CHAPTER 2: ENERGY RECOVERY FROM MSW (ONE STEP FURTHER)

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Introduction

Over the last few decades, the solid waste management systems in many OECD countries have changed significantly. In the past, landfill was the standard disposal route for waste. However, in recent times, waste management has been all about utilising the value of waste in terms of material and energy in the best way possible. The various components of the solid waste management system have been arranged into what has become known as the waste hierarchy. The waste hierarchy is what the waste management policy in most countries is based on. In the first place, it promotes prevention and material recycling. When recycling is not feasible energy recovery is the main option. Landfill is the least preferred option in the chain.

Waste hierarchy, the integrated solid waste management approach:	
Prevention	Life-cycle design, cradle-to-cradle approach
➥ Recycling	Product and material recycling as long as practically reasonable
➥ Energy recovery	Utilisation of combustible non-recyclable waste as an energy source
➥Final disposal	Environmentally safe storage of inert, non-recyclable waste in landfill sites

This hierarchy is implemented in all countries that were present at the workshop. However, differences in implementation are enormous. In particular, the role of EfW shows a variety of policy interpretations, making it impossible to draft one clear picture for the optimal energy recovery system. Therefore, the title of this chapter refers to bringing the energy recovery 'one step further' since an attempt to define just one optimal solution would not be appropriate. The main question is:

Which policy measures are the most effective in a country to improve the energy production from non-recyclable waste?

This chapter will further:

- describe the most important differences between countries;
- investigate the potential of the different technologies employed;
- give the overall lessons learned from the workshop;
- specify the lessons for four different stages in EfW development.

The following abbreviations and definitions are used throughout this chapter:

BAT best available technology

CHP combined heat and power

EfW energy from waste, the technologies aiming to recover energy from waste

LFG landfill gas

MBT mechanical biological treatment, non-thermal treatment technology of MSW

NGO non-governmental organisation

SRF solid recovered fuel, fuel made from waste, to be used in industrial boilers or co-firing

WtE waste to energy, power plants using MSW as fuel, often based on grate technology

The current waste management situation and differences between countries

By using waste as an energy source, the environmental performance of a waste management system improves considerably. Quite simply, the use of fossil fuels is replaced and bio-energy can be produced. Looking at the waste used in WtE plants, roughly 50% (energy based) is biomass and this proportion of the energy recovered can, therefore, be counted as renewable energy.

Three types of energy recovery have been identified: to produce electricity only, to produce heat only and to produce a combination of electricity and heat (CHP). For many years in the Netherlands, energy production has focused on electricity[1], whereas for the last few decades in Scandinavian countries the focus has been on heat production (currently, there is a shift in interest towards CHP).

Table 1: Key figures market penetration of WtE and its energy efficiency (most data 2006)

Country	Combustible, non-recyclable MSW		Energy recovery	
	Mt/year	Incineration	Electricity	Heat
Germany	15.1	98%	11%	33%
France	20.3	55%	6%	16%
Netherlands	5.9	93%	14%	13%
Sweden	4.3	95%	10%	86%
United Kingdom	20[2]	17%	13%	4%
Norway	1.7	35%	7%	92%
Canada	9.2	6%	7%	28%

[1] This figure still underestimates the focus on electricity. Most heat is, in fact, used to raise steam for the production of electricity by integrating the steam cycles of incineration with a nearby gas-fired CHP-plant (at Moerdijk, NL). In case this plant is counted as an electricity producer, the energy recovery rates for electricity and heat are 18% and 4%.

[2] Due to an increase in recycling, it is not to be expected that all the MSW is available for energy production, only 8-9 Mt/year should be considered combustible, non-recyclable waste.

Table 1 gives an indication of the incineration and energy recovery rates in the different countries. The totals in the second column are the sum of MSW incinerated and landfilled. The amount of waste incinerated is well known in most countries, but the amount of combustible, non-recyclable waste that is landfilled is more difficult to extract from available statistics. Most countries know the amount of household waste incinerated; because these data are available and comparable between the countries, these were used for Table 1. However, this ignores commercial and industrial waste that is non recyclable and combustible[3]. This means that the incineration percentages are high estimates. Despite this limitation, Table 1 clearly shows the differences in current waste management systems. This strongly influences the best approach for policies to optimise energy recovery. In some cases, most waste is already incinerated and efficiency improvements should be found within the current system. In countries such as the UK and Canada, new plants will be built in the near future and, therefore, more opportunities for the introduction of heat and electricity will be possible.

This chapter briefly describes the current status in the development of EfW and attempts to identify the best route for energy optimisation for a number of given (national or regional) situations. It is clear that for a country where incineration plays a minor role and is not a well-accepted technology, an alternative strategy is required compared with a country where WtE is well established and accepted.

During the workshop, the situations of the countries mentioned in Table 1 were used as examples for strategies on energy recovery from MSW. Furthermore, a discussion was initiated on how to bring the WtE infrastructure one step further in those countries. This chapter discusses the results in a comprehensive way, paying attention to drivers and barriers for energy recovery from MSW and how national policies can influence these in a positive way. Drivers and barriers are divided into certain policy areas, briefly described here.

Policy areas influencing EfW

Besides the waste policy where EfW is preferred to landfilling and incineration without energy recovery, a number of other policy areas influence the potential for energy recovery. Energy and climate policy has a significant impact in cases where energy efficiency and emissions reduction due to LFG emissions reduction are important topics. An underestimated policy area is spatial planning, which has a major impact on the siting of waste incinerators in the first place and to the subsequent ability to utilise waste heat from the combustion process.

[3] For France, we know that this is about 13 Mt/year, for the Netherlands 1 Mt/year. The incineration percentages are, therefore, high estimates. For France, the percentage would be 35% and for the Netherlands 80%, if these streams were included.

Policy areas interacting with EfW:	
- Waste policy	Defines the framework for waste management systems.
- (Renewable) energy policy	Defines the role of EfW positioning the energy infrastructure, recognises renewable energy component.
- Climate change prevention policy	Interacting with the waste management hierarchy.
- Environmental policy	Defines environmental preconditions for EfW.
- Spatial planning policy	Describes where EfW facilities may be built.
- Industrial and innovation policies	Promote the development of industry and/or technologies.

Although this looks relatively straightforward, in practice, overlap occurs between policies - policies strengthen each other or can be counterproductive. The influence on the development of EfW can be positive or negative. There can be a significant difference between policies, implementation and the market response. Also, differences occur when it comes to how waste management should be implemented between national policies and policies on a regional level. Besides the impact of policies, other factors also play an important role in the way EfW is managed. The major external factors are:

- Energy market: When energy prices are high due to local market conditions, the world energy market or high tax rate on fossil fuels, the energy market becomes a driver.
- Geographic location: The higher the latitude the better the opportunities for district heating in cities; at lower latitudes district cooling may be an additional driver.
- Cultural aspects: Centralised and social versus decentralised and individual cultures. In the former, culture is a driver. In the latter, culture is a barrier for more EfW.
- NGO position: NGOs are very important in relation to the public acceptance of EfW. Therefore, their position is discussed in more detail.

NGOs and public acceptance

In relation to EfW, NGOs are important stakeholders (in addition to authorities and the market). Due to their impact on public opinion, it often appears that they can make or break a project. The different positions taken by NGOs in different countries reflect the complexity of the public-relations topic and, as a consequence, virtually every EfW case has to be treated separately and on its own merits. Some general comments are made in the box below.

Comments on NGOs and energy from waste:

- All NGOs agree that waste management systems have to be improved to move away from landfilling!
- The NGO position towards EfW can differ considerably from country to country.
- Even within a country, the NGO position can differ.
- In countries where NGOs are mostly against it, EfW has a bad reputation.
- When EfW has a good reputation, NGOs accept it if it is performing above a minimum standard.
- In local situations, the 'not in my back yard' (NIMBY) phenomenon plays an important role, whatever the waste management solutions are.
- Small-scale solutions are often preferred to large-scale solutions.
- CHP or heat only is preferred to electricity only.
- Often, biological treatment solutions are preferred to thermal treatment.
- The ultimate goal is the 'zero waste society' - better to be realised today than tomorrow.
- The NGO concern is that investments made in EfW hamper the development towards a zero waste society.

In the zero waste society, waste management is all about prevention and product/material (reuse) recycling. The ideal consequence is that no waste is available for EfW applications or final disposal. Another approach based on these values is 'cradle-to-cradle', meaning everything is designed for reuse making effective recycling or even up-cycling (increasing quality of use) possible. Developing the waste management system, including its EfW applications, must not obstruct the way towards the ultimate goal: a sustainable society.

The best approach for constructive interaction with NGOs and public acceptance:

- Prepare the interaction by means of stakeholder analysis, know their arguments and background.
- Early stage interaction with NGOs is recommended, discover common criteria before making choices.
- The improvement of the waste management system has to be the leading objective.
- Don't look at the single solution only, but place the initiative in the waste hierarchy.
- Locations for processing facilities have to be selected with care using rational arguments.
- Make an environmental impact assessment at an early stage, look seriously at the alternatives.
- Apply BAT as long as it is reasonable and well proven.
- Show the risks of applying innovative technologies on full scale.
- Show the impact of doing nothing, prove that it is time to act and losing time harms the environment.
- Visit similar projects and plants to that intended in the new project, organise stakeholder-to-stakeholder contact.

Energy potential from technologies

Based on the introduction of the EfW topic and the lessons learned, effective policy approaches can be derived leading towards EfW technologies being more extensively applied. To put these approaches in perspective, it is important to know how different methods of waste treatment are related to each other when it comes to energy recovery. The box on the next page presents the key figures.

Lessons learned from Europe on delivering a sound waste management infrastructure[4] and thus creating a sound environment for taking EfW one step further include:

- a regime of certainty making it possible to invest;
- partnership in waste management between different governmental layers;
- transparency creating a basis for public trust;
- an integrated approach across waste streams and their treatment methods.

These aspects can be analysed for the stages in the development of EfW. In the EfW policy approaches, four stages can be identified:

- Stage 1 Utilisation potential of biogas from landfill.
- Stage 2 Production of electricity by means of combustion or digestion.
- Stage 3 Integrated CHP.
- Stage 4 Innovations (towards higher energy utilisation rates).

These stages are described in section 3 and a level of waste utilisation and energy recovery typical for each stage of development is given. Definitions of the terms used in these descriptions are given below. This chapter will not investigate the potentials of the different technologies used, albeit they play a major role in many discussions on energy from waste. Therefore, a short overview of the different technologies is also given in this section.

The development of energy utilisation can be defined in two ways

Starting at stage 1, each stage takes EfW one step further by:

- Increasing the utilisation rate of non-recyclable, combustible **waste** streams W-rate.
- Increasing the **energy** recovery rate per MJ of waste being used as a fuel E-rate.

[4] Delivering key waste management infrastructure: lessons learned from Europe, SLR Consulting/The Chartered Institution of Wastes Management, November 2005.

Definitions of different ratios indicating the extent to which waste is utilised as an energy source:

W-rate: Waste utilisation rate, ratio in % between the waste used as an energy source and the amount of the combustible, non-recyclable waste in a certain country in PJ/year (mass x heating value).

E-rate: Energy recovery rate, ratio in % between the useful energy produced and the energy content in PJ of the waste used in EfW systems.

In reality, a mixture of several stages can occur in a country. The status is determined by the mainstream technologies (including their performance) used in the waste management system. How EfW can be taken one step further and how interaction with policies take place is explained below for each stage.

Potential of different technologies:

This chapter does not analyse the relationship between energy recovery and the technology chosen. However, because of the importance of technology for energy recovery, some comments should be made here. Within Task 36, a lifecycle analysis (LCA) comparison is made of different treatment routes for MSW. The WRATE-model is used, which as one of the results calculates the energy recovery of the waste management system analysed. This is the energy produced in electricity and heat as a percentage of the energy content of the input waste. In the case of fuel production from waste, the energy produced in an external power plant is included. The final energy recovery is from 6% (for a high-quality modern landfill with LFG recovery and heat production) to around 95% (for a waste incinerator with high-efficiency CHP, as currently available in Sweden). For MBT, a wide range of outcomes is presented due to the different possibilities for the use of the high-calorific fractions produced. This means that in the case of bio-drying/separation (especially with a high percentage of fuel production and energy recovery with high efficiency (95%, as in CHP incineration)), the overall efficiency can end up around 60%. With lower percentages of fuel recovery and only electricity production, the overall energy recovery is around 15%. In cases where the biological treatment is only meant as a pre-treatment for landfill, the energy production is much lower. For landfill, the LFG production is limited even in the case of a well-managed landfill site. With optimal recovery of the gas and maximum energy recovery, the energy production as a percentage of the energy content of the waste landfilled is only 6%.

Technology	**Potential energy recovery**
Incineration (electricity)	25%
Incineration (CHP)	40%-95%
MBT bio-drying/separation	15%-60%
MBT anaerobic digestion/separation	15%-30%
MBT stabilisation for landfill (limited SRF-production)	8%-15%
Landfill	6%

Stages in development

The four stages mentioned in section 2 above are described in this section. Section 4 will show the situation in the specific countries of the IEA Bioenergy Task 36.

Stage 1: Proper landfilling and material recycling

Stage 1 is applicable to countries where landfilling is the most common practice and where WtE is not well accepted due to reasons such as:

- too expensive compared with landfill due to high investments and low energy prices;
- no limitation in the availability of landfill sites close to sources of waste;
- the belief that the environmental impact is worse compared with landfill;
- the belief that WtE impedes the growth of material recycling;
- no stringent policy on energy recovery of combustible, non-recyclable waste.

In stage 1, the public acceptance for EfW technologies in general, and WtE in particular, is low and often confirmed by poorly performing, non state-of-the-art EfW facilities in a country. In general, the waste management policy will focus in the first place on proper landfilling, minimising the environmental impact and the escape of harmful greenhouse gases (particularly methane (CH_4) and nitrous oxide (N_2O)), and maximising the recovery of LFG. LFG is used in gas engines or upgraded to 'green' gas (bio-methane) and injected into the natural-gas grid or used locally for transportation purposes. Stage 1 also deals with material recycling, including composting. Attention is paid to the promotion of schemes for separate collection and the build-up of a proper recycling infrastructure. The extent of recycling has to be carefully considered since:

- recycling leads to degradation of the material being recycled, demanding more and more energy and other resources;
- high-end utilisation of recycled materials and/or products need to be guaranteed.

In waste management planning, the capacity for EfW facilities is the result of, on one hand, optimistic estimation of the impact of prevention measures and the recycling capacity and, on the other hand, a conservative approach of the waste supply. Thus, preventing the build-up of excessive EfW capacity is of importance. When there is not enough EfW capacity, export or landfilling take care of the excess waste volumes.

In stage 1, strategic planning is essential to indicate how much EfW capacity is needed in the mid term (say e.g. the next ten years) to improve the performance of the waste management system. Also, indications have to be given of locations, sizes and criteria applicable to the selection of new EfW projects. In relation to energy, these criteria can either be modest or stringent, aiming at high energy efficiency by means of CHP. In the latter case, policies have to be in place promoting CHP and bringing heat supply and heat demand together in such a way that doesn’t lead to unreasonable extra waste-treatment costs.

Special interest is often focused on innovative technologies, as an alternative to traditional mass burn systems (e.g. gasification, pyrolysis, plasma treatment and MSW digestion technologies), because the societal and political acceptance for these technologies is often high. However, experience over time has shown that, in many cases, only pilot plants have been demonstrated, with varying results and no subsequent scale-up to mainstream market application. The search for the ultimate technology doesn’t mean that it is not allowed to apply traditional tried-and-tested technologies. A transition, supported on a national scale, is often the best way to introduce new technologies in the waste management system.

Table 2: Policy impact matrix stage 1, proper land filling and material recycling

<table>
<tr><th>Policy category</th><th>Driver</th><th>Neutral</th><th>Barrier</th></tr>
<tr><td>Waste policy</td><td>++</td><td></td><td></td></tr>
<tr><td>Energy policy</td><td></td><td>√</td><td></td></tr>
<tr><td>Renewable energy policy</td><td>+</td><td>√</td><td></td></tr>
<tr><td>Climate policy</td><td>+</td><td></td><td></td></tr>
<tr><td>Environmental policy</td><td>+</td><td></td><td></td></tr>
<tr><td>Spatial planning policy</td><td></td><td>√</td><td>+</td></tr>
<tr><td>Industrial, trading policy</td><td>+</td><td>√</td><td></td></tr>
<tr><td>Innovation policy</td><td>+</td><td>√</td><td></td></tr>
<tr><td colspan="4">Waste policy is the main driver towards proper landfilling and recycling. The climate, environmental and renewable energy policy are drivers, too. Innovation, industrial and trading policies can be a driver mainly in relation to material recycling.</td></tr>
<tr><td colspan="4">W-rate: from below 0% (dumping, no LFG extraction) to 100% (state-of-the-art landfill sites everywhere)
E-rate: around 10%, LFG is converted to electricity by means of gas engines</td></tr>
</table>

Stage 2: Electricity production in waste-to-energy plants

Stage 2 is applicable to countries moving away from landfilling of combustible waste and having a well-established material recycling system.

Once proper landfilling and material recycling is in place, the emphasis can change towards EfW systems that are fuelled by non-recyclable, combustible waste. Whatever the local situation is, electricity can be produced in all cases and is thus the most common way of utilising the energy content in the waste. The main technologies are:

- biological treatment: digestion of biodegradable waste and the resulting biogas is used in gas engines;
- thermal treatment: waste combustion by means of grate firing or fluidised bed systems.

The main policy leading to the growth of EfW facilities is a ban on combustible wastes going to landfills, often part of an integrated waste management policy. The ban is sometimes enforced by a taxation system, making landfilling so expensive that WtE makes economical sense. In practice, a landfill gate fee of around 100 euro/tonne will be sufficient to enforce a change in the waste management system towards energy recovery. Energy policy can be of help in making energy recovery more feasible, especially when existing energy prices are low. In promoting EfW facilities, careful attention has to be paid to site selection (leading to optimal locations) and, from the point of view of energy, sizing to prevent overcapacity. The impact of energy, renewable energy and climate policy is still relatively low since the energy income is small compared with the gate fee, typically in the order of 20%.

Table 3: Policy impact matrix stage 2, electricity production in WtE plants

Policy category	**Driver**	**Neutral**	**Barrier**
Waste policy	++		
Energy policy	+		
Renewable energy policy	+	√	
Climate policy	+	√	
Environmental policy		√	
Spatial planning policy			+
Industrial, trading policy		√	
Innovation policy		√	
Waste policy is the main driver towards electricity from waste. The energy, climate and renewable-energy policy are drivers too. Spatial planning is often a barrier leading to a lack of suitable locations.			
W-rate: between 80% (some landfill with no LFG extraction) and 100% E-rate: between 15% and 25%, energy conversion is a mixture of LFG, digestion and mass burn			

Stage 3: Integrated CHP approach

Stage 3 is applicable to countries focusing on combined heating (cooling) and power applications instead of electricity-only production. Site selection is crucial for energy supply and energy demand. Supply and demand, especially when they are of the same order of magnitude, have to be brought together to make heat (cooling) delivery economically feasible. To site heat demand (district heating and cooling, heat demand in industry, heating greenhouses, etc) and heat supply by means of EfW technologies close together, the public acceptance and the trust in the technology and reliability of heat supply has to be great. In each new project, CHP has to be the starting point in the development, being as high on the agenda as the waste supply itself. Support of local authorities and stakeholders is a pre-condition for the development of successful CHP projects. Since the infrastructure needed to create CHP is, in most cases, expensive, circumstances have to be created making investments possible under normal market conditions. For example, this can often be 'soft loans' or the government investing in infrastructure and owning it for the first five years or so.

Table 4: Policy impact matrix stage 3, integrated CHP approach

Policy category	**Driver**	**Neutral**	**Barrier**
Waste policy		√ (?)	+
Energy policy	++		
Renewable energy policy	+		
Climate policy	+		
Environmental policy		√	
Spatial planning policy	++		
Industrial, trading policy		√	
Innovation policy		√	
Energy policy is the main driver towards more CHP. The spatial planning policy is crucial for CHP success, bringing heat demand and supply together. Waste policy is sometimes a barrier since facilities promoted by waste policies are often located in remote areas.			
W-rate: almost 100%, all combustible waste is used as an energy source, effective landfill ban (some countries directly implement CHP and, therefore, could have a lower W-rate) E-rate: between 25% and 55%, energy conversion mainly by means of CHP, almost no LFG			

Stage 4: Innovation and increased energy utilisation rates

Stage 4 is applicable to countries were CHP applications are common and a next step is to, possibly, increase utilisation of recovered energy. Stage 4 innovations can also occur in former stages as a demonstration project. In stage 4, innovation and high utilisation of recovered energy are mainstream. Stage 4 countries are international trendsetters.

Increasing the utilisation of recovered energy is possible by:

- lowering internal energy consumption (electricity and heat);
- higher gross electricity conversion efficiencies, by means of high steam parameters, ORC (Organic Rankine Cycle), etc;
- higher CHP efficiencies by means of flue-gas condensation, heat-pump applications, etc;
- energy storage facilities;
- improved re-use of by-products, an indirect energy effect;
- highly energy efficient SRF applications.

Table 5: Policy impact matrix stage 4, innovation and increased energy utilisation rates

Policy category	Driver	Neutral	Barrier
Waste policy		√	
Energy policy	++		
Renewable energy policy	++		
Climate policy	+		
Environmental policy		√	
Spatial planning policy		√	
Industrial, trading policy	+		
Innovation policy	++		
(Renewable) energy policy in combination with innovation policy are the main drivers towards high performance EfW systems. Climate and industrial policies can support this development.			
W-rate: 100%, all combustible waste is used as an energy source, effective landfill ban E-rate: between 45% and 85%, high CHP rates, integration with industry, high electrical efficiencies On a national level, it is almost impossible to go beyond 35% due to asynchronous supply and demand.			

Energy from waste development stage IEA Task 36 countries

The EfW development stage differs from country to country. Even in the EU, where a common waste management policy exists, the development stages differ. In Figure 1, an overview is given of the development stage in the IEA Bioenergy Task 36 countries. Countries with high energy utilisation rates (X-axis) are Germany, Sweden and the Netherlands. Lower utilisation rates occur in Canada, France and the United Kingdom. Norway is a special case. The number of EfW systems in Norway is limited, but the utilisation rate is good because waste is exported to high performing WtE plants in Sweden. The energy recovery (Y-axis) shows a marked difference between the Scandinavian countries, with an almost 100% recovery of available energy, and the other countries. The difference is due mainly to the emphasis on heat production in the Scandinavian countries (see Figure 2). This figure also shows that, for high energy-recovery rates, heat is the key factor.

Figure 1: The amount of combustible waste incinerated (X-axis) and energy (Y-axis)

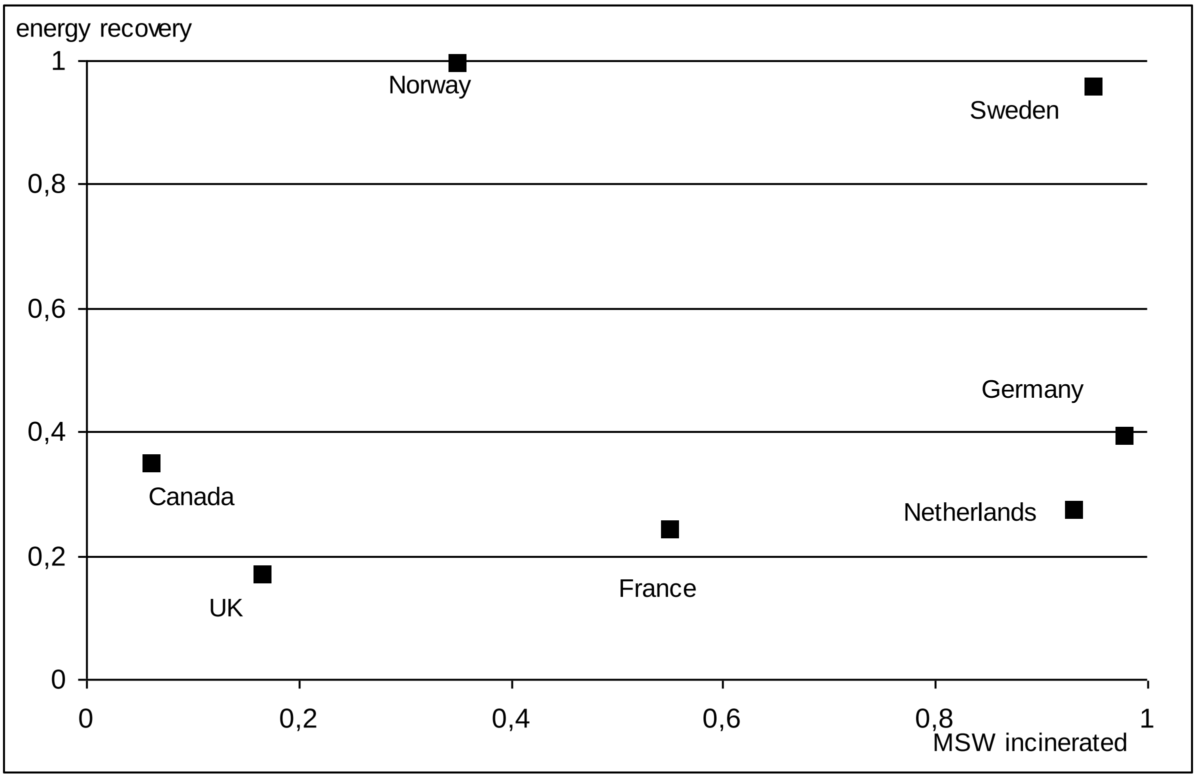
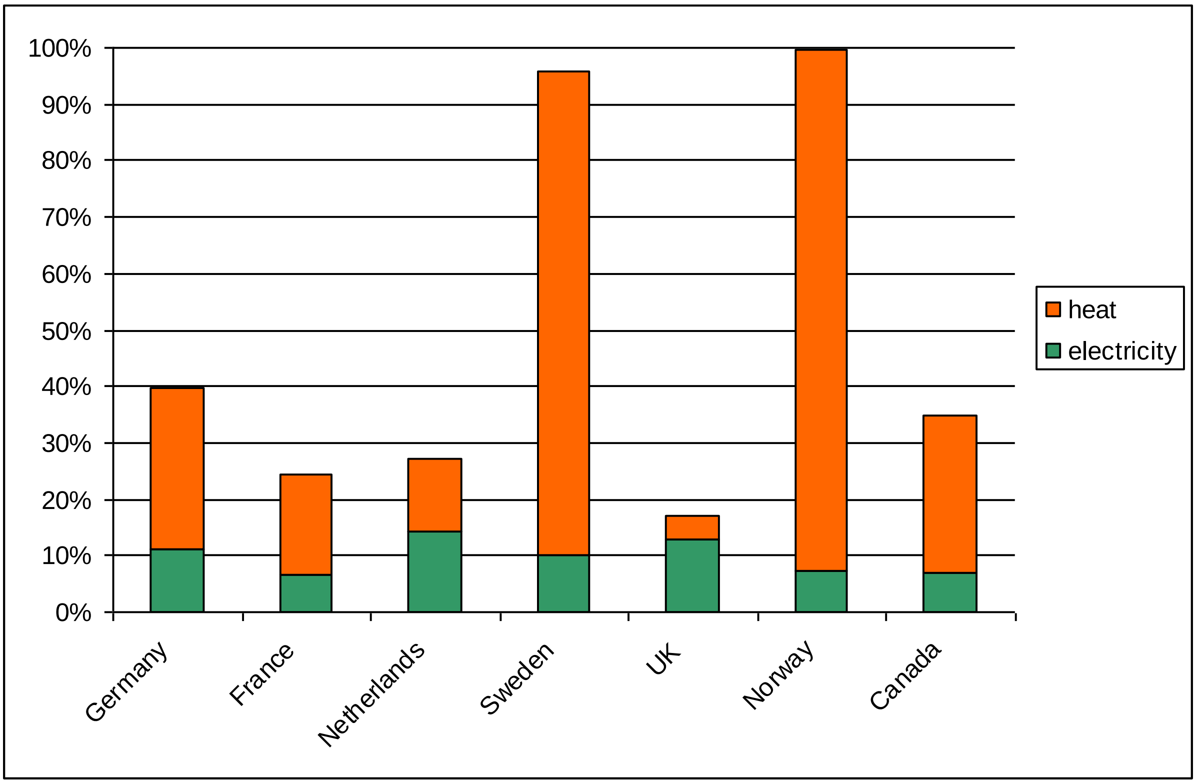


Figure 2: Energy recovery from waste incineration as percentage of the heat content of the input



Country-specific situation

The main drivers and barriers for the development of EfW in the Task member countries are presented below. In combination with the data presented above, this leads to the four-stage development as described in this chapter. It is difficult to describe all countries in terms of the stages mentioned above. However, the points mentioned give a good indication of the position of the country within the framework described.

The Netherlands

- Waste incineration is the common treatment method for MSW. Electricity production is well developed thanks to subsidies for (renewable) EfW, but the heat potential is not extensively exploited.
- The high investment costs of heat networks, combined with low energy prices, presents a high barrier for heat use from incineration. It is difficult to find someone who will take the responsibility for the heat network.
- Spatial planning is vital. What is needed is more insight into heat demand in the vicinity of incinerators and an active policy to cover the long-term risks of building heating capacity.

Germany

- The introduction of a ban on landfilling untreated organic waste in 2005 was a strong driver for waste incineration with energy recovery.
- The incineration capacity has been increased by 50% in subsequent years.
- Siting of waste incineration plants with only electricity export has been revised after the decision of the European Court on ‘disposal’ versus ‘recovery’ of waste in an incinerator (February 13, 2003). Progress is slow since the total capacity has almost been reached.
- Energy policy became a driver during recent years and improved energy efficiency is high on the agenda - although no promotion activities in terms of extra tariffs are in place.
- Public perception promoted MBT for a long time. Technical and economical problems as well as over-estimated markets have subdued development.
- Energy policy is a particularly strong driver for SRF from clean sources of waste. The cement industry is a frequent customer, so also is the lime industry, whereas the future of co-combustion in power plants seems unclear.
- Technology development might improve the situation in the SRF market if economics are favourable.

Norway

- The landfill ban in 2009 will finally increase the use of waste as a fuel.

- Due to the cold climate and the dominant role of hydropower, there is a high interest for heat production.
- Differentiated fees for landfill and incineration resulting in a shift away from landfill.

France

- During the last ten years, the incineration capacity stayed quite stable, but the number of units declined from 330 to 116 sites by the closure of small units (fewer than 10,000 t/year).
- Policy for waste treatment led to a reduction in landfill and incineration, and a focus on waste minimisation, organic valorisation and recycling. Incineration is not really considered an option in this discussion
- A tax similar to the one existing for landfill will be introduced in 2010 for incineration
- The energy recovery will stimulate anaerobic digestion and LFG recovery. Public acceptance is the key factor in the further development of waste incineration. Integration with a waste reduction strategy is vital in getting more incineration accepted.

Sweden

- Energy recovery levels are very high as a result of past decisions to integrate waste incineration into the heat infrastructure.
- Reduction of landfilling by recycling and incineration of the residual waste.
- Waste incineration is integrated in heat production infrastructure.
- Carbon emission tax is differentiated for incineration, with and without energy production.
- Changes in heat demand, due to less cold winters, lead to a renewed demand for balancing heat supply and demand.

Canada

- No active policy so far on the reduction of landfilling; the main interest is on the reduction of LFG emissions at a provincial level.
- Increasing interest in alternative fuels and technologies.
- Public acceptance is essential in the approval of new waste treatment infrastructure and the endorsement of novel technologies.
- Renewable energy incentive programmes in some provinces have led to more energy generation from LFG.

United Kingdom

- The Landfill Allowance Trading scheme (LATs) has been introduced to encourage the diversion of biodegradable waste from landfill and to ensure the UK meets its targets for reducing biodegradable waste in landfill.
- Reference: http://www.defra.gov.uk/environment/waste/localauth/lats/index.htm

At a national level, a number of alternative technologies to landfill are being supported. The market lead is EfW, but there are market mechanisms in place to support new alternative technologies, such as anaerobic digestion. For example, the Renewable Obligation, which places an obligation on all power suppliers to supply a certain percentage of renewable power, has been updated so that novel technologies receive more reward per MWh generated. These technologies include advanced combustion technologies (including those using waste feedstock) and a part of the power generated by waste CHP plants.

- Public acceptance is vital in developing a new waste-treatment infrastructure. In the UK, the public is wary of EfW. This has the effect of encouraging local authorities to select new technologies, which may be less efficient in energy recovery, because the public do not have such a strong aversion to these technologies. The Government's Waste Infrastructure development programme has been developed to encourage the right infrastructure at the right time.
- Overall, waste incineration, including energy recovery, will increase during the years leading up to 2020 (see section 1).

Further reading/more data

- Delivering key waste management infrastructure: lessons learned from Europe, SLR Consulting/The Chartered Institution of Wastes Management, November 2005.
- CEWEP-country-information. Regulatory updated on website http://www.cewep.eu/
- ISWA, Energy from Waste, State-of-the-Art- Report, Statistics 5th Edition, Copenhagen Denmark, August 2006.
- For France www.sinoe.org

All country presentations of the workshop can be found at:
http://library.ieabioenergytask36.org/vbulletin/showthread.php?p=5#post5