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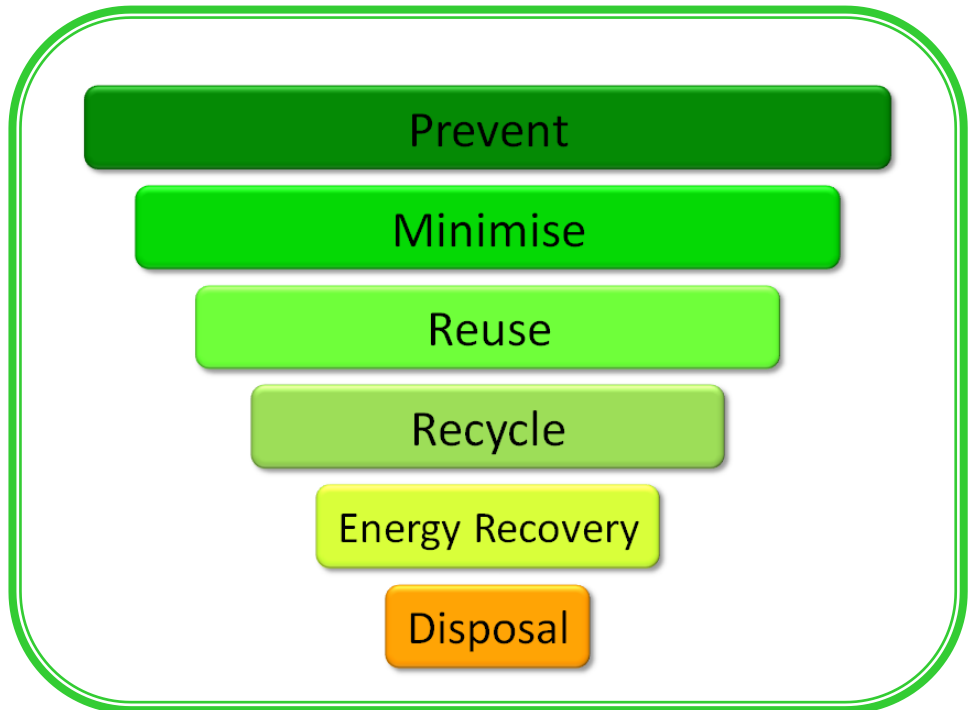
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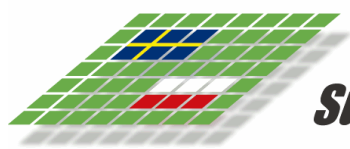


WASTE MANAGEMENT IN ZABRZE

Pathways to a More Sustainable System

Bernice Charles • Cornelia Moser •
Chihiro Sawaki • Caroline Steinvig

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***Swedish-Polish
Sustainable Energy Platform***



Zabrze

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Executive Summary

Zabrze is a medium size town of 200 000 inhabitants in the region of Upper Silesia, Poland. The development of the town was originally based on the exploitation of heavy industries. In the past few years Zabrze has, however, moved towards more service and tourism oriented industries. As part of this journey, the city of Zabrze sees the need to improve its existing waste management system. This report provides possible pathways to reduce municipal solid waste and help Zabrze on its path to become a more sustainable city.

In Poland, it is at present not clear who is responsible for municipal waste unlike in Sweden where responsibility lies in the hand of municipalities. Additionally, environmental awareness and understanding for recycling in the Polish population is very low. As a result, the existing system faces many challenges such as extensive illegal dumping, poor waste separation, mixed waste containing hazardous material, inefficient collection, poor waste collection coverage, loopholes, lack of enforcement and fraudulent waste reporting. Other issues are the lack of funding for infrastructural improvements and for educational and informational campaigns. The city also faces the challenge that many factors such as the introduction of a new waste law, EU fines and targets, producer responsibility and deposit systems need to be approached on a national level.

The looming change in waste law which will hand-over responsibility of municipal waste to municipalities is a particular challenge for the city of Zabrze. The uncertainty on the timeframe and implementation leads to insecurity on how to finance and adapt the waste management system. Another challenge is the weak collaboration within the region of Upper Silesia not allowing for strong regional solutions and lobbying on a national level. On the positive side, waste management can comprise potentials for the city, especially with regards to funding for waste management projects and educational campaigns from the EU. Additionally, investments from private companies for biogas production and recycling could become an interesting business case in the future.

Through this project, experiences from Sweden and particularly the city of Lund as well as the city of Pszczyna in Poland were used and applied to Zabrze. Concrete starting points for improvements include a more proactive approach to waste management, clear decisions on treatment methods and the need for a concrete action plan and schedule.

Main recommendations are to strengthen educational activities and raise awareness to prevent and reduce waste. It is crucial that Zabrze chooses a path which leads to a holistic solution in the region, not relying on one specific solution such as incineration. Most importantly the report shows that change towards a sound waste management system takes time, education, good planning and long-term future vision.

Acknowledgements

Looking back at the experience of this SED-project we feel blessed to have learned so much and to have met so many wonderful people. Special thanks to the city of Zabrze and the International Institute for Industrial Environmental Economics (IIIEE) for making this project possible. This journey has truly been full of knowledge and cultural exchange and we hope that the collaboration between the environmental twin cities Lund-Zabrze continues in the future.

We would like to extend our appreciation to the many interviewees that we got to meet both in Sweden and Poland. Without your input this report would have lacked a connection to the “real world” and we would not have been able to customize our recommendations for the city of Zabrze.

We would like to send our warmest gratitude to two of the most helpful and caring people we have ever met, Marcin Lesiak and Ewa Pawlowska. We feel truly pampered! Thank you for making our stay in Zabrze so enjoyable and for setting up and translating the many interesting and valuable interviews. Without you and your colleagues from the city of Zabrze’s International Relations Office this project could not have been carried out. Dziękuję!

Final acknowledgments to our supervisor Mikael Backman, thank you for initiating this project and sharing your love for Poland with us.

Written 20 April 2011 in a wooden cottage in the sunny mountainous area of Zakopane, Poland.

Bernice, Caroline, Chihiro and Cornelia

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Introduction

Zabrze is a medium sized town in Poland in the region of Silesia with just below 200 000 inhabitants. Zabrze, originally an industrial town with massive emissions and pollution-related health problems, is currently developing new industries mostly based on services and tourism [3, 13, 24]. On its path to becoming a sustainable city, Zabrze collaborates with its environmental twin-city, Lund to take on experiences gathered in Sweden over the last decades [3, 25].

This report, which is part of the collaboration between the city of Lund and the city of Zabrze, is written within the framework of the Strategic Environmental Development module of the Master Program in Environmental Management and Policy at the International Institute for Industrial Environmental Economics (IIIEE). The customer of this project work is the city of Zabrze and more specifically the Department of Ecology.



The report provides possible starting points and indicates pathways to municipal solid waste reduction and a more sustainable waste management system for municipal solid waste (MSW) in Zabrze. While industrial waste still accounts for the largest part of waste production in the city, MSW has become an increasing problem for the city of Zabrze with an increasing number of illegal dumps and very low recycling rate [22]. By taking mainly Sweden and the region of Skåne (Southern Sweden) as an example for waste management development, both, positive and negative learning experiences are considered and analysed.

Most importantly, information about the local situation in Poland and Zabrze was gathered during a site visit between the 9th and 16th of April 2011. Based on information from various stakeholders in Zabrze, ideas for improvements and conclusions are drawn, reflecting the differences and similarities of the twin cities.

This project was enabled by the kind support of the municipality of Zabrze for which we, Bernice, Chihiro, Caroline and Cornelia are very grateful. We hope that our work brings Zabrze one step further on its journey towards sustainability and sustainable waste management.



The Municipal Solid Waste Situation in Poland

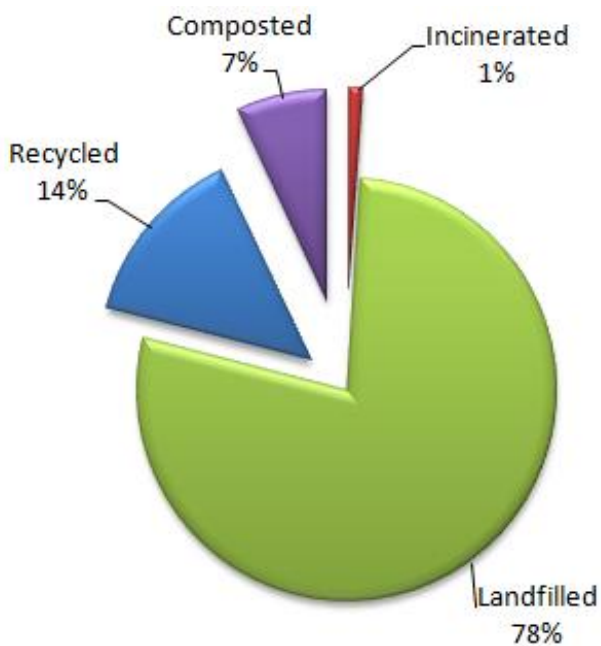
In Poland, waste management within the National Environmental Policy is seen as an important issue for Environmental protection. Waste generation within Polish cities in 2009 was an average of 316 kg per person and year [15, 26, 27]. MSW is obtained from households, shops, offices, schools, graveyards, municipal green areas and infrastructure facilities.

The municipal waste composition is highly dependent on a number of factors such as residents' wealth, selective

collection of recyclable materials, in-house composting and seasons. The greatest share of MSW consists of organic waste, paper and cardboard, plastics, glass, combustible mixed waste, fabric and sanitary products, however differing from city to city and according to seasons [27].

MSW is continually increasing in Poland. This increase has not been accompanied by the development of a sound waste disposal system.

Waste Treatment 2009



Information taken from: [15]



In some instances, hazardous waste such as drugs and batteries are being deposited along with mixed waste [3]. Illegal dumping is a big issue in Poland. Waste dumps can include municipal and hazardous waste leading to significant impacts for the environment, especially for ground and surface water [26].

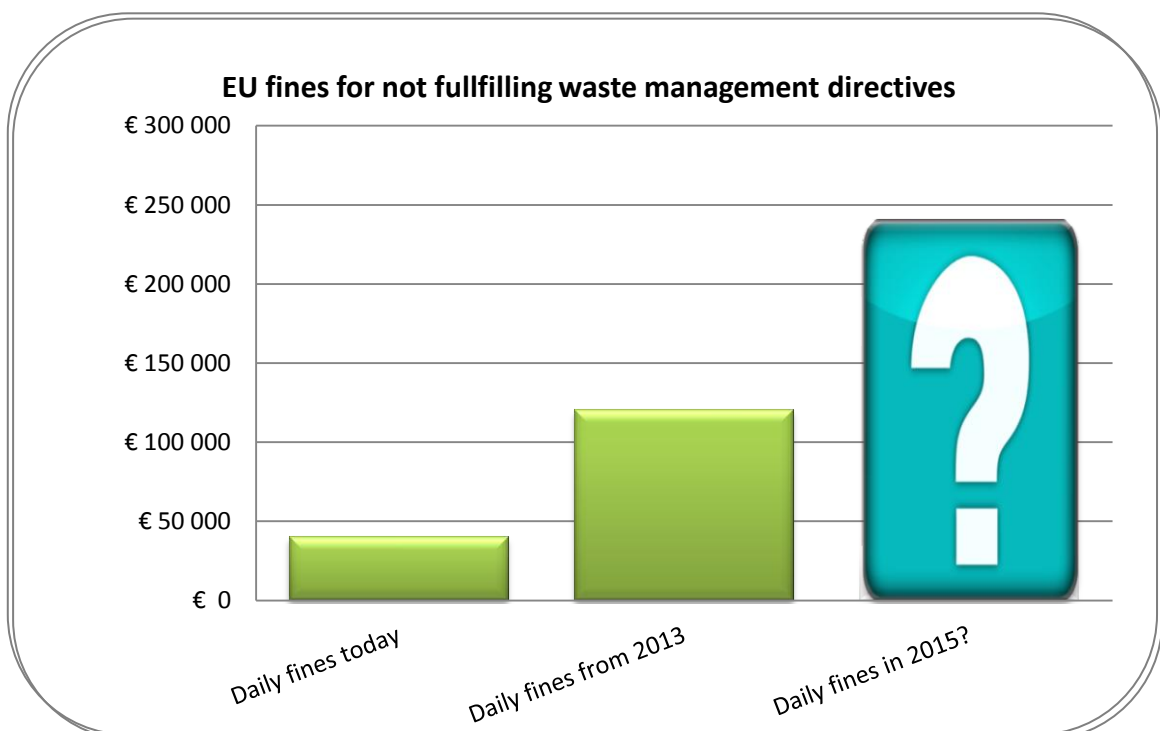
Incineration is increasingly being seen as an option to reduce the amount of waste being landfilled and to recover energy in the process. Incineration is however disputed in Poland and it is a solution that carries a high cost compared to other methods and is not always profitable [28].

Government funding for waste management is limited as the budget for environmental protection is shared

amongst water, air and soil management.

The biggest share goes to air protection and water management and only 10-15% of the money goes to soil protection which also includes waste management [3]. According to estimates from 2001, it will cost Poland EUR 3.6 billion to implement a sound waste management system complying with European Union (EU) directives.

Currently, Poland is paying EUR 40 000 daily, in fines to the EU for non-compliance with waste management and disposal. If Poland remains non-compliant by 2013, the fines will be as high as EUR 250 000 per day. This will happen in case Poland does not manage to reduce landfilled waste to less than 50% [1].

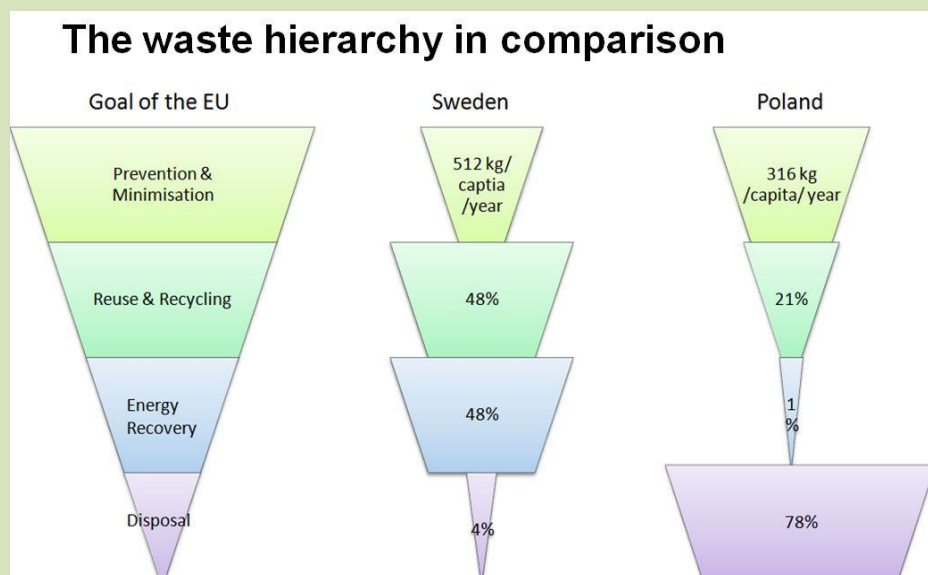


Information taken from various sources: [1-3]

Waste Law in Poland

The 2001 law on waste introduced the waste hierarchy and extended producer responsibility (EPR). It also specifies requirements for waste generators and actors involved in waste management such as waste treatment process, landfill and transboundary waste movement. The law was revised in 2005 and now includes the Waste Management Plan Act. The law on maintaining cleanliness and order in the municipalities of 1996 and the law on Chemical Substances and preparation of 2001 also play a role in waste management in Poland [26, 28]. Goals are set under a seven year (2007-2014) plan for waste prevention and minimization, waste collection and transport, recovery and disposal and market for recovered materials [28].

Municipalities have the legal obligations to keep communities clean, to organise separate collection and recovery, to dispose of MSW and hazardous waste and to monitor waste movement [28]. The problem with this responsibility has been that municipalities could not collect waste management fees from its inhabitants unless 30% of the residents agree to this through a referendum. The lack of financing and ownership of waste has made it hard for municipalities to organise efficient waste management system. This however will change with a new waste law expected to come into force in 2011. The new regulation will give municipalities the responsibility of managing municipal waste, fee collection and tendering [29].



The waste management how it should be and how it looks like in Sweden and Poland

Source: adapted from various sources: [12, 13]

WEEE in Poland

Poland had until 2008 to have set up its WEEE (waste electrical and electronic equipment) management system which includes collection infrastructure and meeting recovery and recycling levels required by the Directive [30]. The WEEE system in Poland consists of a registry for entrepreneurs including producers of EEE, collectors of WEEE such as stores and wholesalers, municipal companies, treatment plants, recovery and recycling plants and their organisations dealing with recovery of WEEE. As of June 2008 there were 2 896 producers of EEE, 6 750 collectors of WEEE, 109 treatment plants, 72 other entrepreneurs and five organisations dealing with recovery of EEE [30].

In 2006, 10 280 tonnes of WEEE were collected from private households. By 2008, 152 000 tonnes need to be collected from the 38.1 million tonnes of EEE produced in 2006. Currently, the weakest link in WEEE management system is the lack of a nation-wide selective collection system of WEEE [30].



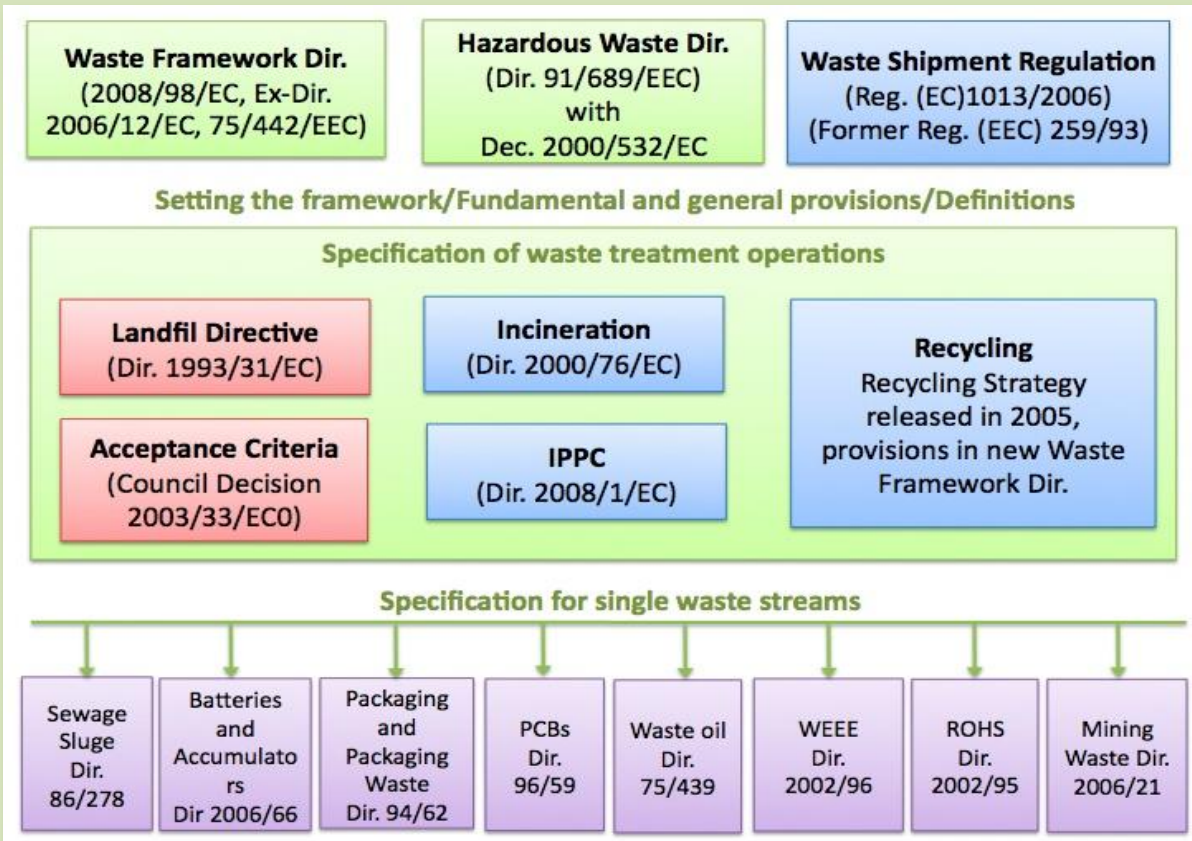
Packaging Waste

Packaging waste such as plastic is becoming one of the growing problems for Poland. It has constantly been increasing with an amount of 3.133 million tonnes in 2007. Packaging waste is treated as MSW, which is landfilled, representing 40% of the total MSW in 2007. Secondary material recovery occurs at recovery facilities or through sorting systems and these are usually not very high [26].

Recycling in Poland focuses on materials that are seen as valuable or that are needed in manufacturing or industrial processes. An additional problem is the lack of market for sorted material hence the low level of recycling and recovery [26].



EU Directives Influencing Waste Management Systems



Sources:[12, 14, 16, 31-33]

Directives	Sweden	Poland
Landfill Directive	Ordinance on the landfill of waste (July 2001) (Decision 2003/33/EC: legally implemented in 1 January 2005)	Legally transposed in 2001 (Need remarkable effort to fully implement till 2012)
Incineration Directive	Ordinance on waste incineration (came into force in 2005)	Act on Waste (2000)
WEEE Directive	Ordinance on WEEE (came into force in 2005) Collection level:16.3kg/inhabitant	WEEE Act (came into force in 2005) (Attain collection rate of 40-45% by 2016 and must achieve the full collection target by 2022 at the latest)
Battery Directive	Implemented through series of ordinances (1 Jan 2009, new ordinance came into force)	Battery Act (24 April 2009)
Packaging Directive	Ordinance on producers responsibility for packaging (achieved recovery & recycling target in 2001)	Act on packaging and packaging waste/ the producer responsibility act (Need to meet recovery & recycling target by the end of 2014)

Campaigns and Attitudes Towards Waste in Poland

The major determinant of recycling behaviour seems to be the attitude towards recycling which are influenced by

- Existing infrastructure
- Knowledge to recycle
- Barriers to physical recycling
 - time
 - convenience
 - space
- Concern for the community
- Previous experience and consequences of recycling

More broadly, these factors can be separated into environmental

values, situational and psychological variables which need to be considered for waste campaigns. A very important point is that different kinds of campaigns are needed to promote the repair and reuse of materials compared to campaigns aiming to reduce waste at the point of purchase. Recycling behaviour can be changed by **convenience, knowledge and incentives** while waste minimisation behaviour depends on the individual concern for the environment and is thereby a lot more difficult to influence [34].



*Logo of the 2010 waste campaign
Source: [4, 5]*

Facts from a 2008 and 2010 attitude survey in Poland [4, 6]:

- 52% systematically recycle waste
- Young, highly educated and urban people are more aware of recycling
- Only 34% understand the term recycling
- Batteries and plastic bags are rated as equally dangerous for the environment
- 20% do not feel environmental responsibility
- Low segregation is influenced by the lack of containers and little knowledge on how to change contracts with private collection companies
- 60% prefer incineration over landfill
- 50% are prepared to live close to an incineration plant
- Glass and plastic get recycled most often, followed by paper and biological waste

The Waste Management System in Zabrze

Zabrze generated 1.4 million tonnes of waste in 2009 [35]. Currently, private companies are responsible for waste management. With the planned implementation of the new waste law this may change soon. However, for the past ten years the Parliament has been deliberating on the introduction of the new waste law with not much progress. As a result, many municipalities like Zabrze feel that this change will not take place and thus the Department of Ecology in Zabrze has not set up any plans to accommodate the possible change in waste management. Once the law is approved, the municipalities will have one year to implement it [21]. The law may however have good chances for introduction with the EU pushing for its implementation.

Today, waste companies negotiate contracts with owners and property managers to collect waste generated by households. The households and property managers are responsible for supplying

waste containers for use and ensuring that they have a contract with a waste collection company [35]. The collection companies make their profit on mixed waste and hence do not inform their customers about recycling options [36].

The role of the municipality is to issue waste collection permits to waste collection companies along with ensuring that all local residents have signed contracts and are included in the waste management system. Such permits are issued once and are valid for an unlimited amount of time. The only communications with the waste collection companies is a yearly report which the companies have to hand it [21].

In Zabrze, different types of waste are collected separately. The Department of City Infrastructure is responsible for the elimination of illegal dumping sites of which 105 were cleaned up in 2010 for a total cost of EUR 62 000. The department also controls the waste.



collection contracts between inhabitants and collection companies with the goal to find out who refused to sign a contract. The municipal police takes care of fining households without contracts and oversee the signing of contracts [35].

The two main problems for Zabrze, regarding their waste management, are:

- 1) the ownership of the waste which is not municipally owned yet
- 2) the lack of financial means

Zabrze is part of the Upper Silesian Metropolitan Association which prepares projects for the region. Within this council, the construction of two waste incineration

plants has been planned. However, the capacity of those plants is unclear and protests have led to the consideration of cutting the capacity to 250 000 tonnes/year instead of the planned 500 000 tonnes/year for one of the plants. The council does not have (EU) funding for these plants at the moment and the scheduled commission is earliest in 2018. In addition, private investors have shown interest in setting up incineration plants. However, as the municipality cannot guarantee access to waste for a given amount of years, investments are not very attractive at the moment until the municipality becomes the owner of the waste through the law [21].

Recycling

The city, together with a few private providers, maintains over 400 collection points for recyclables across Zabrze for the collection of plastics, paper and glass. These materials are then taken to the segregation center for manual sorting where they are further segregated, pressed and sold to recycling companies. In addition, the city maintains mobile containers for bulk waste such as fridges, furnitures etc. which are manned and moved around in the city. The same concept of containers is applied to collect garden waste. It is announced in the newspaper and online where the containers are positioned. Additionally, the city provides containers to 33 pharmacies to collect expired medicines and ensures safe disposal [21, 22].



WEEE and batteries

WEEE can be brought back to the point of sale. Treatment is done outside of the municipality. Large batteries are collected through a deposit system, whilst small ones are collected in designated containers (e.g. at schools) [16].

Between Landfill and Recycling

The landfill in Zabrze is owned by MOSiR, a limited company with 100% of the shares owned by the Zabrze municipality [37]. The landfill is currently profitable due to the large amounts of waste received (approximately 50 000 tonnes/year). The collection companies that deliver waste to the landfill pay a waste tax (PLN 105/EUR 26 per tonne of waste) and also a treatment charge (PLN 65/EUR 16 per tonne of waste). Once the new law is implemented it is likely that the amounts of landfilled waste is reduced, and hence with it profitability [37, 38]. As the legislation in Poland does not allow environmental funding for projects that generate profit such as the use of methane, MOSiR has to collaborate with external companies for the extraction of gas from the landfill. To balance the expected reduced profit from the landfilling operation, MOSiR is planning to build a landfill for hazardous waste such as

asbestos for additional income [37, 38].

The segregation plant in Zabrze was sold by the municipality in 2010 and is now owned by the private company .A.S.A. [39]. The segregation plant is currently not profitable because of the small amounts of recyclables that they receive from the 400 collection points in the city. However, .A.S.A. is expecting the new law to be implemented shortly and once in place they will work with the municipality to increase the collection rates of glass, plastic and paper. The company is also trying to educate the citizens on how to sort their recyclables by arranging study visits to the segregation plant and handing out information materials during theme weeks such as “Cleaning the World” week [39]. Besides sorted recyclables, the segregation plant receives green waste from parks and gardens, and also kitchen waste from a pilot area in Zabrze (approximately 500 households) [21, 39].



The Business Case of Biogas and Landfill Mining

Vireo Energy AB is developing the operation of electricity and heat plants fired by biogas as well as small scale electricity generation at the landfill of Zabrze. The company signed an agreement with MOSiR to build and operate an electricity production facility which will be installed in December 2011 [40].

Vireo Energy says that their operation will become profitable because of the green certificates that they receive for selling renewable energy into the Polish electricity grid (presently PLN 119/EUR 30 per MWh, for electricity and PLN 230/EUR 58 per MWh green certificate). A change in the law would both generate less amounts of

waste for landfilling and also reduce the amounts of organic waste being landfilled, in accordance with EU law. This would force Vireo Energy to move away from landfill gas extraction and put their focus more on biogas production.

Currently they are in the testing phase, producing about 0.5 MW. Their production target is 1 MW of electricity.



Biogas

At landfill sites, the anaerobic digestion of organic wastes occurs naturally and produces landfill gas. This gas is a mix of mostly methane (CH_4) and carbon dioxide (CO_2) as well as small amount of other gases. Landfill gas can be collected and used as renewable energy source for electricity and combined heat and power (CHP), as well as being fed into the natural gas network. However, the landfill gas has to be upgraded so that the CH_4 content increases before it can be fed into a network [5, 23].

In Sweden, landfill gas is used primarily for district heating. The regional waste company NSR extracts 12 million Nm^3 per year from its landfill, and supply the equivalent to 3 450 private houses in Helsingborg a year.

City of Pszczyna - A Polish Case Study

In 2006 the city of Pszczyna arranged a referendum for transferring the ownership of waste to the municipality. Thanks to heavy campaigning and education by the municipality six months in advance almost 37% of the residents voted and the result was “yes” to the proposed change [41]. After the referendum it took the municipality two years to prepare the new waste system [41].

Before the referendum Pszczyna had many problems with its waste system. As in the rest of Poland the waste ownership belonged to the citizens who had to sign individual contracts with private waste collection companies. There were many loopholes in the system. For instance only 90% of the residents had signed contracts, and many dumped their waste illegally in the woods. Citizens are allowed to decide how often the collection company collects their waste. Which made many sign contracts with collection of waste every three months. Also air pollution has been a problem since some citizens burnt the waste for heating [41].

Before the referendum the municipality assessed what amounts of waste each resident would generate and the cost of that. The calculations determined the municipal waste charge to be PLN 6.5 (EUR 1.6) per person per month. This was actually less than what the average family

had paid to private companies before the change of the law (before on average EUR 3.5-4/person/month) [41].

On the 1 May 2008 the new waste system was introduced. The new system is built around four assumptions:

1. Every citizen is assumed to generate 50 litres of mixed waste per month.
2. The system allows for unlimited amounts of recyclables.
3. Collection of the wet (mixed) and dry fractions (recyclables) every two weeks.
4. Collection of bulky waste (e.g. furniture, fridges) twice every year



The waste bins were dimensioned for 50 litres of waste per person, which has shown to be a good assumption for the citizens living in single-family houses. In these houses the recyclables are put in special plastic bags and put out for collection. If the bag does not contain properly sorted recyclables then it will be left outside the house by the waste collectors, something that could be considered embarrassing.

The new system has not worked as well with the block houses. Here the recyclables are put in separate (yellow) waste bins. The residents in block houses are not separating their recyclables as well as the residents in single-family houses are. As a result the bins for mixed waste (the wet fraction) are often overflowing with waste [41]. To improve the situation in the block house areas, the municipality is actively educating the residents by putting up posters, visiting schools and closing the waste chutes in the wall.

Still some loopholes exist in the system: Residents are allowed to start small private companies at the address where they live. In some cases these citizens throw their waste in the block houses' waste bins and hence avoid paying.

The new system has been particularly successful in terms of increasing the quantities of collected recyclables. Data from 2007 reports that approximately 65 tonnes of recyclables were collected, and three years later in 2010 the amounts had risen to close to 3 000 tonnes. Currently, recyclables are taken to a central segregation plant where they are sorted [41].

The city of Pszczyna still sees some problems with the waste management system. According to the EU law they need to start sorting out organic waste and reduce landfilling this fraction. There are some plans for building a facility to treat organic waste, but it will still remain a problem on how to get the residents to separate it [41].



The Swedish Waste Case: 1970 - 1990



In Sweden, a first regulation particularly dedicated to waste management was introduced in 1972 with the Public Cleansing Act, which clarified the *responsibilities* for the collection and transportation of MSW. Those responsibilities were extended in 1979 when municipalities were put in charge of the treatment of MSW [42].

In the late 1980s discussions regarding the use of incinerators and their usefulness or damaging effects (dioxin emissions) took place and a moratorium for incineration plants was introduced in 1984 [43]. In the region of Skåne, two different approaches to waste management were taken at the time: NSR, which today collects and treats the waste of approximately 230 000 inhabitants decided not to use

incinerators and fully rely on *environmental goals* of waste separation and reduction [9, 44]. Sysav, the other waste management company responsible today for 14 municipalities and 655 000 inhabitants decided to use incinerators and waste-to-energy recovery with the goal of minimising landfill and maximise material and energy recycling [8, 13].

In 1988 and 1990s the Swedish Environmental Protection Agency (EPA) and the Swedish Parliament set up an environmental management program to reduce dangerous materials in products, ensure sound collection, treatment and storage of waste, minimise waste production, maximise recycling and develop new treatment technologies [45].

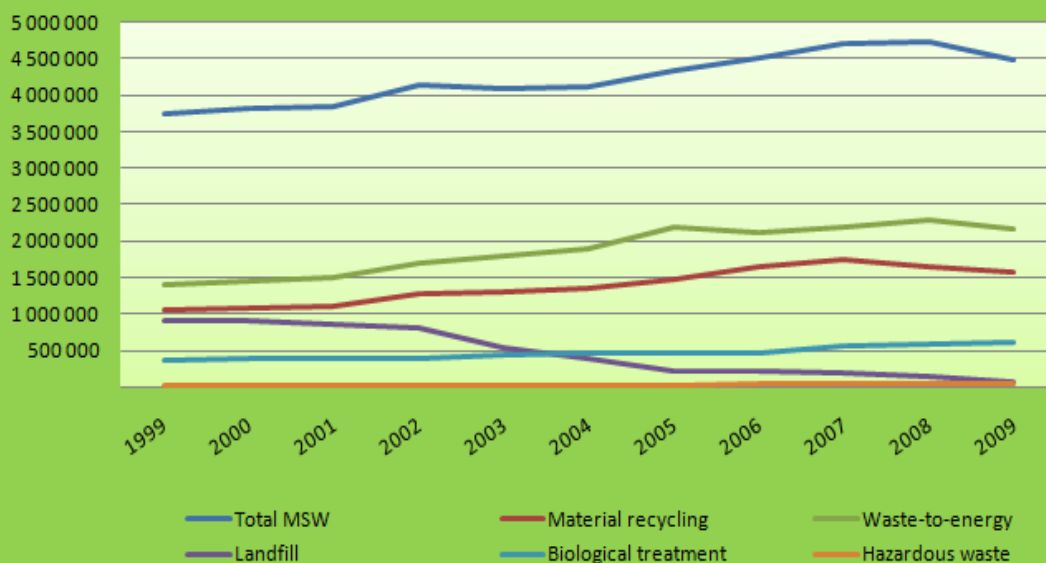
The Swedish Waste Case: 1990 - 2010

In the 1990 Waste Bill, the polluter pays principle was introduced and municipalities were required to develop specific waste plans. The responsibility of the industries to inform municipalities and the public was also increased. By 1994 the law stated that source separation needed to take place and no mixed waste should be delivered to landfills. In 1993, 21 waste-to-energy facilities were in use in Sweden and 50% of all MSW (after source separation) was incinerated [45]. In 1994, producer responsibility was further extended for packaging, recycled paper and tyres [46], supplemented by the electrical and electronic waste Directive (WEEE) in 2005, affecting around 40% of the total waste [43]. Producer responsibility for batteries was introduced in 2009 [47].

Biological waste has only in recent years gained attention and is now collected separately for the production of biogas, heat and / or fertilizer [7].

Beside the introduction of producer responsibility, another important step towards waste separation was the introduction of the EU Landfill Directive in 1999, which led to a Swedish landfill tax in 2000 and strict implementation including a zero-organic waste policy in Sweden: From 2002 no combustible waste was allowed and from 2005 no organic waste was allowed on landfills [43, 48]. An incineration tax was introduced in 2006 but abandoned in 2010. Electricity produced through waste-to-energy is subsidised as renewable energy [43]. The preference of incineration over landfill is based on the EU waste hierarchy.

Development of Municipal Solid Waste in Sweden (in tons)



Main Experiences in Sweden

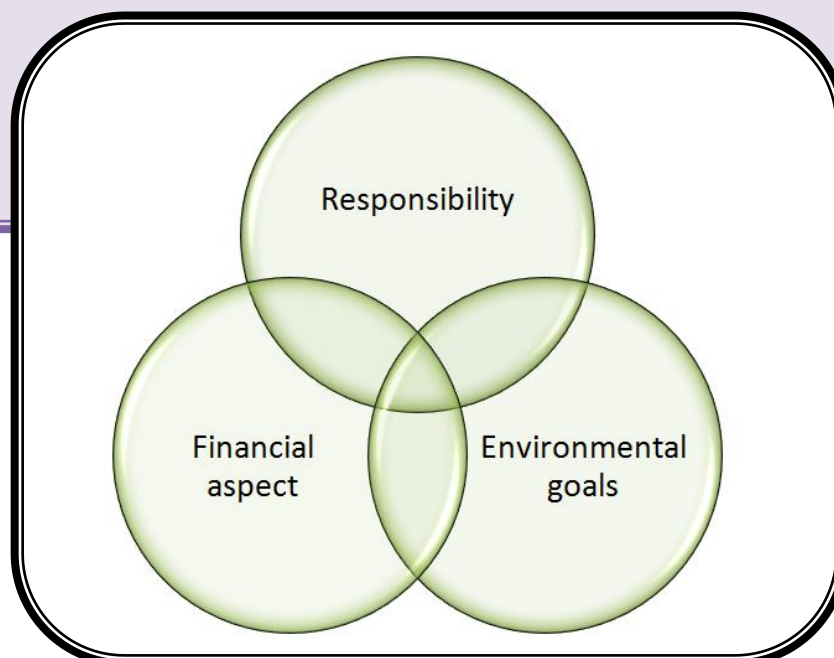
The assignment of *responsibilities* has been the first and most important step in setting up a functioning waste management system in Sweden. If responsibilities are not clear, no investments can be assigned from governmental departments and it is difficult to create a vision and implement laws on a regional and local level. Ideally, waste management systems are controlled by one authority only, with the possibility of outsourcing all elements necessary [7].

A second crucial element for the development of a functioning system is the assignment of concrete *environmental goals*. While municipalities and waste companies in Sweden chose different paths, they all had to achieve the same national goals which requires recycling, source separation and minimisation of waste [7]. An important learning at the time was that:

- Waste sorting had to take place at source
- Markets for recycled products needed to be available
- Dangerous goods (e.g. batteries) needed particular focus to avoid contamination of other waste fractions.

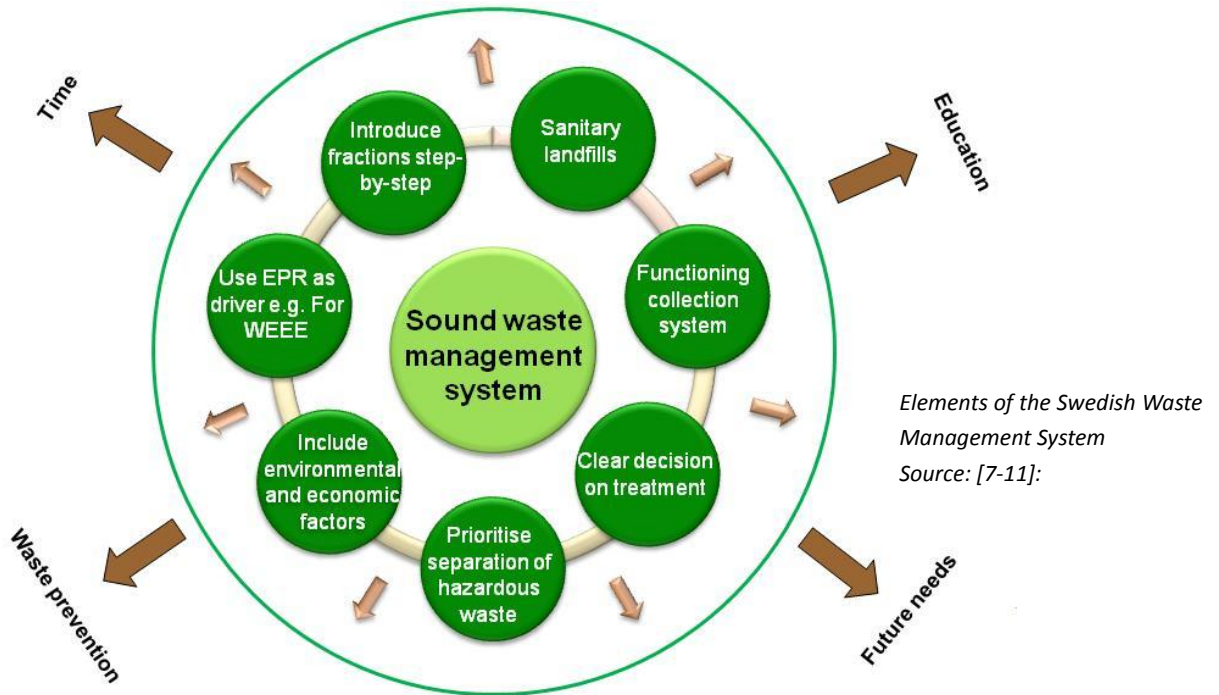
Focus has therefore been given to consumer education [13, 49].

A third important point is the *financial aspects*. It needs to be very clear who is paying for what and to whom. Monetary aspects include for example waste taxes, landfill and incineration taxes. The different allocation of taxes and costs may make a system more or less attractive for municipalities and possibly lead to frustration if monetary revenues and duties do not match. In Sweden, the landfill tax proved to be particularly successful [43, 50].



Foundations of sound waste management systems
Source: [7]

The Current Waste Management System in Sweden



The overall goal of the Swedish waste management system is to work towards reducing the amount and hazardousness of waste. Laws, taxes and national environmental objectives are used as guidance on how to best manage the waste [51]. Elements which the Swedish Waste Management Organisation underestimated at the beginning are the separation of contaminated mixed waste and the segregation of WEEE, which was introduced at a later point.

Another important learning is that incineration cannot be considered as

panacea. It pays off to think through and focus on other elements such as waste minimisation, re-use and recycling right from the beginning when setting up a waste management system [9].

The EU laws and directives control many operations in the Swedish waste management system such as landfilling, incineration and how to treat hazardous waste. When it comes to biological treatment, it is the Swedish national laws that control how it should be done instead [52].

Waste Management in Lund – The Framework



Physical responsibility

The responsibility for waste collection and treatment in Sweden can be divided into three actors:

1. Local government – municipality

The municipality is responsible for collecting and treating all MSW from households. Also waste from industries and companies that is similar to MSW belongs to the responsibility of the local government. The majority of Swedish municipalities hire contractors (private or public companies) to take care of the collection of waste, but some municipalities do this themselves [53].

2. Producers of waste included in the producer responsibility

Producers of waste packaging, vehicles, newsprint, tyres and electrical products are forced by the Swedish law to collect and treat their waste. Voluntary agreements similar to producer responsibility also exist for office paper [54].

In order for producers to properly collect and treat their waste, they can choose to set up their own system for collection or hire e.g. the local government to collect the waste [55].

Batteries

Since 1st January 2009, producers of batteries are in charge of setting up collection systems for used batteries and informing the public about where to hand in batteries. Producers are also responsible for sorting and treatment of used batteries.

The collection system for batteries covers collection points for portable batteries in each municipality, in shops, at recycling stations and recycling centres. [18].

WEEE

As a citizen, one is responsible for dropping off WEEE at a collection point such as municipal recycling centres. The municipality is responsible for informing citizens about where they can drop WEEE and also making sure that producers are doing their job. WEEE that is not included in the producer responsibility, is the responsibility of the municipality [19, 20].

3. Facility operators

Industries and companies must make sure that their waste is collected and treated properly. Every industry must have a licence to operate and also to generate waste. Which authority that issues the licence depends on the size of the operation and how damaging it is to the environment [56].

There is free competition for the collection of industrial waste whilst household waste is covered by the municipal monopoly [57].

Financial responsibility**1. Local government – municipality**

The collection and treatment of MSW is financed through the waste charge that each household or person living in block houses must pay to the municipality. It is the municipal council that decides the exact amount of the charge.

However, according to the Swedish law the waste charge must be set at cost price, meaning that it must only cover the operating cost for the municipality or hired contractor to collect and properly treat the MSW. The waste charge should also cover administrative costs [58].

In 2009 the average single-family household paid SEK 1 970 (EUR 218). For people living in block houses, the average waste charge during 2009 was SEK 1 290 (EUR 143). A large share of the waste charge is used to cover the cost of running the recycling centres where the inhabitants can drop off their garden waste, hazardous waste, bulky waste etc. Since single-family households generate more of this waste compared to people living in block houses they have to pay a larger share of these costs [17].

Most municipalities in Sweden charge their residents based on the size of the waste bin and how often it is emptied. However, some municipalities have started charging their residents according to the weight of the waste. [59, 60].

The figure on the next page shows the shares of the waste charge in Lund municipality in 2007. The environmental charge shown in the graph primarily includes the cost of running the recycling centres, but also the cost of information campaigns, hazardous waste and collection of bulky waste [17].

Packaging Waste

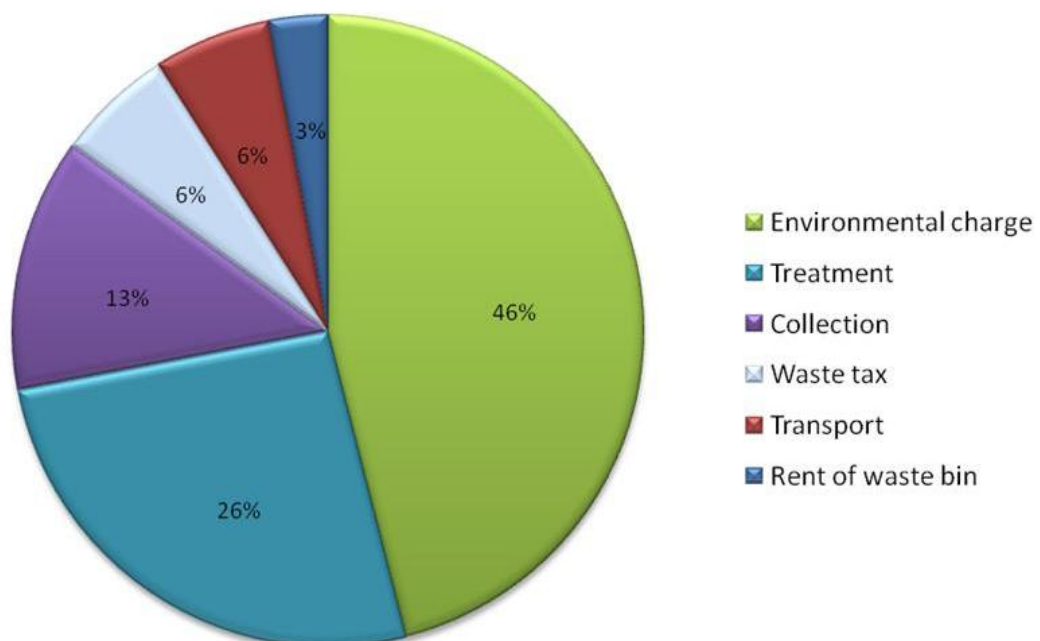
Packaging waste can be dropped off free of charge at any of the recycling stations set up by the packaging producers. To make it easier for the residents to recycle their packaging waste many municipalities (including Lund) offers property-close collection (curbside collection) of packaging waste. To cover the cost of this “extra convenience” the households pay a fee for the waste bins and the collection but nothing for the treatment. Treatment cost is covered by producers [17].

2. Producers of waste included in the producer's responsibility

The collection and treatment of waste included in the producer responsibility is financed by an extra charge on the product itself. This way the consumers pay for the waste that they generate. It is up to the producers to decide how much they charge extra per product to cover the costs [61].

3. Facility operators

The facility operator finances the collection and treatment of their industrial waste. The most common set up is for the facility operator to rent containers (for mixed or sorted waste) from a contractor with a licence to transport and treat industrial waste. Smaller businesses have access to the municipal recycling centres but have to pay a fee for that service [62].



From Treatment to Disposal

The following types of treatments are used in Sweden:

- Material recycling
- Biological treatment (including composting and anaerobic digestion)
- Incineration with energy recovery
- Landfilling

Material recycling

Packaging waste can be dropped off at any of the approximately 5 000 recycling stations that exist in Sweden or can be collected by curbside collection. Following fractions are collected [57]:

- Metal packaging
- Paper packaging
- Soft and hard plastic packaging
- Coloured and transparent clear glass bottles
- Newspapers

Aluminium cans, PET-bottles and glass bottles for beverage such as soft drinks are included in a national deposit-refund system. When a beverage included in the system is bought, an extra charge is added to the price. The cans and bottles can then be returned to a reversed vending machine (called Pantstation) at any supermarket where the deposit is returned [63].

Biological treatment

Roughly half of the Swedish municipalities collect food waste and garden waste separately.

Organic waste such as food waste and garden waste can be composted or anaerobically digested in a biogas plant if the quality is high enough, i.e. no metal and plastic parts are included. The compost is used as a soil improver in e.g. public parks. The bio-fertiliser is an excellent fertiliser and can be used on farmland instead of the more energy intense industrially produced fertiliser.

Many municipalities have chosen to collect the food waste separately in paper bags. To be able to use other types of organic waste, such as food-items from supermarkets, special facilities exist which pre-treat the food items by removing the packaging [8].



Waste-to-energy

Incineration of waste is the most common way to treat waste in Sweden. In 2010 49% of the waste was incinerated, which corresponds to 20% of the total production of district heating [64].

Landfilling

Very little of the waste in Sweden is landfilled today. In 2009 only 1.4% of the household waste was landfilled [65]. A modern sanitary landfill in Sweden is divided into different cells depending on what will be deposited into the cells. Examples of waste that is deposited are non-combustible construction waste, waste contaminated with asbestos, slag from waste incineration etc. [66].

Hazardous waste

Households can drop off hazardous waste at environmental stations. These stations are often put close to petrol stations or other public places where it is easy for citizens to access. Some supermarkets also offer drop off points for smaller hazardous waste such as used mobile phones. Treatment of hazardous waste depends on what type of waste it is [67].



The Economics of Waste

To create economies of scale and to be able to afford proper treatment for waste many municipalities cooperate and form publicly owned companies. In the Skåne-region, two examples of this cooperation are Sysav (the Southern part) and NSR (the North-Eastern part).

Enforcement

The municipality is in charge of monitoring the waste management at industries and companies. For larger operations such as incineration plants and landfills, it is the county administrative board that makes sure laws and regulations are followed [68].

Economic incentives

To reduce the amount of waste being landfilled, there has been a landfill tax in place since 2000. The current tax is SEK 435/tonne (EUR 48/tonne). In 2006 a tax on incineration was introduced to further support material recycling. The tax was, however, taken away in October 2010 [61]. Each treatment facility charges a fee for treatment (in SEK/tonnes), which is paid when the waste arrives at the facility. The fee differs between different facilities. During 2009 the fees were as shown in the illustration below (including VAT, landfill and incineration tax):

Cost of Treatments

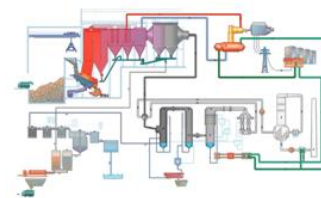
Biological treatment
EUR 44-89 per ton



Landfill
EUR 78-133 per ton



Incineration
EUR 61-122 per ton



The Swedish Waste Management System in Pictures

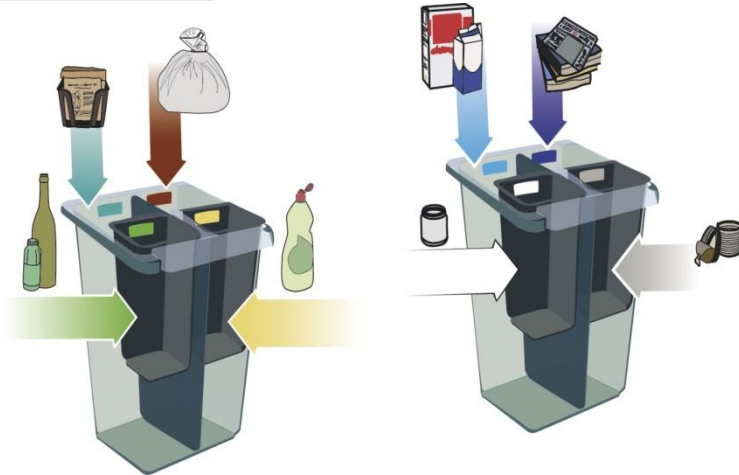
Collection at single-family houses

Bin 1

- Mixed waste
- Food waste
- Coloured glass
- Plastic waste

Bin 2

- Paper
- Cardboard
- Transparent glass
- Metal



Collection at block houses



Recycling Centres (free of charge)



Visual Information

Återvinns, destrueras

Batterier

De batterier du lämnar här innehåller både gifter och ämnen som kan återvinnas. Miljön skonas, resurser och energi sparas.

Vad kan du lämna här?

Ja	Nej
Ficklampsbatterier Radiobatterier Andra småbatterier Laddningsbara batterier Knappcells batterier	Bilbatterier

IL Recycling

Återvinns

Tidningar

De tidningar du lämnar här blir råvara för nytt papper. Det spar energi och träd.

Vad kan du lämna här?

Ja	Nej
Dagstidningar Veckotidningar Magasin Journaler Reklamtryck	Post-it-lappar Gummerade kuvert Plastat papper

IL Recycling

Information Campaigns in Sweden



One of the most important aspects in informing citizens on waste management is to convince them of the usefulness and the actual recycling taking place. Stories about separated waste streams not being recycled have had highly damaging effects on the waste management system in Sweden, with people sometimes not believing in the usefulness anymore and hence giving up recycling efforts [43].

In Sweden, several non-profit organisations have been helping to inform citizens about how to separate waste and increase the awareness level. A lot of information about waste separation, correct handling, and practicalities is available online and through brochures and flyers from the actual waste management companies involved such as Sysav and NSR. "Håll Sverige rent" ("Keep Sweden tidy") and the World Wildlife Fund (WWF) have helped to

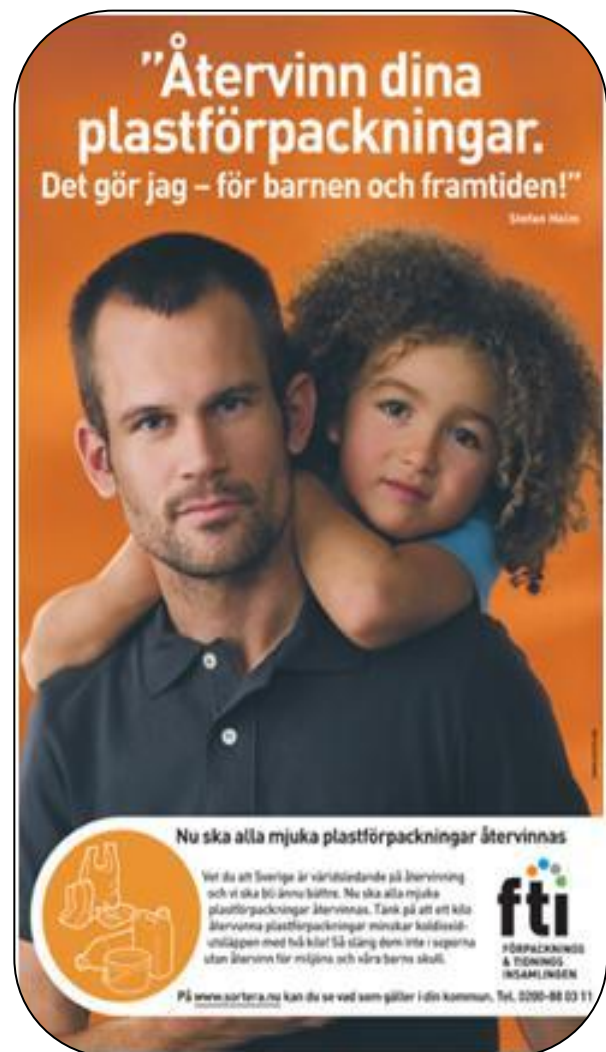
actively integrate environmental topics into the schedules of schools and environmental education is part of every teacher's education. A platform which shows what kind of material is being used and promoted is: www.hutiskolan.se, which has been developed by the University of Malmö [69].

Other associations and organisations with the aim of informing citizens about waste handling include:

- *Batteriinsamlingen*: a collaboration of Swedish Waste Management and two companies in charge of producer responsibility which has promoted the separation of batteries since 1997 [47].
- *El-Kretsen*: A producer responsibility organisation founded in 2001 in charge of WEEE and batteries collection, informing customers about material separation [70].

- *Returpack*: The organisation is in charge of cans and PET-bottles which are collected through a deposit-return system. Their customer information campaign “Pantamera” (meaning “deposit more”) has been running for several years with great success, using a famous song with the lyrics changed in a way to encourage citizens to bring back their cans and plastic bottles. The organisation has been active as well with school education and competitions with a whole webpage dedicated to kids and teenagers.
- *Sopor.nu*: is an internet platform informing citizens about waste and waste separation on national and local level. The organisation is a cooperation between Swedish Waste Management, producer organisations and the Swedish EPA [71].
- The organisation FTI, Förpacknings & Tidnings-insamling (packaging and newspaper collection) is another organisation built through the producer responsibility scheme which provides take back schemes for packaging and newspapers and promotes the separation through information campaigns. Their latest campaign involves Swedish celebrities promoting the separation of plastics as shown in the advertisement on this page [72].

While Sweden has achieved successes in steadily increasing its recycling rates, the total amount of waste has been increasing over the past 40 years. The EU is currently promoting the prevention of waste, which is at the top of the waste hierarchy. In 2009, the project “European Week for Waste Reduction” was introduced by LIFE+, a financial instrument of the EU. The campaign promotes the reduction of waste under one week every year [73].

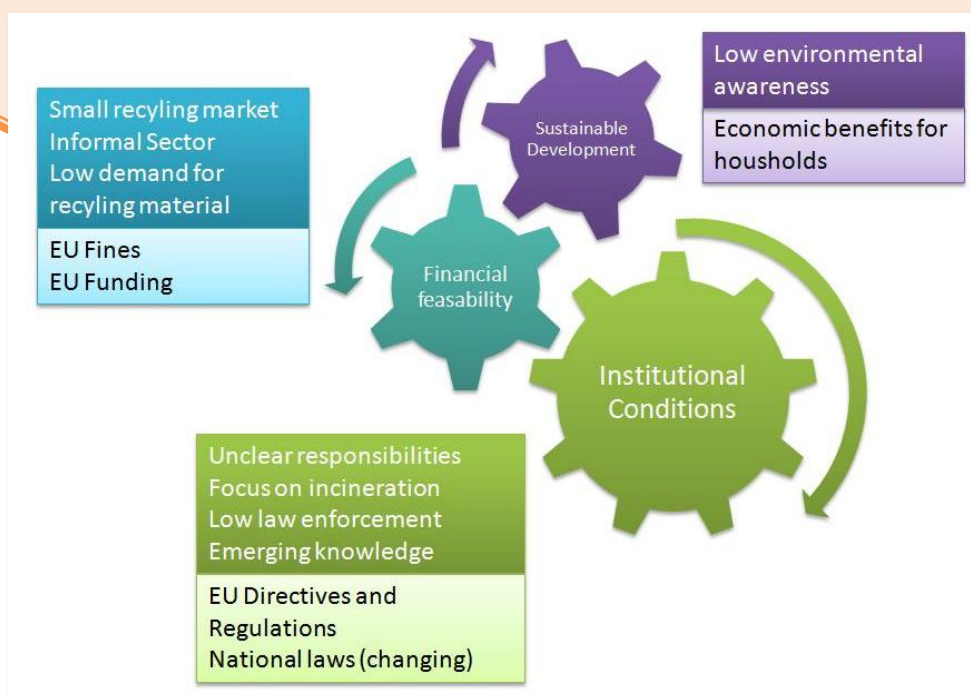


Factors Influencing Waste Management Systems

In order for Poland, and particularly the city of Zabrze, to advance their waste management system as fast as possible, positive and negative learning experiences from Sweden and other places can be used to leapfrog the development and avoid problems encountered in other systems.

The size of the gears in the illustration below indicates the importance of the various aspects with the textboxes referring to some major barriers and drivers. Further aspects which must be considered are amongst others the costs vs. the benefits, the infrastructure available and institutions, the level of know-how, the availability of materials and present and future market conditions [5].

Poland receives financial help from the EU for improvements in waste management. The EU provides help to countries within the EU which have gross domestic products (GDP) of less than 75% of the overall EU average [74]. Between 2007 and 2013, total investments of the EU in Poland amounted to EUR 67 billion of this EUR 17.8 billion are allocated for the protection of the environment, with a large part focusing on waste water facilities [74]. The second priority in the environmental field is waste management. Waste management programs include investments related to prevention and reduction of municipal waste production, recycling technologies and end treatment as well as the elimination of “hazards relating from waste disposal” [2].



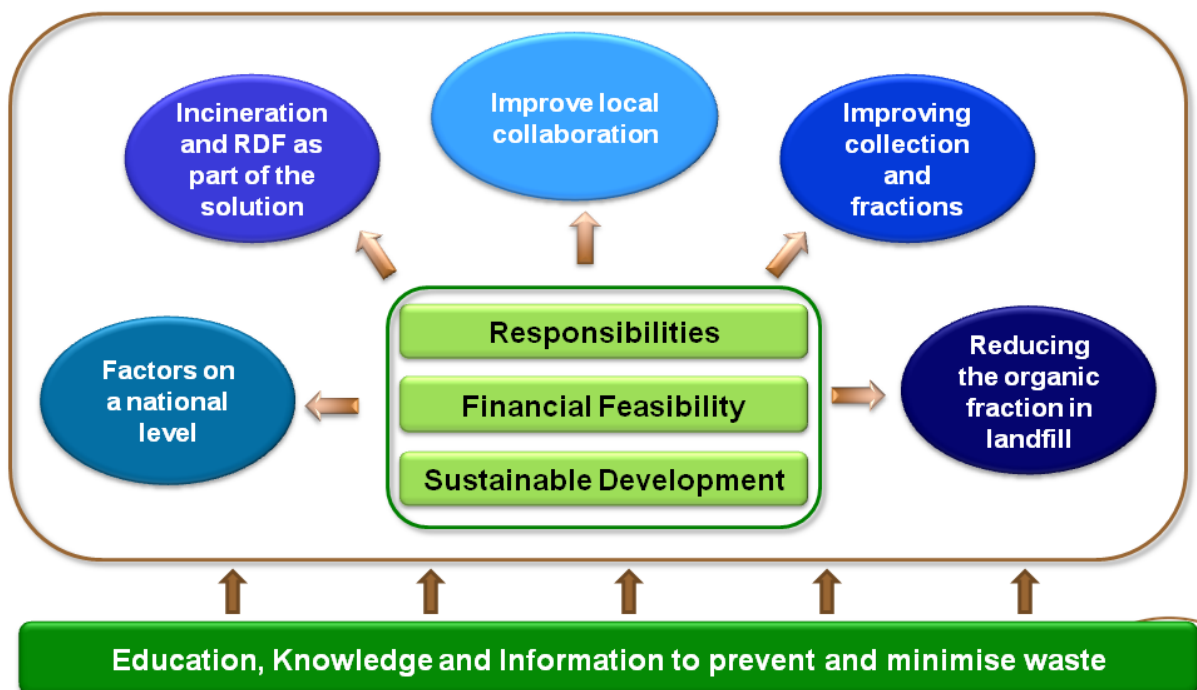
Different factors influencing waste management systems and knowledge transfer

Source: illustration adapted from: [5, 19]

Pathways to a More Sustainable Waste Management System

Looking at the experience in Sweden and other Polish cities, such as Pszczyna, cannot be taken one to one for the implementation in Zabrze. As previously shown in this report, the institutional factors in Sweden are different and more favourable to waste management and the situation for a smaller town

with only 50 000 inhabitants and many more single-family-houses like Pszczyna. However, some of the elements should be possible to take on in order to prepare the city of Zabrze in the best way for the coming new law and to allow for a more forward oriented waste management system.



Starting points for a more sustainable waste management system in Zabrze

Sources: Interviews in Sweden and Poland (compare list at the end of this report)

Responsibility, Financial Aspects and Sustainability

Given the current situation with the new waste law looming it is difficult to establish responsibilities, assign financial means and decide on a long-term sustainable strategy. However, more general recommendations include:

- No referendum for ownership change of waste will be necessary due to the change in law, which will make the city responsible in any case.
- The municipality needs to try and get ready for any eventuality as time is of the essence. This can include an action plan including amongst others:
 - How much the implementation of the new law will cost
 - How the new system could be designed
 - How the responsibility within the municipality will be distributed
 - How and what kind of educational and informational campaigns are needed to inform and educate residents to segregate their waste
 - Specific milestones and intermediary goals within a 6 -12 months timeframe
 - How incentives can be used to encourage segregation
- Try to close all loopholes to ensure that small businesses do not slip under the radar (meaning using bins meant for residents in block houses).
- Start with collecting what is most valuable, which means collecting the existing waste streams; glass, paper, and plastic.
- Educate citizens on the importance of increasing recycling rates and the benefits. This might help make it easier to accept such changes.

Education is the most important aspect to ensure success of an improved waste management system. An educated city will be more willing to sort waste and prevent, once citizens know why and how to do this.

Tackle Factors on a National Level

Certain important limitations which hinder the implementation of an effective waste management system are at the national level. These require a change of the national law or the introduction of new goals and vision on a national level. However, municipalities can still play a role in removing these hindrances by joining together and lobby at the national government level to bring about changes. Barriers on a national level include:

- The national government does not ensure that the *producer responsibility* is effective in achieving the set targets and that packages are collected everywhere
 - There is no *deposit- return* system on a national level. Only the national government can set up such a system for PET-bottles and cans.
 - The national government does not seem to have a coherent action plan for the collection, recovery and recycling of WEEE, which means that municipalities receive limited information outlining their roles within the management of such waste.
- The timeframe for the new waste law is unclear leading to a situation where municipalities currently do not know how to act and in which timeframe they will have to make changes. At present, many municipalities are still unsure where they stand on this law change and whether it will take place or not. Financial support for the change is unclear as well.

- The national government sets national targets for recycling, recovery and landfilling based on EU directives. However, the government does not take into account economic differences between the East of Poland and the rest of the country.
- It is unclear how fines are levied on national and regional level if EU targets are not met. If the financial responsibility was shifted to the municipalities, this could become a strong driver to increase recycling.
- The national government does not provide enough funding for educational campaigns or environmental activities in schools.

Zabrze should increase its collaboration efforts within the Upper Silesia Metropolitan Association to lobby on a national level and pool their resources together.

Incineration & RDF as Part of the Solution

The Upper Silesian Metropolitan Association is planning to build one or two incineration plants that will be in operation no earlier than 2018 [21]. Since Poland is not meeting the requirements in the EU Landfill Directive and will have to pay even higher fines in the near future one can understand why incineration seems to be an attractive alternative. However, incineration should not be seen as a solution to waste problems. In fact, apart from landfilling incineration is regarded as the second worst option by the EU when it comes to waste management. Building of incineration plants is very costly and installing the required cleaning systems along with operation costs makes waste-to-energy plants an investment with very long payback time.

Also uncertainty exists regarding if and when an incineration plant will be built since consensus has not been reached in the regional association.

RDF (refuse-derived fuel) is a technique where waste with high calorific value

(e.g. plastic) is pre-treated and used as alternative fuel in e.g. cement plants. Already today, small volumes of MSW in Zabrze are used as RDF. However, there are no current plans to convert coal-fired plants to RDF-plants or to further expand the existing use in cement plants [21].

Apart from being an expensive investment, incineration is also a lock-in solution. Once the waste-to-energy plant is in place there will be a constant need for generating enough waste to make it profitable. This goes against EU's policies of waste minimisation and waste prevention. There is also a risk that the recycling market, which is essential to close material-loops and achieve a sustainable society, will not be properly developed due to disincentives from the incineration technology.

It is very important that waste-to-energy is not considered as THE solution. There will always be some fractions that will have to be incinerated, fractions that should not remain in society. In that way incineration is only part of the solution.

Put a stronger focus on developing the recycling market. This is a better option than incineration since it is in line with EU policy.

Local Collaboration

The city of Zabrze cooperates with 14 other cities through the Upper Silesian Metropolitan Association. Their tasks are to prepare projects such as the construction of new incineration plants. Additionally, Zabrze already deploys actions for educational campaigns and research to organisations such as research institutes.

It would however be contributively to have a more holistic waste management collaboration across cities. As an example, even the city of Pszczyna, with its high rates of recycling, is having problems of illegal dumping. The reason for those problems is that surrounding municipalities have not implemented similar collecting system yet. People living outside of Pszczyna are therefore dumping their waste in the neighbouring municipality.

Zabrze and the surrounding municipalities should collaborate

strongly and push the national government to change policies. As a case in point, Barcelona adopted solar obligations in 1999 and this obligation was expanded in more than 50 Spanish municipalities including large cities. These broad political consensuses lead to the inclusion of a solar obligation in the New National Building Code, which was finally adopted in 2006. This so called “Barcelona model” shows that the strong lead from a city with charisma can change policies on a national level if the timing is right. It took, however, six years to gain the support of different political parties throughout the country [75].

For Zabrze, it may be possible to start a local initiative and collaborate with municipalities and other sectors such as educational, economic, industrial and non-governmental organisations to push national policies in the long term.

Local collaboration with various stakeholders is an important factor to advance the waste management system and policies on a national level. Other cases show that this takes time but is possible!

How to Improve Collection of MSW

Besides lacking municipal ownership of waste, one big problem for Zabrze is that many people live in block houses. In these places separating waste is not successful. Even in municipalities with responsibility for waste, such as Pszczyna, this is an unsolved problem. Due to the issue of anonymity some of the residents misuse the facilities and put their waste in wrong bins.

Potential starting points to improve the collection are:

- Extend the waste management system with colour codes: bins should be coloured differently representing different fractions that should go into them. These coloured bins can be accompanied by visual information to show what kind of waste goes into the bin and what does not.
- Small openings on the bins prevent misuse but still allow enough space for the disposal of the correct waste.
- Existing collection points for recyclables should be maintained and expanded upon to increase the coverage area and make it more convenient for the people to dispose of their recyclable waste.
- The municipality could install large recycling centres, which are accessible by cars, to encourage the legal disposal of bulk and other waste free of charge (i.e. included in the waste charge); this in accordance with the Swedish model.
- The municipality should define and enforce the frequency of collection whether this will be once a week or once every two weeks to ensure that recyclable waste does not overflow at collection points.
- Increase number of collection points for hazardous waste to more locations, such as block houses, supermarkets and schools.
- Create collection points for WEEE to ensure that such waste is being collected appropriately.
- Small-scale pilot project at e.g. block houses could be conducted using education, information or other means to see what works best.
- Introduce zoning for waste collection companies. This should improve the existing situation where four or five different collection companies are collecting waste in the same location.
- Close the waste chutes (“holes in the wall”) in block houses, which also poses a fire risk to the residents.

Convenience, knowledge and incentives are the cornerstones of a successful waste collection system.

Reduce the Organic Waste Fraction

Organic waste must be reduced in landfills according to the EU Landfill Directive. The directive requires a reduction of municipal organic waste to 75% of the amounts generated in 1995 by 2006, further reductions to 50% by 2009, and to 35% by 2016 (all figures in relation to 1995-levels) [76]. Many initiatives focus on the organic waste since it has, potentially, high environmental impacts [76]. Poland has not achieved the 2006 target so far and hence still needs to work on reducing organic waste and collect it separately from each household as well as restaurants, supermarkets and wholesaler.

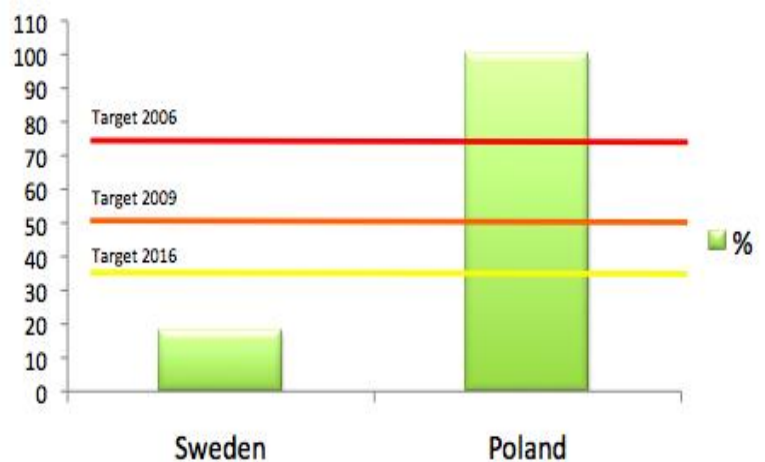
Activities which could increase collection rates by citizens are:

- Educational measures the introduction of a paper-bag system for separate collection
- Containers with easily recognisable colour

As an example the Swedish waste management company, NSR, successfully uses paper bags for the collection of organic waste. However, not only households,

but also the organic waste fraction from restaurants and supermarkets need to be considered. To smooth the start of organic waste collection, these shops could be prioritised and equipped with special containers for organic waste.

Collected organic waste can be transported to a biogas plant where the gas can be used for generating heating and/or electricity as well as upgraded to vehicle fuel for cars, buses and trucks. Currently Zabrze does not have a biogas plant; however, such a facility could be part of a long-term vision on how to meet EU directives.



Municipal Organic Waste Landfill in 2006, compared to targets of the EU Landfill Directive

Source:[14]

The increase of the organic fraction is difficult to achieve and needs time. It is important to have a long term vision to achieve the goals.

Prevent Waste!

Awareness of why recycling is important is not the most significant factor when it comes to making people recycle more. Instead it has been shown that convenience is by far the most essential element in a successful recycling system. On the other hand awareness and knowledge on why material recycling is important is a key factor for preventing and minimising waste generation in the long run [77]. It is therefore recommended to balance education with supplying appropriate infrastructure for recycling such as property-close bins or easily accessible collection points.

The city of Zabrze could start by making citizens more aware about issues of waste management and waste generation. There does not seem to be any systematic education in schools in Zabrze that focuses on environmental issues. Only two or three lessons on the topic are included in biology class. While this is mainly an issue that needs to be solved on the national level, lobbying

through the regional association as well as by making local changes, could be starting points.

Campaigns in the city could be a good way to reach out to a large share of the citizens. All channels such as TV, billboards, posters and radio should be utilised. What seems to have worked best in other cities are focused campaigns on one issue (e.g. plastic waste) in order not to cause confusion. As with any education there is a strong need for repetition!

As a final recommendation it is important to keep in mind that changing people's behaviour takes time but it is possible! Although waste prevention should be the long-term goal and vision, starting by making the current system for recyclables more convenient is crucial in order to make the waste management system more sustainable. Recyclable waste should be seen primarily as a valuable raw material rather than a source for energy.

Convenience and incentives are important elements to increase recycling. However, for the overall goal of waste prevention and reduction of waste, educational awareness needs to be increased.

Conclusions

It takes a long time to make municipal waste management systems more sustainable. As this report clearly shows, reasons are the complexity and the many factors influencing waste management systems on national and regional levels. This fact is exemplified by looking at the Swedish case, where the development of waste management has been ongoing for the last 40 years with improvements still under way.

The experience from Sweden shows that the assignment of responsibility, national environmental goals and financial aspects play a crucial role in the development of a sustainable waste management system. Given the current institutional and financial situation in Poland it is difficult for Zabrze to take a path similar to the Swedish case. However, some elements and experiences may still suit the local situation in Upper Silesia and can be adapted and used as inspiration and starting points to a more sustainable system.

Even without the new waste law in place, Zabrze should act more proactively and prepare itself for future development and business opportunities in the area of recyclables

and waste. Important starting points which should be prioritised are:

1. Educational activities to reduce, prevent and segregate waste
2. Aim to receive EU funding for waste infrastructure and educational campaigns
3. Increase the collaboration within the region across municipalities, business sectors, schools and non-governmental organisations.

One important point is that incineration cannot be regarded as THE solution to the waste problem. The focus needs to be on recycling and developing the market for recyclables, following the EU waste hierarchy.

It is important for the city of Zabrze to note that it will take a considerable amount of time to change to a more sustainable waste management system. Convincing citizens and businesses as well as other municipalities that waste prevention and segregation is not only beneficial, but crucial for the future of their society. A long-term vision and commitment is needed to achieve the necessary changes.

The International Institute for Industrial Environmental Economics

The International Institute for Industrial Environmental Economics (IIIEE) in Lund is an independent part of Lund University. IIIEE was established in 1994 by the Swedish Parliament and has since the start carried out multidisciplinary research and education in a cross-cultural environment.

Students from all over the world are trained in how to prevent environmental degradation rather than setting up end-of-pipe solutions. A Masters programme in Environmental Management and Policy (currently two-years) has been the core of the IIIEE since the start. By close collaboration with industry the students are exposed to decision-making in the “real world” and trained in how to set up policies for a sustainable development.

As part of the Environmental Management and Policy Programme a four-week course on Strategic Environmental Development (SED) takes place. During the course the students are divided into groups and work as consultant for real clients on various projects (mostly) in countries outside of Sweden. During March-April 2011 a group of students prepared for a project in collaboration with the city of Zabrze in Poland, followed by a one-week field research in Zabrze.

About the Team

Bernice Charles – is Seychellois and has a Bachelor degree in Urban and Regional Planning from Curtin University in Western Australia. Previous to the studies in Environmental Management & Policies she worked in the governmental Land-Use Planning Department in the Seychelles.

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Chihiro Sawaki – is Japanese and has a Bachelor degree in International Relations from Nihon University in Japan. Before she joined the master education at the IIIIEE in Lund, she worked for a Japanese Environmental NGO in the field of renewable energy and climate change policies.

Cornelia Moser – is Swiss and has a Bachelor of Honours in International Management from the University of Applied Sciences Northwest Switzerland. Before joining the Master education at the IIIIEE she worked in the Communications Department of an international company in the power industry in Switzerland.

Mikael Backmann (supervisor) – is a senior research fellow at the IIIIEE. He has been involved in developing the Swedish waste management system and particularly the deposit return system and extended producer responsibility. His main research areas today are sustainable tourism and waste management.

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- Picture of packaging campaign from Sweden pg. 28 author FTI: www.ftiab.se

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