the MSWC Kassel:

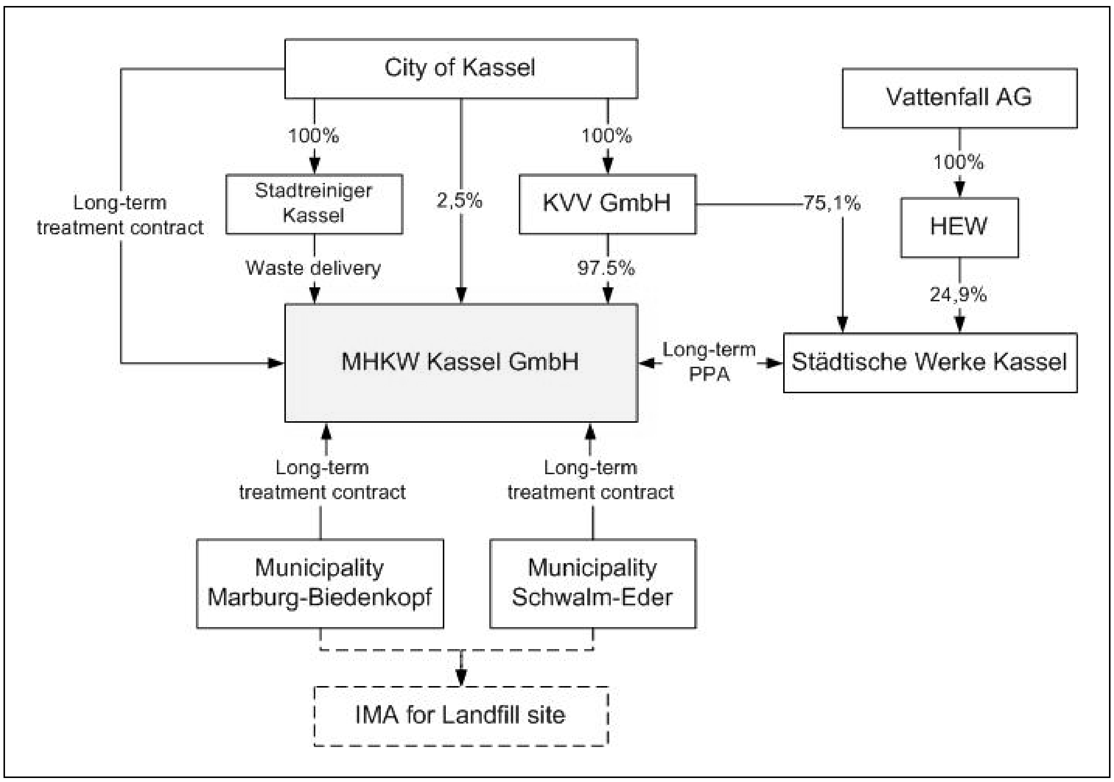

Figure 6-14: Stakeholders and their relationships at the MSWC Kassel

Source: own, based on personal interviews (2007)

There exist strong relationships among the companies that are owned by the City of Kassel. The public waste management company “Stadtreiniger Kassel” delivers waste from house-

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[135] In Hessen, the waste management plan is made for the entire state and not for regional administrative areas (Regierungspräsidium).

holds to the MSWC plant and also actively acquires waste from private waste generators to be treated at the MSWC Kassel. There is also a strong personal interdependence between the stakeholders, e.g. the managing director of the MSWC plant is responsible for all energy production facilities within KVV and its subsidiaries.

The available access capacities that are not used by the three contracted municipalities amount currently to around 5-10% and are sold at the spot market to generate additional income for the MSWC Kassel. In 2005, an EBIT of 5.2m € was earned and transferred to the mother company KVV (KVV, 2005).

6.3.3.3 Discussion

The MSWC Kassel is a representative case study for the hierarchical institutional arrangement of public company. Key characteristics comprise the ownership and operation in a company that is publicly owned and it operates under private law.

The initial hierarchical arrangement of public administration can be explained from a historic perspective, because the MSWC Kassel was built in 1968 as one of the first MSWC plants in Germany and at that time all waste management services were delivered by the public sector throughout Germany. The formal privatization of the MSWC plant and therefore the change to hierarchical institutional arrangement of public company was primarily motivated by gaining more flexibility and independence from the public budget. This became necessary, because a change in the institutional environment towards enhanced emission standards required large capital investments that were difficult to implement under the institutional arrangement of public administration due to budgetary and organizational constraints.

The City of Kassel in this institutional arrangement benefits from the generation of profits that can be used to leverage losses of other KVV subsidiaries[136]. The energy branch of KVV benefits from an environmentally friendly, reliable and cost-effective source of thermal and electrical energy that it can sell to its customers[137]. The personal and organizational relations between the MSWC Kassel and other public companies owned by the City of Kassel under the umbrella of KVV create trust and can therefore be very helpful in finding a consensus for investment decisions needed.

For the two municipalities Marburg-Biedenkopf and Schwalm-Eder, the long-term contracts with the MSWC Kassel provided a solution for the treatment of their waste that became legally necessary since June 2005. The usage of the MSWC Kassel by the two municipalities

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[136] E.g. the public transport company KVG made financial loss of 14.4m € in the year 2005 (KVV, 2005).

[137] The energy market has been liberalized in Germany and smaller energy companies are experiencing severe competitive pressure.

was favored by the regional environmental ministry and therefore included in the central waste management plan. The signing of the long-term waste treatment contracts was supported by formal and informal relationships between the various public stakeholders involved.

6.3.4 MSWC Weisweiler

6.3.4.1 Background

The MSWC Weisweiler is located next to the coal burning power plant Weisweiler in the vicinity of the City of Aachen in the Federal State of North Rhine-Westphalia. The coal burning power plant operates since 1955 and is owned by RWE, one of the largest energy companies in Germany.

By the end of 1980s, the City of Aachen (250,000 inhabitants) and the county of Aachen (300,000 inhabitants) began to search for a solution to cope with growing waste amounts. The availability of existing landfill capacities was limited and the development of a new landfill site was very difficult due to the lack of a suitable location. In 1991, both municipalities founded the special purpose company "Abfallwirtschaft Kreis und Stadt Aachen GmbH"[138] (AWA) to jointly develop the future waste infrastructure development project.

In 1992, the regional waste management plan for the administrative district of Cologne was published and it predicted strong growth of municipal waste volumes. The residual waste quantities for the City of Aachen and the County of Aachen where estimated with 120,000 Mg/a and 160,000 Mg/a respectively by the year 2000[139]. Assuming a capacity buffer of 15% and an average plant availability of 80%, the waste management plan recommended the development of an MSWC plant at Weisweiler with a capacity of 400,000 Mg/a by the year 1996 (Regierungsbezirk Köln, 1992, pp. 94-95,109).

Based on these estimations and the pressure from the district presidency to develop an MSWC plant, AWA started negotiations with RWE to jointly develop an MSWC plant with a nominal capacity of 360,000 Mg/a. An agreement was made under which AWA would own and finance the MSWC plant, while a contract would be assigned to RWE for technical operations of the facility for a period of 20 years. According to the agreement, AWA would deliver sufficient waste quantities and bear all demand risks.

The planning approval was applied for in May 1993. After undergoing various processes, which included a public hearing with 16,000 public objections (Claus, 2000, p. 100), the construction of the MSWC plant could start in June 1994.

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[138] Each one owned 50% of the equity.

[139] Excluding commercial waste, the quantities were estimated to be 105,000 Mg/a each. In 2006, the actual waste quantity treated for the City of Aachen and the County of Aachen were only approx. 58,000 Mg each (Aachen, 2007, p. 34).

Already during the construction period it became evident that the demand estimations were too high. This was mainly caused by the introduction of the new waste law KrW-/AbfG in 1996 (see chapter 6.1.3), which excluded commercial waste from the responsibility of the public sector. To find a solution for the excess capacities, AWA started negotiations with the private waste management company R+T Entsorgung GmbH (R+T), that promised to acquire waste from public and private sources in the open market. At that time, R+T was owned by RWE Umwelt GmbH and Trienekens GmbH, which later merged into Trienekens AG[140].

For the partnership between AWA and R+T, the special purpose company “MVA Weisweiler GmbH & Co. KG” was founded in 1997[141], at which each company held 50% of the shares. The agreement has a duration of 20 years and specified that both partners would have to guarantee a minimum waste delivery of 145,000 Mg/a. The internal price is to be based on LSP calculation (see chapter 3.4.2), whereby R+T would not pay more than 112€/Mg until June 2005 (implementation of TASi regulation), because of low competitive pricing of landfill sites.

The construction of the MSWC Weisweiler was completed in 1996, but due to various technical problems during the trial phase, it took more than one year before regular operation started in June 1998. The demand was low during the initial years and in 1999, a total amount of only 290,000 Mg was combusted at plant.

During 2000 and 2001, Trienekens AG actively pursued the acquisition of AWA and subsequently MSWC Weisweiler. Even though the City of Aachen and the County of Aachen agreed to sell, the sale was rejected by the courts. At the same time, one of the largest corruption scandals in German history became public. It was proven that Mr. Trienekens paid bribes for the participation in the MSWC Cologne. Therefore, many other regional MSWC plants, including Weisweiler, came under investigation. Unlawful agreements or anticompetitive behavior could never been proven at the MSWC Weisweiler, even though the negative impacts of the scandal continue to be present[142].

One outcome of the scandal was the takeover of Trienekens AG by RWE GmbH in 2002. The 50% of the shares of the MSWC Weisweiler including all contractual agreements with AWA were integrated into RWE Umwelt West GmbH (RUW).

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[140] Trienekens and RWE held 50% each, with W. Trienekens have one more share.

[141] For tax and financing purposes, also the company MOENA GmbH & Co. KG was founded, who formally owns the MSWC and leases it back.

[142] Accusations were made against AWA and the mayor of Aachen, because the supplier Babcock did not have to pay penalties for the delayed start of operation. The company was also an important sponsor for the local soccer club.

In the same year 2002, the municipality Dueren (270,000 inhabitants) searched for options to implement a new waste management strategy, because capacities of its own landfill site were limited. With the support and pressure of the district presidency it was decided that Dueren would also participate in the MSWC Weisweiler and deliver its waste to the facility. Because a shareholding at AWA was not possible without public tender (with unclear outcome), the City of Aachen and the County of Aachen as well as the Municipality of Dueren founded the IMA "Zweckverband Abfallwirtschaft West" (ZEW). Most public municipal waste management services (incl. collection, transportation and treatment) were transferred by its three members to ZEW, to which the City of Aachen and the County of Aachen sold its shares of AWA[143].

In 2005, RWE made the strategic decision to refocus on its core competencies of energy production and withdrew from the waste management business[144]. In November 2005, RUW was sold for 112m € to the public utility company Stadtwerke Krefeld AG (SWK), which is owned by the City of Krefeld and renamed it into "Entsorgungsgesellschaft Niederrhein mbH" (EGN). The contract with RWE for technical operation of MSWC Weisweiler until 2017 remained unaffected.

In 2005, there was a dispute between the MSWC Weisweiler and RWE about the cost calculation for the operations contract (details are not publicly disclosed). An arbitration court finally solved the disagreement.

Currently, the MSWC Weisweiler operates under favorable market conditions due to the high demand for waste treatment capacities after the introduction of TASi regulation. In 2006, a total amount of 401,214 Mg was treated, of which 184,858 Mg (46%) came from the area of ZEW (Aachen, 2007).

6.3.4.2 Arrangement

Today, public stakeholders own 100% of the assets of the MSWC Weisweiler. The assets are shared between AWA, which is owned by the inter-municipal association ZEW and the public waste management company EGN that is owned by the City of Krefeld.

The following Figure 6-15 illustrates the most important relationships among the stakeholders of the MSWC Weisweiler:

[143] The City of Aachen and the County of Aachen still own 3.125% each of AWA to avoid real estate purchase tax.

[144] Later, RWE also sold its water business (e.g. Thames Water).

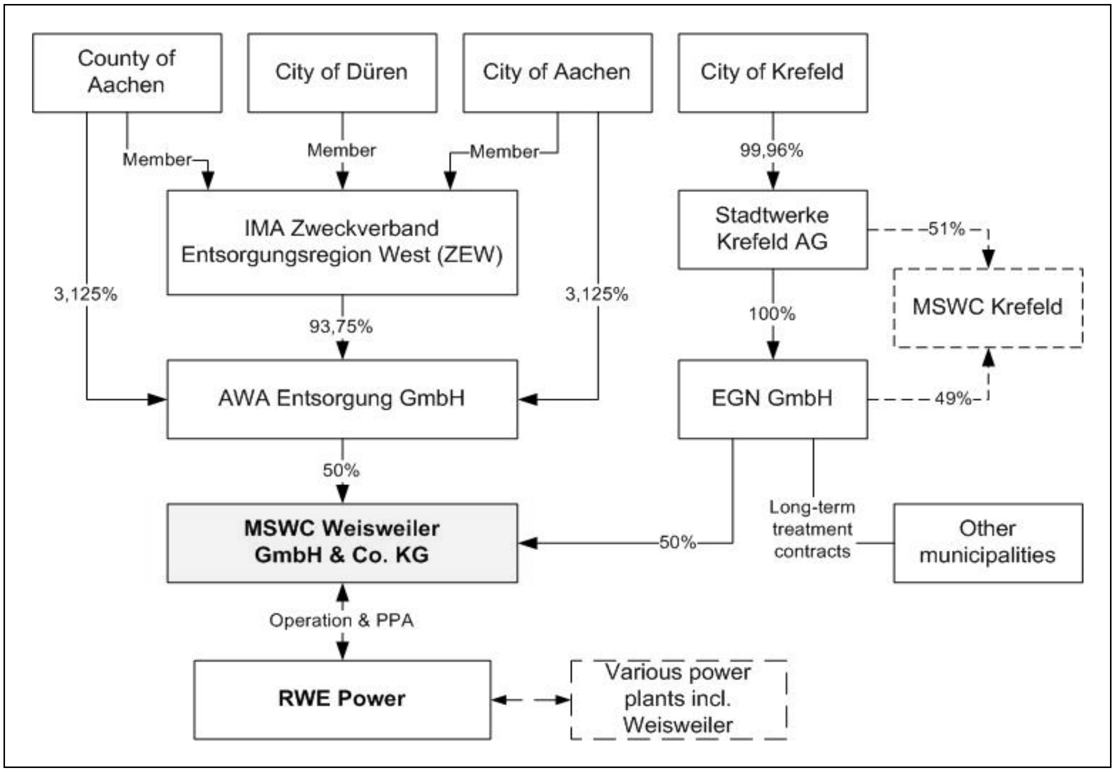

Figure 6-15: Stakeholders and their relationships at MSWC Weisweiler

Source: own, based on personal interviews (2007)

For the operation of the MSWC Weisweiler, a contract exists with RWE Power, which owns and operates a coal burning power plant at the same location. The operations contract has a duration of 20 years (1997-2017) and assigns the responsibility for operating the plant to RWE with its own technical personnel. All investment decisions including the specification of maintenance works are still done by the MSWC Weisweiler that also bears all commercial (esp. demand) risks. The payments to RWE are based on the LSP calculation plus a 5% premium. In addition to the technical operations contract, there also exists a long-term power purchase agreement between the parties.

The cooperation of AWA and EGN is based on the initial contract that was signed in 1997 between AWA and R+T. The core element of the contract specifies that each company bears demand risks of up to 145,000 Mg/a. The capacities of AWA are used for treating waste from ZEW's municipal members, whereas EGN has long-term waste treatment contracts with Heinsberg, Rhein-Erft-Kreis and other municipalities. All capacities above 290,000 Mg/a are jointly marketed to public and private waste generators at market prices. Since 2005, waste from the Netherlands is also treated at the MSWC Weisweiler, showing that the market is becoming more international.

6.3.4.3 Discussion

The institutional arrangement for the MSWC Weisweiler is classified as the hybrid institutional arrangement of operations model. The key characteristics include the public asset ownership while operation is outsourced to the private company for a limited period of time.

The development of the institutional arrangement was driven by various and complex factors. Based on the central waste management plan of the administrative district Cologne, the City and County of Aachen were strongly encouraged to develop an MSWC plant, for which the private company RWE seemed to be a suitable partner. RWE could provide a suitable location next to its coal burning power plant, it had expertise in the operation of power plants and could employ synergies in operation and energy production. At that time, RWE also pursued an aggressive strategy to expand into the waste management business. The close relationships between RWE and many local municipalities, which still own more than 20% of RWE[145], were of great advantage during the development of the institutional arrangement.

With the sale of RWE Umwelt West GmbH (RUW) to the public utility company Stadtwerke Krefeld AG (SWK), the MSWC Weisweiler is an interesting case for the transfer of private ownership to public ownership[146]. The objectives of SWK in this institutional arrangement are to expand in the profitable waste management market, especially after the implementation of TASi regulation in June 2005. Hereby, EGN acts in direct competition with private companies and contributes to the annual profits of SWK[147]. Recently, such return of functionally privatized tasks and services back to public sector can increasingly be witnessed at other waste management value chain elements (Keppler, 2007).

Another outcome of the case study is the negative economic effects of centralized waste management planning. In this case, bureaucrats tended to overestimate waste quantities to ensure adequate development of capacities. Commercial considerations obviously played only a subordinate role after ensuring adequate treatment capacities, because waste streams could be assigned to without competition.

Altogether, the presented case study illustrates impressively how dynamically institutional arrangements can change over a period of time and how informal institutions play a very important role in their emergence.

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[145] The percentage is decreasing constantly since 1990s with many municipalities selling their shares.

[146] In many cases, it is the way around, i.e. formerly public assets are sold to private companies.

[147] In 2005, SWK generated total net profits of 10.3m € (20.5m € without retained earnings) which was distributed to public budget of the City of Krefeld. After SWK Energie (25.5m € earnings), EGN is the second most profitable business within SWK and contributed 9.9m € to the total net profits. SWK Mobil, responsible for public transportation in Krefeld, incurred a loss of 18.8m € in the same period (Krefeld, 2005).

6.3.5 MSWC Pirmasens

6.3.5.1 Background

The IMA "Zweckverband Abfallwirtschaft Suedwestpfalz" (ZAS) was founded in 1987 by the six municipalities Pirmasens, Germersheim, Südwestpfalz, Suedliche Weinstrasse, Landau and Zweibruecken. It is located in the Federal State of Rhineland-Palatinate and the year 2006 the combined population of 460,000 inhabitants generated approx. 75,000 Mg of residual municipal waste (ZAS, 2006). Among other obligations, founding statute of ZAS defined the tasks to plan, build and operate an MSWC plant in Pirmasens. The ZAS was formed with a strong political support and under the leadership of the regional environmental ministry which was highly concerned about insufficient waste treatment and disposal capacities in the state at that time[148].

Even though the statute of ZAS explicitly permitted that any task could be accomplished by contracting private parties, the political decision makers of IMA members initially decided that the MSWC Pirmasens would be developed, built, financed and operated within its own organization and with own resources. Other options, such as the development of a public-private joint venture were also discussed, but not pursued.

In 1988, technical advisors were selected to plan an MSWC plant with three combustion lines and a nominal capacity of 264.000 Mg/a. The tendering for three major parts of (i) firing unit incl. boiler, (ii) flue-gas treatment and (iii) energy recovery started in 1989 and contracts were awarded in 1990. Ten months later, in 1991, the planning approval processes officially started on the basis of the specified technology. The following procedures took place with extensive participation of citizens, interest groups and bureaucracies, and in 1993, the project was finally approved. Due to considerable reductions in expected waste quantities, the ZAS decided to reduce the nominal capacity of the MSWC plant to approx. 168,000 Mg/a (7,000 h/a; NCV = 10,500 kJ/kg; 2 combustion lines x 12Mg).

In the beginning of the 1990s, municipal elections took place in the Federal State of Rhineland-Palatinate and political power was shifted in some municipalities that are members of the IMA. Due to changed political interests, the members of ZAS decided in 1995 to find a private partner that would be assigned the task of construction, financing and operation of the MSWC plant for 17 years.

6.3.5.2 Arrangement

Following an EU-wide tendering based on VOL/A-tendering procedures, the contract was awarded in December 1995 to SOTEC (Saarberg Oekotechnik) GmbH. Its alternative offer was the most economic one mainly due to higher guaranteed availability of 8,000 hours/a

[148] The landfill site in Pirmasens became close to its capacities at that time.

that increases capacity to 180,000 Mg/a (10,500 kJ/kg). At that time, Saarbergwerke AG was a public enterprise and owned by the Federal State of Saarland (26%) and the German Federal Republic (74%). In 1998, SOTEC was sold along with other non-coal based operations of Saarbergwerke AG to the private company RAG Saarberg AG, which was renamed in 2004 to STEAG Saar Energie AG. In 2006, STEAG Saar Energie sold 49.9% of SOTEC to the private energy company BKB AG[149] (see also case studies Rothensee and Buschhaus). Today, SOTEC owns and operates six MSWC pants as well as one RDF power plant.

The contract between ZAS and SOTEC included following major specifications:

1. SOTEC had to finance, build and operate the MSWC plants with a nominal capacity of 180,000 Mg/a (10,500 kJ/kg) on the land provided through a land lease contract by ZAS;
2. The specification of the official planning approval notice applied and SOTEC had to accept all design specifications;
3. All existing contracts between ZAS and suppliers had to be taken over by SOTEC;
4. The operation had to start on 01.01.1999 with duration of 25 years until 31.12.2023;
5. SOTEC had to pay and finance all the planning costs that had occurred during the development phase by ZAS with a value of 12.8m €;
6. SOTEC will receive regular payments from ZAS consisting of (i) basic payment (fixed), (ii) work payment (variable component based on actual throughput) and (iii) residual disposal payment (variable);
7. ZAS is obliged to deliver all residual municipal waste that is generated within the IMA to the MSWC plant Pirmasens and will also aim at selling excess treatment capacities to third-party public or private waste generators.

Initially it was anticipated that the utility company Stadtwerke Pirmasens GmbH, which is mostly owned by the ZAS member City of Pirmasens, would be involved in the operation of the MSWC plant and that it would hold 25.1% of the SPC's shares. Their primary objective was to secure a reliable and cost-effective source of energy for the local district heating system and electricity supply. The other members of ZAS, however, finally objected to such an arrangement and eventually this consideration was not pursued anymore. Today, there exists a power purchase agreement between the MSWC Pirmasens and Stadtwerke Pirmasens, under which all the revenues will be transferred directly to ZAS.

The following Figure 6-16 illustrates the most important relationships among the stakeholders of the MSWC Pirmasens:

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[149] By 01.01.2008 the remaining 50.1% of SOTEC are sold to BKB.

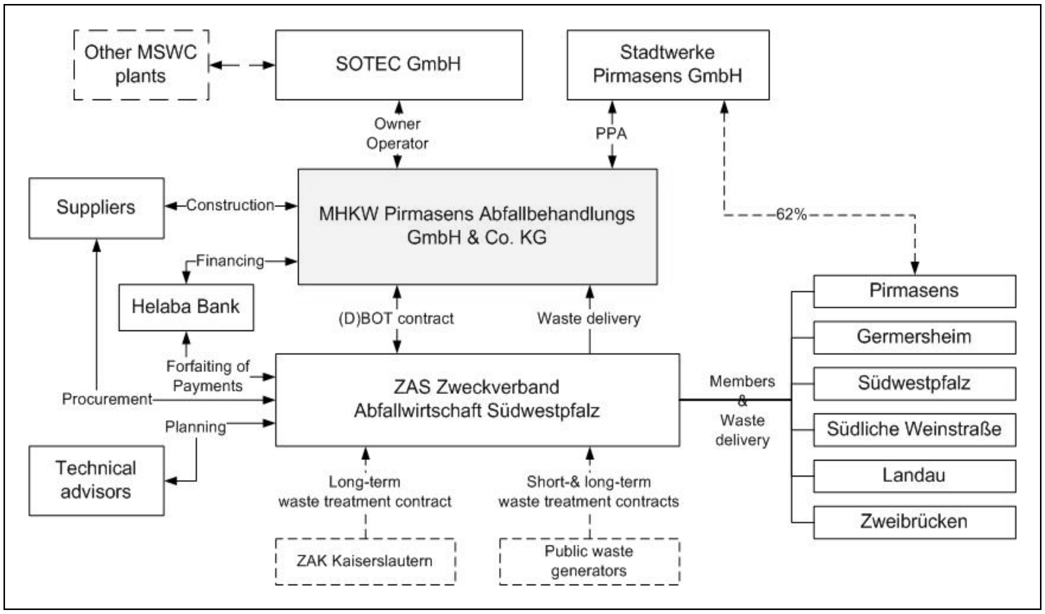

Figure 6-16: Stakeholders and their relationship at MSWC Pirmasens

Source: own, based on personal interviews (2007)

Even though a majority of the plant's design was already specified in the planning approval notification, SOTEC was still able to optimize some technical aspects. It could do so only to a limited extent, because it had to take over also the existing contracts from ZAS for firing unit, flue-gas treatment and energy recovery. SOTEC independently procured all other facilities, most importantly civil works as well as control and monitoring system. With its own internal management team, SOTEC also managed and coordinated all required planning and supervisory work.

To use the existing excess capacities of MSWC Pirmasens, ZAS signed an inter-communal waste treatment agreement with the IMA "Zweckverband Abfallwirtschaft Kaiserlautern" (ZAK), which lasts until 2018. Additionally, it also signed waste treatment contracts with several private waste management companies, which have durations of up to 5 and 13 years. From 2007 onwards, ZAS and ZAK pay the same prices, while prices for private waste generators continue to be market based.

The following Table 6-7 provides an overview of the usage of capacities in 2006:

Source	**Quantity [Mg/a]**	**Average price €/Mg**
ZAS	77,310	192.98
ZAK	32,517	139.90
Diverse (delivered by private waste management companies)	73,512	139.15
Sum	*183,339*	

Table 6-7: Waste treatment at MSWC Pirmasens in the 2006

Source: ZAS (2006)

In this institutional arrangement, the technical operation of the MSWC plant by SOTEC is separated from the waste stream management which continues to be done by ZAS. The public principal ZAS therefore bears all commercial risks that are related to demand changes. The practical experience has shown that this separation is a potential source of dispute between ZAS and SOTEC in case of unplanned operational interruption concerning waste from sources outside the ZAS.

6.3.5.3 Discussion

The MSWC Pirmasens is a representative case study for the hybrid institutional arrangement of (Design)-Build-Operate-Transfer. Its main characteristics are the integration of the life-cycle elements of construction, financing and operation and their transfer to a private company for a limited period of time. In this case, the majority of design work was not integrated into the outsourcing package, because the public principal ZAS initially planned to establish the MSWC plant within its own hierarchy. The development of MSWC Pirmasens under public leadership of ZAS can be explained with a high degree of uncertainty during the planning approval and the expectation that the assets would mostly be dedicated to ZAS due to anticipated high waste generation volumes.

When the contract was awarded, SOTEC was still operating under public ownership as part of the public STEAG Saar Energie AG, respectively public RAG group. Its material privatization took place in sequences in 2006 and 2008. The case MSWC Pirmasens therefore illustrates the shift from the hierarchical institutional arrangement of public company to the hybrid institutional arrangement of (D)BOT. However, the initial institutional arrangement already contained significant elements of the hybrid (D)BOT, because of the integration of life-cycle elements and its outsourcing to a third party in open competition.

On the whole, through the case study of MSWC Pirmasens different reasons for the emergence of this particular institutional arrangement could be identified. The change of political objectives and normative attitudes towards private sector participation after local elections in the municipalities of ZAS was the main reason for the shift from a planned hierarchical arrangement within ZAS towards the search for an external partner based on an (D)BOT contract. The sale of the formerly public company SOTEC to the private company BKB (e.on) is part of restructuring of the German energy market and the reason for the fulfillment of all criteria for the hybrid institutional arrangement of (D)BOT.

6.3.6 MSWC Oberhausen

6.3.6.1 Background

The MSWC Oberhausen is located in the City of Oberhausen and with a nominal capacity of up to 700,000 Mg/a, it is one of the largest and oldest waste treatment plants in Europe. In 1968, the IMA "Zweckverband Gemeinschafts-Müllverbrennungsanlage Niederrhein“ with its members Duisburg, Oberhausen, Dinslaken, Moers and Voerde made the decision to transform the old power plant of Concordia Bergbau AG into an MSWC plant. Operation started in 1972 after converting three existing boilers according to technical requirements for combustion of residual municipal waste. The public utility company “Energieversorgung Oberhausen GmbH“ (evo), which is owned by the City of Oberhausen, was assigned to the technical operation of the MSWC plant and receives energy produced as part of a power purchasing agreement.

In 1984, the MSWC plant was formally privatized with the establishment of the special purpose company "Gemeinschafts-Müllverbrennungsanlage Niederrhein GmbH“ (GMVA). The public shareholders of the SPC were Duisburg (59%), Oberhausen (25%) and the three cities of Dinslaken, Moers and Voerde within the County of Wesel (together 16%). In the beginning of the 1990s, the County of Wesel developed its own MSWC plant in Ansdonkshof with a capacity of 235,000 Mg/a to handle the expected growth of waste generation. With the commencement of operation in 1997, the authorities of the County of Wesel obliged its three cities Dinslaken, Moers and Voerde to treat their residual municipal waste at MSWC Ansdonkshof.

In 1996, the MSWC Oberhausen experienced severe commercial pressure. The demand for waste treatment decreased dramatically due to enactment of the new waste law KrW-/AbfG (see chapter 6.1.3), which reduced the demand for the treatment of residual municipal waste from commercial sources. The non-delivery of waste by the three shareholding cities Dinslaken, Moers and Voerde added to a further decrease in demand.

In 1996, a contract was signed with the private waste management company Trienekens GmbH to deliver 150,000Mg/a of residual municipal waste from commercial sources to be acquired from tertiary sources. Primarily due to competition with cheap landfill sites, the revenues from treated commercial municipal waste mainly covered only the variable costs. Even though most of the capacities were used, the MSWC Oberhausen made continuously financial losses. In the three years from 1998 to 2000, the operational losses accumulated to more than 35m €. Bankruptcy of the SPC was only avoided through the financial guarantees from the Cities of Oberhausen and Duisburg (Duisburg, 2001). Because only the unavoidable maintenance works were implemented at that time, the operational reliability of the plant was seriously threatened.

Due to this unsatisfying commercial and operational situation, the shareholders of MSWC Oberhausen decided in 2000 to restructure asset ownership and operation. The minority shareholders Dinslaken, Moers and Voerde sold their shares to Oberhausen and Duisburg, which then searched for a strategic private partner to acquire 49% of the MSWC plant. After running through a time consuming EU-wide tendering process that was strongly influenced by German antitrust authorities and regional courts, the shares were eventually sold in December 2001 to Rethmann Oberhausen GmbH (now: Remondis Oberhausen), a subsidiary of the largest German waste management company Rethmann (now: REMONDIS)[150].

6.3.6.2 Arrangement

Today, the special purpose company "GMVA Niederrhein GmbH" owns and operates the MSWC Oberhausen. Its shareholders are the Cities of Duisburg and Oberhausen (together 51%) and the private waste management company Remondis (49%).

In this arrangement, Remondis has technical as well as commercial management control of MSWC Oberhausen and appoints two out of three executive directors. Along with the acquisition of shares, Remondis had to provide a parent company guarantee for the existing and future debt of MSWC Oberhausen as well as an investment plan for the implementation of necessary maintenance and upgrading works.

In December 2001, i.e. shortly before the sale of shares to Remondis, long-term waste treatment contracts were signed with the Cities of Oberhausen and Duisburg. Additionally, there exists another long-term waste treatment contract with the County of Kleve, which dates back to the year 1996. These three waste treatment contracts are forfeited and together guarantee around 60% utilization of the plant at a nominally fixed price (price adjustment mechanisms apply). Remondis bears the remaining demand risks and is therefore responsible for acquiring residual municipal waste from tertiary public and private sources[151].

The following Figure 6-17 illustrates the most important relationships among the stakeholders of MSWC Oberhausen:

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[150] In June 2001, the federal antitrust authority (Bundeskartellamt) initially approved the sale to the preferred bidder Trienekens. REMONDIS appealed the decision and a regional court (Kartellsenat OLG Düsseldorf) overruled the antitrust decision in September 2001 (Deutscher Bundestag, 2003, p. 217). However, in 2005, the sale of other MSWC plants of Trienekens/ RWE to Remondis was approved by antitrust authorities and courts (see also case study Weisweiler in chapter 6.3.4).

[151] There exist for example waste treatment contracts with the municipalities of Coesfeld (35,000 Mg/a) and Steinfurt (90,000 Mg/a).

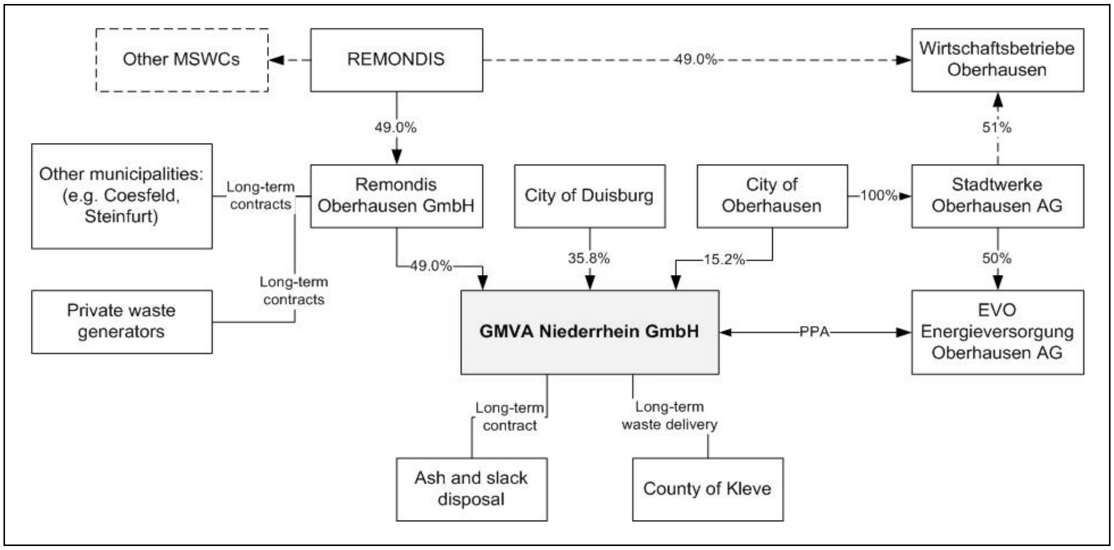

Figure 6-17: Stakeholders and their relationships at MSWC Oberhausen

Source: own, based on personal interviews (2007)

After becoming a shareholder, Remondis restructured most operational and managerial activities according to the requirements of a professional industrial organization. Since the year 2006, the MSWC Oberhausen is in a healthy financial position (Duisburg, 2005).

As part of the relationships between the stakeholders, a power purchase agreement was signed between MSWC Oberhausen and public utility company Energieversorgung Oberhausen AG (evo). Before the sale of shares to Remondis, evo was assigned to a contract for the commercial management and technical planning of the MSWC Oberhausen and therefore possesses strong linkages with the management and shareholders[152].

In 1998, Remondis already acquired a stake of 49% of 'Wirtschaftsbetriebe Oberhausen GmbH' (WBO), the public company that manages municipal waste in the City of Oberhausen. The existing personal relationships were regarded as helpful by the stakeholders for the cooperation at MSWC Oberhausen.

6.3.6.3 Discussion

The MSWC Oberhausen is a representative case study for the hybrid institutional arrangement of public-private joint venture. Its main characteristics are the joint ownership and operation of an MSWC plant for an unlimited period of time. The case study also illustrates the transition from the hierarchical institutional arrangement of public company to the hybrid institutional arrangement of public-private joint company through the sale of shares.

[152] The contract was signed in 1988 and will officially run until 2008. However, since 2001 all management decisions are taken by Remondis.

The sale of shares of MSWC Oberhausen to a private company was primarily motivated by severe financial and operational problems that put pressure on the public budgets of its public owners Duisburg and Oberhausen. The participation of the private waste management company Remondis was primarily motivated by its strategic decision to expand vertically its existing value chain into the waste treatment. Remondis anticipated profitable business opportunities at MSWC Oberhausen and realized them by introducing incentive based management organization and restructuring of operations.

6.3.7 MSWC Rothensee

6.3.7.1 Background

The City of Magdeburg is the capital of the Federal State of Saxony-Anhalt and has around 230,000 inhabitants. The local utility company “Städtische Werke Magdeburg” (SWM) was founded in 1993 by the City of Magdeburg (54%) and the private energy companies VEBA (29%) and VEW (17%). The year 2000, the merging and restructuring of VEBA and VEW resulted in the creation of e.on AG and Gelsenwasser AG, which now hold 26.67% and 19.33% of SWM, respectively.

In 1997, a working group was formed between SWM and VEBA with the name “star” (SWM thermische Abfallbehandlung Rothensee) which had the objective to jointly develop an MSWC plant in Rothensee, a well located old industrial area in Magdeburg. Due to the lack of waste treatment facilities in the City of Magdeburg and many surrounding areas it was clear, that high demand for MSWC would exist after the enforcement of TASi regulation in June 2005. In the following years, star undertook a number of feasibility studies to assess technical and commercial potential and a business plan was prepared.

In October 2001, the working group star was further formalized and the special purpose company (SPC) „Müllheizkraftwerk Rothensee GmbH” (MSWC Rothensee) was contractually founded between SWM and BKB, a subsidiary of the energy company e.on AG[153]. This SPC continued the business development and marketing efforts of star and participated in a number of public tenders for waste treatment in the region. At the same time, the MSWC plant started to take shape and planning approval processes were initiated in June 2002.

After winning public tenders in December 2002, the first long-term waste treatment contracts with a total amount of 110,000 Mg/a were signed between MSWC Rothensee and the three municipalities Magdeburg, Ohrekreis and Boerdekreis. Only eight months after initiating the processes, planning approval was received in February 2003 and the construction of two combustion lines with a nominal capacity of 300,000 Mg/a could start in March 2003.

[153] For more details about BKB, see also case study Buschhaus in chapter 6.3.9

Meanwhile, the MSWC Rothensee successfully continued to acquire more long-term waste treatment contracts with public authorities as well as private waste generators. Soon it became clear that the demand would exceed the capacities under construction and therefore two more lines with an additional capacity of 330,000 Mg/a were developed. Planning approval for this expansion was received in January 2005 and the construction started shortly afterwards.

The operation of the first two lines commenced in time on June 1, 2005, the starting day of TASi enforcement. The construction of the additional two combustion lines was finished in June 2007, and with a nominal capacity of 630,000 Mg/a, MSWC Rothensee is today one of the largest MSWC plants in Germany (compare 6.3.7), producing heat and electricity for around 40,000 people.

6.3.7.2 Arrangement

The MSWC Rothensee is owned and operated by the SPC “Müllheizkraftwerk Rothensee GmbH”. The equity of the SPC is shared between the private company BKB (51%) and SWM (49%), the majority of which is publicly owned. The total capital investment of around 250m € was financed through loans from its shareholders and the two banks Helaba and Commerzbank.

The following Figure 6-18 illustrates the most important relationships among the stakeholders of the MSWC Rothensee:

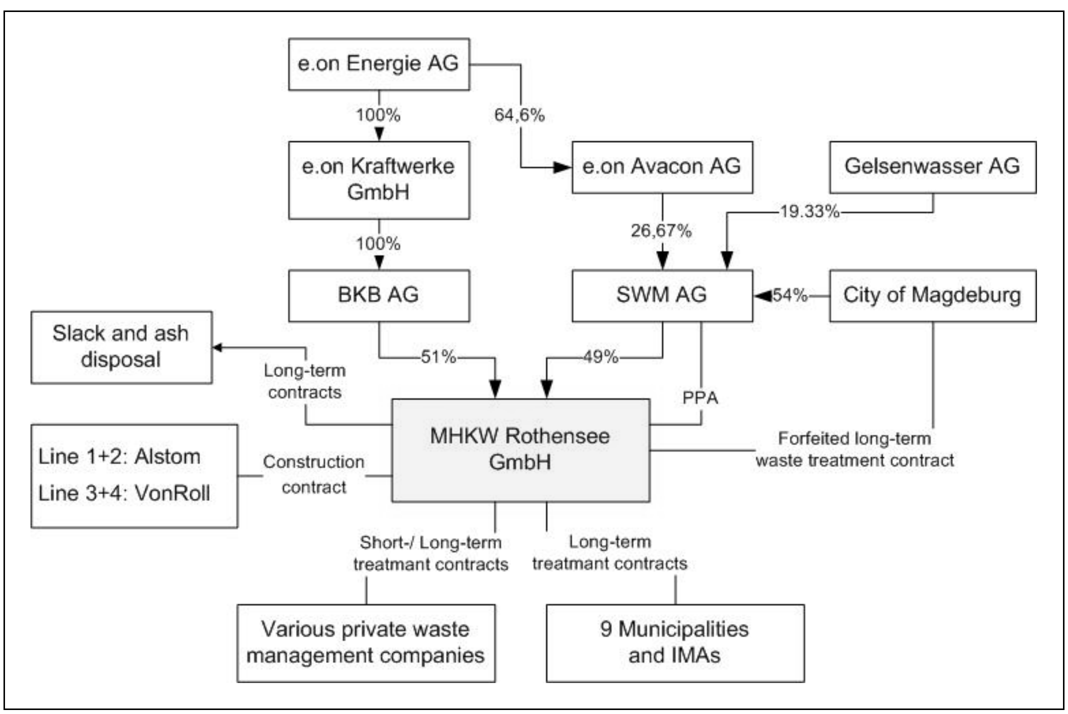

Figure 6-18: Stakeholders and their relationships at MSWC Rothensee

Source: own, based on personal interviews (2007)

Management decisions are jointly made within the organization of MSWC Rothensee, for which BKB appoints the technical executive manager and SWM the commercial executive manager. Today, around 300 people are employed by the SPC, 20 of which were transferred from SWM.

As shown in the following Table 6-8, a comparatively high number of long-term waste treatment contracts have been signed with the municipalities or IMAs after winning public tendering processes:

Municipality or IMA	**Capacity at MSWC [Mg/a]**[154]
Magdeburg	74,000
Ohrekreis	23,000
Bördekreis	13,000
Aschersleben-Stassfurt	23,000
Schönebeck	12,500
Peine, Gifhorn, Wolfenbuettel	together 107,000
Anhalt-Mitte	24,000
Jerichower Land	28,000
Bitterfeld	25,000
Stendal	23,000
Bernburg	15,000
Sum	*367,500*

Table 6-8: Public long-term waste treatment contracts of MSWC Rothensee
Source: NUM (2004a) , LVwASA (2005), personal interviews (2007)

All municipalities and IMAs are from the Federal States of Lower Saxony and Saxony-Anhalt. Concerning the largest waste treatment contract between MSWC Rothensee and the City of Magdeburg it is important to note, that 62% of contracted waste quantities were forfeited in 2006 (Koehli & Zuleger, 2006).

There exists a long-term power purchase agreement for produced heat and electricity between MSWC Rothensee and its shareholder SWM, which owns the heat distribution network in the City of Magdeburg and possesses 100% market share.

6.3.7.3 Discussion

The MSWC Rothensee is a representative case study for the hybrid institutional arrangement of public-private joint venture. The private company BKB and mostly publicly owned SWM jointly formed an SPC to develop, finance, build and operate the MSWC Rothensee. It is classified as a hybrid institutional arrangement, because the City of Magdeburg is an impor-

[154] Actual quantities can exceed given min. capacities.

tant shareholder of MSWC Rothensee and has also signed the largest individual waste treatment contract, which (as a further sign of common objectives) has been forfeited to reduce risk patterns and financing costs.

Initially, the development of this public-private joint venture was driven by the close relationships between the energy company e.on and the City of Magdeburg in their joint shareholding of the local utility company SWM. On this existing basis of trust and cooperation, MSWC Rothensee was developed in a way, that both BKB and SWM could pursue their objectives. BKB could primarily increase the German market share in its core business of MSWC through organic growth. The major objective of SWM was to expand local business operations in energy production, which improved their commercial performance and reduced the problem of over staffing (20 employees could be transferred internally from SWM to MSWC Rothensee).

The public-private joint venture of the MSWC Rothensee benefits from the technical and managerial expertise of BKB in developing, constructing and operating MSWC plants. On the other hand, it benefits from SWM who provided a suitable development location, an easily accessible energy distribution network for district heating and electricity, as well as important local knowledge and contacts with local political and administrative decision makers. From a commercial point of view, MSWC Rothensee is currently very successful and in the year 2006 generated a net profit of 16.1m€ (Magdeburg, 2007, p. 58).

Strong political and administrative support for the development of MSWC Rothensee could be witnessed from the City of Magdeburg and the Federal State of Saxony-Anhalt, which ensured fast planning approval and favorable regulatory environment[155]. Their objective was not only to ensure that municipal waste is treated in time and in accordance with TASi regulation, but also to develop an MSWC plant in an economically weak region which provides desperately needed jobs and taxes.

Even though classified as public-private joint venture, the MSWC Rothensee also shows some characteristics of the institutional arrangement of private company. The main similarity is that a comparatively high number of municipalities and IMAs have awarded long-term waste treatment contracts to MSWC Rothensee on the basis of public competition.

6.3.8 MSWC Zorbau

6.3.8.1 Background

SITA Deutschland GmbH (below named: SITA) is among the largest private waste management companies in Germany and is owned by the French utility company Suez. SITA has

[155] E.g. Saxony-Anhalt changed law and allowed municipal waste transportation across borders.

operations in municipal as well as commercial waste management. In 2006 it employed 3,500 people with a turn-over of 470m €.

Since the beginning of 1990s, SITA is also active in Eastern Germany where it participates in municipal waste management services in different institutional arrangements. Based on the market situation in the south of Eastern Germany, where almost all municipal waste was disposed of in landfill sites before 2005, SITA actively started to develop and own MSWC plant. Through market research activities it was known that many municipalities and IMAs in the region would tender long-term contracts for treating their residual municipal waste after June 2005.

To develop an MSWC plant, SITA approached different manufactures, and in May 2001 a memorandum of understanding (MoU) was signed with VonRoll (Switzerland) to design and construct a facility with a nominal capacity of 300,000 Mg/a. Even though SITA did not own any MSWC plants in Germany at that time, it could benefit from the expertise of its mother company Suez Environment, which owns and operates more than 60 MSWC plants throughout Europe.

During the initial project development, SITA planned to develop an MSWC plant at a location near the City of Zeitz in the Federal State of Saxony-Anhalt. With the technical specifications of the MOU, the official planning approval processes were initiated at that location. Meanwhile, SITA started participating in various public tenders for residual municipal waste treatment in the region. However, the location in Zeitz became unavailable due to different circumstances. Being under immense time pressure because of ongoing tendering procedures, SITA was able to find another strategically well located site near the small City of Zorbau, which had been developed by the municipality for industrial development. The municipality and its politicians strongly supported the project, because the technology was environmentally friendly and it promised investments, jobs and taxes to this economically weak area.

By the year 2002, SITA had won two public tenders from the two IMAs “Sachsen-Anhalt Süd” (ZAW-SAS) and “Südwestsachsen” (ZAS) to treat exclusively their residual municipal waste after the legal deadline of June 2005. Together, these two contracts were expected to have an average volume of 150,000 to 170,000 Mg/a. In August 2002, SITA was also chosen as the preferred bidder for a public tender of the IMA “Zweckverband Restabfallbehandlung Westsachsen” (ZRO) that had specified treatment volumes of up to 120,000 Mg/a (see also Table 6-9 below). The waste quantities of these three IMAs together were sufficient to justify investments in an MSWC plant with the anticipated capacity of 300,000 Mg/a. If the construction had started in the second half of 2002, there would have been a comfortable schedule to commence operation prior to first waste deliveries in June 2005.

However, for the public tender of ZRO, also Stadtwerke Gera AG submitted a proposal ranked behind[156]. Stadtwerke Gera AG is a public utility company under private law and is owned by the City of Gera. With approximately 105,000 inhabitants, Gera is the largest of seven municipalities within ZRO. The City of Gera initially supported a hierarchical institutional arrangement for residual municipal waste treatment of ZRO. The other members, however, favored an open competition, in which Stadtwerke Gera AG could participate as a bidder. After SITA was announced preferred bidder for the public tender of ZRO, Stadtwerke Gera AG and another bidder made use of their rights and raised a formal objection against the decision. Being under time pressure to start the construction and not knowing the outcome of the legal dispute, SITA and Stadtwerke Gera AG came to terms and mutually agreed to jointly own and operate the MSWC Zorbau (see arrangement below). In exchange, SITA obtained a share of 25.1% of Entsorgungs-Logistik-Thüringen GmbH (Elogo), of which the rest 74.9% are owned by Stadtwerke Gera AG. Elogo owns and operates a waste transfer station and transports the waste for ZRO to the treatment facility. Meanwhile, Stadtwerke Gera AG and the other bidder withdrew their objection[157], and SITA eventually signed the waste treatment contract with ZRO in June 2003. Even though the construction started with a considerable delay, it went into operation in time due to tremendous efforts of all participants.

6.3.8.2 Arrangement

The MSWC Zorbau is owned and operated by the special purpose company (SPC) "SITA Abfallverwertung GmbH". The SPC's equity of 6m€ is shared between SITA (74.9%) and Stadtwerke Gera AG (25.1%). SITA has signed three long-term contracts with IMAs coming from different Federal States (see Table 6-9), organizes the waste stream management and sells excess capacities at the market. SITA pays a fixed price for the operation and availability of the plant and therefore bears all demand risks.

Municipality or IMA	Capacity at MSWC	Duration
ZRO Ostthüringen (7 members)	40,000 – 120,000 Mg/a	10 years
ZAS Südwestsachsen (4 members)	max. 84,000 Mg/a	15 years
ZAW-SAS Sachsen-Anhalt Süd (2 members)	max. 90,000 Mg/a	15 years

Table 6-9: Public long-term waste treatment contracts of MSWC Zorbau
Source: personal interviews with IMAs (2007)

Stadtwerke Gera AG is responsible for most of the administrative activities of the SPC (e.g. accounting and financial reporting), for which it receives a fixed compensation. The technical

[156] Among others, also MSWC Leuna submitted a proposal.

[157] The trial went to the second instance. The second bidder eventually withdrew its objection due to the reduction of available capacities at its own MSWC plant after winning other tenders.

and commercial risks of the operation are shared. A long-term power purchase agreement (PPA) was signed with a public-private energy company “Energieversorgung Gera GmbH” that is jointly owned by the City of Gera (50.1%) and Suez (49.9%)

The following Figure 6-19 illustrates the most important relationships among the stakeholders of the MSWC Zorbau:

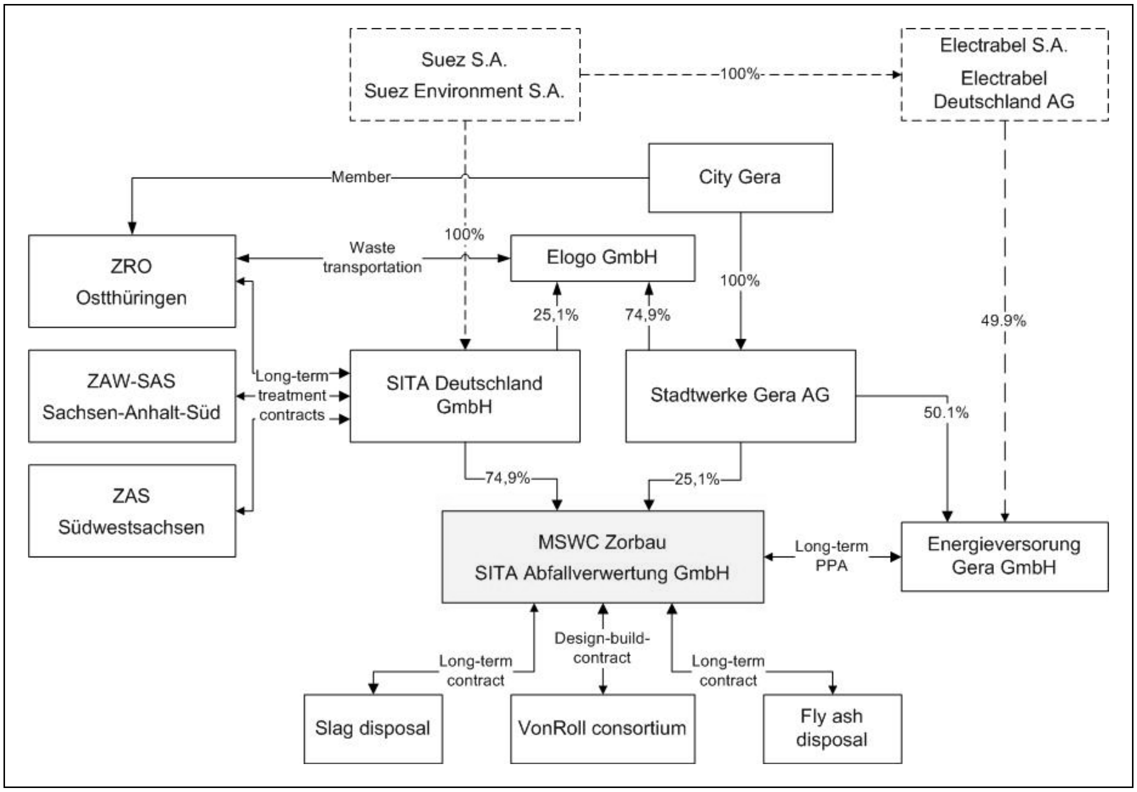

Figure 6-19: Stakeholders and their relationships at MSWC Zorbau
Source: own, based on personal interviews (2007)

The costs for project development, planning and construction summed up to around 120m € and were initially financed by the balance sheets of SITA. After successful commissioning of the plant, i.e. after all technical and commercial risks of the construction phase overcome, a structured project finance was arranged by KBC Bank (for more information about the financing see Savage, 2006).

6.3.8.3 Discussion

The MSWC Zorbau is a representative case study for the hybrid institutional arrangement of public-private joint venture. Key characteristics are the development, ownership and operation of the MSWC plant by a company that is jointly owned by public and private shareholders for an unlimited period of time. The public-private joint venture has signed long-term contracts for waste treatment that secure the asset specific investments.

Even though the City of Gera and Suez (mother company of SITA) already collaborated at a local level since 1991 through their joint ownership of “Energieversorgung Gera GmbH”, this relationship had only marginal impact on the emergence of the final institutional arrangement.

The described institutional arrangement also shows some characteristics of the institutional arrangement of private company, because the MSWC plant was initially planned and developed by an independent private company and the public participation only evolved at a later stage.

The MSWC Zorbau is an interesting case for exploring the development of institutional arrangements, because it reveals that institutional arrangements do not necessarily emerge as the result of a planned and structured process between the stakeholders (see for example the case study of MSWC Rothensee in chapter 6.3.7). Even though the public-private joint venture was not initially pursued by SITA, this institutional arrangement was the only practical way to gain investment security within the constraints of the time schedule. For the public utility company Stadtwerke Gera AG, the MSWC Zorbau is an opportunity to participate in the profitable waste management market and to employ existing excess resources.

The separation of technical and commercial management between SITA and Stadtwerke Gera has the effect, that all capital investment decisions are thoroughly analyzed from technical as well as financial point of views. Because Suez is listed at the US stock exchange, the commercial management (under responsibility of a manager appointed by Stadtwerke Gera) is quite influential due to obligations in fulfilling Sarbane-Oxley certification requirements.

6.3.9 MSWC Buschhaus

6.3.9.1 Background

In the year 1985, Braunschweigische Kohlenbergwerke (BKB), a subsidiary of e.on energy (at that time part of VEBA), built the coal burning power plant “Buschhaus” near the City of Helmstedt in the Federal State of Lower Saxony. This is the last of nine coal burning plants, which BKB operated in the region since 1909.

Due to the decline of the coal mining industry in the region it is planned to terminate the coal burning business of BKB by the year 2017. As a consequence, the management of BKB started to explore new business fields in the beginning of 1990s. After conducting several feasibility studies, one promising opportunity seemed to be the entering into the MSWC business. The location next to the Buschhaus coal burning plant was favorable due to synergies with electricity generation and public acceptance.

At the same time, the City of Brunswick (approx. 40km away from Buschhaus and within the same administrative region) started searching for new waste management solutions. Its own landfill site in Watenbüttel approached its full capacity and the development of a new site was very difficult due to the lack of a suitable location and public objections. In 1995, negotiations between BKB and the City of Brunswick resulted in a waste treatment contract, which encompassed the combustion of 136,000 Mg/a for a duration of 30 years from 1999 onward. For waste delivery, the City of Brunswick built a transfer station at its old waste disposal site for the waste transportation by rail to Buschhaus.

With the existence of the long-term contract with the City of Brunswick as well as through its participation in other ongoing public tendering processes, BKB had sufficient investment confidence and continued to pursue the development of the MSWC Buschhaus. Planning approval for the project was received in 1996, and the construction of two combustion lines with capacities of 2 x 175,000 Mg/a started in November 1996. By 1997, two more contracts were signed with the City of Helmstedt and the County of Hanover. Altogether, about 70% of the capacities of the MSWC Buschhaus were now guaranteed with public long-term contracts.

The construction was completed in 1998 and the operation of the two combustion lines started in January 1999. In the following years, various other municipalities in the region tendered the treatment of their waste for the time after June 2005, when the TASi regulation came into effect. BKB successfully bid for some of these contracts and therefore decided to expand capacities. In 2005, a third line was added. Today, with a total nominal capacity of 525,000 Mg/a, the MSWC Buschhaus is a comparatively large waste treatment plant and produces a maximum of 45MW of electrical energy.

In 2000, the European Commission inspected the contract between the City of Brunswick and MSWC Buschhaus. Even though the contract complied with the German procurement law, it was ruled that the tendering process did not comply with the EC directive on public procurement of services (92/50/EEC), mainly because the contract was awarded under a negotiated procedure and without EU-wide publication. After several years of legal dispute and to avoid penalties from the EC, the prime minister of Lower-Saxony, the mayor of Brunswick and the CEOs of e.on Energy as well as BKB agreed to amicably annul the contract in 2005. Consequently, the waste treatment contract was tendered again in an EU-wide competition, which was won by the competing waste management company Remondis that developed another new MSWC plant in the region at that time.

6.3.9.2 Arrangement

MSWC Buschhaus is owned by the private company BKB AG that is part of the e.on group. The following Figure 6-20 illustrates the most important relationships among the stakeholders of the MSWC Buschhaus:

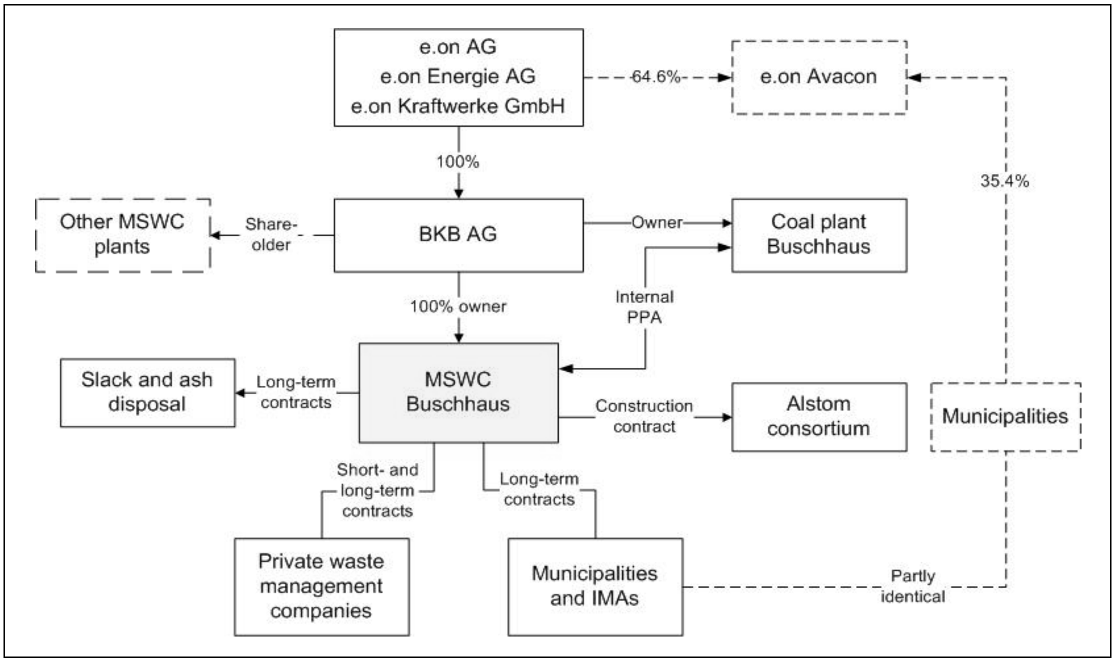

Figure 6-20: Stakeholders and their relationships at MSWC Buschhaus

Source: own, based on personal interviews (2007)

MSWC Buschhaus was privately planned and developed by BKB, and the financing was secured by the mother company e.on. The construction was divided into several lots and contracted to different suppliers.

The following Table 6-10 indicates the minimum waste treatment volumes that are based on long-term contracts between public waste authorities and MSWC Buschhaus:

Municipality or IMA	**Capacity at MSWC [Mg/a]**
Brunswick[158]	136,000
Helmstedt	25,000
IMA Region Hanover	102,000
IMA Nordharz	52,000
Salzgitter	30,000
Wolfsburg	65,000
Goslar	37,000
IMA Celle, Municipality Uelzen	50,000
Sum	*497,000*

Table 6-10: Public long-term waste treatment contracts of MSWC Buschhaus

Source: NUM (2004a; 2004b; 2004c) , LVwASA (2005), personal interviews (2007)

[158] By 2008, the waste will be delivered to Stassfurt.

All municipalities and IMAs are from the Federal State of Lower-Saxony, except for IMA Nordharz, which comes from the neighboring Federal State of Saxony-Anhalt. The duration of these contracts varies from 5 to 15 years and maximum waste quantities can considerably exceed the minimum amounts[159]. All contracts include price adjustment mechanisms that are different among each others. For contracts with municipalities that included waste transportation, BKB frequently allies with private waste management companies, such as Sulo (formerly Cleanaway).

There also exist linkages between e.on (the owner of BKB) and some municipalities that have contracts with MSWC Buschhaus. Through complicated holding structures, these municipalities (including City of Brunswick, County of Helmstedt and County of Hanover) hold 35.4% of “e.on Avacon”, a regional multi-utility company from in the Federal States of Lower-Saxony and Saxony-Anhalt with its head office in Helmstedt.

6.3.9.3 Discussion

The MSWC Buschhaus is a representative case study for the hybrid institutional arrangement of private company. Key characteristics are the development, ownership and operation of the MSWC plant by an independent private company that has signed long-term contracts for waste treatment with several municipalities and IMAs.

The most significant factors for the development of this institutional arrangement were the motivation of BKB to expand into the business field of MSWC, and the ability to contract sufficient waste treatment volumes for a long period of time that justified the capital investments. With its core competence in developing and operating large power plants, BKB possessed sufficient internal experience and resources to develop a location next to an existing coal burning plant, which provided synergies in energy production and faced comparably little public resistance.

For the municipalities and IMAs, on the other hand, MSWC Buschhaus offered sufficient capacities for treating their residual municipal waste. By signing long-term waste treatment contracts with the private company, they ensured their compliance with TASi regulation after June 2005.

The historical and regional roots of BKB as well as the existing formal and informal networks between e.on and some regional municipalities were surely advantageous during the development phase of MSWC Buschhaus[160]. Without political and bureaucratic support it would

[159] E.g. the contract of IMA Hanover specified amounts of up to 138.000 Mg/a (aha, 2005, p. 17).

[160] Similar local networks are also evident at other MSWC locations with the institutional arrangement of public company: RWE/ MSWC Essen; EnBW/ MSWC Stuttgart; Vattenfall/ MSWC Borsigstrasse (Hamburg).

have been very unlikely to achieve the right timing and sequencing of project preparation, planning approval and tendering of long-term waste treatment contracts that are necessary for such big capital investments.

Starting with MSWC Buschhaus, BKB successfully met its objective to initiate a structural transformation that prepared for the future after coal burning. Today, BKB is the largest owner and operator of MSWC plants in Germany (see chapter 6.2.6) and has been established itself as the waste treatment competence center within the e.on group[161]. With MSWC Buschhaus and further MSWC plants of BKB, the energy giant e.on was able to pursue its strategy in expanding electricity generation from non-fossil fuels that reduces greenhouse gas emissions.

6.4 Summary

The presented empirical analysis on the MSWC in Germany aimed at meeting two objectives: First, to verify the theoretically elaborated institutional arrangements in this developed market (research objective 4), and secondly, to explain the multifaceted reasons for their emergence (research objective 5).

Prior to the empirical analysis, the existing institutional environment for municipal waste management in Germany, which is treated as exogenously given, has been briefly presented. It was shown that the institutional environment is formally governed by a hierarchical waste legislation, in which municipalities are ultimately responsible for ensuring the implementation of municipal waste management services. MSWC has long been an important element of municipal waste management and since June 2005, the treatment of all residual municipal waste is legally required by TASi regulation. By 2007, there existed a total number of 65 MSWC plants with an aggregated nominal capacity of 17.5m Mg that treated an estimated 76% of residual municipal waste in Germany.

There are four legal options available under public law for the hierarchical institutional arrangement of public administration in Germany. These are *Regiebetrieb*, *Eigenbetrieb*, *AöR* and special purpose IMA, which differ in their legal and organizational dependence on the owning municipality. All other institutional arrangements function under private law, and there exist various legal options, most importantly GmbH and AG, exist.

To verify the theoretically elaborated institutional arrangements, a survey was undertaken for collecting quantitative data from all MSWC plants in Germany. The response rate of the survey was very high with 86% and the missing data was collected from secondary sources. The results verified the existence of all hierarchical and hybrid institutional arrangements for

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[161] By April 2008, the coal burning and MSWC business of BKB will be separated. All MSWC activities will be bundled in the newly created “e.on Energy from Waste”.

MSWC in Germany, but showed, that the institutional arrangement of spot market is not applied. The institutional arrangement of public-private joint venture enjoys the largest application with 22 plants and with a market capacity share of 39.7%, followed by private company (9 plants, 16.6%), public administration (11 plants, 14.9%), public company (12 plants, 14.7%) and operations model (7 plants, 10.1%). The institutional arrangement of (D)BOT is least frequently applied and are represented only by 4 plants with a capacity share of 4.0%.

The quantitative analysis revealed that inter-municipal associations (IMAs) are shareholders in 19 cases, in 4 cases of which the hierarchical institutional arrangement of special purpose IMA is applied. Furthermore, IMAs are the public principal in 5 out of 7 operations models and 3 out of 4 (D)BOTs.

In the survey, a significant number of MSWC plants showed horizontal as well as vertical integration. Altogether 30 MSWC plants (45.9% of the total market capacity) are horizontally integrated through shareholders who own at least one other MSWC plant. However, with the largest private company BKB owning fully or partly only 8 out of 65 MSWC plants (10.0% of market share), no dominant market concentration exists yet. Vertical integration with other activities in the waste management value system was verified for 29 MSWC plants.

The eight case studies of Berlin (Ruhleben), Kassel, Weisweiler, Pirmasens, Oberhausen, Magdeburg (Rothensee), Zorbau and Buschhaus were selected to illustrate the characteristics of the quantitatively verified institutional arrangements as well as to explore the reasons for their emergence. An overview of the multiple case studies with their main characteristics can be found in the following Table 6-11.

The MSWC Ruhleben is the only MSWC plant in Berlin and operates under the hierarchical institutional arrangement of public administration. High demand for waste treatment in Germany’s largest municipality causes highly dedicated assets to one customer, which increases total asset specificity. The emergence of a hierarchical institutional arrangement can therefore be explained from a transaction cost economic point of view.

The MSWC Kassel is a representative case study for the hierarchical institutional arrangement of public company, that emerged from a public administration through formal privatization in 1995. The change of hierarchical institutional arrangement was primarily motivated by gaining more flexibility and independence from the public budget, without which the large capital investments for legally required upgrading of the flue-gas treatment system were not achievable. Today, the public owner of the MSWC plant benefits from high earnings that are used to cross-subsidize other public services.

The case study MSWC Weisweiler exemplifies the hybrid institutional arrangement of operations model, the emergence of which was influenced by complex factors. In the beginning, the reason to outsource the technical operation for a period of 20 years to a private energy company was primarily motivated by the deployment of synergies with a neighboring coal burning power plant. The case study also concluded that centralized waste management planning and changes in the institutional environment resulted in the development of severe excess capacities. To solve the subsequent financial problems, a private waste management company temporarily took over 50% of the shares of the MSWC Weisweiler. However, today 100% of the assets are again owned by the public sector, which can be explained by changes in the strategy of a private energy company that caused withdrawal from waste management sector as well as the strategy of a public utility company to expand its profitable business of waste management. The case study also reveals that informal institutions, mainly personal networks among various stakeholders, play a decisive role in the emergence and transformation of institutional arrangements.

The MSWC Pirmasens represents the hybrid institutional arrangement of (D)BOT. The change of political objectives and normative attitudes of political decision makers towards private sector participation in MSWC have been identified as the major reasons for its emergence. In addition to that, the privatization of a publicly owned company as part of the restructuring of the German energy market, led to the development of the currently existing institutional arrangement.

The MSWC Oberhausen is one out of three case studies for the hybrid institutional arrangement of public-private joint venture. It has emerged through the sale of 49% of the shares of a public company, which was motivated by the search for a solution to overcome severe financial and operational problems. The strategic decision of a private waste management company to expand its value chain as well as the deployment of its existing financial and managerial capacities are further reasons for the emergence of this public-private joint venture.

The MSWC Rothensee is the second case study for the hybrid institutional arrangement of public-private joint venture. In this case, a joint venture was specially founded by a public and private company to develop, own and operate a new MSWC plant. The collaboration emerged on the basis of existing formal and informal relationships between the public and private stakeholders. The development of the institutional arrangement was supported by local knowledge and contacts of the public partner as well as by the expertise in technical development and operation of MSWC plants of the private partner.

The MSWC Zorbau is the third case study for the hybrid institutional arrangement of public-private joint venture. Here, the institutional arrangement did not primarily emerge as the result of a planned and structured process between the public and private stakeholders. Instead, the participation of a public utility company emerged as the only practical solution for gaining investment security for a private waste management company, which pursued the strategic objective to expand its value chain in Germany.

The MSWC Buschhaus is a representative case study for the hybrid institutional arrangement of private company. The MSWC plant is independently developed, owned and operated by a private energy company, which has signed several long-term waste treatment contracts with various municipalities and IMAs. The emergence of the institutional arrangement was primarily motivated by new business field development of the private energy company that it needed to strategically compensate for closing of coal burning activities. Verifiable formal and informal contacts of the private company to politicians at municipal and regional levels also supported the development of this institutional arrangement.

The different paths for the development and transformation of institutional arrangements can be found in the following Figure 6-21.

	Case study 1: Ruhleben	**Case study 2: Kassel**	**Case study 3: Weisweiler**	**Case study 4: Pirmasens**	**Case study 5: Oberhausen**	**Case study 6: Rothensee**	**Case study 7: Zorbau**	**Case study 8: Buschhaus**
NIE taxonomy	Hierarchy		Hybrid					
Privatization taxonomy	Public administration	Formal privatization	Functional privatization	Functional privatization	Partial material privatization	Partial material privatization	Partial material privatization	Full material privatization
Waste taxonomy	Public administration	Public company	Operations model	BOT	Public-private joint venture	Public-private joint venture	Public-private joint venture	Private company
Development	Public	Public	Public	Public	Public	Shared	Private	Private
Asset ownership	100% Public: City of Berlin	100% Public: City of Kassel	100% Public: 50% IMA ZEW 50% City KR*	100% Private: IMA ZAS	51% Public: Cities DU*/OB* 49% Private: Remondis	51% Private: BKB 49% Public: City of MD*	74.9% Private: SITA 25.1% Public: City of Gera	100% Private: BKB
Technical operation	Public	Public	Private	Private	Private	Shared	Shared	Private
Risks of operational costs	Public	Public	Shared	Private	Shared	Shared	Shared	Private
Anticipated duration	Perpetual	Perpetual	20a	20a	Perpetual	Perpetual	Perpetual	Perpetual
Demand risks	Public	Public	Public	Public	Shared	Shared	Private	Private
Waste stream management	Public	Public	Public	Public	Private	Shared	Private	Private

* KR – Krefeld, DU – Duisburg, OB – Oberhausen, MD – Magdeburg,

Table 6-11: Overview of case studies

Source: own

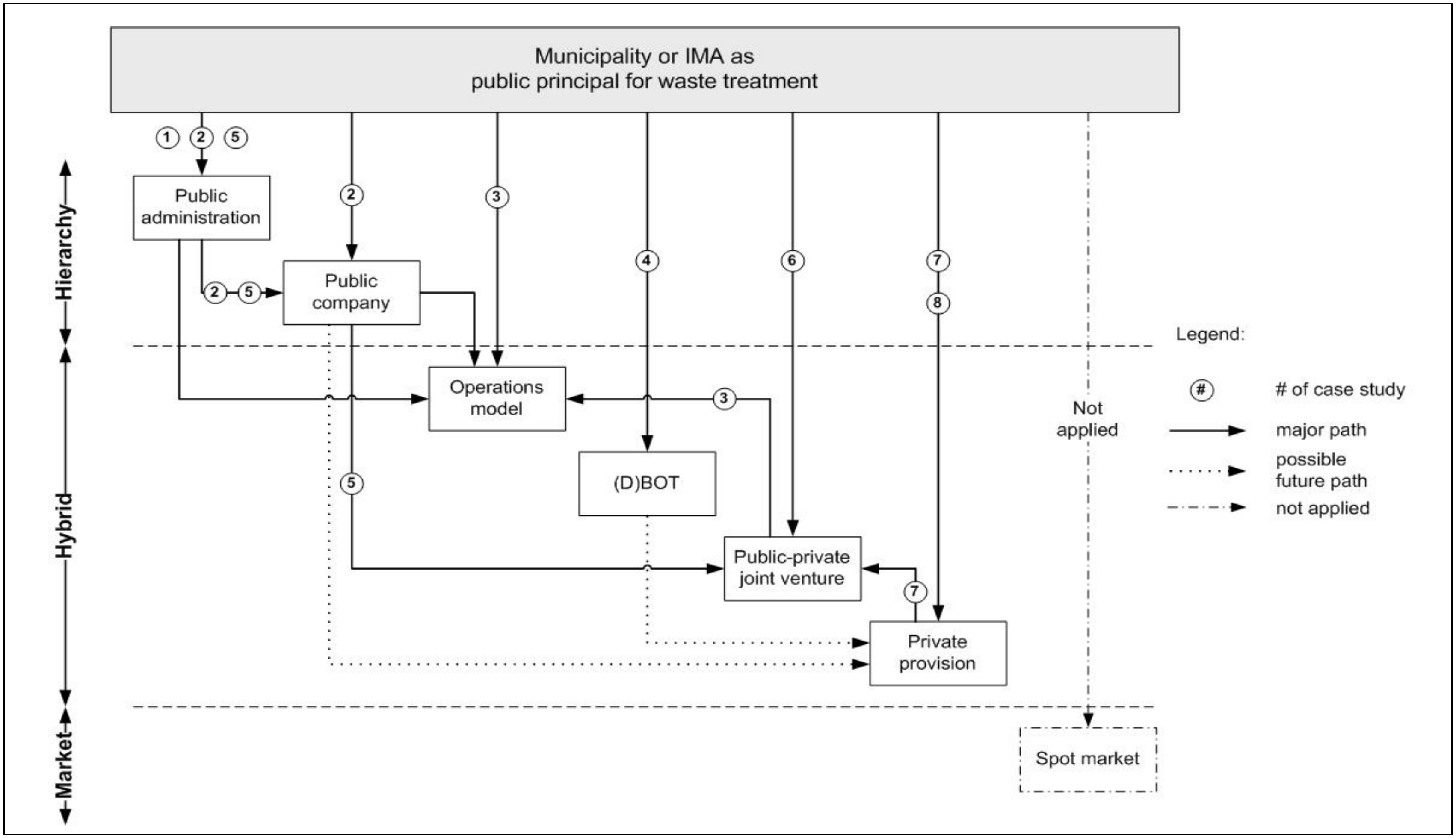

Figure 6-21: Development and change of institutional arrangements for MSWC

Source: own

7 Empirical study in Singapore[162]

7.1 Background

The Republic of Singapore is an island state in South-East Asia. Around 4.2m people live in an area of 697 km² and make Singapore to one of the most densely populated states in the world. With a GDP per capita of approx. 34,000 US$ in 2007, Singapore ranks among the most developed countries in Asia (IMF, 2007).

Singapore enjoys the reputation of being a "green and clean" city. However, continuous social and economic achievements of the past decades came along with environmental problems, such as the high amounts of generated waste by households, commerce and industry. In 2006, a total amount of 2.56m Mg of waste was generated, of which 57% came from residential households and 43% from commercial and industrial sources. With an average of 610 kg per year and capita, municipal waste generation rates are at the same levels as in other developed countries (compare Figure 2-6).

The following Figure 7-1 indicates the development of waste generation and treatment in Singapore during 1995 to 2006:

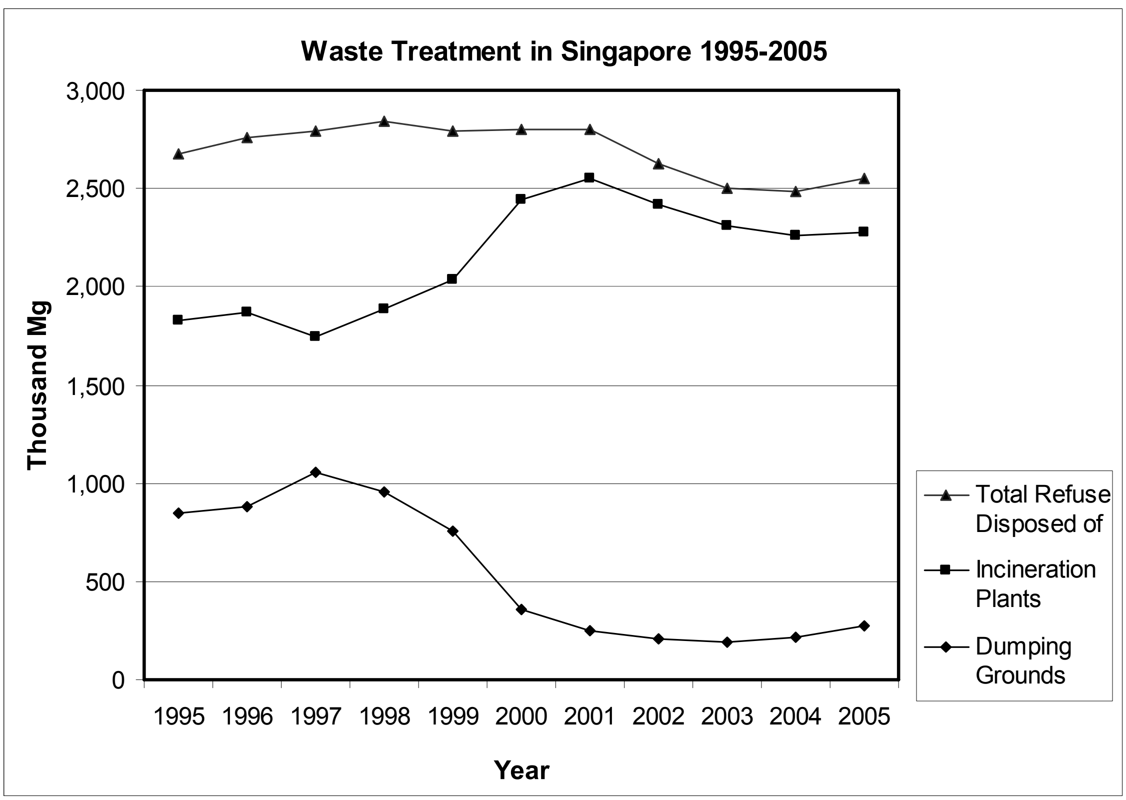

Figure 7-1: Waste treatment statistics in Singapore 1995-2006
Source: NEA (2007)

[162] This section is derived from Kleiss & Alfen (2007).

7.2 Waste Management

7.2.1 Waste collection

In the past, all activities of the waste management value chain were exclusively provided by the public sector in Singapore. This started to change in the year 1999, when the collection of household waste was progressively privatized. For the duration of five years[163], concessions for household waste collection in all nine districts were sequentially tendered to privately owned and licensed companies. The dominant criterion for the evaluation of bids was the proposed fixed household waste management fee, which is based on the type of premise[164] and includes waste collection, transportation and treatment. As for the year 2007, four private companies share the market for household waste collection in Singapore. Because the bids were done independent of one another, waste collection fees differ among the concession areas depending on local factors, especially population density[165]. The household collection fees are fixed for the entire concession period and will only be revised if the treatment fees at the MSWC plants are changed by National Environment Agency (NEA, see below). Changes in inflation or consumer price indexes (including fuel prices) do not allow an adjustment of these household collection fees.

While private waste collectors receive fixed revenues based on their concession agreement with NEA[166], they pay waste treatment fees at the MSWC plants that depend on the weight of collected waste. Therefore, the private collecting companies bear most market risks and have strong economic incentives to promote waste reduction and recycling. As a result, the waste collectors started to separate recyclables from the collected waste and actively support public waste reduction and recycling promotion programs.

All commercial and industrial entities are free to choose from any licensed waste management company. They can bilaterally negotiate prices for any waste management service (Upadhyaya, 2006, p. 30).

7.2.2 Waste treatment

Due to the growing amounts of municipal waste and severe land scarcity in the densely populated island of Singapore, the disposal of untreated waste in landfill sites is not a suitable option (Bai & Sutanto, 2002). During the beginning of the 1970s, the Ministry of Envi-

[163] The first round of contracts had a duration of 5 years. Since the second round of contracts, the duration has been increased to 7 years.

[164] Premises are distinguished between flats, landed residential, market stalls and different trade premises.

[165] The waste collection fees are fixed and range between 4.31 S$ and 7.35 S$ for flats per month.

[166] Revenues will only change if the number of premises changes in the concession area, and not if waste quantities per premises change.

ronment and Water Resources (MEWR) therefore started to support the MSWC to reduce waste disposal quantities. The MEWR opened its first MSWC plant in Ulu Pandan in 1979, and by 2000, a total number of four MSWC plants were in operation (see the following Table 7-1).

Name of MSWC	Year	Combustion lines	Nominal capacity[167]	Gate fee
Ulu Pandan	1979	4	1,100 Mg/day	81 – 87 S$/Mg*
Tuas	1986	5	1,700 Mg/day	77 S$/Mg
Senoko	1992	6	2,400 Mg/day	81 S$/Mg
Tuas South	2000	6	3,000 Mg/day	77 S$/Mg
* based on daytime				

Table 7-1: Existing MSWC plants in Singapore

Source: NEA (2007)

The following Figure 7-2 shows the locations of MSWC plants in Singapore.

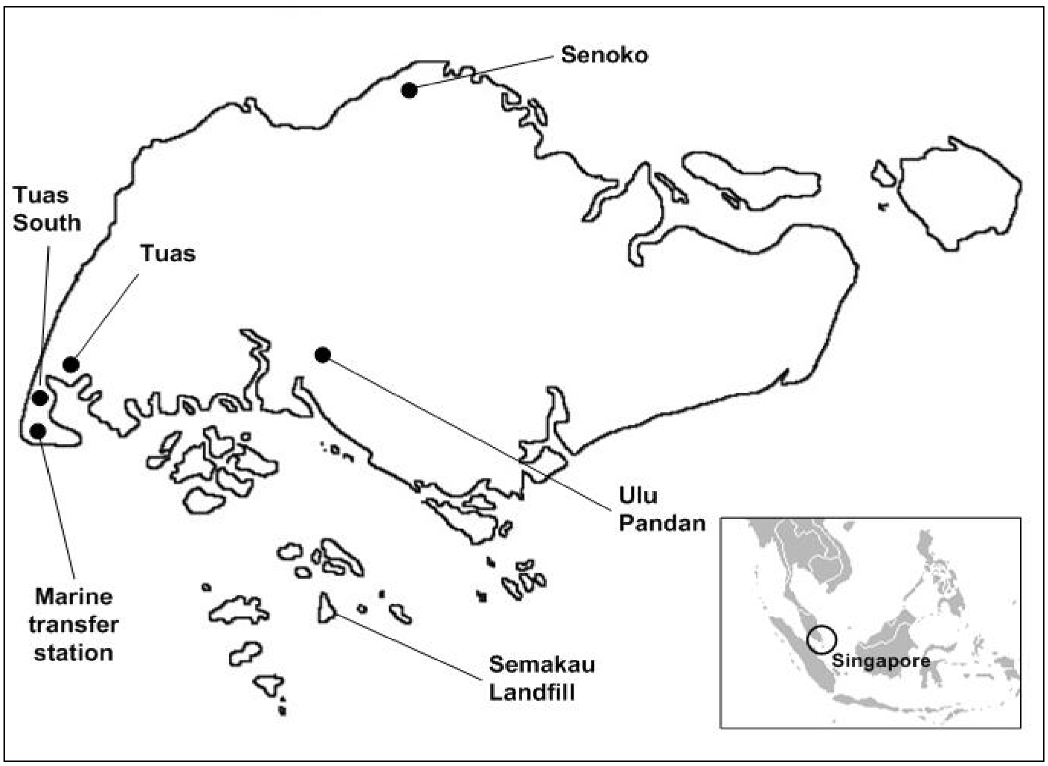

Figure 7-2: Locations of MSWC plants in Singapore

Source: own

These four MSWC plants are publicly developed, owned and operated by MEWR and therefore apply the institutional arrangement of public administration. Because the MSWC Ulu Pandan is approaching its design lifespan, it was decided to replace it with a new MSWC

[167] In Singapore, waste treatment capacities are given as daily capacities.

plant next to an existing one in the industrial zone of Tuas South. For this new MSWC plant, MEWR and its implementing agency NEA envisaged the usage of a market or hybrid institutional arrangement (see chapter 7.4).

In the beginning of 2000s, NEA launched a National Recycling Programme, which relied strongly on voluntary and educational measures (see chapter 4.3.2.1 for theoretical analysis of education and appeal measures). In the future, additional waste minimization and reduction policies might be implemented by NEA to achieve the ultimate goals of zero waste and zero landfill (Yeo, 2007). Therefore, the aggregate capacities for the MSWC will slowly be reduced in Singapore and the new MSWC plant will have lower capacities than MSWC Ulu Pandan.

7.3 Institutional environment

Formal institutions

Due to the size of Singapore, the formal institutions for waste management are comparatively straightforward. The Environmental Public Health Act (chapter 95) from the year 1987 regulates most important issues concerning waste management and was last revised in 2002. The Environmental Pollution Control Act (chapter 94A) specifies air pollution control issues for all industrial and commercial premises including the MSWC plants.

In July 2002, the National Environment Agency (NEA) was formed under the Ministry of the Environment and Water Resources (MEWR) and is responsible for the development and implementation of environmental policies. As part of the NEA, the Waste Management Department within the Environmental Protection Division is in charge of operating the four publicly owned MSWC plants as well as the Semakau off-shore landfill and the waste transfer station (see Table 7-1). The Waste Management Department is also responsible for licensing, controlling and regulating private waste collectors as well as future private MSWC plants (see case study below).

In the beginning of the 2000s, the Ministry of Finance Singapore (MoF) started to pursue a new strategy that aims at increased participation of the private sector in infrastructure development and operation. In the year 2002, it issued guidelines and standard procurement procedures for so-called “Public Private Partnerships” (PPP), which are derived from similar policies in Victoria State, Australia. The guidelines and procedures emphasize the creation of maximum value for money through the application of output specification, appropriate risk allocation and life-cycle integration. By the year 2003, four projects are awarded under the PPP program, among them are a desalination plant and a water treatment plant (MoF, 2007).

Informal institutions

The political landscape of Singapore is dominated by the People’s Action Party (PAP), which has won all general elections since 1959. This political one-party rule affects almost all public as well as commercial areas. Similar to other small countries or city economies, there exist intense informal networks among PAP's members, bureaucrats, media, as well as public and private companies. Hereby, the investment company Temasek Holdings that is owned by the Government of Singapore and headed by the President's wife, plays a leading role through its ownership in various enterprises.

However, in comparison to many other countries in the region, the public bureaucracy is very effectively organized and implements multiple principles of meritocracy (Quah, 2007). Corruption levels in Singapore are among the lowest in the world, ensuring a transparent, reliable and enforceable legal system[168] (Transparency International, 2007).

7.4 Case study: MSWC Tuas South II

7.4.1 Methodology

The case study of the MSWC Tuas South II is carried out to pursue the fifth research objective, i.e. to illustrate institutional arrangements for the MSWC and to explore the reasons for their development in the developed market of Singapore. As it will be shown, the case study possesses a strong revelatory character, because the failure to create a market based institutional arrangement and finally applied hybrid institutional arrangement could be observed and analyzed for the first time in the developed economy (Yin, 2003, p. 42). Because of its revelatory character and in contrast with the multiple-case study in Germany (see chapter 6), this case study will be carried out in more detail. Hereby, stakeholder relationships, output specifications, payment mechanism and risk allocation will be described in-depth.

The process of knowledge creation was iterative and started with interviewing the technical and commercial advisors of NEA by using open questions. After the basic information about the background, stakeholder relationships and tendering processes were gathered, several key stakeholders were approached and personally interviewed in a structural manner. These included NEA bureaucrats, external consultants, private companies, banks as well as researchers from local universities. To validate the information, a draft of the case study was sent to two key stakeholders who confirmed its accuracy.

7.4.2 Background

Based on the positive experiences from privatizing waste collection services (see chapter 7.2.1), MEWR and its implementing agency NEA envisaged also transferring other activities of the waste management value system to private companies. For the replacement of the MSWC Ulu Pandan, which will be closed shortly after 30 years of operation, the development of a new MSWC plant in the vicinity of the existing MSWC Tuas South was planned.

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[168] Singapore ranks the fourth along with Sweden in the global corruption perception index (Transparency International, 2007).

Due to changes in the institutional environment that support increased private sector participation in infrastructure development (see above), NEA initially favored the development of the new MSWC Tuas South II under an institutional arrangement that possessed mostly characteristics of a spot market (see chapter 5.4.1.4). Hereby, NEA planned to tender publicly an exclusive license for a private company to develop, own and operate an MSWC plant at Tuas South. The license would be granted to the bidder, who offered the lowest waste treatment fees, which would be capped for the first five years of operation. In this envisaged institutional arrangement, NEA would not guarantee any minimum waste delivery to the private MSWC plant throughout the entire project life-cycle. It is important to note, that in order to prevent possible exploitation of market power (see chapter 4.2.3 for theoretical analysis) waste collection companies were excluded from the bidding for the MSWC license. NEA promised that after granting the license it would privatize the remaining MSWC plants by selling their assets to private companies and slowly deregulate price setting for waste treatment fees. However, the schedule of MSWC privatization and price deregulation was not disclosed.

In 2000, NEA started tendering for the license to develop, own and operate the new MSWC plant with a nominal capacity of 800 Mg/day. However, the response from private companies was very unsatisfying, because only one bid was received that did not meet the minimum compliance criteria. The year 2001, NEA had to close the tendering procedures without granting the license. Instead, it started pursuing a hybrid institutional arrangement for the development of the new MSWC plant.

The challenge for NEA was to implement a more suitable hybrid institutional arrangement that would balance the risk allocation between the public and private sector while ensuring efficient and reliable service provision. Based on the guidelines and standard procurement procedures of MoF for so-called “Public Private Partnerships”, the institutional arrangement of (D)BOT was chosen. Hereby, it was planned to contract a private company for the design, financing, construction and operation of an MSWC plant with a designed capacity of 800 Mg/day. The operational period would be limited to 25 years with an option of extension upon mutual agreement between NEA and the private company. Because it was planned that the MSWC plant would have to be dismantled after the project termination, this institutional arrangement was named by NEA as Design-Build-Own-Operate (DBOO).

Under the DBOO agreement, the private company would not directly receive payments from the waste collectors based on delivered quantities but instead receive scheduled payments from NEA that are based on defined availability and performance criteria. Therefore, the private partner does not bear the demand risks, which he was reluctant to bear in the market arrangement envisaged in the first place.

7.4.3 Tendering

In December 2004, NEA launched the procurement for the new MSWC plant in Tuas South under the institutional arrangement of DBOO by issuing the notice for *“Pre-qualification of tenderers for the provision of refuse incineration services under a design-build-own-operate scheme”*. Interested bidders had to prove sufficient experience in developing and operating the MSWC plants and in implementing BOT or similar procurement schemes. A total number of 9 companies or consortia pre-qualified and received the tender documents. During the tendering phase, several meetings were held with all bidders to explain and clarify the project specification. Out of the 9 bidders, only 4 submitted an eligible proposal by the deadline in early 2005.

Based on the offered availability payments as well as on non-financial performance criteria (for details see below) the private company Keppel Seghers was chosen as a preferred bidder. Keppel Seghers is owned by Keppel Integrated Engineering Ltd. (KIE) and part of the Keppel Corporation, which is an industrial giant that is publicly listed at the Singaporean stock exchange. In 2002, KIE acquired Seghers Engineering NV from Belgium, a specialized company for manufacturing of environmental technologies, such as MSWC plants.

7.4.4 Institutional arrangement

<u>Stakeholder relationship</u>

In November 2005 the contract was awarded and two months later signed by NEA and “Keppel Seghers Tuas South Waste to Energy Plant Ltd.”, the special purpose company (SPC) sponsored by Keppel Seghers. Within 6 months from contract signing, the SPC had to achieve financial closure with its two lending banks ING and DZ Bank. The commencement of full operation will have to start the latest 40 months after contract signing, i.e. in May 2009.

After the successful commencement, Keppel Seghers will have to operate the MSWC plant for a period of 25 years during which it receives the so-called availability payments from NEA (see below). Private waste collection companies that deliver the residual waste to the MSWC plant will pay the treatment fees directly to NEA, which also sets prices.

The following Figure 7-3 illustrates the most important relationships among the stakeholders of the MSWC Tuas South II:

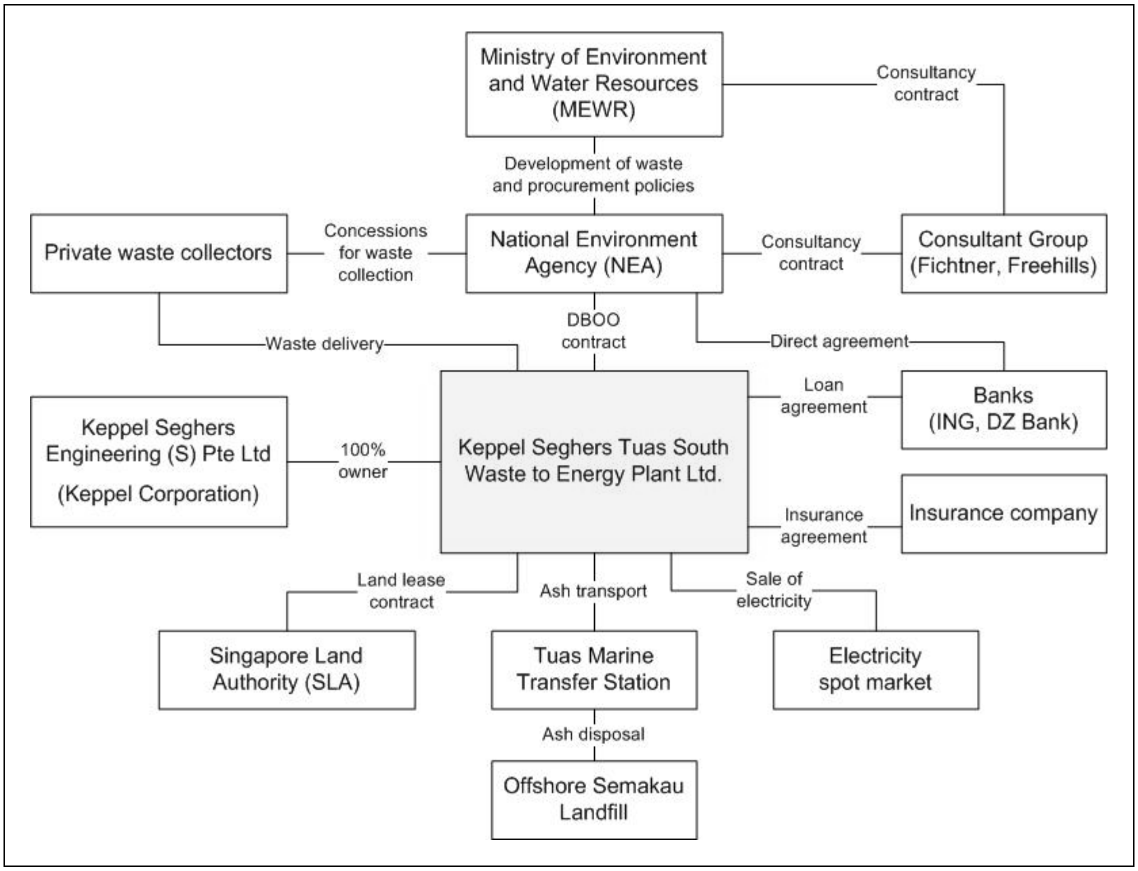


Figure 7-3: Stakeholders and their relationships at MSWC Tuas South II

Source: own, based on personal interviews (2006)

<u>Output specifications</u>

An important characteristic of the DBOO agreement is the definition of so-called output specifications. Here, the NEA did not specify the technical details for the MSWC plant, but instead defined the general technical framework for compliance during the operation. The private company Keppel Seghers could therefore optimize different technical and operational aspects throughout the life-cycle and freely design and combine various components, such as combustion unit, energy recovery, flue-gas cleaning system, process control and construction works (see chapter 3.2).

The main elements of the output specifications comprise:

1. The available treatment capacity shall be at least 800Mg/day in relation to a design net calorific value (NCV) of 9.000 kJ/kg municipal waste. Waste with a NCV from 6,000 – to 12,000 kJ/kg shall be treated.
2. The plant shall be built at the land in the industrial area of Tuas South that is provided for lease by Singaporean Land Authority (SLA) or at another suitable land procured by the private company.
3. The thermal treatment shall reduce the waste volume by at least 90% and the weight by at least 70%. The total organic content of the ash shall be less than 3%.

4. The ash shall be transported to the Tuas Marine Transfer Station from where it will be shipped to the off-shore Semakau landfill at no cost.
5. All facilities and processes shall comply with all environmental regulations and stipulations of the Republic of Singapore. Especially the flue-gas treatment system shall comply with the Environmental Pollution Control Act (EPCA).
6. Electricity shall be generated at a minimum guaranteed level dependent on the waste's NCV for own usage and sale to the spot market. The sale of excess electricity and its transmission have to be done in compliance with the "Transmission Code" of the Energy Market Authority of Singapore and SP PowerGrid.
7. The turnover-time for waste delivery trucks shall be less than 30 minutes.
8. Other specifications regarding civil works, waste receiving installations, electrical and mechanical design, control system, monitoring procedures, etc.

The payment mechanism

Throughout the operational period of 25 years, the SPC receives availability payments[169] from NEA that are calculated by a set of defined performance criteria. The installments are done on a monthly basis and consist of the following six components:

(1)	+	Combustion capacity payment (CCP)
(2)	+	Electricity generation payment (EGP)
(3)	+	Service payment (SP)
(4)	+	Electricity generation incentive payment (EGIP)
(5)	+	Payment for energy market charges (PMC)
(6)	-	Payment deduction (PD)
	=	**Total payment by NEA**

The combustion capacity payment (CCP) includes two payment elements for the fixed assets of the MSWC plant: (i) a fixed capital cost component without indexation for debt service, return on equity and taxes; as well as (ii) a fixed operation and maintenance component that is subject to indexation (consumer price index). Similarly, the electricity generation payment (EGP) consists of a single fixed component for the electricity generation comprising a fixed capital cost component without indexation for debt service, return on equity and taxes; and a fixed operation and maintenance component. The service payment (SP) is based on the variable operation and maintenance component and is subject to indexation. The electricity generation incentive payment (EGIP) is 2% share of actual revenues for generated energy sold to the Singaporean spot market. To cover the transaction costs for the sale of electricity,

[169] Availability payments are often applied in PPP road projects - see for example the E39 Klett-Bårdshaug project in Norway.

the payment for energy market charges (PMC) is part of the total payment. In addition to the above mentioned five positive elements, the payment structure also includes payment deductions (PD) that reflect penalties for (i) not meeting the required quality of bottom ash, (ii) turn-around times longer than 30 minutes or (iii) failing to generate minimum required electricity.

Besides minimizing life-cycle costs that are directly related to the MSWC plant, there exist also other financial incentives to the SPC that are not directly reflected by the payment mechanism stipulated in the contract between NEA and the SPC.

The first one is related to land use. In that the SPC used the designated land at the industrial zone in Tuas South, it would have to close a land lease agreement with the Singaporean Land Authority (SLA). Because the lease fee depends on the actual space used for the MSWC plant and its auxiliary facilities, the SPC has an incentive to minimize total land use. The optimization of land use is an important issue in the densely populated island.

Secondly, NEA will pay 30S$/Mg to the SPC for avoiding the disposal of bottom ash at the Semakau landfill. It has therefore a strong financial incentive to minimize the generation of bottom ash and to divert it from the disposal at the offshore landfill site, e.g. by using it for the production of construction materials[170].

The recovery of scrap metals is the third incentive for the SPC. With increasing market prizes for metals and sufficient content of metal in the waste, it could be financially beneficial to install equipment for extracting these metals during the combustion processes. However, the SPC is not allowed to separate marketable recycling products (e.g. glass, plastic, metals) upfront before thermal treatment, because NEA wants this part of the waste management value chain to be done by waste collectors.

The following Figure 7-4 indicates the most important financial arrangements and qualitative flow of funds between the key stakeholders:

[170] This is one reason, why Keppel currently sponsors a large research project on the utilization of bottom ash at the Nanyang Technological University, Singapore.

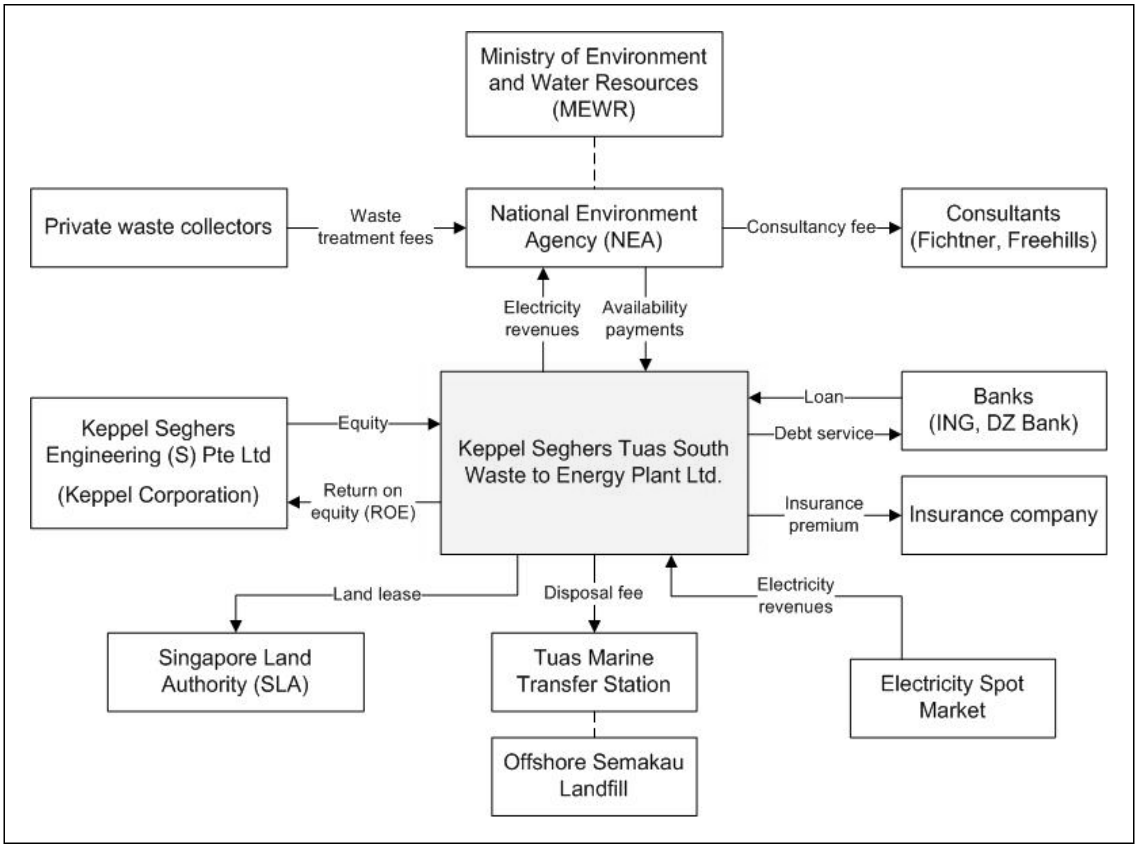


Figure 7-4: Flow of funds among key stakeholders at MSWC Tuas South II

Source: own, based on personal interviews (2006)

<u>Risk allocation</u>

The presented institutional arrangement is characterized by a sophisticated allocation of risks between the NEA and the private SPC. Based on the defined output specifications as well as the payment mechanism, the risk allocation is summarized in the following Table 7-2:

Risk	NEA	Private
Availability of minimum effective MSWC capacity of 800 Mg/d		X
Minimum energy recovery		X
Compliance with environmental laws and regulations		X
Net calorific value (NCV) of waste outside 6,000 – 12,000 kJ/kg	X	
Composition of waste other than reflected by NCV		X
Quality of residues (mass reduction > 70%, volume reduction > 90%, total organic content of bottom ash < 3%)		X
Construction and planning costs		X
Permission and monitoring costs		X
Costs for dismantling/ demolition after project termination		X
Construction delay		X
Land use		X
Change in law	X	
Demand risk	X	
Price for sale of electricity	98%	2%
Change of inflation rate	X	
Change of taxation	X	
Change of price for operating materials/ consumer price index	X	
Change of disposal fee for bottom ash	X	
Change of gate fee	X	

Table 7-2: Risk allocation for MSWC Tuas South II

Source: own, based on interviews (2006)

7.5 Discussion

The case study of the MSWC Tuas South II has revealed two important findings. First, it showed that private companies were not willing to engage in the institutional arrangement of market under the given circumstances for the MSWC in Singapore. Secondly, it provided an in-depth view of the characteristics of the hybrid institutional arrangement of (D)BOT.

The unwillingness of private companies to engage in the institutional arrangement of market in which they have to develop, own and operate an MSWC plant under a license of NEA is consistent with the elaborated theoretical framework for the MSWC and the quantitative findings from Germany. The attributes for the transactions of the MSWC Tuas South II can be characterized by (i) high site and physical asset specificity, (ii) medium intensity of dedicated assets, due to the limited number of customers (waste collection companies), (iii) medium volume uncertainty, because the development in the future of waste quantities is relatively unknown and (iv) low technology uncertainty, because MSWC is already a commonly applied technology in Singapore. Given these attributes of transaction, the heuristic model of institutional arrangements based on the theory of transaction cost economics is coherent with the rejection of a market arrangement. In case of the MSWC Tuas South II, private companies were unwilling to make idiosyncratic investments for transactions with the described characteristics because no contractual safeguards existed (compare also with chapter 5.3). However, the attempt of the Singaporean government to implement a market arrangement for the MSWC has revealed very valuable insights into the functioning of this infrastructure sector[171].

It can be speculated that the initially desired institutional arrangement of market might have worked if vertical integration of the MSWC had been allowed, because this would have considerably reduced volume uncertainty. However, the prohibition of vertical integration is justified to prevent market exploitation in the comparatively small market of Singapore.

The successfully implemented hybrid institutional arrangement of (D)BOT was better suited to function for the specific characteristics of the MSWC infrastructure sector. In case of the MSWC Tuas South II, a major reason for the emergence of this particular hybrid institutional arrangement was a shift in public policy. Since the end of 1990s, the MoF supports increased private sector participation in infrastructure development. The presented institutional arrangement for the MSWC Tuas South II applied the general guidelines and standard procurement procedures for “Public Private Partnerships” and showed how life-cycle integration, output specifications, payment mechanism and adequate risk allocation provide incentives for the efficient development and operation of an MSWC plant. Due to the illustrated performance incentives, the presented hybrid institutional arrangement of (D)BOT forms a suitable alternative for hierarchical institutional arrangements, in which X-inefficiencies can survive (see chapter 4.2.1).

[171] For further theoretical and empirical analysis on trial-and-error privatization or outsourcing see e.g. Post, Broekema, & Obirih-Opareh (2003) or Bennedsen & Schultz (2005).

8 Summary and conclusions

8.1 Research objectives and methodology

This research aimed at the theoretical and empirical analysis of the institutional arrangements for the provision of municipal solid waste combustion (MSWC) infrastructure. Thereby, five detailed research objectives were addressed:

1. To gain a purposeful understanding of the technical and economic aspects of MSWC,
2. To analyze the microeconomic characteristics of the market for MSWC and to identify possible deviations from the model of perfect competition,
3. To elaborate on a theoretical framework for categorizing and describing institutional arrangements for MSWC,
4. To verify these institutional arrangements in the two developed markets for MSWC of Germany and Singapore,
5. To explain the reasons for the emergence of the institutional arrangements for MSWC in these two markets.

To accommodate the transdisciplinary character of the research objectives, critical theory review and its implications to the research object were combined with quantitative and qualitative case study analyses. This chapter provides a summary of the key findings with reference to the addressed research objectives and identifies major theoretical as well as practical implications. The conclusions from the empirical analysis (research objectives 5 and 6) switch between theory and data, which is characteristic of the chosen research methodology of descriptive and exploratory case study analysis (Eisenhardt, 1989b).

In this connection it is important to emphasize that the research did not aim at the evaluation of particular institutional arrangements for MSWC. Therefore, no recommendations can be given for choosing a particular institutional arrangement in a project specific setup.

8.2 Technical and economic aspects of MSWC

Waste treatment is a crucial element of the waste hierarchy and an important activity in the waste management value system. MSWC is the most widely applied technology for waste treatment in many developed countries. It is primarily done to convert the heterogeneous mixture of harmful substances in the residual municipal waste into inert materials that can be fractioned and captured in the slag and flue-gas. While the volume and weight of the waste is considerably reduced, the energy and recyclable materials contained in it can be captured during the various processes.

MSWC plants consist of various machinery components, which include waste receiving and charging facilities, firing unit, energy recovery, flue-gas cleaning, emission control and monitoring system as well as auxiliary facilities. These components are designed and combined depending on the project specific requirements.

Today, the state-of-the-art MSWC plants reduce the negative environmental impacts of the applied physical and chemical processes to a minimum. Furthermore, MSWC generates important positive environmental impacts by reducing greenhouse gas emissions and land use for the disposal of final residues.

The financial analysis of costs and revenues throughout the life-cycle of MSWC plants showed that the capital investments are by far the largest share of total their life-cycle costs. They are determined by various project specific factors (total capacity, waste characteristics, flue-gas cleaning requirements, redundancy, civil works, local site conditions and energy utilization) and global factors (competition, macro economy, public acceptance and legal requirements). Other life-cycle costs include planning, operation, maintenance, residual disposal and financing costs. There exists a strong negative correlation between total unit costs and the capacities of MSWC plants. However, as the research showed, these economies of scale cannot be explored indefinitely due to technical limitations. An important finding of the analysis is, that up to 75% of the total life-cycle costs of MSWC plants are fixed costs.

The assessment of revenues identified waste treatment fees (based on actual throughput or availability payments) as the most important revenue stream during the life-cycle of MSWC plants. Other revenues include sale of recovered energy and materials as well as possible subsidies. However, with increasing prices for energy and material resources, the share of waste treatment fees of the total life-cycle revenues will decrease. As a result, the energy and resource efficiency of MSWC will gain in importance in the future and therefore provides incentives for improved technical and operational performance.

Another important conclusion from the technical and economic analysis of MSWC plants especially for the practice, is the identification of multiple opportunities to leverage capital investments, operational expenditures and revenues against one another. In practice, an assessment of all life-cycle costs and revenues should be thoroughly conducted to form the basis for efficient provision of MSWC infrastructure as well as continuous innovation. Institutional arrangements should therefore be chosen to employ organizations hat are able to optimize the total life-cycle costs and revenues in their investment decisions.

8.3 Microeconomic characteristics of the market for MSWC

The analysis has revealed that the characteristics of the market for MSWC deviate in multiple ways from the assumptions of the economic model for perfect competition and that they can be potential sources of market failure. It was shown that the possible existence of a natural monopoly, which is caused by the subadditive cost function of MSWC and limited contestability, depends on the relationship between the total unit costs for MSWC and the costs for transporting waste to a MSWC plant. There are two types of natural monopoly that can evolve: a local natural monopoly with spatial limitations or an extended natural monopoly.

However, even in densely populated areas with comparatively low transportation costs, the size of an extended natural monopoly is limited due to technical restrictions in the maximum size of MSWC plants. Applicable regulative measures to avoid or limit monopoly pricing (e.g. price regulation) must be based on a thorough assessment of the elaborated interdependencies.

Another potential source for market failure is the existence of different positive and negative technological externalities. Here, command-and-control measures are best suited to reduce negative environmental externalities, but also taxes, subsidies, liability for damages and tradable permits can help to reduce positive and negative externalities and be applied in addition to command-and-control measures. Education and ethical appeal[172] or measures based on the Coase theorem have very little practicability to the MSWC infrastructure.

While incomplete markets or unstable market equilibriums are unlikely to cause inadequate adaptation of the market for MSWC, a comparatively high inflexibility in coping with significant long-term demand changes can cause a market failure through timely limited gaps between demand and supply. In practise, any policy changes with a high impact on demand or supply in waste treatment must therefore be implemented with appropriate scheduling to allow for adequate market adaptation.

Possible causes for market failures that are rooted in incomplete information and uncertainty are unlikely to evolve for MSWC infrastructure, because signalling and screening mechanisms are usually in place in the relevant geographical markets due to the high capital investment costs for MSWC infrastructure.

Altogether, the economic analysis of the market specific aspects of MSWC revealed various deviations from the economic model of perfect competition. Different applicable measures to mitigate any problems caused by these deviations were identified. It was shown that none of the existing types of market failures necessarily necessitates a provision of MSWC by the public sector. Instead, various institutional arrangements can be considered appropriate from the microeconomic point of view. The presented theoretical elaborations controvert the influential public policy recommendations of the German “Rat von Sachverständigen für Umweltfragen”, who strongly favors the public provision of MSWC (RSU, 2002, pt. 1147). An important practical implication of this research study is therefore to revise these recommendations.

A further recommendation drawn from the theoretical analysis is that the small customers of MSWC plants, e.g. small municipalities or private enterprises, should find means to aggre-

[172] However, education and ethical appeal can be applicable to the other elements of the waste hierarchy, e.g. waste reduction and recycling, but their impact depends strongly on the normative and cultural-cognitive institutional elements.

gate their demand in case of locally existing natural monopolies. This will restrict the monopolist in enforcing Cournot-prices.

Based on the theoretical discussion of internalizing technological externalities, one important conclusion with high practical implications is that MSWC plants should participate in greenhouse gas emission trading programs. By doing so, positive external effects from substituting fossil fuels could be better internalized and therefore increase the economic incentives for improved energy recovery.

8.4 Theoretical framework for the institutional arrangements for MSWC

The theoretical framework for the institutional arrangements for MSWC is developed based on the transaction cost economics and stakeholder analysis. Based on transaction cost economics, the institutional arrangements for MSWC can take the shape of a hierarchy, various hybrid forms or a market. They are selected by individuals with bounded rationality to minimize transaction costs, which are the functions of asset specificity, uncertainty and frequency. The extended theoretical model showed that the predictions of transaction cost economics are also valid to public ordering and therefore applicable to MSWC.

In theory, the institutional arrangements for MSWC can be categorized into (1) hierarchical institutional arrangements: public administration and public company; (2) hybrid institutional arrangements: operations model, DBOT, public-private joint venture and private company; and (3) spot market. Due to comparatively high site and physical asset specificity, the theory of transaction cost economics predicts the application of hybrid or hierarchical arrangements for MSWC. The other two transaction attributes of frequency and uncertainty, which are specific for individual MSWC projects, are likely to influence the choice between hybrid and hierarchical arrangements.

Most important stakeholders of MSWC projects are politicians, bureaucrats, public service providers, citizens, private companies, manufactures, financiers as well as consultants. The stakeholder analysis showed from the theoretical point of view that these stakeholders can have different influences on the emergence of institutional arrangements. The involved actors that are either individual stakeholders or participants of a stakeholder organization do not necessarily aim at minimizing transaction costs, but instead may act opportunistically with bounded rationality and pursue different pecuniary and non-pecuniary objectives.

8.5 Verification and quantification of the institutional arrangements in Germany and Singapore

This research provides a unique quantitative analysis on institutional arrangements for MSWC plants in Germany. The results of a survey among all 65 MSWC plants in Germany have verified the existence of all hierarchical and hybrid institutional arrangements that were theoretically elaborated. The survey also showed that the theoretically possible institutional arrangement of a spot market is not applied to MSWC in Germany.

With a total capacity share of approx. 39.7%, the hybrid institutional arrangement of a public-private joint venture is most frequently applied in Germany. It is followed by private company (16.6%), public administration (14.9%), public company (14.7%), operations model (10.1%) and (D)BOT (4.0%).

In addition to verifying the institutional arrangements, the survey also quantified how MSWC plants are horizontally or vertically integrated. Currently, almost half of the MSWC plants in Germany are horizontally integrated through identical shareholders, who fully or partially own multiple MSWC plants. Even though there does not exist a dominant market concentration in Germany yet, further horizontal integration should be intensively observed by antitrust agency to prevent the development of monopolistic structures. Vertical integration with other activities in the waste management value system was identified at approx. 40% of the MSWC plants in Germany. Here, antitrust agencies have the obligation to ensure that market players do not exploit market power across the waste management value system.

In Singapore, there exist four MSWC plants in total. By the year 2007, all of them operated under the hierarchical institutional arrangement of a public administration. Currently, a new MSWC plant is under construction to which the institutional arrangement of a (D)BOT is applied.

Overall, the quantitative analysis of institutional arrangements for MSWC in Germany and Singapore validate the conclusions from transaction cost economics that predict the application of hierarchical and hybrid institutional arrangements for MSWC. However, no specific pattern exists that explains the choice between the different forms of hierarchical and hybrid institutional arrangements.

8.6 Rationale for the emergence of the institutional arrangements in Germany and Singapore

Altogether, eight representative case studies from Germany and one case study from Singapore were conducted to explore the emergence of different institutional arrangements. The criterion for the selection of the case studies was to represent all applied hierarchical and hybrid institutional arrangements that were validated in the quantitative survey.

The empirical analysis showed that institutional arrangements change over time and that new institutional arrangements emerge. Any quantitative survey is therefore only a snapshot of the current situation in a geographical market. A profound understanding of the historical developments in the market for MSWC is therefore required for any policy development or practical activity. Therefore, prior to changing any law or regulation on MSWC, i.e. the formal institutional environment, an assessment of its impact on applied institutional arrangements is recommended.

The multiple case studies have shown that hierarchical institutional arrangements can emerge in large municipalities with high demand for waste treatment and dedicated assets, like in the City of Berlin, especially if technological uncertainties are high. If technological uncertainty is low, like in the Singaporean case, the hybrid institutional arrangement of a (D)BOT based on the availability payment will provide a suitable alternative to hierarchical arrangements.

The gathered evidence also indicated that the hierarchical institutional arrangement of a public company can emerge out of a public administration through formal privatization. A strong motivation for doing so is an increase in operational and investment flexibility that might be required due to changes in the institutional environment. The case study analysis also revealed that the institutional arrangement of a public company is sometimes used to expand the business activities of existing public companies and to cross-subsidize public activities with profits made from MSWC.

In some explored case studies, waste management plans had a strong impact on the emergence of hierarchical and hybrid institutional arrangements. Because these plans mandatorily required municipalities to ensure the development of MSWC plants for a defined waste collection area, hierarchical or hybrid institutional arrangements emerged and were later transfromed to different institutional arrangements due to economic problems or changed stakeholder objectives. An important conclusion is that such centrally developed waste management plans should have only very limited impact on the institutional arrangement. E.g. they should not determine where and for which municipalities a new MSWC plant has to be built.

The multiple case studies revealed that hybrid institutional arrangements can emerge from hierarchical institutional arrangements or from scratch. The case studies from Germany showed that the existence of strong private waste management and energy companies is very important for the development of hybrid institutional arrangements. Therefore, a liberalized waste collection market or energy market, in which such private companies can evolve, is considered as a pre-requisite for the development of many hybrid institutional arrangements. Various reasons have been identified due to which private waste management as well as energy companies want to expand their value chain and invest in MSWC plants. The explored case studies provided evidence, that the existing formal and informal relationships that had evolved at the hybrid institutional arrangements for waste collection or energy production supported the emergence of hybrid institutional arrangements for MSWC with similar stakeholders.

Finally, the uncertainties in receiving a planning permission were identified to have strong impact on the emergence of institutional arrangements. The case studies showed that in institutional environments, where the receiving of a planning permission is difficult and requires high transaction costs, the emergence of hierarchical institutional arrangement is more likely. However, a transformation to a hybrid institutional arrangement can take place at a later stage when uncertainty is reduced. This finding validates the prediction of transaction cost economics that institutional arrangements also align with the transaction attribute of uncertainty.

Overall, the case studies showed that formal as well as informal institutions play an important role in the emergence of institutional arrangements for MSWC. Transaction cost economics as a stand alone theory framework can provide general explanations for the emergence of hierarchy, hybrids or market. However, the objectives of individual stakeholders and the particular institutional environment play a decisive role for the selection of a particular institutional arrangement within the groups of hierarchy, hybrids and market.

These findings have important practical implications. They emphasize that formal institutions, such as laws, regulations and written standards alone do not determine the application of a particular institutional arrangement. Informal institutions, which change only over a long period of time, must also be considered when planning the employment of a particular institutional arrangement.

8.7 Outlook and recommendations for further research

This research provided a unique and comprehensive analysis of the MSWC infrastructure sector. The theoretical and empirical assessments have laid the foundation for further research on institutional arrangements in general and the waste management sector in specific.

Further research can be conducted to expand the empirical analysis to other waste treatment technologies, most importantly mechanical biological treatment. Here, the results might deviate from MSWC due to different transaction attributes (e.g. high technological uncertainty) or different formal and informal institutions (e.g. different level of technological acceptance in the society).

Another possible field for further research could be a comparative analysis of institutional arrangements for MSWC. Existing benchmarking systems (see e.g. Przybilla, 2002; Stegmann, 2002) could be expanded to test the impact of institutional arrangements on the performance of MSWC infrastructure provision. However, constraints in accessing confidential data and information are expected to be the major challenges for such research. As an outcome of such a comparative analysis, the development of a so-called public sector comparator (PSC) would have high practical relevance. Such a PSC is frequently applied in other infrastructure sectors, e.g. public real estate sector, and provides a transparent decision making support tool for choosing the institutional arrangement.

A further research need is identified with respect to possible interdependencies between institutional arrangements for MSWC plants and the waste hierarchy. This research proposes testing the hypothesis that hierarchical institutional arrangements and some hybrid institutional arrangements have a negative impact on waste separation and recycling strategies, because the public sector may have strong motivations to ensure the employment of MSWC capacities, which it fully or partially owns.

Overall, the research has highlighted the importance of conducting theoretical and empirical analysis on institutional arrangements in physical infrastructure provision. By rigorously applying various theoretical frameworks to MSWC and based on a comprehensive understanding of complex technical and economic aspects of MSCW, this research hopes to trigger similar theoretical and empirical studies in other geographical markets as well as in other infrastructure sectors.

9 References

9.1 Interviews

The following table provides a selection of interviews that were specifically undertaken as part of the presented research.

Name	Organization	Topic
Prof. Dr. Kazuaki Miyamoto	Musashi Institute of Technology, Yokohama	PFIs in Japan
Mr. Nobutaka Kano; Mr. Akira Nakamura	Manager of Chikusa Environmental Works Office, Nagoya City	Narumi PFI project
Mr. Ryo Hiraga; Mr. Teroaki Fujikawa	Japan Waste Research Foundation, Osaka Research Center	Japanese PFI waste projects
Masakazu Matsuzaki	Hitachi Zosen, Ohdate Ecomanagement Corp.; Tokyo	Ohdate PFI project
Mr. Dr. Andreas Korn	Fichtner Consultant	DBOO Tuas South, Singapore
Prof. Dr. Heinz-Georg Baum	Bayerisches Institut für Abfallforschung	Private Participation in Waste Management
Mr. Goh Chin Aik	Keppel Integrated Engineering, Singapore	Keppel Tuas South Waste-to-Energy Plant
Mrs. Christina Lee	Sulo/ Müller Allvater, Singapore	Private Waste Collection in Singapore
Mr. Vincent Yeo	Ministry of Environment and Water Resources (MEWR), Singapore	PPP Waste Policy in Singapore; DBOO Tuas South
Mr. Dr. Luiz Diaz	CalRecovery Inc., USA; Editor of the journal "Waste Management"	Recent development in waste management
Mr. Thomas Kempin	BSR Berliner Stadtreinigung	MVA Ruhleben
Mrs. Dr. Bettina Enderle	Allen & Overy, Frankfurt	German waste laws and regulations
Mr. Dr. Stefan Elßer	3i Stuttgart	Investment in MSWC
Mr. Helmut Wensing	BKB AG, Helmstedt	MSWC plant Helmstedt
Mr. Josef Staus	SITA Abfallverwertung GmbH	MSWC plant in Zorbau
Mr. John Waffenschmidt, Mr. James Emmet	Covanta Energy Corp., Fairfield, NJ; USA	MWC in the USA, Participation of Covanta
Mrs. Dr. Eileen Berenyi	Governmental Advisory Associates, Westport, CT, USA	MWC in the USA
Mr. Prof. Nicholas Themelis	Columbia University, WTERT	MWC in the USA
Mrs. Catherine Coble, Mr. Chris Skaggs	Northeast Maryland Waste Disposal Authority (NMWDA), Baltimore, MD; USA	Institutional arrangement for MWC in Baltimore
Mr. Martin Vogell	C.C. Reststoff-Aufbereitung GmbH & Co. KG	Market for disposal of slag and ashes
Mr. Erhard Barth	AVA Augsburg GmbH	Technical, social and economic aspects of flue-gas treatment
Mr. Steffen Scholz	Martin GmbH	Investment costs for MSWC plant
Mr. Urs Brunner	VonRoll Inova, Zürich	Operation and maintenance of MSWC plants

Mr. Dr. Ansgar Fendel	Remondis, Lünen, Manager treatment facilities	Waste management companies and MSWC
Mr. Werner Hols	Remondis West, managing director	GMVA Oberhausen
Mr. Wagner	ZRO, Gera, Head	MSWC Zorbau
Mr. Harm-Peter Büchner	BKB AG, Helmstedt	Energy producers and companies and MSWC
Mr. Bernd Hahn	Sotec GmbH, commercial manager	MSWC Pirmasens
Mr. Norbert Schnauber	ZAS Pirmasens, Managing Director	MSWC Pirmasens
Mr. Dr. Erhard Edom	Ministry of Environment, Niedersachsen	MSWC in Lower Saxony
Mrs. Andrea Schappmann Mr. Dr. Jochen Fischer	MSWC Zorbau / Stadtwerke Gotha	MSWC Zorbau
Mr. Dr. Peter Zulauf	DZV Schwalm-Eder-Kreis und Landkreis Marburg-Biedenkopf	MSWC Kassel, Marburg-Biedenkopf
Mr. Reuter	AWA GmbH	MVA Weisweiler
Mr. Rolf Kaufmann	BKB AG, Helmstedt	MSWC of BKB
Mr. Rolf Oesterhoff	MHKW Rothensee GmbH / Stadtwerke Magdeburg	MHKW Rothensee
Mr. Tinnefeld	City Duisburg	GMVA Oberhausen
Mr. Schnellbacher	City Oberhausen	GMVA Oberhausen
Mr. Tippner	Bezirksregierung Köln	Waste Management plans in NRW
Mr. Schreyer	MSWC Kassel, Managing director	MSWC Kassel
Dr. Katja Lander	Evonik, communication	MSWC Pirmasens

9.2 Bibliography

Aachen. (2007). *Beteiligungsbericht der Stadt Aachen*.

Abednego, M. (2007). *An examination of the relationship between risk allocation and project success on PPP projects through Good Project Governance Assessment: Case studies of tollway projects in Indonesia, Vietnam and Thailand.* Unpublished PhD thesis, Asian Institute of Technology, Bangkok.

AFEA. (2002). *State of the Art for Waste Incineration Plants*. Vienna: Austrian Federal Environment Agency.

aha. (2005). *Abfallwirtschaftskonzept für die Region Hannover ab 2005*. Hannover: Zweckverband Abfallwirtschaft Region Hannover.

Akerlof, G. A. (1970). The Markets for "Lemons" - Quality Uncertainty and the Market Mechanism. *Quarterly Journal of Economics, 84*(3), 488-500.

Akintoye, A., Beck, M., & Hardcastle, C. (Eds.). (2003). *Public-Private Partnerships: Managing Risks and Opportunities* Oxford: Blackwell Publishers.

Alchian, A. (1965). Some Economics of Property Rights. *Il Politico, 30*(4), 816-829.

Alfen, H. W. (2007). *The diversity of PPPs in the sector of Public Real Estate and Infrastructure Management –an approach of defining and delimiting PPP as an alternative provision and procurement method*. Paper presented at the Evaluerles partenariatspublic-privé. Roundtable 1.

Alfen, H. W., Elbing, C., & Leupold, A. (2005). Show Me the Money. Payment Mechanisms for PPP Road and Highway Projects. *Infrastructure Journal*, 30-38.

Alfen, H. W., & Kleiss, T. (2003). *Saudi Arabian National Transportation Study. Private Sector Participation.* Riyadh: Kingdom of Saudi Arabia. Ministry of Economy and Planning.

Alwast, H. (2006). *Entsorgungsmarkt - Preise, Mengen, Behandlungskapazitäten*. Paper presented at the 11. Tagung Siedlungsabfallwirtschaft Magdeburg.

Amsterdam, C. o. (2006). *Value from waste - waste fired power plants. The new standard for recovery of sustainable energy, metals and building materials from urban waste.* City of Amsterdam.

Auksutat, M., & Löffler, R. (1998). *Kostenstrukturuntersuchung von Abfallbeseitigungsanlagen*. Berlin: Umweltbundesamt.

Bagchi, A. (2004). *Design, Construction, and Monitoring of Sanitary Landfill* (3rd ed.). John Wiley &sons: Hoboken

Bai, R., & Sutanto, M. (2002). The practice and challanges of solid waste management in Singapore. *Waste Management, 22*(5), 557-567.

Baker, G., Gibbons, R., & Murphy, K. J. (2002). Relational Contracts and the Theory of the Firm. *Quarterly Journal of Economics, 117*(1), 39-84.

Baum, H.-G., Cantner, J., Ilg, G., & Sprinkart, S. (2003). *Liberalisierung der Abfallwirtschaft - Empiriebericht*. Augsburg: Bayrisches Institut für Angewandte Umwelttechnik und -forschung.

Baumol, W. J. (1977). On the Proper Cost Tests for Natural Monopoly in a Multiproduct Industry. *The American Economic Review, 67*(5), 809-822.

Baumol, W. J. (1982). Contestable markets: An Uprising in the Theory of Industry structure. *The American Economic Review, 72*(1), 1-15.

Baumol, W. J., & Oates, W. E. (1971). The Use of Standards and Prices for Protection of the Environment. *Swedish Journal of Economics, 73*(1), 42-54.

Baumol, W. J., & Oates, W. E. (1988). *The theory of environmental policy* (2nd Edition ed.). Cambridge: Cambridge University Press.

Baumol, W. J., Panzar, J. C., & Willig, R. D. (1988). *Contestable markets and the theory of industry structure* (Revised ed.). San Diego: Harcourt Brace Jovanovich.

Becker, G. S. (1981). Altruism in the Family and Selfishness in the Market Place. *Economica, 48*, 1-15.

Beckers, T. (2005). *Die Realisierung von Projekten nach dem PPP-Ansatz bei Bundesfernstraßen - Ökonomische Grundlagen und eine Analyse des F-Modells, des A-Modells sowie des Funktionsbauvertrages.* TU Berlin, Berlin.

Beckmann, M. (2007a). *Vorlesungsunterlagen Thermische Verfahrenstechnik*. Weimar: Bauhaus-Universität Weimar.

Beckmann, M. (2007b). *Wege zur Effizienzsteigerung bei der Abfallbehandlung.* Paper presented at the 12. Fachtagung Thermische Abfallbehandlung, Kassel.

Beckmann, M., & Scholz, R. (2007). Ermittlung der Energieeffizienz in Anlagen zur thermischen Abfallbehandlung - Zur Problematik von Äquivalenzwerten und der Berechnung des Heizwertes. In K. J. Thomé-Kozmiensky & M. Beckmann (Eds.), *Energie aus Abfall. Band 2* (pp. 145-164). Neuruppin: TK Verlag Karl Thomé-Kozmienzky.

Beede, D. N., & Bloom, D. E. (1995). Economics of the Generation and Management of Municipal Solid Waste. *Discussion Paper Series No. 729. Columbia University. Department of Economics. New York*.

Bennedsen, M., & Schultz, C. (2005). Adaptive contracting: the trial-and-error approach to outsourcing. *Economic Theory, 25*(1), 35-50.

Benz, M., & Frey, B. S. (2007). Corporate governance: what can we learn from public governance? *Academy of Management Review, 32*(1), 92-104.

Berenyi, E. B. (2006). *Municipal Waste Combustion in the United States. Yearbook & Directory 2005-2006* (8th Edition ed.). Westport: Governmental Advisory Associates, Inc.

Bernier, L., & Simard, L. (2007). The governance of public enterprises: the Quebec experience. *Annals of Public and Cooperative Economics, 78*(3), 455-474.

Bidlingmaier, W. (2000). *Biologische Abfallverwertung*. Stuttgart: Ulmer.

Bidlingmaier, W. (2007). Die vergessene Hierarchie. *Müll und Abfall*(10), 465.

Bilitewski, B. (2007). *Ist die MBA gescheitert?* Paper presented at the 12. Fachtagung Thermische Abfallbehandlung, Kassel.

Bilitewski, B., Härdtle, G., & Marek, K. (1996). *Waste Mangement*. Berlin, Heidelberg: Springer.

Bilitewski, B., & Schirmer, M. (2006). Einsparpotenziale und CO2-Vermeidungskosten bei der energetischen Nutzung von Abfällen in Müllverbrennungsanlagen. *Wasser und Abfall*(7-8), 48-52.

Blum, U., Dudley, L., Leibbrand, F., & Weiske, A. (2005). *Angewandte Institutionenökonomik. Theorien-Modelle-Evidenz*. Wiesbaden: Gabler.

BMU. (2005). *Waste Incineration - A Potential Danger? Bidding Farewell to Dioxin Spouting*: German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.

Bognetti, G., & Robotti, L. (2007). The provision of local public services trough mixed enterprises: the Italian case. *Annals of Public and Cooperative Economics, 78*(3), 415-437.

Bohm, P., & Russell, C. E. (1985). Comparative analysis of alternative policy instruments. In A. V. Kneese & J. L. Sweeney (Eds.), *Handbook of natural resource and energy economics* (Vol. 1, pp. 395-460). New York: Elsevier.

Boll, P. (2007). *Investitionen in Public Private Partnership-Projekte im öffentlichen Hochbau unter besonderer Berücksichtigung der Risikoverteilung : eine theoretische und empirische Untersuchung* Köln: Immobilien Manager Verlag.

Bolton, P., Brodley, J. F., & Riordan, M. H. (2000). Predatory Pricing: Strategic Theory and Legal Policy. *Georgetown Law Journal, 88*(4), 2239-2330.

Bruce, K., & Jordan, J. (2007). Between Markets and Hierarchies: Towards a Better Taxonomy of Hybrid Organizational Forms? (Vol. 19, pp. 7 - 16): Routledge.

Bruch, G. (2004). *Modell zur Entwicklung gewerblicher Geschäftsfelder in kommunalen Entsorgungsunternehmen.* TU Berlin, Berlin.

Brunner, M. (2006). Thermische Abfallbehandlung im Spannungsfeld zwischen Abfallpolitik und Wirtschaftlichkeit. In A. Versteyl & K. J. Thomé-Kozmiensky (Eds.), *Texte zur Abfallwirtschaft - Politik, Recht, Wirtschaft, Management* (Vol. 1, pp. 115-124). Neuruppin: TK Verlag Karl Thomé-Kozmiensky.

Bryman, A., & Bell, E. (2003). *Business Research Methods*. Oxford: Oxford University Press.

Bryson, J. M., & Ring, P. S. (1990). A transaction-based approach to policy intervention. *Policy Sciences, 23*(3), 205-229.

BSR. (2005). *Geschäftsbericht 2005*. Berliner Stadtreinigung AöR.

Buchanan, J. M. (2003). *Public Choice: The Origins and Development of a Research Program*. Fairfex: Center for Study of Public Choice, George Mason University.

Buchanan, J. M., & Tullock, G. (1962). *The calculus of consent : logical foundations of constitutional democracy /*. Ann Arbor University of Michigan Press.

Bundeskartellamt. (2006). *Fusionsverfahren Verfügung gem §40 Abs. 2 GWB. Kennziffer B 10 – 90003 – Fa – 155/05*.

BUWAL. (2005). *Ökobilanz für Energie aus Kehrichtverbrennungsanlagen*. Bern/Zürich: Schweizer Bundesamt für Umwelt, Wald und Landschaft (BUWAL).

Cantner, J. (1997). *Die Kostenrechnung als Instrument der staatlichen Preisregulierung*. Heidelberg: Physica-Verlag.

Carson, S. J., Madhok, A., & Wu, T. (2006). Uncertainty, opportunism, and governance: The effects of volatillity and ambiguity on formal and relational contracting. *Academy of Management Journal, 49*(5), 1058-1077.

Carter, R., & Hodgson, G. M. (2007). The impact of empirical tests of transaction cost economics on the debate on the nature of the firm. *Strategic Management Journal, 38*, 431-476.

Child, J., & Faulkner, D. (2002). *Strategies of Cooperation: Managing Alliances, Networks, and Joint Ventures* (2nd ed.). New York: Oxford University Press.

Choe, C., & Fraser, I. (1998). The economics of household waste management: a review. *The Australian Journal of Agricultural and Resource Economics, 42*(3), 269-302.

Christmann, C. (2004). *Liberalisierung von Monopolmärkten*. Frankfurt am Main: Peter Lang.

Claus, J. C. (2000). *Planung komplexer Abfallbehandlungsanlagen. Genehmigte Dissertation.* Unpublished Doctoral Thesis TU Berlin, Berlin.

Coase, R. H. (1937). The Nature of the Firm. *Economica, 4*(16), 386-405.

Coase, R. H. (1960). The Problem of Social Cost. *Journal of Law and Economics, 3*, 1-44.

Coase, R. H., & Fowler, R. F. (1935). Bacon Production and the Pig-Cycle in Great Britain. *Economica, 2*(6), 142-167.

Cointreau-Levine, S., & Coad, A. (2000). *Private Sector Participation in Municipal Solid Waste Management*. St. Gallen: Swiss Centre for Development Cooperation in Technology and Management (SKAT).

Cournot, A. A. (1938). *Researches into the Mathematical Principles of the Theory of Wealth* (Reprint ed.). New York: Augustus M. Kelley Publishers.

Creswell, J. W. (2006). *Research design : qualitative, quantitative, and mixed methods approaches* Thousand Oaks, Calif. : Sage Publishing.

Crounauge, U., & Westermann, G. (2003). *Kommunale Unternehmen* (4th ed.). Berlin: Erich Schmidt Verlag.

David, R. J., & Han, S.-K. (2004). A systematic assessment of empirical support for the transaction cost economics. *Strategic Management Journal, 25*(1), 39-58.

Dehoust, G., Wiegmann, K., Fritsche, W., Stahl, H., Jenseit, W., Herold, A., et al. (2005). *Statusbericht zum Beitrag der Abfallwirtschaft zum Klimaschutz und mögliche Potentiale*. Berlin: Umweltbundesamt. Forschungsbericht 205 33 314.

Demsetz, H. (1967). Towards a Theory of Property Rights. *American Economic Review, 57*(2), 347-359.

Demsetz, H. (1968). Why Regulate Utilities? *Journal of Law and Economics, 11*(1), 55-65.

Deutscher Bundestag. (2003). *Drucksache 15/1226. Bericht des Bundeskartellamtes über seine Tätigkeit in den Jahren 2001/2002 sowie über die Lage und Entwicklung auf seinem Aufgabengebiet*. Berlin.

Doedens, H., & Kühle-Weidemeier, M. (2004). *Rechtliche. ökonomische und organisatorische Ansätze zur Schließung von Siedlungsabfalldeponieraum*: Umweltbundesamt.

Dollery, B. (2001). New Institutional Economics and the Analysis of the Public Sector. *Policy Studies Review, 18*(1), 1985-1211.

Downs, A. (1957). *An Economic Theory of Democracy*. New York: Harper.

Downs, A. (1972). Up and Down with Ecology. *The Public Interest, 28*(Summer), 38-50.

Duisburg. (2001). *Beteiligungsbericht 2000/2001*. Duisburg: Municipality.

Duisburg. (2005). *Beteiligungsbericht 2005*. Duisburg: Municipality.

Dunleavy, P. (1991). *Democracy, Bureaucracy and Public Choice. Economic Explanations in Political Science*. New York: Harvester Wheatsheaf.

Dunleavy, P. (2004). *Authoring a PhD - how to plan, draft, write and finish a doctoral thesis or dissertation*. Basingstoke: Palgrave Macmillan.

Dyer, J. H. (1997). Effective interfirm collaboration: How firms minimize transaction costs and maximize transaction value. *Strategic Management Journal, 18*, 535-556.

Ebisch, H., & Gottschalk, J. (1994). *Preise und Preisprüfungen bei öffentlichen Aufträgen einschliesslich Bauaufträge* (6th ed.). Munich: Valen.

Eckert, A. (2002). Predatory Pricing and the Speed of Antitrust Enforcement. *Review of Industrial Organization, 4*(20), 375-383.

EEX. (2007). *EEX Product Information Power*. Leipzig: European Stock Exchange.

Eggers, M. (2004). *Public Private Partnership. Eine strukturierte Analyse auf der Grundlage von ökonomischen und politischen Potentialen*. Frankfurt am Main: Peter Lang.

Eggerth, L. L. (2005). The evolving face of private sector participation in solid waste management. *Waste Management, 25*(3), 229-230.

EIB. (2002). *EIB financing of Solid Waste Management Projects. Evaluation Report*. Luxemburg: European Investment Bank.

EIPPCB. (2005). *Reference Document on the Best Available Techniques for Waste Incineration*. Seville: European Integrated Pollution Prevention and Control Bureau.

Eisenhardt, K. M. (1989a). Agency theory: An assessment and review. *Academy of Management Review, 14*(1), 54-74.

Eisenhardt, K. M. (1989b). Buidling Theories from Case Study Research. *Academy of Management Review, 14*(4), 532-550.

Elbing, C. (2006). *Risikomanagement für PPP-Projekte*. Lohmar: Eul Verlag.

Elliott, S. J. (1998). A comparative analysis of public concern over solid waste incinerators. *Waste Management & Research, 16*(4), 351-364.

Endres, A. (1994). *Umweltökonomie: Eine Einführung*. Darmstadt: Wissenschaftliche Buchgesellschaft.

Eriksson, O., Carlsson Reich, M., Frostell, B., Bjorklund, A., Assefa, G., Sundqvist, J. O., et al. (2005). Municipal solid waste management from a systems perspective. *Journal of Cleaner Production, 13*(3), 241-252.

European Commission. (2004). *Green Paper on public-private partnerships and Community law on public contracts and concessions, COM/2004/0327 final*.

EUWID. (2006). Entsorgungsmarkt für Siedlungsabfälle. *Europäischer Wirtschaftdienst. Recycling und Entsorgung*(50).

Ezekiel, M. (1938). The Cobweb-Theorem. *Quarterly Journal of Economics, 52*(2), 255-280.

Faulstich, M. (2006). Thermische Abfallbehandlung: Wichtiger denn je! *Müll und Abfall, 11*(11), 265.

Feldman, A. M., & Serrano, R. (2006). *Welfare economics and social choice theory. 2nd Edition*. New York: Springer.

Fischer, J. (1999). *Die Konzentrationsprozesse in der deutschen Entsorgungswirtschaft und ihre Konsequenzen für die Volkswirtschaft.* Free University Berlin, Berlin.

Fischer, K. (2007). *Lebenszyklusorientierte Projektentwicklung öffentlicher Immobilien als PPP - ein Value Management-Ansatz.* Unpublished PhD thesis, Bauhaus-Universität Weimar.

Francois, P. (2000). 'Public service motivation' as an argument for government provision. *Journal of Public Economics, 78*(3), 275-299.

Freeman, R. E. (1984). *Strategic Management: A stakeholder approach*. Boston, MA: Pitman.

Frickke, K., Bahr, K., Münnich, H., & Santen, H. (2006). Stand und Entwicklungsperspektiven der mechanisch-biologischen Restabfallbehandlung in Deutschland. In R. Stegmann, G. Rettenberger, W. Bidlingmaier, B. Bilitewski & K. Fricke (Eds.), *Deponietchenik 2006, Dokumentation der 5. Hamburger Abfallwirtschaftstage vom 10.-11.01.2006* (Vol. Hamburger Berichte Bd. 29, pp. 47-64). Hamburg: Verlag Abfall aktuell.

Fritsch, M., Wein, T., & Ewers, H.-J. (2003). *Marktversagen und Wirtschaftspolitik*. München: Verlag Franz Vahlen.

Fuchs, C. (2006). Abgasreiningung bei neuen Herausforderungen. In A. Versteyl & K. J. Thomé-Kozmiensky (Eds.), *Optimierung der Abfallverbrennung 3* (Vol. 3, pp. 596-618). Neuruppin: TK Verlag Karl Thomé-Kozmiensky.

Fullerton, D., & Kinnaman, T. C. (1996). Household Responses To Pricing Garbage By The Bag. *American Economic Review, 86*(4), 971-984.

Furubotn, E. G., & Richter, R. (2005). *Institutions and economic theory: the contribution of the new institutional economics*: The University of Michigan Press.

Gaube, T. (2006). *Regulierung und Effizienz. Eine empirische Analyse der deutschen Abfallwirtschaft*. Vallendar: WHU - Otto Beisheim School of Management.

Gaube, T., & Weigand, J. (2005). Wollen wir stinkende Riesen? Größe und Emissionswerte als Einflussfaktoren auf die Stückkosten einer Müllverbrennungsanlagen. *Controlling & Management, 50*(1), 30-36.

Gellynck, X., & Verhelst, P. (2007). Assessing instruments for mixed household solid waste collection services in the Flemish region of Belgium. *Resources, Conservation and Recycling, 49*, 372-387.

Genugten, M. v. (2005). Matching governance structures and transactions: An outlook. In A. Prinz, A. Steenge & J. Schmidt (Eds.), *Reforming the Welfare State*. Münster: Lit Verlag.

German federal statistical office. (2005). Waste statistics. from http://www.destatis.de

Geyskens, I., Steenkamp, J.-B. E. M., & Kumar, N. (2006). Make, buy, or ally: a transaction cost theory meta-analysis. *Academy of Management Journal, 49*(3), 519-543.

Glachant, J.-M., & Saussier, S. (2006). Introduction to special issue on public private partnerships. *Review of Industrial Organization, 29*(1-2), 1-2.

Gómez-Ibáñez, J. A. (2006). *Regulating Infrastructure: Monopoly, Contracts, and Discretion: Monopoly, Contracts and Discretion* (Second ed.). Cambridge: Harvard University Press.

Goshal, S., & Moran, P. (1996). Bad for practice: a critique of the transaction cost theory. *Academy of Management Review, 21*(1), 13-47.

Groothuis, P. A., & Miller, G. (1994). Locating Hazardous Waste Facilities: The Influence of NIMBY Beliefs. *American Journal of Economics and Sociology, 53*(3), 335-346.

Grossman, S. J., & Hart, O. D. (1986). The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration. *Journal of Political Economy, 94*(4), 691-718.

Gummesson, E. (2000). *Qualitative methods in management research* (2nd ed.). Thousand Oaks: Sage Publications.

Hart, O. (2003). Incomplete contracts and public ownership: remarks, and an application to public-private partnerships. *The Economic Journal, 113*(March), C69-C76.

Hart, O., & Moore, J. (1988). Incomplete contracts and renegotiation. *Econometrica, 56*(56), 4.

Hart, O., & Moore, J. (1999). Foundations of Incomplete Contracts. *Review of Economic Studies 66*, 115-138.

Heide, J. B., & Miner, A. S. (1992). The shadow of the future: effects of anticipated interaction and frequency of contact on buy-seller cooperation. *Academy of Management Journal, 35*(2), 265-291.

Helfand, G. E. (1981). Standards versus standards: The effects of different pollution restrictions. *American Economic Review, 81*(3), 622-635.

Hernberg, H. (1986). *Mikroökonomik. Kurseinheit 6: Wettbewerb und Wohlfahrt*. Hagen: FernUniversität. Own Publishing.

Hirschinger, H. (2002). Gesellschaftsformen für die Abfallwirtschaft. *Müll und Abfall*(7), 377-382.

HMULV. (2005). *Abfallwirtschaftsplan 2005*. Wiesbaden: Hessisches Ministerium für Umwelt, ländlichen Raum und Verbraucherschutz.

Höftmann, B. (2001). *Public Private Partnerships als Instrument der kooperativen und sektorübergeifenden Leistungsbereitsstellung - dargestellt an der neu strukturierten kommunalen Abfallwirtschaft*. Lütjensee: Paul Albrechts Verlag.

Höhr, H. (1988). Thermische Müllverwertung außerhalb von Ballungsgebieten - Einfluß der Mülltransportkosten. *Müll und Abfall, 20*(2), 41-46.

Holcombe, R. G., & Sobel, R. S. (2001). Public policy toward pecuniary externalities. *Public Finance Review, 29*(4), 304-325.

Holm-Müller, K. (1997). *Oekonomische Anreize in der deutschen Abfallwirtschaftspolitik*. Heidelberg: Physica-Verlag.

Holthusen, J. (2002). Die Kalkulation von Entsorgungsgebühren am Beispiel der Tarifkalkulation 2001 der Berliner Stadtreinigung (BSR). *Müll und Abfall*(9), 522-529.

Hong, S. (1999). The effects of unit pricing system upon household solid waste management: The Korean experience. *Journal of Environmental Management, 57*, 1-10.

IMF. (2007). *World Economic Outlook Report*. Washington D.C.: International Monetary Fund.

Inhabler, H. (1992). Of NIMBYs, LULUs, and NIMTOOs, *The Public Interest* (pp. 52-64).

IPCC. (2007). *Climate Change 2007: Impacts, Adaptation and Vulnerability. Working Group II. Assessment Report. Summary for Policy makers*. Brussels: Intergovernmental Panel on Climate Change.

Iseley, P., & Lowen, A. (2007). Price and Substitution in Resdiential Solid Waste. *Contemporary Economic Policy, 25*(3), 433-443.

IWSA. (2007a). Fact Sheet: Waste-to-Energy and State Renewable Statues. Retrieved 14.4.2007, from http://www.wte.org/docs/FactSheetState.pdf

IWSA. (2007b). Waste-to-Energy is an insignificant source of dioxin. Retrieved 14.04.2007, from http://www.wte.org/environment/dioxin.shtml

Johnson, D. B. (1991). *Public Choice: An Introduction to the New Political Economy*. Mountain View, CA: Mayfield Publishing Company.

Johnstone, N., & Labonne, J. (2004). Generation of Household Solid Waste in OECD Countries: An Empirical Analysis Using Macroeconomic Data. *Land Economics, 80*(4), 529-538.

Joskow, P. L. (1985). Vertical Integration and Long-term Contracts: The Case of Coal-burning Electric Generating Plants. *Journal of Law, Economics, and Organization, 1*(1), 33-80.

Joskow, P. L. (1988). Asset Specificity and the Structure of Vertical Relationships: Empirical Evidence. *Journal of Law, Economics, and Organization, 4*(1), 95-117.

Joskow, P. L. (1990). The performance of long-term contracts: further evidence from coal markets. *RAND Journal of Economics, 21*(2), 251-274.

Kaufhold, E., Kaufmann, R., & Goedecke, H. (2005). Kostenstrukturen bei der thermischen Abfallbehandlung. In A. I. U. M. F. B. Bilitewski (Ed.), *10. Fachtagung Thermische Ab-*

fallbehandlung (pp. 219-235). Dresden: Schriftenreihe des Instituts für Abfallwirtschaft und Altlasten, TU Dresden.

Kaufmann, R. (2006). Kostenführerschaft und Systemkonkurrenz vor dem Hintergrund der Entwicklung der Energiepreise. In A. Versteyl & K. J. Thomé-Kozmiensky (Eds.), *Texte zur Abfallwirtschaft - Politik, Recht, Wirtschaft, Management* (Vol. 1, pp. 185-203). Neuruppin: TK Verlag Karl Thomé-Kozmiensky.

Kaufmann, R., & Heinemann, S. (2007). Wird es Überkapazitäten bei der thermischen Behandlung von Abfällen geben? In A. Versteyl & K. J. Thomé-Kozmiensky (Eds.), *Texte zur Abfallwirtschaft - Recht, Konzepte der Abfallwirtschaft* (Vol. 3, pp. 199-224). Neuruppin: TK Verlag Karl Thomé-Kozmiensky.

Kempin, T., & Zahn, H. (2007). Erneuerung der Prozessleittechnik in der MVA Ruhleben. In K. J. Thomé-Kozmiensky & M. Beckmann (Eds.), *Energie aus Abfall* (Vol. 2, pp. 253-266). Neuruppin: TK Verlag Karl Thomé-Kozmiensky.

Keppler, V. (2007). Mut zur Eigeninitiative: Lukrative Margen in der deutschen Abfallwirtschaft - Kommunen lösen private Entsorger ab. *Der Neue Kämmerer*(3), 1-7.

Kessides, C. (1993). *Institutional Options for the Provision of Infrastructure*. Washington: World Bank Discussion Paper 212.

Kinnaman, T. C., & Fullerton, D. (2001). The economics of residential solid waste management. In T. Tietenberg & H. Folmer (Eds.), *The international yearbook of environmental and resource economics: a survey of current issues* (pp. 100-147). Cheltenham: Edward Elgar Publishing.

Klein, B., Crawford, R. G., & Alchian, A. A. (1978). Vertical Integration, Appropriable Rents, and the Competitive Contracting Process. *Journal of Law and Economics, 21*(2), 297-326.

Klein, B., & Leffler, K. B. (1981). The Role of Market Forces in Assuring Contractual Performance. *The Journal of Political Economy, 89*(4), 615-641.

Klein, P. G. (2005). The Make-or-Buy Decisions: Lessons from Empirical Studies. In C. Menard & M. M. Shirley (Eds.), *Handbook of New Institutional Economics*. Dordrecht, Berlin, Heidelberg, New York.

Klein, P. G. (2006). The treatment of frequency in transaction cost economics. Retrieved 14.05.2007, from http://organizationsandmarkets.com/2006/09/06/the-treatment-of-frequency-in-transaction-cost-economics/

Kleiss, T., & Alfen, H. W. (2007). The application of PPP models to municipal waste infrastructure projects - the Tuas South wast incineration plant in Singapore. In K. Töpfer & H. Bodner (Eds.), *Ideenimport* (pp. 147-158). Stuttgart: Schäffer-Poeschel

Kleiss, T., & Imura, H. (2006). The Japanese private finance initiative and its application in the municipal solid waste management sector. *International Journal of Project Management, 24*, 614-621.

Knauer, P., & Ooyen, G. v. (1979). Planning the deposit and course of recultivation of dumps. *European Journal of Forest Research, 98*(1), 42-51.

Koehli, J., & Zuleger, V. (2006). Forfeiting financing and the construction of the waste-fuelled power station (Müllheizkraftwerk) MHKW Rothensee GmbH. *European Commission Competition Policy Newsletter*(2), 68-70.

Kolstad, C. D. (2000). *Environmental Economics*. Oxford, New York: Oxford University Press.

Krass, K., Brüggemann, M., & Görener, E. (2004). Anfall, Aufbereitung und Verwertung von Recycling-Baustoffen und industriellen Nebenprodukten im Wirtschaftsjahr 2001: Teil 2: Industrielle Nebenprodukte. *Straße+Autobahn, 5*, 275-281.

Krefeld. (2005). *Beteiligungsbericht 2005 der Stadt Krefeld*.

Kruse, J. (1985). *Ökonomie der Monopolregulierung*. Göttingen: Vandenhoeck & Ruprecht.

Kusenbach, H. (2002). *Kommunale Abfallorganisation im Wandel*. Hagen: ISL-Verlag.

KVV. (2005). *Konzernjahresabschluss 2005*. Kassel: Kasseler Verkehrs- und Versorgungs-GmbH.

Larson, B. A. (1996). Environmental policy based on strict liability: Implications of Uncertainty and Bankruptcy. *Land Economics, 72*(1), 33-42.

Lee, Y. (1997). The privatization od solid waste infrastructure in Asia. *Third world planning review, 19*(2), 139-162.

Leibenstein, H. (1966). Allocative efficiency vs. "X-efficiency". *American Economic Review, 56*(3), 392-415.

Leiringer, R. (2003). *Technological innovations in the context of public-private partnership projects*. Stockholm: Own Publisher.

Leyendecker, H. (2005). Case study: Oversized incinerator burns up Cologne's cash. In Transparency International (Ed.), *Global Corruption Report 2005* (pp. 51-54). Cambridge: Cambridge University Press.

Littwin, F., & Schöne, F.-J. (Eds.). (2006). *Public Private Partnership im öffentlichen Hochbau : Handbuch*. Stuttgart: Kohlhammer.

LUA. (2001). *Untersuchungen zur Effizienz von unterschiedlichen Systemen zur Rauchgasreinigung bei Müllverbrennungsanlagen*. Essen: Landesumweltamt Nordrhein-Westphalen.

LVwASA. (2005). *Waste management plan for Saxony-Anhalt*. Magdeburg: Landesverwaltungsamt Sachsen-Anhalt - Regional administrative department Saxon-Anhalt.

Macneil, I. R. (1978). Contracts: Adjustment of Long-Term Economic Relations under Classical, Neoclassical, and Relational Contract Law. *Northwestern University Law Review, 72*, 854-906.

Magdeburg. (2007). *Neunter Beteiligungsbericht 2007*. Magdeburg: Landeshauptstadt Magdeburg. Dezernat Finanzen und Vermögen.

Mahalingam, A. (2005). *Understand and mitigating institutional costs on global projects.* Unpublished PhD Thesis, Stanford University, Palo Alto.

Makowski, L., & Ostroy, J. M. (2001). Perfect Competition and the Creativity of the Market. *Journal of Economic Literature, 39*(2), 479.

Mamadouh, V., Jong, M. D., & Lalenis, K. (2002). An introduction to institutional transplantation. In M. D. Jong, K. Lalenis & V. Mamadouh (Eds.), *The Theory and Practice of Institutional Transplantation*. Dordrecht, The Netherlands: Kluwer Academic Publisher.

Mankiw, N. G. (2004). *Principals of Economics*. Mason: Thomson Higher Education.

Martin. (2007). Firing grate. Munich: provided by Marting GmbH für Umwelt und Energietechnik.

Masten, S. E. (1988). A Legal Basis for the Firm. *Journal of Law, Economics and Organization, 4*(1), 181-198.

Masten, S. E., & Crocker, K. J. (1985). Efficient Adaption in Long-Term Contracts: Take-or-Pay Provisions for Natural Gas. *The American Economic Review*.

Masten, S. E., James W. Meehan, J., & Snyder, E. A. (1991). The Costs of Organization. *Journal of Law, Economics, & Organization, 7*(1), 1-25.

Menard, C. (2001). Methodological Issues in Institutional Economics. *Journal of Economic Methodology, 8*(1).

Ménard, C. (2004). The economics of hybrid organizations. *Journal of Institutional and Theoretical Economics, 160*(3), 345-376.

Ménard, C. (2005). A New Institutional Approach to Organizations. In C. Ménard & M. M. Shirley (Eds.), *Handbook of New Institutional Economics* (pp. 281-318). Dordrecht, Berlin, Heidelberg, New York.

Ménard, C., & Shirley, M. M. (2005). Introduction. In C. Ménard & M. M. Shirley (Eds.), *Handbook of New Institutional Economics* (pp. 1-18). Dordrecht, Berlin, Heidelberg, New York.

Merna, T., & Njiru, C. (2002). *Financing Infrastructure Projects*. London: Thomas Telford.

Miller, G. J., & Moe, T. M. (1983). Bureaucrats, Legislators, and the Size of Government. *The American Political Science Review, 77*(2), 297-322.

MoF. (2007). Ministry of Finance Singapore. Public Private Partnerships. Background. Retrieved 05.12.2007, from http://www.mof.gov.sg/policies/ppp.html

Monopolkommission. (2003). *Wettbewerbsfragen der Kreislauf- und Abfallwirtschaft. Sondergutachten der Monopolkommission gemäß § 44 Abs. 1 Satz 4 GWB*. Bonn.

Mueller, D. (2003). *Public Choice III*. Cambridge: Cambridge University Press.

Mühlenkamp, H. (1999). *Eine ökonomische Analyse ausgewählter institutioneller Arrangements zur Erfüllung öffentlicher Aufgaben*. Baden-Baden: Nomos Verlag.

Mühlenkamp, H. (2002). "Marktversagen" als ökonomische Begründung für Interventionen der öffentlichen Hand. In R. Hrbek & M. Nettesheim (Eds.), *Europäische Union und mitgliedstaatliche Daseinsvorsorge* (pp. 65-78). Baden-Baden: Nomos-Verlags-Gesellschaft.

Mühlenkamp, H. (2005). "Public Private Partnership" ökonomisch analysiert - Eine Abhandlung aus der Sicht der Transaktionskostenökonomik und der Neuen Politischen Ökonomie. In D. Budäus (Ed.), *Kooperationsformen zwischen Markt und Staat - Theoretische Grundlagen und praktische Ausprägungen*. Badan-Baden: Nomos-Verlag.

Murphy, J. D., & McKeogh, E. (2004). Technical, economic and environmental analysis of energy production from municipal solid waste. *Renewable Energy, 29*(7), 1043-1057.

Myles, G. D. (1995). *Public Economics*. Cambridge: Cambridge University Press.

NEA. (2001). *Environmental pollution control act (Chapter 94A, Section 77 (1))*. Retrieved. from http://app.nea.gov.sg/cms/htdocs/category_sub.asp?cid=192.

NEA. (2007). Refuse Disposal Figures. National Environmental Authority. Singapore. Retrieved 28.12.2007, from http://app.nea.gov.sg/cms/htdocs/article.asp?pid=401

Nelson, M. A. (1997). Municipal government approaches to service delivery: An analysis from a transactions cost perspectives. *Economic Inquiry, 35*(1), 82-97.

Nelson, R. R. (1987). Roles of Government in a Mixed Economy. *Journal of Policy Analysis and Management, 6*(4), 541-557.

Niskanen, W. A. (1968). Nonmarket decision making. The peculiar economics of bureaucracy. *American Economic Review, 58*(2), 293-306.

Niskanen, W. A. (1971). *Bureaucracy and Representative Government*. New York: Aldine Press.

Niskanen, W. A. (1975). Bureaucrats and Politicians. *Journal of Law and Economics, 18*(3), 617-643.

Noorderhaven, N. G. (1995). Transaction, interaction, institutionalization: Toward a dynamic theory of hybrid governance. *Scandinavian Journal of Management, 11*(1), 43-55.

North, D. C. (1990). *Institutions, institutional change and economic performance*. Cambridge: Cambridge University Press.

NUM. (2004a). *Waste management plan for the administrative region Brunswick - Municipal waste part*. Hanover: Niedersächsisches Umweltministerium - Environmental Ministry Lower-Saxony.

NUM. (2004b). *Waste management plan for the administrative region Hanover - Municipal waste part*. Hanover: Niedersächsisches Umweltministerium - Environmental Ministry Lower-Saxony.

NUM. (2004c). *Waste management plan for the administrative region Lüneburg - Municipal waste part*. Hanover: Niedersächsisches Umweltministerium - Environmental Ministry Lower-Saxony.

Obermann, G. (2007). The Role of the state as guarantor of public services: transaction costs issues and empirical evidence. *Annals of Public and Cooperative Economics, 78*(3), 475-500.

OECD. (2004). *Adressing the Economics of Waste*. Paris, France.

OECD. (2007). OECD Factbook 2007 - Economic, Environmental and Social Statistics. Retrieved 15.12.2007, from http://puck.sourceoecd.org/vl=2885098/cl=12/nw=1/rpsv/factbook/

Olson Jr, M. (1965). *The Logic of Collective Action: Public Goods and the Theory of Groups*. Camebridge: Harvard University Press.

Palmer, K., Sigman, H., & Walls, M. (1997). The cost of reducing municipal solid waste. *Journal of Environmental Economics and Management 33*(2), 128-150.

Park, M. A. J. (2004). *Von der Müllkippe zur Abfallwirtschaft - Die Entwicklung der Hausmüllentsorgung in Berlin (West) von 1945 bis 1990.* TU Berlin, Berlin.

Paschlau, H. (2002). Liberalisierungstendenzen in der deutschen und europäischen Abfallwirtschaft. *Müll und Abfall*(2), 147-159.

Petersen, T., Malte, F., & Herrmann, B. (1999). Vom "Müllnotstand" zum "Müllmangel". Die neuere Entwicklung in der deutschen Abfallwirtschaft. *Müll und Abfall*(9), 537-545.

Pigou, A. C. (1932). *The Economics of Welfare*. London: Macmillan.

Podolsky, M. J., & Spiegel, M. (1999). When Does Interstate Transportation of Municipal Solid Waste Make Sense and When Does It Not? *Public Administration Review, 59*(3), 250-255.

Porter, M. E. (1985). *The Competitive Advantage: Creating and Sustaining Superior Performance*. New York: Free Press.

Posner, R. A. (1969). Natural Monopoly and Its Regulation. *Stanford Law Review, 21*(3), 548-643.

Post, J., Broekema, J., & Obirih-Opareh, N. (2003). Trial and Error in Privatisation: Experiences in Urban Solid Waste Collection in Accra (Ghana) and Hyderabad (India). *Urban Studies, 40*(4), 835-852.

Pretz, T., & Uepping, R. (2007). Grenzen mechanischer Abfall-Trennverfahren. *Umwelt Managezin*(4/5), 47-49.

Przybilla, R. P. (2002). *Benchmarking als Wettbewerbssurrogat in der öffentlichen Abfallwirtschaft*. Lohmar - Köln: Josef Eul Verlag.

Pschera, T. (2003). *Kreislaufwirtschaft- und Abfallgesetz*. Berlin: Erich Schmidt Verlag.

Quah, J. S. T. (2007). Public Administration in Singapore: Maximizing efficiency and minimizing corruption. In K. Töpfer & H. Bodner (Eds.), *Ideenimport* (pp. 197-207). Stuttgart: Schäffer-Poeschel

Rahmeyer, F. (2006). Abfallwirtschaft zwischen Überkapazitäten und Entsorgungsengpass. Eine kritische Bestandsaufnahme. Universität Augsburg.

Rand, T., Haukohl, J., & Maxen, U. (2000a). *Municipal Solid Waste Incineration: A Decision Maker's Guide* (No. %(). Washington D. C.: World Bank Technical.

Rand, T., Haukohl, J., & Maxen, U. (2000b). *Municipal Solid Waste Incineration: Requirements for a Successful Project*. Washington D. C.: World Bank Technical Paper WTP 462.

Regierungsbezirk Köln. (1992). *Abfallentsorgungsplan für den Regierungsbezirk Köln*. Köln: Der Regierungspräsident Köln.

Reichard, C. (2005). Organisations-PPP - Typologie und praktische Ausprägungen. In D. Budäus (Ed.), *Kooperationsformen zwischen Markt und Staat - Theoretische Grundlagen und praktische Ausprägungen* (pp. 77-94). Badan-Baden: Nomos-Verlag.

Reinhardt, F. (1999). Market Failure and the Environmental Policies of Firms: Economic Rationales for "Beyond Compliance" Behavior. *Journal of Industrial Ecology, 3*(1), 9-21.

RenoSam. (2006). *Waste-to-energy in Denmark*: RenoSam.

Rinschede, A., & Wehking, K.-H. (1991). *Entsorgungslogistik* (Vol. 1). Berlin: Erich Schmidt Verlag.

Riordan, M. H., & Sappington, D. E. M. (1987). Awarding Monopoly Franchise. *The American Economic Review, 77*(3), 375-387.

Rogerson, W. P. (1992). Contractual Solutions to the Hold-Up Problem. *Review of Economic Studies, 59*(201), 777.

Ross, T. W. (2004). Viewpoint: Canadian competition policy: progress and prospects. *Canadian Journal of Economics / Revue canadienne d'Economique, Vol. 37, No. 2, 37*(2), 243-268.

Rothschild, M., & Stiglitz, J. (1976). Equilibrium in Competitve Insurance Markets: An Essay on the Economics of Imperfect Information. *Quarterly Journal of Economics, 90*(4), 629-650.

RSU. (2002). *Umweltgutachten*: Rat von Sachverständigen für Umweltfragen. Deutscher Bundestag.

Ruiter, D. W. P. (2005). Is Transaction Cost Economics Applicable to Public Governance? *European Journal of Law and Economics, 20*(3), 287-303.

Saboe, S. (2007). *Leveraging End-Of-Life Waste Fleet Assets To Improve Your Bottom Line*. Paper presented at the Twenty-Second International Conference on Solid Waste Technology and Management. Philadelphia. USA.

Salvato, J. A., Nemerow, N. L., & Agardy, F. J. (2003). *Environmental Engineering* (5th ed.). Hoboken: John Wiley & Sons.

Sappington, D. E. M. (1991). Incentives in Principal-Agent Relationships. *Journal of Economic Perspectives, 5*(2), 45-66.

Saunders, M., Lewis, P., & Thornhill, A. (2003). *Research Methods for Business Students* (3rd ed.): Pearson Education.

Savage, J. (2006). The Zorbau Waste-to-Energy project. In *Project Finance Yearbook 2006/2007*. London: Euromoney Publishing.

Schanze, E. (1991). Symbiotic Contracts: Exploring Long-Term Agency Structures between Contract and Corporation. In C. Joerges (Ed.), *Franchising and the Law. Arbeiten zur Rechtsvergleichung* (Vol. 153). Baden-Badrn: Nomos-Verlag-Ges.

Schenkel, W. (2003). Zur Geschichte der Abfallwirtschaft in Deutschland. *Müll und Abfall*(12), 620-626.

Schink, A. (2001). Die Abfallwirtschaftspläne in Nordrhein-Westfalen im Vergleich. *Müll und Abfall*(5), 285-295.

Scholz, R., Beckmann, M., & Schulenburg, F. (2001). *Abfallbehandlung in thermischen Verfahren*. Leipzig, Wiesbaden: B. G. Teubner.

Scholz, R. W., & Tietje, O. (2002). *Embedded Case Study Methods. Integrating quantitative and qualitative knowledge*. Thousand Oaks, CA: Sage Publications.

Schumpeter, J. A. (1908). *Wesen und Hauptinhalt der theoretischen Nationalökonomie (transl.: The Nature and Essence of Theoretical Economics)*. Leipzig: Duncker & Humblot.

Schwarze, R. (2004). *Ökonomische Wirkung des Umwelthaftungsgesetzes*. Berline: Deutsches Institut für Wirtschaftsforschung.

Scott, W. R. (2001). *Institutions and Organizations* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Shelanski, H. A., & Klein, P. G. (1995). Empirical Research in Transaction Cost Economics: A Review and Assessment. *Journal of Law, Economics and Organization, 11*(2), 335-361.

Simon, H. A. (1978). Rationality as Process and as Product of Thought. *American Economic Association, 68*(2), 1-16.

Simon, H. A. (1985). Human Nature in Politics: The Dialogue of Psychology with Political Science. *The American Political Science Review, 79*(2), 293-304.

SLB. (2006). *Die kleine Berlin-Statistik 2006*. Berlin: Statistisches Landesamt Berlin.

Sotec. (2007). TREA Breisgau, Emissionsbericht 2005. Retrieved 21.05.2007, 2007, from http://www.sotec.de/download/de/emissionen_trea_2005.pdf

Soyez, K. (Ed.). (2001). *Mechanisch-biologische Abfallbehandlung: Technologien, Ablagerungsverhalten und Bewertung. Gesamtdarstellung der wissenschaftlichen Ergebnisse des Verbundvorhabens "Mechanisch-biologische Behandlung von zu deponierenden Abfällen"*. Berlin: Erich Schmidt Verlag.

Stadtreinigung Hamburg. (1996). *100 Jahre Müllverbrennung in Hamburg: 1896 - 1996*. Hamburg: Themen Verlag.

Stegmann, B. (2002). *Benchmarking als Instrument einer New-Puclic-Management-orientierten Controllingkonzeption für kommunale Abfallwirtschaftsbetriebe*. Aachen: Shaker Verlag.

Stehling, F. (1999). *Ökonomische Instrumente der Umweltpolitik zur Reduzierung stofflicher Emissionen*. Stuttgart Akademie für Technikfolgenabschätzung in Baden-Württemberg.

Stigler, G. (1951). The division of labor is limited by the extend of the market. *Journal of Political Economy, 59*(3), 185-193.

Stiglitz, J. E. (2000). *Economics of the Public Sector* (Third Edition ed.). New York, London: W.W. Norton & Company.

Stiglitz, J. E., & Wallenstein, S. J. (2000). Public-Private Partnerships. Promises and Pitfalls. *American Behavioral Scientist, 43*(1), 52-73.

Tashakkori, A., & Teddlie, C. (2000). *Mixed methodology : combining qualitative and quantitative approaches*. Thousand Oaks, Calif. : Sage Publishing.

Thärichen, H. (2004). *Öffentliche Interessen im Abfallrecht Zum Rechtsbegriff der „überwiegenden öffentlichen Interessen" im Kreislaufwirtschafts- und Abfallgesetz*. Berlin: Erich Schmidt Verlag.

Themelis, N. J. (2007). Thermal treatment review. *waste Management World*(July-August), 37-45.

Thomas, A. V. (2005). *Identification, Assessment and Allocation of Critical Risks in Indian BOT Road Projects.* Indian Institute of Technology Madras, Chennai.

Thomé-Kozmiensky, K. J. (2006). Das System der Abfallverbrennung. In K. J. Thomé-Kozmiensky & M. Beckmann (Eds.), *Optimierung der Abfallverbrennung 3* (pp. 3-115). Neuruppin: TK Verlag Karl Thomé-Kozmiensky.

Thorneloe, S. A., Weitz, K. A., Nishtala, S. R., Yarkosky, S., & Zannes, M. (2002). The Impact of Municipal Solid Waste Management on Greenhouse Gas Emissions in the United States. *Journal of the Air& Waste Management Association, 52*(September), 1000-1011.

Tirole, J. (2003). *The Theory of Industrial Organization* (Fourteenth ed.). Camebridge, MA: The MIT Press.

Transparency International. (2007). *Global Corruption Report 2007*. Cambridge: Cambridge University Press.

Trescher, S. (2007). *Finanzierungsmöglichkeiten für thermische Müllverbrennungsanlagen in Deutschland.* Unpublished Wissenschaftliches Kolleg under supervision of T. Kleiss, Bauhaus-Universität Weimar, Weimar.

UBA. (2002). *Jahresbericht 2002*. Berlin: Umweltbundesamt.

UBA. (2005a). *Siedlungsabfallentsorgung - Statistiken und Grafiken*. Berlin: Umweltbundesamt.

UBA. (2005b). *Strategie für die Zukunft der Siedlungsabfallentsorgung*. Berlin: Umweltbundesamt.

UN. (1992). *Report of the United Nations Conference on Environment and Development (Rio de Janeiro, 3-14 June 1992). A/CONF.151/26 (Vol. I)*. New York: United Nations.

UN. (1997). *Glossary of Environment Statistics*. New York: United Nations.

Upadhyaya, G. P. (2006). *Study of Solid Waste Disposal in Singapore.* National University of Singapore, Singapore.

Vaccani, A. (2007). Marktpotenziale und -strukturen der Abfallverbrennung in Europa. In A. Versteyl & K. J. Thomé-Kozmiensky (Eds.), *Texte zur Abfallwirtschaft- Recht, konzepte der Abfallwirtschaft- Band 3*. Neuruppin: TK Verlag Karl Thomé-Kozmiensky.

Varian, H. R. (1996). *Intermediate Microeconomics. A Modern Approach* (Fourth ed.). New York. London: W. W. Norton & Company.

VDI. (2002). *3460 Emission control - Thermal treatment of waste*: Verein Deutscher Ingenieure. Kommission Reinhaltung der Luft (KRdL) im VDI und DIN - Normenausschuss.

VDI. (2006). *Bewertung der Energieeffizienz in Anlagen zur thermischen Abfallbehandlung. Stellungnahme des Ausschusses VDI 3460 der Komission Reinhaltung der Luft im VDI und DIN - Normenausschuss KRdL*: Verein Deutscher Ingenieure.

Viner, J. (1932). Cost curves and supply curves. *Zeitschrift für Nationalökonomie, 3*(1), 23-46.

vonRoll Inova. (2007). Layout of municipal solid waste combustion plant, TREA Breisgau, Germany. Zurich: provided by von Roll Environmental Technology Ltd.

Waffler, B. (2002). *Formalprivatisierung kommunaler Aufgaben zwischen Hierarchie, Kooperation und Vertrauen*. Frankfurt am Main: Peter Lang.

Wagner, J. M. (2000). *Organisations- und Rechtswahlform in der öffentlichen Siedlungsabfallwirtschaft: eine empirische Untersuchung unter Berücksichtigung ökologischer, rechtlicher, und politischer Restriktionen*. Frankfurt am Main: Peter Lang Verlag.

Walker, G., & Weber, D. (1984). A Transaction Cost Approach to Make-or-Buy Decisions. *Administrative Science Quarterly, 29*(3), 373.

Weber, B., Alfen, H. W., & Maser, S. (2006). *Projektfinanzierung und PPP*. Köln: Bank-Verlag.

Weber, M. (1922). *Wirtschaft und Gesellschaft. Grundriß der Verstehenden Soziologie*. Thuebingen: Mohr Siebeck.

Wiesmeth, H. (2003). *Umweltökonomie: Theorie und Praxis im Gleichgewicht*. Berlin; Heidelberg; New York: Springer.

Williamson, O. E. (1971). The Vertical Integration of Production: Market Failure Considerations. *The American Economic Review, 61*(2), 112-123.

Williamson, O. E. (1984). The Economics of Governance: Framework and Implications. *Journal of Institutional and Theoretical Economics, 140*, 195-223.

Williamson, O. E. (1985a). Assessing Contracts. *Journal of Law, Economics, and Organization, 1*(1), 177-208.

Williamson, O. E. (1985b). *The economic institutions of capitalism*. New York: The Free Press.

Williamson, O. E. (1990). A Comparison of Alternative Approaches to Economic Organization. *Journal of Institutional and Theoretical Economics, 146*, 61-71.

Williamson, O. E. (1991). Comparative Economic Organization: The Analysis of Discrete Structural Alternatives. *Administrative Science Quarterly, 36*, 269-296.

Williamson, O. E. (1996). Economic organization: the case for candor. *Academy of Management Review, 21*(1), 48-57.

Williamson, O. E. (1999). Public and Private Bureaucracies: A Transaction Cost Economic Perspective. *Journal of Law, Economics and Organization, 15*(1), 306-342.

Williamson, O. E. (2000). The New Institutional Economics: Taking Stock, Looking Ahead. *Journal Economic Literature, 38*, 595-613.

Williamson, O. E. (2005). Transaction Cost Economics. In C. Menard & M. M. Shirley (Eds.), *Handbook of New Institutional Economics*. Berlin, Heidelberg, New York: Springer.

Winkler, A. (1999). *Privatisierungshemnisse - dargestellt am Beispiel der deutschen Abwasserwirtschaft*: Dissertation an der Universität Hamburg.

Winterstein, M., Hilbert, C., Pflüger, H., Sabrowski, R., & Kahle, M. (2004). Repräsentative Heizwerte von Hausmüll einer Großstadt – Illusion oder Wirklichkeit? *Müll und Abfall*(4), 166-174.

Wübbenhorst, K. L. (1984). *Konzept der Lebenszykluskosten : Grundlagen, Problemstellungen u. technolog. Zusammenhänge*. Darmstadt Verlag für Fachliteratur.

Yeo, V. (2007). Integrated thinking. Solid waste management in Singapore. *Waste Management World*(January-February), 95-99.

Yin, R. K. (2003). *Case Study Research: Design and Methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.

ZAS. (2006). *Geschäftsbericht 2006*. Pirmasens: Zweckverband Abfallwirtschaft Südwestpfalz 2006.

Zenger, T. R., Lazzarini, S. G., & Poppo, L. (2002). Informal and Formal Organization in New Institutional Economics. *Advances in Strategic Management, 19*, 277-306.

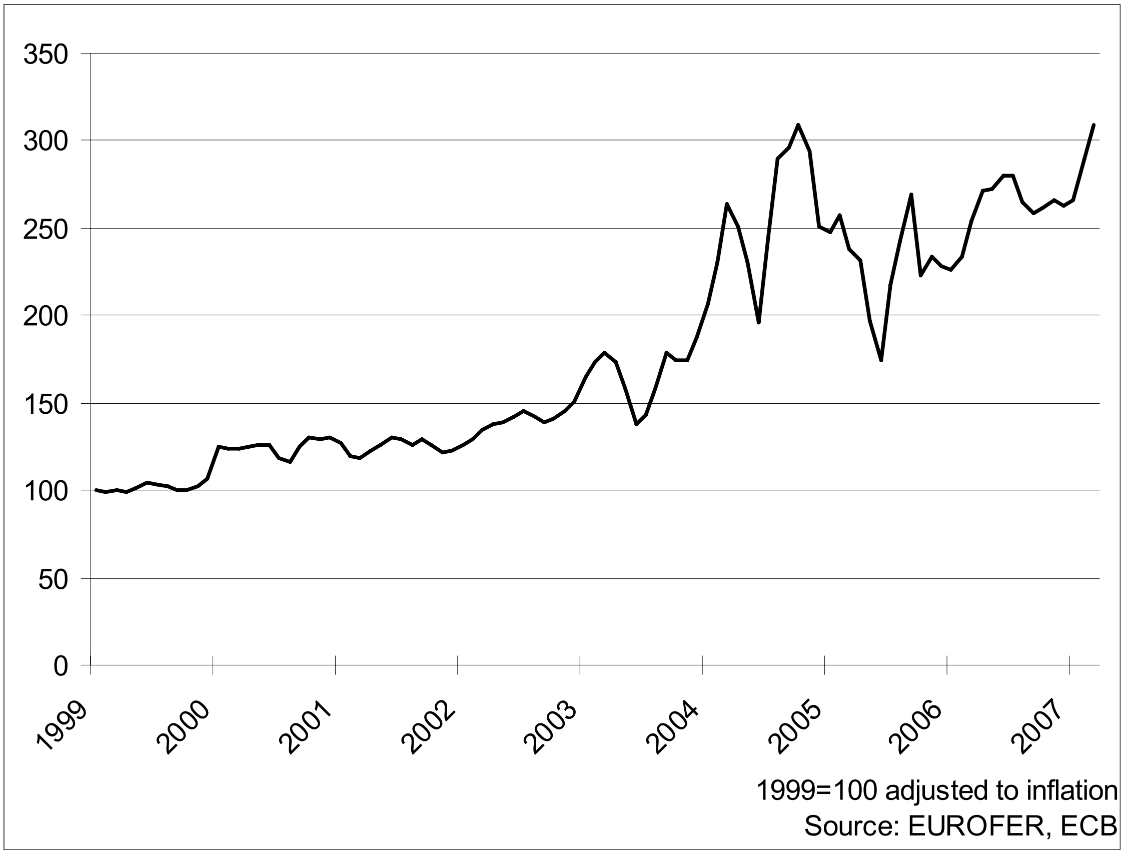
Zerbe, R. O., & McCurdy, H. E. (1999). The Failure of Market Failure. *Journal of Policy Analysis and Management, 18*(4), 558--578.

ZV-TAD. (2007). Zweckverband Technische Abfallverwertung Donautal. Retrieved 10.04.2007, 2007, from http://www.zv-tad.de

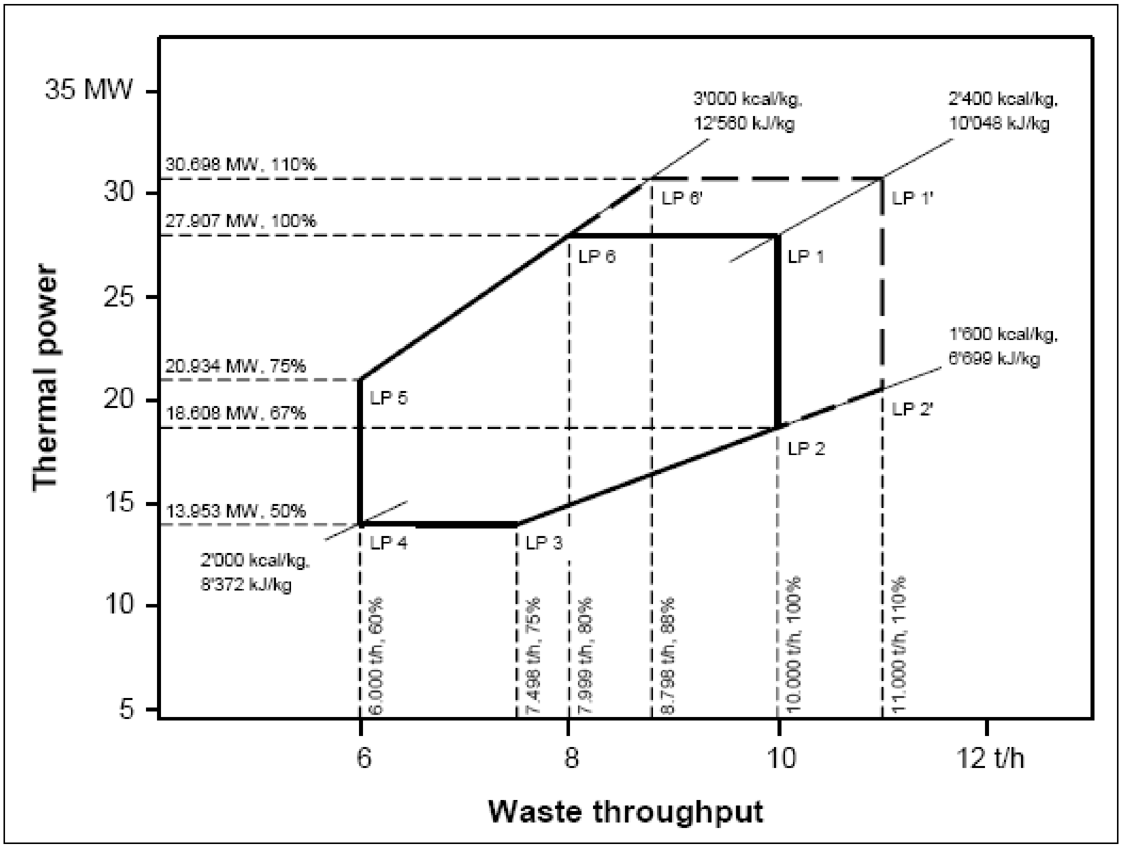
Zweifel, P., & Tyran, J.-R. (1994). Environmental impairment liability as an instrument of environmental policy. *Ecological Economics, 11*(1), 43-56.

10 Appendix

Appendix 1: Change of price for scrap metals in Germany between 1999-2007

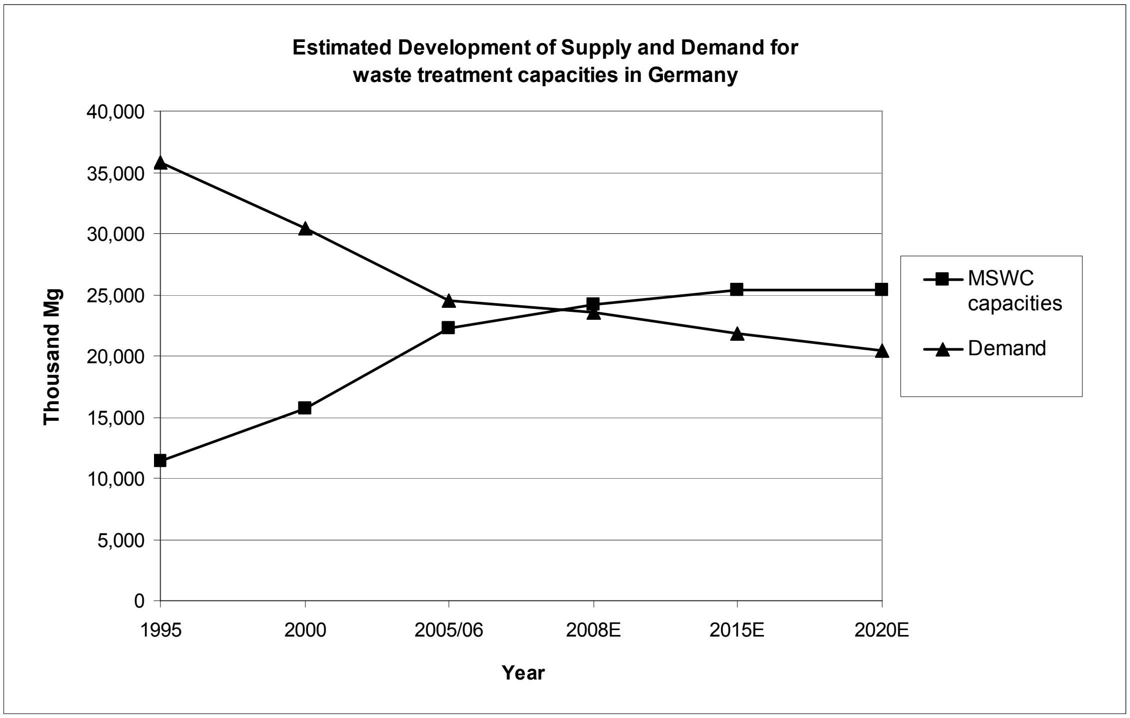


Appendix 2: Example waste combustion diagram



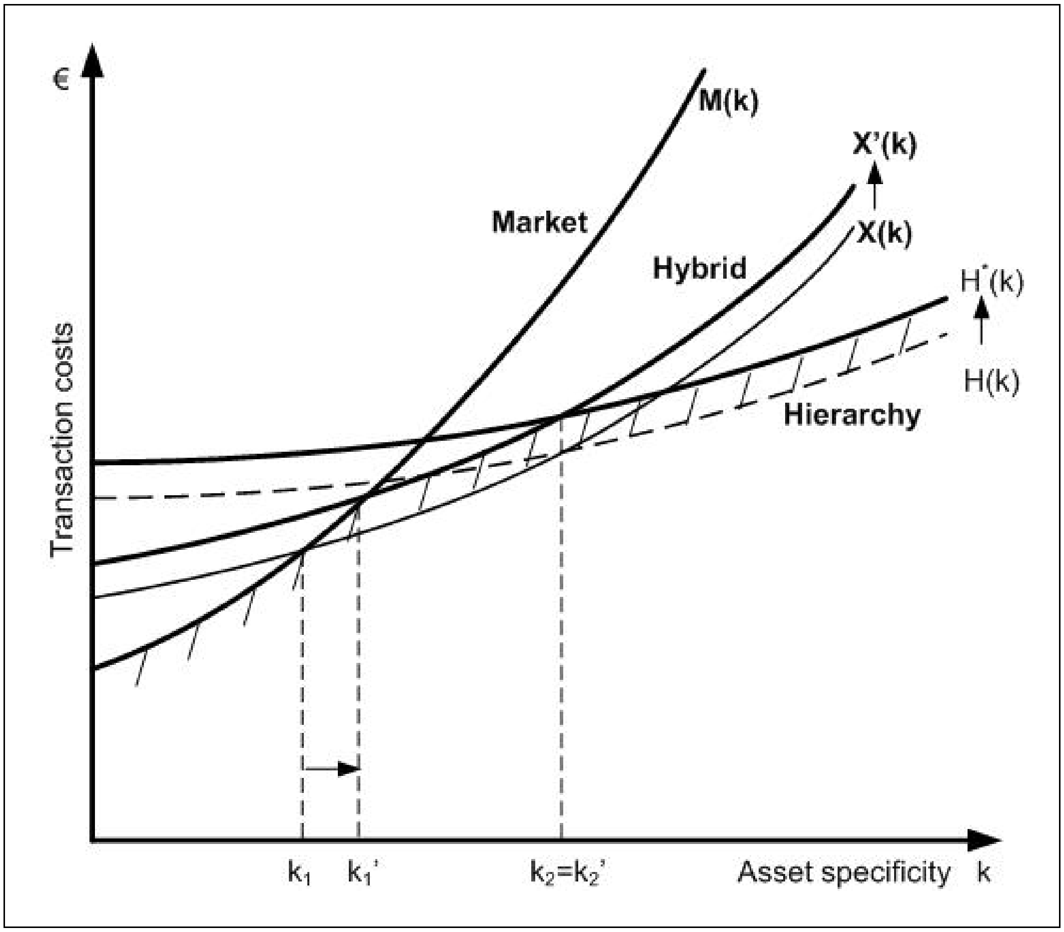
Source: VonRoll Inova (2007)

Appendix 3: Adaptation for market equilibrium



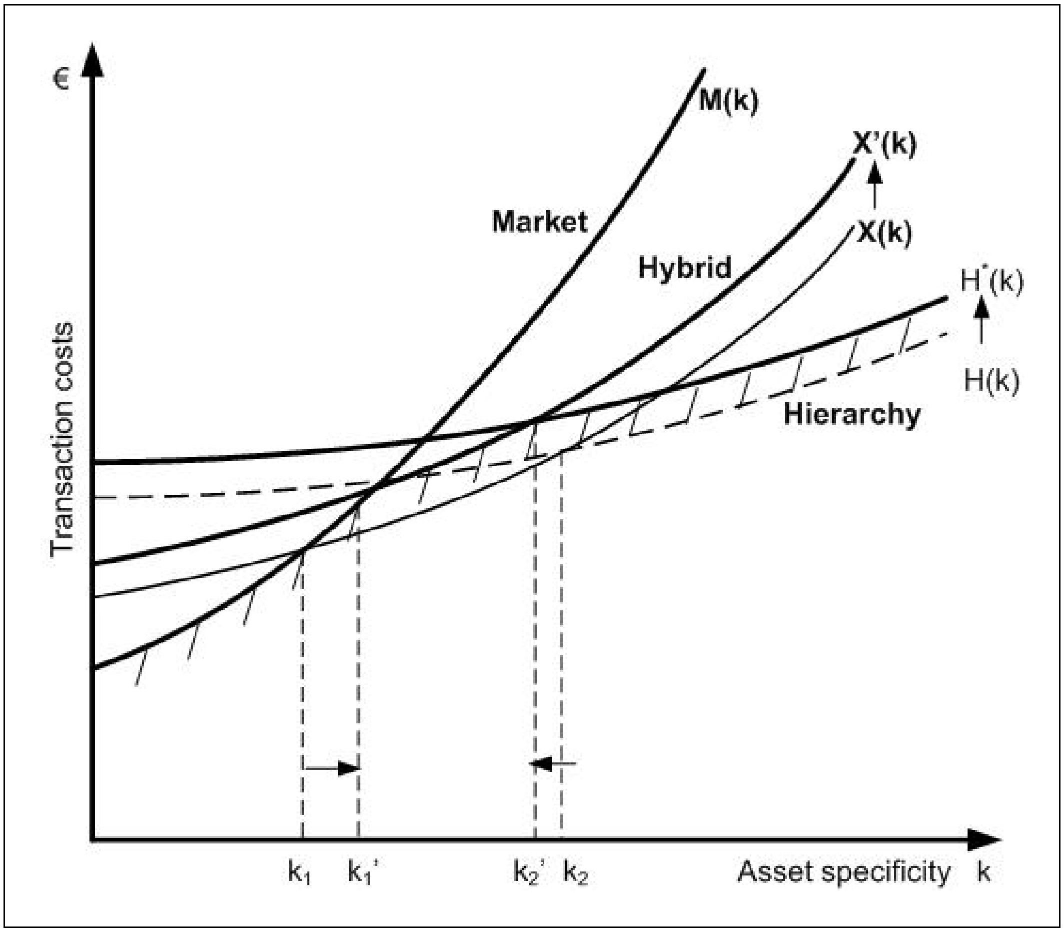
Source: Alwast (2006)

Appendix 4: Change of transaction costs for institutional arrangements in the public sector



Appendix 4.1: Change of transaction costs institutional arrangements in the public sector where $k_2 = k_2'$

Source: Own, adapted Williamson (1991)



Appendix 4.2: Change of transaction costs for institutional arrangements in the public sector where $k_2' < k_2$

Source: Own, adapted Williamson (1991)

Appendix 5: Operating municipal waste combustion plants in Germany (July, 2007)

Appendix 5.1: Locations of MSWC plants in Germany

Source: own, based on survey (2007)

Name of municipal waste combustion plant	Location	Nominal Capacity
AVA Abfallverwertung Augsburg	Augsburg	200,000
MHKW Bamberg	Bamberg	127,500
MVA Ruhleben	Berlin	520,000
MVA Bielefeld	Bielefeld	440,000
RMHKW Böblingen	Böblingen	140,000
MVA Bonn	Bonn	240,000
Müllheizwerk Bremen	Bremen	550,000
MHKW Bremerhaven	Bremerhaven	315,000
MHKW Burgkirchen	Burgkirchen	210,000
MVA Coburg	Coburg	115,000
MHKW Darmstadt	Darmstadt	212,000
Stadtwerke Düsseldorf	Düsseldorf	450,000
TREA Breisgau	Eschbach, Breisgau	150,000
MVA Weisweiler	Eschweiler	360,000
MHKW Essen-Karnap	Essen	740,000
AVA Frankfurt-Nordweststadt	Frankfurt am Main	200,000
BKB Göppingen GmbH	Göppingen	155,000
MVA Hagen	Hagen	120,000
MVA Stellinger Moor	Hamburg	280,000
Müllverwertung Borsigstraße GmbH	Hamburg	320,000
MVR Müllverbrennung Rugenberger Damm	Hamburg	230,000
Enertec Hameln	Hameln	240,000
MVA Hamm	Hamm	295,000
BKB Hannover	Hannover	230,000
TRV Buschaus	Helmstedt	525,000
RZR Herten	Herten	290,000
MVA Ingolstadt	Ingolstadt	250,000
MHKW Iserlohn	Iserlohn	259,000
AEZ Asdonkshof	Kamp Lindfort	235,000
MHKW Kassel GmbH	Kassel	150,000
MHKW Kempten	Kempten (Allgäu)	80,000
Müllverbrennung Kiel	Kiel	130,000
RMVA Köln	Köln	569,400
MVKA Krefeld	Krefeld	350,000
MVA Landshut	Landshut	40,000

Name of municipal waste combustion plant	**Location**	**Nominal Capacity**
Thermische Abfallbehandlung Lauta	Lauta	225,000
MVV Umwelt Trea Leuna GmbH	Leuna	400,000
MHKW Leverkusen	Leverkusen	210,000
MHKW Ludwigshafen	Ludwigshafen	180,000
TAV Ludwigslust	Ludwigslust	50,000
MHKW Mainz	Mainz	210,000
MVA Mannheim	Mannheim	420,000
Abfallheizkraftwerk Neunkirchen	Neunkirchen	150,000
MVA Neustadt	Neustadt	61,900
Abfallwirtschaft und Stadtreinigungsbetrieb-Nürnberg -ASN-	Nürnberg	205,000
GMVA Niederrhein	Oberhausen	700,000
MHKW Offenbach	Offenbach	220,000
MVA Geiselbullach	Olching	95,000
MHKW Pirmasens	Pirmasens	180,000
MHKW Rosenheim	Rosenheim	60,000
MHKW Rothensee	Magdeburg	660,000
AVA Velsen	Saarbrücken	210,000
SRS EcoTherm	Salzbergen	120,000
Zweckverband Müllverwertung Schwandorf	Schwandorf	450,000
Gemeinschaftskraftwerk Schweinfurt	Schweinfurt	155,000
MHKW Solingen	Solingen	92,000
BKB Stapelfeld	Stapelfeld	345,000
Kraftwerk Stuttgart	Stuttgart	420,000
MVA Tornesch-Ahrenlohe	Tornesch	80,000
MHKW Ulm-Donautal	Ulm	120,000
MHKW München Nord	Unterföhring	700,000
Müllkraftwerk Weißenhorn	Weißenhorn	100,000
AWG Abfallwirtschaftsgesellschaft Wuppertal	Wuppertal	425,000
MHKW Würzburg	Würzburg	230,000
SITA Abfallverwertungs GmbH	Zorbau	300,000

Appendix 5.2: List of MSWC plants in Germany

Source: own, based on survey (2007)

Appendix 6: Questionnaire

Fragebogen zur "Untersuchung von Organisationsmodellen für Planung, Bau, Finanzierung und Betrieb von Müllverbrennungsanlagen"

Ziel der Befragung:

Im Rahmen meiner Dissertation "Organisationsmodelle für Müllverbrennungsanlagen" sollen unterschiedliche institutionelle und organisatorische Strukturen für Planung, Bau, Finanzierung und Betrieb von Müllverbrennungsanlagen (MVA) analysiert werden. Neben Japan, Singapur und den USA wird hierbei auch der Markt in Deutschland betrachtet. Im Rahmen dieser Befragung sollen Informationen zu **Eigentums- und Betriebsstrukturen sowie die wesentlichen Risiken und deren Verteilung** gesammelt werden. Die Ergebnisse der Dissertation dienen u.a. als Entscheidungsgrundlage für zukünftige MVA's in Wachstumsmärkten (Europa und Asien).

Wissenschaftliche Betreuung der Dissertation:

Prof. Dr.-Ing. Dipl.-Wirtsch.-Ing. Hans Wilhelm Alfen
Professur für Betriebswirtschaftslehre im Bauwesen
Bauhaus-Universität Weimar

Diese Umfrage wird unterstützt durch:

(1) Verband Kommunale Abfallwirtschaft und Stadtreinigung im VKU (VKS im VKU)
(2) Bundesverband der Deutschen Entsorgungswirtschaft e.V. (BDE)
(3) Interessengemeinschaft der thermischen Abfallbehandlungsanlagen in Deutschland e.V. (ITAD)

Vertraulichkeit:

Es wird versichert, dass alle Bedingungen zum Datenschutz strengstens eingehalten, die gesammelten Daten vertraulich behandelt und alle Angaben im Rahmen der Dissertation statistisch neutral ausgewertet werden.

Wichtige Hinweise zur Beantwortung der Fragen:

Zur Beantwortung des Fragebogens sollten Sie möglichst über umfassendes kaufmännisches Wissen im Rahmen von Müllverbrennungsanlagen verfügen. Von Vorteil wäre es daher, wenn Sie eine leitende Funktion in diesem Bereich Ihrer Einrichtung ausüben würden.

Um eine empirisch korrekte Auswertung des Fragebogens zu ermöglichen, bitte ich Sie höflichst um die vollständige Beantwortung aller Fragen.

Ich bitte Sie, den Fragebogen auszudrucken und handschriftlich zu beantworten. Über eine Zusendung per Post oder Fax bis spätestens **15. Februar 2007** würde ich mich sehr freuen.

Wenn Sie eine Zusendung der Auswertung erhalten möchten, dann geben Sie bitte Ihre Kontaktdaten an. Sollten Sie die Fragen anonym beantworten wollen, so senden Sie mir bitte eine vom Fragebogen getrennte Email mit Wunsch zur Zusendung der Auswertung.

Vielen Dank vorab für Ihre Mitwirkung!

Kontaktinformationen:

Dipl.-Ing. Torsten Kleiß
Bauhaus-Universität Weimar
Professur BWL im Bauwesen
Marienstr. 7A
99423 Weimar

Tel. 03643 - 58 4385
Mobil: 0176 - 200 277 06
Fax: 03643 - 58 4565
Emal: torsten.kleiss@bauing.uni-weimar.de
Web: http://www.uni-weimar.de/Bauing/bwlbau/neu/index.php

(A) Persönliche Informationen (freiwillig)

Nachname: ____ Vorname: ____

Position/ Aufgabengebiet: ____

Telefon: ____

Email: ____

(B) Allgemeine Angaben zur MVA (freiwillig)

Name der MVA: ____

Standort: ____ PLZ: ____

Jahr der Inbetriebnahme: ____

Kapazität (t/a): ____ für Heizwert (kJ/kg): ____

Investitionsvolumen (€): ____

(C) Eigentumsstruktur

In diesem Abschnitt sollen Informationen zu Organisations- und Rechtsform gesammelt werden.

1. Welche Rechtsform besitzt Ihre MVA?

○ Regiebetrieb ○ Eigenbetrieb ○ AöR ○ GmbH ○ AG

2. Wie ist das Eigentum an der MVA zwischen öffentlichen und privaten Gesellschaftern verteilt?

○ 100% öffentlich ○ >75% öffentlich <25% privat ○ >50% öffentlich <50% privat ○ >25% öffentlich <75% privat ○ >0% öffentlich <100% privat ○ 100% privat

3. Aus welchem Bereich kommen der/die öffentlichen Gesellschafter? (Mehrfachnennungen möglich)

☐ Kommune ☐ Zweckverband

☐ Eigengesellschaft mit 100% öffentlicher Beteiligung (z.B. Stadtwerke, Entsorgungsbetriebe)

☐ Gesellschaft mit öffentlicher Mehrheitsbeteiligung (z.B. Stadtwerke, Entsorgungsbetriebe)

4. Aus welchem Bereich kommen der/die privaten Gesellschafter? (Mehrfachnennungen möglich)

☐ 100% privater Entsorgungsbetrieb

☐ 100% privates Energieunternehmen

☐ Strategischer Investor

☐ Gesellschaft mit privater Mehrheitsbeteiligung (z.B. Stadtwerke, Entsorgungsbetriebe)

☐ andere: ____

5. Erwägen Sie kurz- bis mittelfristig eine Änderung der Eigentumsstruktur?

○ Ja ○ Nein

6. Sind die Gesellschafter auch an anderen MVA's direkt oder indirekt beteiligt?

○ Ja ○ Nein Wenn ja, an wievielen? ____

Anmerkungen zur Eigentumsstruktur: ____

(D) Trennung von Eigentum und Betrieb

In diesem Abschnitt sollen Informationen zur möglichen Trennung von Eigentum am Anlagevermögen einer MVA und dessen Betrieb erfragt werden. Zur Abstrahierung der möglichen Beteiligungskonstrukte soll hierbei nicht zusätzlich zwischen möglichen Betreiber- und Betriebsführungsgesellschaften unterschieden, sondern diese als eine Betriebsgesellschaft betrachtet werden.

7. Sind Eigentum und Betrieb Ihrer MVA rechtlich voneinander getrennt?

◯ Ja   ◯ Nein   Wenn nein, dann fahren Sie bitte mit Abschnitt (E) fort!

8. Wer sind die Gesellschafter der Betriebsgesellschaft Ihrer MVA?

◯ 100% öffentlich   ◯ >75% öffentlich <25% privat   ◯ >50% öffentlich <50% privat   ◯ >25% öffentlich <75% privat   ◯ >0% öffentlich <100% privat   ◯ 100% privat

9. Aus welchem Bereich kommen der/die öffentlichen Beteiligten? (Mehrfachnennungen möglich)

◯ Kommune

◯ Zweckverband

◯ Eigengesellschaft mit 100% öffentlicher Beteiligung (z.B. Stadtwerke, Entsorgungsbetriebe)

◯ Gesellschaft mit öffentl. Mehrheitsbeteiligung (z.B. Stadtwerke, Entsorgungsbetriebe)

10. Aus welchem Bereich kommen der/die privaten Beteiligten? (Mehrfachnennungen möglich)

☐ 100% privater Entsorgungsbetrieb

☐ 100% privates Energieunternehmen

☐ Strategischer Investor

☐ Gesellschaft mit privater Mehrheitsbeteiligung (z.B. Stadtwerke, Entsorgungsbetrieb)

☐ andere: ____________

11. Erwägen Sie kurz- bis mittelfristig eine Änderung der Gesellschafterstruktur der Betriebsgesellschaft?

◯ Ja   ◯ Nein

12. Die Dauer des Pacht- bzw. Betriebsführungsvertrages beträgt (in Jahren): ____________

13. Der Pacht- bzw. Betriebsführungsvertrag endet im Jahr: ____________

14. Wurden die folgenden Risiken voll/teilweise/nicht auf die Betriebsgesellschaft übertragen?

	voll	teilweise	nicht
Geringere Umsätze aufgrund außerplanmäßiger Betriebsstörungen	◯	◯	◯
Geringere Umsätze aufgrund geringerer Kapazitätsauslastungen	◯	◯	◯
Einheitspreis für Verbrennung	◯	◯	◯
Einheitspreis für verkaufte Energie	◯	◯	◯
Wirkungsgrad der Energiegewinnung	◯	◯	◯
Höhe der Personalkosten	◯	◯	◯
Höhe der Kosten für Betriebsmittel	◯	◯	◯
Höhe der Kosten für Entsorgung der Aschen/Schlacken	◯	◯	◯
Änderung der Finanzierungskosten für Anlageinvestitionen (z.B. EURIBOR)	◯	◯	◯
Außerplanmäßige Investitionen aufgrund neuer rechtlicher Bestimmungen	◯	◯	◯

Weitere Risiken bzw. Anmerkungen: ____________

(E) Beteiligungen

In diesem Abschnitt sollen Informationen zu Beteiligungen an anderen MVA's erfragt werden.

15. Sind die Gesellschafter der Besitz- oder Betriebsgesellschaft auch am Betrieb anderer MVA's direkt oder indirekt beteiligt?

◯ Ja ◯ Nein Wenn nein, dann fahren Sie bitte mit Frage 17 fort!

16. Bewerten Sie bitte auf einer Skala von 1 (nicht relevant) bis 5 (sehr relevant) die möglichen Vorteile dieser Beteiligung an anderen MVA's?

	nicht 1	2	(relevant) 3	4	sehr 5
Bessere Konditionen beim Einkauf (Betriebsmittel, Ersatzteile)	◯	◯	◯	◯	◯
Bessere Kapazitätsauslastungen durch Disponierung von Entsorgungsmengen	◯	◯	◯	◯	◯
Kostenvorteile durch Teilung kaufmännischer Ressourcen (z.B. Buchführung)	◯	◯	◯	◯	◯
Kostenvorteile durch Teilung betrieblicher Ressourcen (z.B. Wartungspersonal, IT)	◯	◯	◯	◯	◯
Effizienterer Betrieb aufgrund von Erfahrungsaustausch (Know-How-Transfer)	◯	◯	◯	◯	◯

Weitere Vorteile:

17. Sind die Gesellschafter der Besitz- oder Betriebsgesellschaft auch an Entsorgungsunternehmen zur Sammlung und Transport der Abfälle beteiligt?

◯ Ja ◯ Nein Wenn nein, dann fahren Sie bitte mit Abschnitt (F) fort!

18. Bewerten Sie bitte auf einer Skala von 1 (nicht relevant) bis 5 (sehr relevant) die möglichen Vorteile dieser Beteiligung an Entsorgunsgunternehmen?

	nicht 1	2	(relevant) 3	4	sehr 5
Bessere Kapazitätsauslastungen durch Disponierung von Entsorgungsmengen	◯	◯	◯	◯	◯
Leichterer Zugang zu gewerblichen Abfallverursachern	◯	◯	◯	◯	◯
Effizienterer Verkauf freier Kapazitäten am Spotmarkt/ durch kurzfristige Verträge	◯	◯	◯	◯	◯

Weitere Vorteile:

(F) Entsorgungsverträge

In diesem Abschnitt sollen Informationen zu den Entsorgungsverträgen zwischen der MVA (ggf. Betriebsgesellschaft) und deren Kunden (öffentlich-rechtliche und gewerbliche) erfragt werden.

19. Wie hoch ist die durchschnittliche Auslastung der Anlage durch kommunale Abfälle? (in %)

20. Wie groß ist der Anteil von langfristig vereinbarten Mindestmengen (min. 5 Jahre) mit öffentl.-rechtlichen Entsorgungsträgern in Bezug auf die gesamte Anlagenkapazität? (in %)

21. Mit wie vielen öffentl.-rechtlichen Entsorgungsträgern (örE) bestehen langfristige Liefer-verträge (min. 5 Jahre)?

22. Wie hoch ist die durchschnittliche Dauer der kommunalen Entsorgungsverträge? (in Jahren)

23. Wie groß ist der Anteil von langfristig vereinbarten Mindestmengen (min. 5 Jahre) mit gewerblichen Entsorgungsträgern in Bezug auf die gesamte Anlagenkapazität? (in %)

24. Mit wie vielen gewerblichen Entsorgungsträgern bestehen langfristige Lieferverträge?

25. Wie hoch ist die durchschnittliche Dauer der gewerblichen Entsorgungsverträge? (in Jahren)

26. *Gibt es vertraglich zugesicherte Abnahmekapazitäten, welche über den Mindestmengen liegen? (örE oder gewerbliche Verträge)* ◯ Ja ◯ Nein

27. *Wie hoch ist die Summe aller maximalen Abnahmekapzitäten in Bezug auf die gesamte Anlagenkapazität? (in %, Wert über 100% ist zulässig)*

28. *Beinhalten die langfristigen Entsorgungsverträge Preisgleitklauseln für?:*

Inflation oder EURIBOR/ LIBOR	◯ Ja	◯ Nein
Betriebsmittel oder Consumer Price Index (CPI)	◯ Ja	◯ Nein
Personalkosten	◯ Ja	◯ Nein
Energiepreise	◯ Ja	◯ Nein
Entsorgungspreise für Aschen oder Schlacken	◯ Ja	◯ Nein
Abfalleigenschaften (v.a. Heizwert, Wassergehalt)	◯ Ja	◯ Nein
Änderung von Versicherungsgebühren	◯ Ja	◯ Nein
Rechtliche Änderungen (z.B. neue BImSchV)	◯ Ja	◯ Nein

Weitere Preisgleitklauseln bzw. Anmerkungen:

(G) Energetische Nutzung

In diesem Abschnitt sollen Informationen zur energetischen Nutzung und zu Verträgen mit den Energieabnehmern gesammelt werden.

29. *In welcher Form wird die thermische Energie aus der Verbrennung genutzt?*

☐ Stromerzeugung ☐ Prozessdampf für Industrie ☐ Fernwärme ☐ keine Nutzung

30. *An wen wird die Energie verkauft? (Mehrfachnennungen möglich)*

☐ Örtliches Industrieunternehmen
☐ Überregionaler Netzbetreiber
☐ Regionales Energieunternehmen/ Stadtwerke
☐ Strombörse (Spotmarket)

Weitere:

31. *Ist der Hauptabnehmer der Energie ebenfalls Gesellschafter der Besitz- oder Betriebsgesellsschaft?* ◯ Ja ◯ Nein

32. *Gibt es langfristige Verträge für die Energieabnahme?* ◯ Ja ◯ Nein

33. *Wie hoch ist die durchschnittliche Dauer dieser Energieabnahmeverträge? (in Jahren)*

34. *Wie hoch ist der durchschnittliche Anteil der durch langfristige Verträge verkaufte Energie an der insgesamt produzierten Energie? (in %)*

Anmerkungen:

(H) Finanzierung.

35. *Wie wurde die MVA im Wesentlichen finanziert? (Mehrfachnennungen möglich)*

☐ Kommunalkredit
☐ Anlagenleasing
☐ Kreditfinanzierung aus der Bilanz der Gesellschafter
☐ Projektfinanzierung
☐ Gesellschafterdarlehen
☐ Forfaitierung/ Factoring der Mindestabnahmeverträge

Vielen Dank für die Beantwortung der Fragen!

Bitte senden Sie den Fragebogen nun per Fax oder Post an die auf dem Deckblatt angegebene Adresse.

11 German summary

Problemstellung

1. Die Bereitstellung und der Betrieb von abfallwirtschaftlicher Infrastruktur ist eine Leistung der öffentlichen Daseinsvorsorge. Das Wertschöpfungssystem der kommunalen Abfallwirtschaft besteht hierbei aus Abfallsammlung, -umschlag, -transport, -behandlung, und -entsorgung.
2. Die Müllverbrennung hat sich als umweltfreundliche und zuverlässige Abfallbehandlungstechnologie zur Minimierung der negativen Umwelteinflüsse von Abfall bewährt. In vielen entwickelten Ländern ist die Müllverbrennung deshalb die am häufigsten angewandte Abfallbehandlungstechnologie.
3. Die öffentliche Hand ist für die Koordinierung und Überwachung der notwendigen abfallwirtschaftlichen Dienstleistungen zuständig. In der Praxis aggregieren Kommunalbehörden die Nachfrage an abfallwirtschaftlichen Dienstleistungen und machen eine klassische Make-or-Buy Entscheidung als Prinzipal der Transaktion, d.h. sie können entscheiden, ob sie die notwendigen abfallwirtschaftlichen Dienstleistungen selbstständig erbringen oder an Externe vergeben.
4. Die institutionellen Arrangements beschreiben hierbei die Beziehungen der einzelnen Akteure, welche an spezifischen abfallwirtschaftlichen Projekten und Dienstleistungen beteiligt sind. Die institutionellen Arrangements werden durch formelle und informelle Institutionen bestimmt und variieren zwischen den extremen Formen „Hierarchie“ und „Markt“, wobei verschiedene hybride Formen dazwischen existieren.

Zielsetzung

5. Das übergeordnete Forschungsziel ist die theoretische und empirische Analyse der institutionellen Arrangements für die Bereitstellung von Müllverbrennungsanlagen (MVA’s) auf der Basis einer fundierten Untersuchung ihrer technischen und wirtschaftlichen Eigenschaften.
6. Zur Erreichung des übergeordneten Forschungsziels, wurden fünf detaillierte Unterziele definiert:
   a) Untersuchung der technischen und wirtschaftlichen Aspekte von MVA’s;
   b) Analyse der mikroökonomischen Eigenschaften des Müllverbrennungsmarktes und Identifizierung möglicher Abweichungen vom „Modell der vollkommenen Konkurrenz“;
   c) Erarbeitung eines Theorierahmens zur Kategorisierung und Beschreibung von institutionellen Arrangements für MVA’s;
   d) Verifizierung der theoretisch hergeleiteten institutionellen Arrangements in den zwei entwickelten Müllverbrennungsmärkten Deutschland und Singapur;
   e) Untersuchung der Gründe zur Entstehung von institutionellen Arrangements für MVA’s in den beiden Märkten.
7. Die Forschungsarbeit verfolgt nicht das Ziel, die institutionellen Arrangements aus technischer oder wirtschaftlicher Sicht zu bewerten und zu vergleichen. Ausserdem bleiben alternative Abfallbehandlungsverfahren, wie z.B. mechanisch biologische Abfallbehandlung, unberücksichtigt.

Stand der Forschung

8. Die Anzahl der existierenden Forschungsarbeiten zu wirtschaftlichen und institutionellen Aspekten von kommunaler Abfallwirtschaft, insbesondere Abfallbehandlung, ist sehr limitiert. Viele Studien zur Privatsektorbeteiligung bei der Infrastrukturentwicklung fokussieren sich oft auf allgemeine und übergeordnete Aspekte, wie z.B. Risikomanagement oder Finanzierung. Ausserdem konzentrieren sie oftmals sich auf öffentliche Immobilien oder Verkehrsinfrastruktur.
9. Es existiert eine kleine Anzahl von Forschungsarbeiten zu institutionellen und organisatorischen Aspekte der kommunalen Abfallwirtschaft in Deutschland. Die häufige Einschränkung dieser Arbeiten ist dabei die breite Betrachtung des gesamten Wertschöpfungssystems der Abfallwirtschaft, ohne dass auf die spezifischen Eigenschaften der einzelnen Wertschöpfungselemente in ausreichendem Masse eingegangen wird.
10. In Deutschland sind viele theoretische Studien zu institutionellen Arrangements für Infrastrukturbereitstellung erstellt worden. Die Anzahl der empirischen Studien bleibt jedoch sehr unzureichend.
11. Es existieren bisher keine Forschungsarbeiten, in denen die theoretische und empirische Aspekte der institutionellen Arrangements für MVA's vereint und auf Basis von Primärdaten analysiert wurden.

Untersuchungsmethoden und Vorgehensweise

12. Um dem transdiziplinären Charakter der definierten Forschungsziele gerecht zu werden, wurden quantitative und qualitative Forschungsmethoden miteinander kombiniert.
13. Eine kritische Bewertung und Anwendung von anerkannten Theorien und existierenden Studien wurde für die Forschungsziele (a) – (c) erbracht. Hierfür wurde eine umfassende Literaturrecherche und Theorieanalyse durchgeführt. Im beschränkten Masse wurden die theoretischen Ergebnisse zusätzlich durch Primardaten unterstützt.
14. Quantitative Forschungsansätze wurden zur Verifizierung der theoretisch abgeleiteten institutionellen Arrangements in Deutschland und Singapur angewandt. In Deutschland wurde eine umfassende Umfrage zur Erhebung von branchenspezifischen Daten für institutionelle Arrangements für MVA's durchgeführt. Für den Markt in Singapur wurden die benötigten Daten und Information aus persönlichen Interviews und Sekundärquellen gewonnen.
15. Qualitative Forschungsmethoden wurden angewandt, um die Gründe für die Entstehung von institutionellen Arrangements für MVA's zu untersuchen. Insgesamt wurden acht repräsentative Fallstudien aus Deutschland und eine aus Singapur durchgeführt. Die gewählten Fallstudien decken sämtliche quantitativ verifizierten institutionellen Arrangements ab.
16. Die Anwendung von Fallstudien ist eine anerkannte Forschungsmethode. Ihre potentiellen Stärken im Bezug auf die definierten Forschungsziele bestehen v. a. in der Identifizierung und Analyse von komplexen Prozessen und Beziehungen innerhalb von institutionellen Arrangements.

Wesentliche Ergebnisse der Arbeit

17. MVA's bestehen aus verschiedenen Anlagenkomponenten. Die Kapitalinvestitionen nehmen den grössten Anteil an den gesamten Lebenszykluskosten ein, wobei eine starke negative Korrelation zwischen Stückkosten und Gesamtkapazität von MVA's besteht. Die Abfallbehandlungsgebühren sind die wichtigste Ertragsgrösse im Lebenszyklus von MVA's. Jedoch wird die Bedeutung der Einnahmen aus Energie- und Ressourcengewinnung im Fall weiter steigender Energie- und Ressourcenpreise zunehmen.

18. Der Markt für MVA's weicht vom ökonomischen „Modell der vollkommenen Konkurrenz" ab und besitzt potentielle Eigenschaften für Marktversagen. Es besteht die Möglichkeit zur Entstehung von lokalen natürlichen Monopolen mit räumlichen Grenzen oder räumlich unbegrenzten natürlichen Monopolen. Ausserdem können verschiedene technologische externe Effekte und Anpassungsmängel bei langfristigen Nachfrageänderungen als Ursachen für Marktversagen auftreten. Bei sämtlichen Formen von Marktversagen stehen wirtschaftspolitische Eingriffsmöglichkeiten zur Verfügung.
19. Keine der identifizierten Formen von Marktversagen erfordert eine Bereitstellung von MVA's durch die öffentliche Hand als notwendige wirtschaftspolitische Eingriffsmöglichkeit. Stattdessen stehen aus mikroökonomischer Sicht verschiedene institutionelle Arrangements zur Verfügung.
20. In Anlehnung an die Transaktionskostenökonomie können institutionelle Arrangements für MVA's aus theoretischer Sicht kategorisiert werden in: (1) hierarchische institutionelle Arrangements: öffentlich-rechtliche Organisationseinheiten, privatrechtliche Unternehmen der öffentlichen Hand; (2) hybride institutionelle Arrangements: Betreibermodelle, (D)BOT, öffentlich-private Joint Venture und private Unternehmen; sowie (3) Spotmarkt.
21. Aufgrund der vergleichsweise hohen Anlagen- und Standortspezifität von Investitionen in MVA's, sind hierarchische und hybride institutionelle Arrangements für MVA's zu erwarten, um Transaktionskosten zu minimieren. Die beiden anderen Transaktionscharakteristika Häufigkeit und Unsicherheit sind unterschiedlich für spezifische MVA-Projekte und können die Wahl zwischen hierarchischen und hybriden institutionelle Arrangements beeinflussen.
22. Eine Stakeholderanalyse zeigt, dass die beteiligten Akteure von MVA's unterschiedliche Einflüsse auf die Entstehung von institutionellen Arrangements ausüben. Sie streben nicht zwingend nach der Minimierung von Transaktionskosten, sondern handeln oftmals opportunistisch mit beschränkter Rationalität und folgen dabei verschiedenen pekuniären und nicht-pekuniären Zielen.
23. Die Ergebnisse aus der theoretischen Analyse der Transaktionskostenökonomie wurden durch die quantitative Untersuchung der institutionellen Arrangements für MVA's in Deutschland und Singapur bestätigt.
24. Mit einem Anteil von 39.7% nehmen die hybriden institutionellen Arrangements von öffentlich-privaten Joint Ventures den grössten Anteil and der Gesamtverbrennungskapazität in Deutschland an. Sie werden gefolgt von Privatunternehmen (16.6%), öffentlich-rechtliche Organisationen (14.9%), öffentliche Unternehmen (14.7%), Betreibermodelle (10.1%) und (D)BOT (4.0%).
25. Derzeit sind in Deutschland fast die Hälfte aller MVA's durch gemeinsame Eigenkapitalgeber horizontal miteinander integriert. Vertikale Integration mit anderen Elementen des Wertschöpfungssystems der kommunalen Abfallwirtschaft wurde bei ca. 40% der deutschen MVA's festgestellt.
26. In Singapur werden alle vier MVA's im Rahmen von hierarchischen institutionellen Arrangements betrieben. Eine neue MVA entsteht derzeit unter Nutzung des hybriden institutionellen Arrangements (D)BOT.
27. Ein Entwicklungspfad wurde modellhaft skizziert, um die verschiedenen Entstehungswege von institutionellen Arrangements für MVA's aufzuzeigen. Jedoch sind keine spezifischen Muster zu erkennen, welche die Wahl zwischen den verschiedenen hierarchischen und hybriden institutionellen Arrangements allgemeingültig erklären.
28. Die Fallstudien lassen erkennen, dass hierarchische institutionelle Arrangements oftmals in grossen Kommunen mit hoher Nachfrage an Abfallbehandlung und somit hohen transaktionsspezifischen Investitionen entstehen. Bei geringen technologischen Unsicherheiten bietet das hybride institutionelle Arrangement (D)BOT auf Basis von Verfügbarkeitszahlungen hierbei eine geeignete Alternative.

29. Das hierarchische institutionelle Arrangement von öffentlichen Unternehmen kann aus formeller Privatisierung von öffentlich-rechtlichen Organisationen entstehen. Ein starker Beweggrund ist oftmals die Gewinnung erhöhter operativer und finanztechnischer Flexibilität, die aufgrund von Änderungen des institutionellen Rahmens notwendig wurde. Das hierarchische institutionelle Arrangement von öffentlichen Unternehmen wird mitunter auch für MVA's gewählt, um die funktionalen und geographischen Geschäftsbereiche von bestehenden öffentlichen Unternehmen auszuweiten oder um andere öffentliche Aufgaben mit Gewinnen aus MVA's zu quersubventionieren.

30. Viele hierarchische und hybride institutionelle Arrangements sind in der Vergangenheit entstanden, weil zentralisiert erstellte Abfallwirtschaftpläne die Kommunen zur Entwicklung von MVA's rechtlich verpflichteten. Zu einem späteren Zeitpunkt ist hierbei oft ein Wechsel der institutionellen Arrangements aufgrund wirtschaftlicher Probleme oder geänderter Zielstellungen von verschiedenen Stakeholdern zu beobachten.

31. Hybride institutionelle Arrangements entstehen regelmässig auch direkt und ohne Transformation aus hierarchischen institutionellen Arrangements. In solchen Fällen spielen häufig grosse private Abfallwirtschaftsunternehmen und Energiekonzerne eine wichtige Rolle. Die zuvor bestandenen formellen und informellen Beziehungen dieser Unternehmen zu öffentlichen Beteiligten aus anderen hybriden institutionellen Arrangements innerhalb des Abfall- oder Energiesektors wurden dabei als wichtige Einflussfaktoren zur Entstehung der neuen institutionellen Arrangements identifiziert.

32. Die Unsicherheiten im Rahmen von komplexen Planungs- und Genehmigungsprozessen für MVA's haben ebenfalls eine grosse Bedeutung für die Entstehung der institutionellen Arrangements. In Fällen mit relativ unsicheren und langfristigen Planungs- und Genehmigungsprozessen sowie damit verbunden hohen Transaktionskosten sind oftmals hierarchische institutionelle Arrangements entstanden. Die Änderung in ein hybrides institutionelles Arrangement kann sich dabei vollziehen nachdem sich die Unsicherheiten zu einem späteren Zeitpunkt reduziert haben.

33. Die Forschungsergebnisse zeigen nachdrücklich, dass formelle Institutionen nicht allein die Entstehung von institutionellen Arrangements determinieren. Informelle Institutionen, welche sich nur über einen langen Zeitraum verändern, müssen ebenfalls berücksichtig werden, wenn ein spezifisches institutionelles Arrangement angewandt werden soll.