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Waste-to-Energy and the revision of the Waste Framework Directive

Opportunities to reduce climate change by using energy from waste

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Content

Executive summary

The future of the EU's waste management policy is being determined at this very moment. The European Parliament and the Council of Ministers are discussing a package of measures that was proposed by the European Commission at the end of 2005. This package consists of three proposals:

- a Thematic Strategy for the sustainable use of natural resources
- a Thematic Strategy on prevention and recycling of waste,
- a revision of the Waste Framework Directive.

This package should, once it is adopted, set the scene for waste management policy for the next decades.

Until now the discussion on these proposals did not place enough emphasis on the potential to use the energy content of waste to reduce greenhouse gas emissions. There is an important potential to reduce CO_2 emissions in the EU via a balanced policy that promotes prevention and recycling, and at the same time the generation of energy from waste.

The operators of Waste-to-Energy plants in the EU want to stress the importance of supporting the formula for energy efficiency in order to distinguish recovery operations from disposal operations. This is a proposal made by the Commission in the revision of the Waste Framework Directive (in Annex II). They propose to set a threshold of 0.6 for existing installations and 0.65 for new installations. Implementation of this formula will lead to two important effects:

The first is that the status as a recovery installation would facilitate the building of new Waste-to-Energy plants with highly efficient energy production. The benefits in terms of CO_2 reduction have been calculated within two scenarios. Both scenarios assume an ambitious policy for recycling resulting in an increase of recycling of municipal waste from 36% in 2004 to 60% in 2020. Scenario 1 assumes that prevention policies will result in the limitation of the growth of generation of waste to 2% per year. Scenario 2 assumes an even stricter prevention policy, which would result in stabilisation of the generation of municipal waste at the level of 2004.

If the Member States decide to build new Waste-to-Energy plants to treat the waste that would otherwise be landfilled, CO_2 emissions in the EU would be reduced by 41 million tons CO_2 in 2020 in scenario 1 and by 27 million tons in scenario 2. This would not hamper recycling initiatives as it only targets residual waste that remains after implementation of a policy aiming at 60% recycling.

The second major effect would be the increase of the energy efficiency of existing Waste-to-Energy plants that currently process almost 53 million tons of waste. This could result in an additional reduction of 4 million tons of CO_2 per year.

The potential for CO_2 reduction from both scenarios together is therefore 31 – 45 million tons of CO_2 per year.

The EU policy ‘an energy policy for Europe’ (sec(2007)12) assumes that a reduction of CO_2 emissions in 2020 by 20% is necessary. This would require a reduction of CO_2 emissions of more than 800 million tons of CO_2. The CO_2 reduction that can be obtained by promoting Waste-to-Energy could be an important part of this reduction and should be taken into account. Moreover, waste is a source of energy that is available within the EU and therefore reduces its dependency on imported fuels.

To obtain the CO_2 reduction it is important that the EU:

- grants the recovery status to Waste-to-Energy plants with a high energy efficiency according to the formula proposed by the Commission in Annex II of the revision of the Waste Framework Directive.

This approach will stimulate the operators of existing plants to invest in substantial improvements of their energy performance. It will also facilitate the building of new plants with even higher energy efficiency and e.g. extend the application of heat from Waste-to-Energy plants.

It is also important that the EU or individual Member States consider:

- making additional measures to reduce the landfilling of waste which cannot be recycled, but is still suitable for incineration.

This would allow the EU to fully profit from the CO_2 reduction potential the use of highly efficient Waste-to Energy plants can offer.

Introduction

The future of the EU's waste management policy is being determined at this very moment. The European Parliament and the Council of Ministers are discussing a package of measures that was proposed by the European Commission at the end of 2005. This package consists of three proposals:

- a Thematic Strategy for the sustainable use of natural resources
- a Thematic Strategy on prevention and recycling of waste,
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This package should, once it is adopted, set the scene for waste management policy for the next decades.

In the discussions much attention is being paid to a wide variety of subjects, including concrete measures to promote prevention and recycling of waste, the waste management hierarchy and the introduction of criteria to determine when waste ceases to be waste. On some of these points the possible way forward seems to become clearer. The Parliament is preparing for a vote in plenary in February 2007 on amendments to the Waste Framework Directive as proposed by the Environmental Committee. Also Council is working towards a common position on the Proposals.

For the generation of energy from waste, within a sustainable waste management system, the way forward is less clear. The measures proposed seem to be more controversial. A key topic is the discussion under which conditions the incineration of waste should be regarded as a recovery operation. This issue is of great importance for the waste management sector.

The Commission had proposed to use the efficiency with which these installations convert the calorific content of the waste into energy which could be produced by the installation itself as a criteria to distinguish operations for recovery of energy from operation for disposal of waste. This approach received in principle the support of the Waste-to-Energy sector, but was heavily criticised by other actors. Arguments that came up in the discussion include:

- The rather complex nature of the formula itself that makes it difficult for decision makers to understand the rationale and impact of a policy based upon this criterion;
- The level of the proposed threshold and the assessment if this level is correct in order to provide an incentive for the sector to move towards improved environmental performance;
- The question whether this approach would promote incineration to such an extent that it would be detrimental to the growth of recycling and impact on the transport and transboundary movement of waste;
- The impact on the possibilities of Member States to apply the principles of self sufficiency and proximity for waste disposal.

All these elements are important. However, it seems that the benefits for the EU of promoting the generation of energy from waste with a highly efficient energy conversion receives less attention than it deserves. Apart from the benefits related to rational waste management it also contributes to the objectives of European energy policy. Waste is a source of energy that can play an important role in a policy for sustainable generation of energy. This energy source is available within the EU and reduces the EU's dependency on fuels from politically unstable regions. Moreover, waste consists partly of carbon of non-fossil origin. Therefore energy from waste could also contribute to fulfilling the targets for CO_2 and CH_4 (methane) reduction within EU climate policy.

> *The aim of this paper is to quantify the potential benefits promoting energy generation from waste could have to reduce CO_2 emissions. It demonstrates the important role the formula, as proposed by the Commission, can play in this context.*

The paper is meant to contribute to an informed and balanced discussion on this point. It was prepared by FFact Management Consultants on the request of the Dutch Association of Waste Management Companies.

The paper first describes the current situation of waste management in the EU in chapter 1. Then the role of waste as source of greenhouse gas emissions and the CO_2 emissions that can be avoided are identified in chapter 2. The amount and composition of waste that could be used to generate energy without hampering measures for prevention and recycling is estimated in chapter 3. Generation of energy from waste should be limited to waste for which there are no cost efficient and environmentally relevant possibilities for prevention and recycling. Options for optimised treatment of this residual waste are identified and it is assessed what their impact would be in terms of potential for CO_2 reduction and supply of sustainable energy for the EU, in chapter 4 and 5.

The geographical scope of the paper is the EU27. The assessment focuses on municipal solid waste (MSW), as this is the waste stream which is in the centre of the debate. This is also the waste stream for which most data are available. There are also other waste streams for which such an assessment could be useful. Examples would be mixtures of non-hazardous waste from industry and businesses. However, at this stage there is insufficient EU wide information readily available to provide for a quantitative assessment. If such information were available it could be assumed that it would further support the conclusions of this paper and would indicate an even larger potential for improvement in the interest of EU climate policy.

1. Current situation regarding waste management in the EU

1.1 Generation and treatment of Municipal Waste

Eurostat collects information about the generation and management of municipal waste in the EU. The total amount of waste in 2004 was estimated at 259 million tons. The following graph provides an overview of the management of this waste. The Member States are shown in decreasing rates of recycling. The underlying data for the calculation are given in Annex 1.

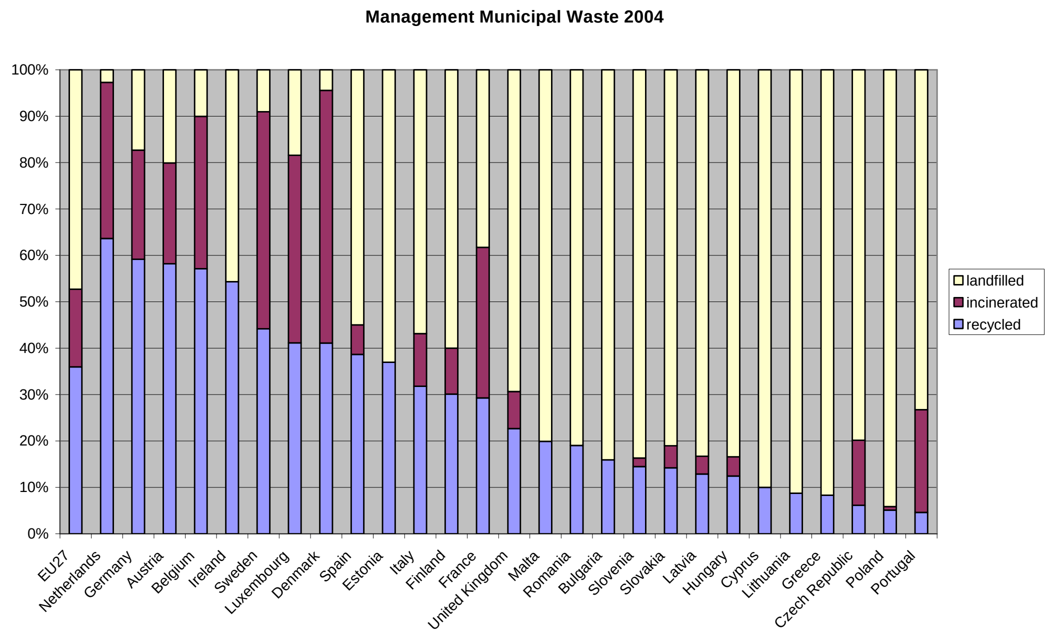


Figure 1 Management of municipal waste in the EU27 in 2004.Source: Eurostat.

The EU average is 36% recycling and composting, 17% incineration and 48% landfilling. Member States vary considerably in their treatment of municipal waste.

1.2 Current situation of waste incineration

In 2004 there were 370 plants in operation within the EU. They treat a total amount of 53 million tons of waste. Most of this waste is municipal waste. According to the data from Eurostat 17% or 43 million tons of municipal solid waste was incinerated. Therefore around 10 million tons of non municipal waste was incinerated in 2004.

Some of these installations do not generate any heat or electricity for outside use. These are typically smaller installations, where investment in energy generating equipment is more costly per ton of waste. Waste-to-Energy plants generate electricity, heat or both.

Production of electricity is widespread across Europe. This is less dependent on the choice of the location, because it can nearly always be delivered to the grid without large investments.

Use of heat is mainly concentrated in the northern part of Europe. This is due to the climate which makes investment in district heating more profitable. The infrastructure for district heating therefore is already well developed in these countries. In central and southern Europe district heating is a less obvious as outlet for heat. This is why it is sometimes argued that use of heat from waste is not a viable option for the South of Europe. This may be the case for district heating. But also plants in the South can use heat if they are located close to industrial activities that need heat. In some cases the heat from incinerators can also be used by wastewater treatment plants. A good example of a Waste-to-Energy plant that produces heat and found a good application for this in the South of Europe is the plant in Brescia (Italy).

The number of plants operational in 2004 and the amounts of waste treated for the EU and for the different Member States are given in table 2.

Member State	Number of plants	Treated waste (million tons)
Germany	61	13.88
France	130	12.00
Netherlands	12	5.36
Italy	48	4.22
Denmark	30	3.40
Sweden	29	3.18
UK	15	2.60
Belgium	18	2.30
Spain	11	1.78
Austria	7	1.40
Portugal	3	1.06
Poland	1	0.76
Czech Republic	3	0.40
Hungary	1	0.16
Luxembourg	1	013
Finland	1	0.05
Total	370	52.68

Table 2. Waste-to-Energy plants in Europe. (source: CEWEP)

1.3 Current status of energy production from waste.

It is difficult to get a complete overview of the total amount of electricity and heat that is produced by WtE plants. CEWEP conducted a study[1] on the energy performance of 97 plants within their membership. It is assumed that these plants are among the most efficient in Europe. Installations in France are not covered by this survey. FFact received some additional data on French installations. Based upon the CEWEP data, this French data and additional research by FFact we estimate that for the average yield of the 370 installations within the EU is approximately 12% for electricity delivered to the grid. Additionally 12% of the heat is used for district heating or industrial heat. It has not been possible to provide data on efficiency per Member State within the time the study had to be completed.

[1] CEWEP Energy Report (status 2001 – 2004), July 2006.

The energy production corresponds to a total electricity production of 16.8 million MWh and 16.8 million MWh heat. This is 0.5% of the current electricity production in the EU27. It is also the amount of electricity that is used by 4.2 million households annually.

The Commission proposed a formula to calculate the efficiency with which the energy content of waste is transformed into heat and electricity that finds a useful application in the economy. This formula was developed when preparing the reference document to determine Best Available Technology for waste incineration as is required under the Directive on IPPC. This formula is:

Energy efficiency .= (Ep -(Ef + Ei)) / (0.97 x (Ew + Ef))[2]

It includes a factor 0.97 to compensate for the energy needed for the slag. It also uses a factor 2.6 and a factor of 1.1 to allow heat and electricity to be added together in one factor. This also allows comparison of the performance of waste incinerators with other installations for generation of heat and power (e.g. coal fired power plants). More information on the background and of this formula and how it should be understood is given in Annex 2.

When this formula is used for the average energy yield of the plants that are operational in 2004, the efficiency is 0.43.

[2] Ep: energy produced, Ef: energy in added fuels, Ei: other energy imported, Ew: energy in the waste.

2. Impact on climate change

2.1 Methodology

To calculate the contribution to climate change of generation of energy from waste with high efficiency we use the methodological agreements made by the Intergovernmental Panel on Climate Change (IPCC) in the framework of the UN convention of Climate change. The emissions of CO_2 e.g. from the combustion of waste, CH_4, e.g. landfill gas, and N_2O are relevant for this study. Other greenhouse gases, such as CFC/HCHC are not relevant because they are not emitted in relevant quantities by the waste management technologies that are evaluated in this study[3].

The Global Warming Potential (GWP) of the different gasses is based upon the assumption that the emissions are released immediately. This is true for the emissions from combustion, but in particular emissions from landfill may in practise occur over a period of decades. In accordance with the IPCC methodology this variability over time is not assessed in this study.

The GWP of the gasses is established on the basis of a period of 100 years when these gasses would be in the atmosphere. The GWP for CO_2 originating from non-fossil biogenic carbon is considered as a GWP of 0.

CH_4 emissions only occur when biodegradable organic matter is decomposed under anaerobic conditions. CH_4 emissions are therefore by definition emissions of carbon from non-fossil origin.

The treatment of these greenhouse gases is shown in Table 3.

Emission	Origin	Global Warming Potential Emission
CO_2 (fossil C)	Combustion of plastics	+1
CO_2 (non-fossil C)	Combustion and aerobic decomposition of biomass	0
CH_4 (non-fossil C)	Anaerobic decomposition of biomass	+21
N_2O	Combustion processes. Nitrogen metabolism in soils.	+310

Table 3. Greenhouse gasses from waste and their global warming potential.

Several waste management technologies produce energy. Examples are the production of heat and electricity from the incineration of waste or the production of electricity or heat from captured landfill gas. The energy that is produced reduces the need to produce this energy via other processes. This production therefore avoids emissions of greenhouse gases in other places in the economy and this emission reduction is taken into account when calculating the impact of improved waste management.

[3] CFC and HCFC emissions may occur from waste management activities involving electrical equipment such as fridges and freezers. In this study it is assumed that they are treated according to the EU legislation and therefore are not included in the different treatment scenario's covered by this study

2.2 Impact per ton of waste treated

For the purpose of this study the impact of changes in the treatment of waste are calculated using the methodologies as outlined by the IPCC. For most parameters we used the estimations made by AEA technology[4] unless we had more recent data. We calculated the emissions for the different treatment options by calculating the direct emissions and compensated for avoided emissions for energy production if applicable.

The estimations we used are given in table 4.

Parameter	Value	Source
Calorific value of residual MSW	10 MJ/KG	CEWEP
Carbon content MSW	40%	AEA
Percentage fossil carbon	40%	CEWEP
Combustion efficiency MSW	95%	AEA
Energy generation of the current incinerators	12% electricity and 12% heat	Assumptions FFact
Emission factor electricity production EU27	0.382 kg CO_2/kWh	Calculated based upon the emission factors per type of fuel from DG TREN and the Eurostat data on electricity generation in the EU27 in 2004
Emission factor heat produced in the EU27	0.28 kg CO_2/kWh	AEA

Table 4. Composition of municipal solid waste, combustion and energy performance of incinerators and emission factors for replaced energy production.

The emissions from incineration are calculated in two steps. First the emissions from the combustion of the fossil carbon within the waste are calculated. Emissions from non-fossil carbon do not contribute to global warming and are therefore not taken into account.
The second step is to calculate the emissions that are avoided when using the energy from incineration in stead of energy generated by power plants. These are extracted from the emissions of incineration. The detailed calculations for the different types of installations are given in Annex 3.

For the emissions avoided from the generation of electricity, we assume that this would replace electricity produced on the basis of the average fuel mix for power generation in the EU27. This assumes that the electricity would also partly replace renewable energy or nuclear power with very low emission levels of CO_2/kWh. This is therefore certainly not an overestimation of the avoided emissions, as it is very unlikely that renewable energy production would in fact be replaced when energy is produced from waste.

[4] AEA technology, Waste management options and climate change, 2001. Study for the European Commission.

For the current average Waste-to-Energy plant, this leads to an emission factor of 0.348 kg CO_2/kg municipal waste.

The most common alternative treatment operation for waste that is not recycled (residual waste) is landfilling. Therefore the CO_2 implications are compared with the impact of landfilling. The dominant factor determining the impact of landfilling on global warming are the emissions of methane formed by biodegradable waste in the landfill. We apply the emission factor of 0.69 tCO_2 eq / kg[5] ton municipal waste that is landfilled as in the study of AEA because the composition of municipal waste in that study corresponds with the current values observed in our report.

In summary:

Treatment	Emission factor
Average European Waste-to-Energy installation in 2004	0.348 kg CO_2 eq / kg waste
Landfilling	0.69 kg CO_2 eq / kg waste

Table 5. Emission factors treatment operations for residual waste.

[5] 0.712 kg direct emissions and 0.22 kg of avoided emissions from energy production of methane capture.

3 Waste management scenarios and improvement options

The preferred options within the waste management hierarchy are prevention and recycling. Generation of energy should be promoted in particular for the residual waste stream for which prevention and recycling are not preferable for environmental or economic reasons. Therefore in this chapter we estimate how much residual waste remains if a strict policy on prevention and recycling would be implemented. To calculate the potential of improved use of incineration we define 2 scenarios.

3.1 Scenario's

Scenario 1 contains the following elements:

1. Prevention measures will limit the growth of generation of municipal waste to 2% per year.

2. Ambitious separate collection schemes and recycling will be implemented for the EU as a whole and these will result in 60% recycling and composting of municipal waste. This will include:

- Full implementation of the Landfill Directive including measures to reduce landfilling of biodegradable waste;
- Full implementation of the EU directives on packaging and Waste Electrical and Electronic Equipment.[6]
- Additional policies to implement best practise for separate collection of biodegradable waste, plastics, metals and textile within the EU as a whole.

This would result in the following long term recycling percentages for the EU as a whole:

Constituent of municipal waste	Long term recycling percentage
Biodegradable waste	50%
Paper and cardboard	65%
Glass	70%
Plastics	33%
Metal	90%
Textile	50%
Other	40%
Overall	60%

Table 6. Long term recycling targets achievable with an ambitious policy for recycling and composting

– [6] The directives e.g. on end-of-life vehicles and batteries as well as on sewage sludge have not been taken into account as they have limited impact on the amount of residual municipal waste.

The overall recycling percentage of 60% is equivalent to the percentage that is currently achieved by the best performing Member States in the EU such as the Netherlands, Austria, Germany and Belgium.

3. All the residual waste is used to generate energy and only inert residues from recycling and incineration are be landfilled.

Implementation of the Landfill Directive is not sufficient to reduce landfilling to inert residues only. For that additional policy measures would be necessary.

We consider that limiting the growth of generation of municipal waste to 2% per year already requires some strict prevention measures. Until now the growth of waste generation was equal or larger than the economic growth. However, we also consider a second scenario in which prevention leads to stabilisation of the generation of municipal waste to the level of 2004. In other words, no growth. This scenario is the same as scenario 1 for all the other assumptions. It also assumes an increase of recycling to 60% of the waste generated and the use of all residual waste to generate energy.

These scenarios are chosen to illustrate a situation where a balanced waste management system would promote incineration as an element of ambitious prevention and recycling policies. It is not the intention to stimulate incineration in such a way that it would hamper prevention or recycling initiatives. The policies implemented in the Netherlands, Germany, Belgium, Sweden and Denmark show that it is very possible to combine such approaches (see Annex 1).

3.2 Waste quantities

The development of waste quantities and treatment in the two scenarios is given in table 7.

Scenario	Municipal waste generated (Mtons)	% recycled	Quantities recycled (Mtons)	% residual waste %	Quantities residual waste (Mtons)
Situation 2004 EU27	259	36	93	64%	165
Scenario 1	341	60	205	40%	136
Scenario 2	259	60	155	40%	104

Table 7. Developments of total generation, recycling and generation of residual waste in the EU27

Scenario 1 assumes that in the long term (2020) 136 million tons of residual municipal waste would be available for landfilling or to generate energy. Scenario 2 assumes that this would be around 104 million tons.

3.3 Waste composition

The composition of this residual waste is not the same as of the municipal waste as it is generated. The different components of the waste are collected separately in different percentages. Since these assumptions on recycling are quite similar to the rates that are currently achieved in the Netherlands we assume that the composition of the residual waste would also be comparable to that waste as it is currently in the Netherlands. The parameters that determine the energy generation and the CO_2 emissions are the fossil carbon content and the calorific value of the waste. These are 40% fossil carbon and 10 MJ/kg for municipal waste in the Netherlands in 2004. These values are essentially the same as the values given in table 4 in chapter 2.

4 Opportunities for the EU to generate more energy from waste

We considered two opportunities for the EU to generate more energy from waste.

1. Building new highly efficient Waste-to-Energy plants that would use waste that otherwise would be landfilled
2. Optimisation of the energy performance of the existing Waste-to-Energy plants

4.1 Replacing landfilling by energy generation from waste

Member States may decide to develop a policy that goes beyond the requirements of the Landfill Directive and promote the use of residual waste to generate energy. This would require building new installations. For these installations optimising the use of energy could be taken into account from the very beginning. This would and result in electricity generation with a high efficiency. There are also more possibilities to choose a site close to demand for heat.

We calculated the impact of two types of new installations with both installations meeting the energy efficiency factor of 0.65 as proposed by the Commission.

The first installation would be designed solely for generation of electricity, but not for the use of the heat. This installation would have an efficiency of electricity generation of 26% for outside use. It would have a CO_2 emission of 0.313 kg CO_2per kg of waste. (Calculation see Annex 3)

The other type of installation would be an installation for combined heat and power. This installation would generate electricity for outside use with an efficiency of 10% and at the same time would supply heat with an efficiency of 40%. This installation would have a CO_2emission of 0.179 kg CO_2 per kg of waste.

We assume that both type new installations would be built with equal capacity and that the average new plant would emit 0.246 kg CO_2 per kg waste.

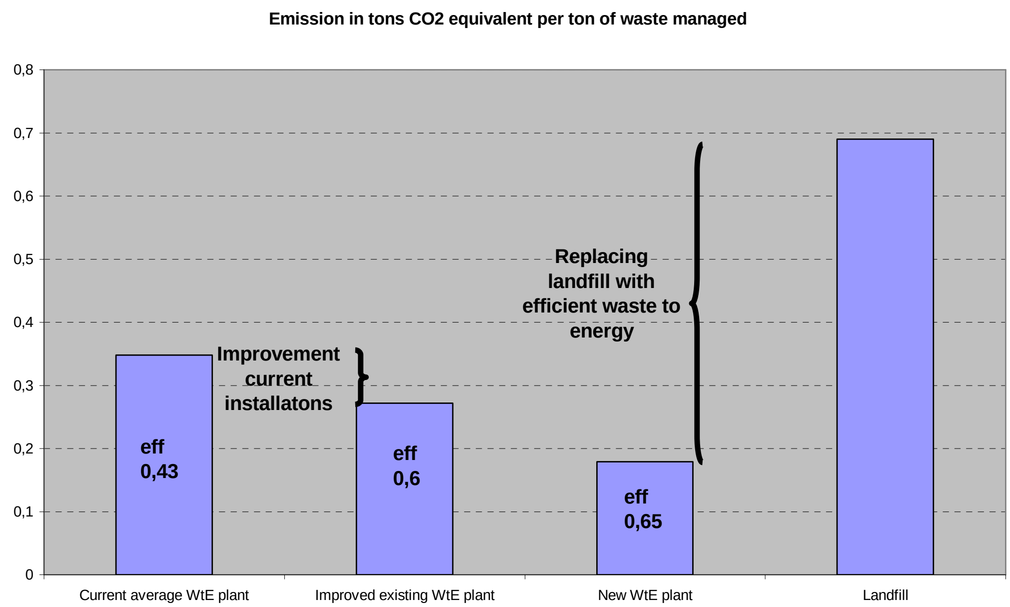
These installations would substitute landfilling of waste, which has an emission of 0.69 kg CO_2 eq per kg of waste. Replacing landfilling of one ton of waste with treatment in a new Waste-to-Energy plant would reduce CO_2 emissions with 0,444 t CO_2.

4.2 Optimisation of the energy performance of the current Waste to Energy plants

The installations that are currently in operation can be improved. With reasonable investment some of the current installations can be refurbished. Other, very old installations, may have to be partly replaced. With the existing installations the potential to improve the electricity yield is better than the potential to improve the use of heat. If heat is used to date, this use is very efficient already. Finding new heat outlets for existing installations is in most cases not realistic. We therefore assume that yield of electricity could grow to 18% instead of the current 12% and that the use of heat could grow from 12% to 14%. This is equivalent to an energy efficiency factor of 0.6 for existing installations as proposed by the Commission.

The CO_2 emission of the improved existing installations would be 0,274 kg CO_2 per kg waste. The current installations emit 0,348 kg CO_2 per kg waste and the improvement would result in a CO_2 reduction of 0.075 t CO_2 per ton of waste.

The potential for improvement is illustrated in Figure 1.



4.3 Total CO_2 reduction potential for the EU and Member States

The potential for energy from waste production in the EU is calculated using the following data.

Scenario	Municipal waste generated (Mtons)	Amount recycled (Mtons)	Amount used in WtE plants in 2004 (Mtons)	Available for new WtE plants (Mtons)
Scenario 1	341	205	43	93
Scenario 2	259	155	43	60

Table 8. Amounts of residual waste available for new Waste-to-Energy plants according to the two scenarios.

Calculating the total potential does not imply that we consider that all Member States should use all residual waste to generate energy. It only illustrates the potential gain in terms of reduced CO_2 emissions for the EU as a whole and for the different Member States should they decide to exploit this potential to the full.

The long term additional capacity could be around 93 million tons in scenario 1 and 60 million tons in scenario 2. The reduction in CO_2 emissions would amount to 41.3 million tons of CO_2 in scenario 1 and 26.6 million tons in scenario 2.

Table 9 gives an overview of the additional amounts of waste each Member State could thermally treat to reach the 40% within the two scenarios. While the Member States that do already incinerate up to 40% do not have any room for expanding their capacity for municipal solid waste within these scenarios, other Member States have no or very little incineration capacity installed already.

Member State	Scenario 1 Amount of residual waste available for new installations (1000 tons)	CO_2 reduction per year (1000 tons)	Scenario 2 Amount of residual waste available for new installations (1000 tons	CO_2 reduction per year (1000 tons)
Austria	1,588	705	934	415
Belgium	973	432	349	155
Bulgaria	1,940	862	1,470	653
Cyprus	282	125	213	95
Czech Republic	1,101	489	737	328
Denmark	0	0	0	0
Estonia	320	142	243	108
Finland	1,019	453	715	318
France	7,151	3,177	2,653	1,179
Germany	14,509	6,446	8,171	3,630
Greece	2,524	1,121	1,912	850
Hungary	2,490	1,106	1,835	815
Ireland	1,848	821	1,400	622
Italy	12,913	5.736	8,926	3,965
Latvia	353	157	261	116
Lithuania	666	296	504	224
Luxembourg	37	17	0	0
Malta	121	54	91	41
Netherlands	1,942	863	644	286
Poland	5,086	2,259	3,834	1,703
Portugal	1,395	620	813	361
Romania	4,333	1,925	3,283	1,458
Slovakia	708	315	520	231
Slovenia	443	197	331	147
Spain	13,023	5,785	9,435	4,191
Sweden	251	112	0	0
United Kingdom	16,047	7,129	11,462	5,092
EU27	93,002	41,315	59,912	26,615

Table 6. CO_2 reductions per year, per Member State

The total reduction of CO_2 emissions that can be obtained with the improvement of existing installations is 0.075 kg CO_2 per kg waste. Applied to the total amount of 53 million tons currently incinerated this would provide for a reduction of CO_2 emissions of 4.0 million tons per year for the EU as a whole. It is not possible to calculate a CO_2 reduction potential per Member State. Exact data on Member State level on the performance of their installations is not available.

If the current installations are improved and additional capacity is built the total CO_2 reduction would be 45.5 million tons CO_2 per year in scenario 1 and 30.6 million tons in scenario 2. Compared to the total emissions of CO_2 in the EU this would be a reduction of the emissions of 0.75 to 1% of the total emissions. Under the Kyoto protocol the EU has committed itself to reduce the emissions with 8% and it might be necessary to reduce the emissions with even 20% by 2020. The reductions that are possible therefore would represent an important part of the emission reductions that are needed for long term EU climate policy.

4.4 Advantages and opportunities for a region in Europe

To illustrate this we imagined a hypothetical region somewhere in Europe. This region has in total 750.000 inhabitants consists of a medium sized town of 400,000 inhabitants and surrounding villages and small towns also of 350,000 inhabitants. All small towns and villages are located in a distance of less than 50 km from the medium sized town and they developed their waste management plan together.

The inhabitants generate 537 kg of municipal waste per year, the average amount of municipal waste generation in Europe. In total they generate 400,000 tons of waste per year.

The separate collection of recyclable and compostable waste amounts to 250,000 and there is 150,000 tons of residual waste. The region decides to no longer send this waste to their local landfill site but to build an incinerator for this waste.

The calorific value of the waste is 10 MJ/kg. The installation transforms 26% of the energy included in the waste into electricity. This is an efficiency of 0.66 according to the formula proposed by the Commission. The installation generates 102.9 MWh electricity delivered to the grid. This covers the electricity needs of more than 50,000 inhabitants in the region.

Because of the incineration of the waste 66,600 tons of CO_2 equivalents are reduced because the waste no longer goes to the landfill site where it would have produced methane.

5. Energy aspects

Energy generated from waste contributes to the objectives of the energy policy for Europe[7], which the Commission launched a Communication at the beginning of 2007. These policy aims from a package to establish sustainable production and use of energy. Important elements include the assessment that a reduction of CO_2 emissions by 20% is needed by 2020 in order to limit climate change to maximum 2 ° C. Also the subject of EU dependency on fuels imported from outside the EU is an important issue in the paper. The EU aims to reduce its fuel dependency because this may not be sustainable in the long term.

Promotion of the use of energy from waste in the revision of the Waste Framework Directive will contribute to achieving these energy policy objectives. They will of course not be sufficient on their own to achieve them, but they would contribute significantly.

In particular it helps to work towards sustainable production of electricity as it reduces CO_2 emissions. The calculated CO_2 emission reductions of 31 – 46 million tons of CO_2 per year by 2020 are important. On the whole the reduction needed in the EU would be in the order of magnitude of 800 million tons of CO_2.

It also helps reducing the dependency of the EU on fuels that have to be imported. The existing Waste-to-Energy plants generate approximately 17 million MWh of electricity. That is around 0.5% of the total electricity production of the EU. If the generation of energy from residual waste is stimulated and the potential according to the two scenarios is fully utilised this contribution will increase to 54 million MWh in scenario 2 or 69 million MWh in scenario 1. That is 1.5 to 2% of the electricity production in 2020.

Moreover, the use of residual waste as described in this paper does not compete with other forms of renewable energy production such as the use of biomass from other sources. The development of energy from biomass is not effected by the building of new Waste-to-Energy plants for residual waste.

[7] Document SEC (2007)12

6. Conclusions and recommendations

If 60% of all municipal waste is recycled, still 40% of residual waste remains. Depending on the growth in the generation of waste this would allow Member States to use an additional 60 – 93 million tons of residual waste that would either go to landfill or to use it to generate energy by 2020. If these installations would meet the efficiency threshold of 0.65 proposed by the European Commission for future plants this would reduce emissions of CO_2 with 27 – 41 million tons of CO_2 per year.

If the energy performance of the current Waste-to-Energy plants was improved to meet the efficiency of 0.60 as proposed by the European Commission for existing plants this would result in a CO_2 reduction of 4 million tons CO_2 per year.

The total potential therefore is a reduction of CO_2 emissions 31 – 45 million tons per year in 2020. This is 0.75 to 1% of the total emissions of CO_2 in the EU and would be an important contribution to the reduction target of 20% as indicted in the EU policy ‘energy for the future’.

The total amount of energy generated would be 54 – 69 million MWh of electricity and 51 – 69 million MWh heat. The contribution of waste as a generator of electricity can increase from the current 0.5% to 1.5 – 2%.

Without a policy to promote Waste-to-Energy plants with high energy efficiency the potential to reduce CO_2 emissions will not be reached.

It should be kept in mind that promoting use of energy from waste should be part of a balance and comprehensive policy. In such a policy incineration does not hamper prevention initiatives or recycling. The largest threat to recycling is the cheap outlet for waste - that of landfills.

To achieve this CO_2 reduction it is important that the EU:

- grants the recovery status to Waste-to-Energy plants with a high energy efficiency according to the formula proposed by the Commission in Annex II of the revision of the Waste Framework Directive.

This approach will stimulate the operators of existing plants to invest in substantial improvements of their energy performance. It will also facilitate the building of new plants with even higher energy efficiency and e.g. extend the application of heat from Waste–to-Energy plants.

It is also important that the EU or individual Member States consider:

- taking additional measures to reduce landfilling of waste which cannot be recycled, but is still suitable for incineration.

This would allow the EU to fully profit from the CO_2 reduction potential that the use of highly efficient Waste-to Energy plants can offer.

Annex 1 Generation and treatment of MSW per Member state

2004	Generation Municipal waste (x 1000t)	recycled	incinerated	landfilled
EU27	258,350	36%	17%	48%
Netherlands	10,145	64%	34%	3%
Germany	49,519	59%	24%	17%
Austria	5,104	58%	22%	20%
Belgium	4,876	57%	33%	10%
Ireland	3,500	54%	0%	46%
Sweden	4,165	44%	47%	9%
Luxembourg	302	41%	40%	18%
Denmark	3,757	41%	54%	4%
Spain	28,033	39%	6%	55%
Estonia	607	37%	0%	63%
Italy	31,144	32%	11%	57%
Finland	2,375	30%	10%	60%
France	35,145	29%	32%	38%
United Kingdom	35,820	23%	8%	69%
Malta	229	20%	0%	80%
Romania	8,207	19%	0%	81%
Bulgaria	3,674	16%	0%	84%
Slovenia	868	14%	2%	84%
Slovakia	1,474	14%	5%	81%
Latvia	721	13%	4%	83%
Hungary	5,119	12%	4%	83%
Cyprus	533	10%	0%	90%
Lithuania	1,261	9%	0%	91%
Greece	4,781	8%	0%	92%
Czech Republic	2,839	6%	14%	80%
Poland	9,777	5%	1%	94%
Portugal	4,546	5%	22%	73%

Source: Eurostat data and FFact

Annex 2 Explanation on the Commission's energy efficiency formula

The Commission had proposed a formula to calculate the efficiency with which the energy content of waste is transformed into heat and electricity that finds a useful application in the economy. This formula was developed when preparing the reference document to determine Best Available Technology for waste incineration as is required under the Directive on IPPC. This formula is:

Energy efficiency .= $(E_p - (E_f + E_i)) / (0.97 \times (E_w + E_f))$[8]

It includes a factor 0.97 to compensate for the energy needed for the slag. It also uses a factor 2.6 and a factor of 1.1 to allow heat and electricity to be added together in one factor. This also allows comparison of the performance of waste incinerators with other installations for generation of heat and power (e.g. coal fired power plants).

In the EU the average efficiency of production of electricity in power plants, such as coal or gas fired power plants, is 38%. If a Waste-to-Energy plant would produce electricity with an efficiency of 38% its energy efficiency is regarded to be the factor 1. The same calculation is applied to production of heat. Conventional systems convert fuel energy into exported heat with an efficiency of 91%. If the conversion of energy in the waste to heat would have the same efficiency its performance is regarded to be 1. This is why the Commission proposes a factor of 2.6 for electricity provided to the grid (100/38) and of 1.1 for heat delivered to district heating or industrial application (100/91). A Waste-to-Energy plant with an efficiency of 1 is as efficient as an installation that generates energy from traditional fuels.

The formula takes into account the energy content of waste and the additional fuels that are fed into the installation and compares this with the energy produced by the installation in the form of electricity and/or heat. It makes sure that the efficiency of the installations does not take into account the energy from additional fuels, as these cannot be attributed to recovery of energy from the waste. It therefore seeks to provide for a correct equation in the sense that only energy coming from waste is taken into account.

Energy from waste can be provided in a useful form to the economy as heat for district heating or industrial uses, but also in the form of electricity which is fed into the grid. Some installations only produce heat, some only produce electricity and others provide both. In order to provide a calculation that can be used for all three types of installations in a comparable way it was decided to compare the efficiency of production of both heat and electricity with the average efficiency of production of these forms of energy in conventional industrial processes.

[8] Ep: energy produced, Ef: energy in added fuels, Ei: other energy imported, Ew: energy in the waste.

Annex 3 Calculation of CO_2emission factors

Average existing incinerator

Parameter	value	Units
Calorific value	10	MJ/t
% electricity produced	12	
% heat produced	12	
Carbon content	40	%
Of which fossil carbon	40	%
Combustion efficiency	95	%
CO_2 emission	0.557	kg CO_2/kg MSW
Electricity produced	0.317	kWh
Heat produced	0.317	kWh
Emission factor electricity	0.382	kg CO_2/kWh
Emission factor heat	0.28	kg CO_2/kWh
Avoided emissions	0.210	kg CO_2/kg MSW
Net emissions	0.348	kg CO_2/kg MSW
R1/D10 formula	0.43	

Improved average existing incinerator

Parameter	Value	Units
Calorific value	10	MJ/t
% Electricity produced	18	
% heat produced	14	
Carbon content	40	%
Of which fossil	40	%
Combustion efficiency	95	%
CO_2 emission	0.557	kg CO_2/kg MSW
Electricity produced	0.475	kWh
Heat produced	0.369	kWh
Emission factor electricity	0.382	kg CO_2/kWh
Emission factor heat	0.28	kg CO_2/kWh
Avoided emissions	0.285	kg CO_2/kg MSW
Net emissions	0.272	kg CO_2/kg MSW
R1/D10 formula	0.60	

New incinerator, electricity only

Parameter	Value	Units
Calorific value	10	MJ/t
% electricity produced	26	
% heat produced	0	
Carbon content	40	%
Of which fossil	40	%
Combustion efficiency	98	%
CO_2 emission	0.575	kg CO_2/kg MSW
Electricity produced	0.686	kWh
Heat produced	0	kWh
Emission factor electricity	0.382	kg CO_2/kWh
Emission factor heat	0.28	kg CO_2/kWh
Avoided emissions	0.262	kg CO_2/kg MSW
Net emissions	0.313	kg CO_2/kg MSW
R1/D10 formula	0.66	

New incinerator, combined heat and power

Parameter	Value	Units
Calorific value value	10	MJ/t
% electricity produced	10	
% heat produced	40	
Carbon content	40	%
Of which fossil	40	%
Combustion efficiency	98	%
CO_2 emission	0.575	kg CO_2/kg MSW
Electricity produced	0.264	kWh
Heat produced	1.056	kWh
Emission factor electricity	0.382	kg CO_2/kWh
Emission factor heat	0.28	kg CO_2/kWh
Avoided emissions	0.396	kg CO_2/kg MSW
Net emissions	0.178	kg CO_2/kg MSW
R1/D10 formula	0.68	