

# User guide for CO<sub>2</sub>ZW<sup>®</sup>



*Versions 'CO<sub>2</sub>ZW v1.1' and 'CO<sub>2</sub>ZW Management in Industrial Areas'*



Register of Community Trade Marks N° 010842789

Authors:



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License.



## COORDINATION

Xavier Gabarrell, Sostenipra Coordinator (UAB)

## TOOL DEVELOPMENT AND REALIZATION OF USER GUIDE

UAB (Xavier Gabarrell, Pere Llorach, Eva Sevigné, Joan Rieradevall)  
inèdit (Ramon Farreny, Markel Cormenzana, Simon Colman, Carles M. Gasol)

Bellaterra (Barcelona), June 2014

# Table of contents

Assistance on the Use of CO <sub>2</sub> ZW® .....	1
1) Introduction .....	2
Who should use the CO <sub>2</sub> ZW® Carbon Footprint Tool?.....	2
How can European municipalities use CO <sub>2</sub> ZW®? .....	2
2) Accessing the calculator .....	4
How to download the calculator .....	4
Which Microsoft Excel© versions support the calculator?.....	4
3) Using the calculator.....	5
Step 1: System of study.....	5
Step 2: System description .....	6
Step 3: Composition of Municipal Solid Waste (MSW) .....	11
Step 4: Performance indicators .....	12
Step 5: Key Parameters Influencing the Global Warming Potential of the Waste Sector ....	13
Step 6: Methodological Approach for the Estimation of Emissions from Landfills .....	14
Step 7: CO <sub>2</sub> eq Credits for Material and Energy Recovery.....	16
Step 8: Results & Graphs.....	17
4) Abbreviations.....	18
5) Glossary .....	18
Appendix A: List of default values .....	20
Appendix B: CO <sub>2</sub> ZW® Management in Industrial Areas.....	23
Appendix C: References & document notes.....	24

# Preface

The CO<sub>2</sub>ZW® Carbon Footprint Tool for Waste management (from now on, CO<sub>2</sub>ZW®) provides a means of calculating the greenhouse gas (GHG) emissions (in carbon dioxide equivalents) emanating from waste management operations. The tool has been designed and developed by the Sostenipra Research Group (2014 SGR 1412), which integrates members from the Institute of Environmental Sciences and Technology, ICTA, from the Universitat Autònoma de Barcelona, and from inèdit, a spin-off company from the research group.

The first version of CO<sub>2</sub>ZW® was developed with funding provided by the European programme MED 2007-2013 via the Low Cost - Zero Waste Municipality project (1G-MEDo8-533) in 2012. In this first version (v1), the Tool included background data for waste management systems in a set of EU countries (Spain, Italy, Slovenia and Greece). Later, the Sostenipra research group has further developed CO<sub>2</sub>ZW® in order to integrate new functions and present internal improvements and bug fixes. In addition, CO<sub>2</sub>ZW® has included additional background data for Catalonia and has been translated into Catalan, thanks to the collaboration with the Catalan Waste Agency. These changes have resulted in the release of CO<sub>2</sub>ZW® v1.1 in 2013. In January 2014, CO<sub>2</sub>ZW® v1.1 has been translated into Spanish, together with the User Guide, within the project Zero Waste Pro and with the collaboration of FAMPC (Federación Aragonesa de Municipios, Provincias y Comarcas). Besides, the Sostenipra Research group has made the effort to divulgate the tool, such as this illustrative video. Finally, within the project ECO-SCP-MED 'Capitalizing experiences for MED sustainable future', cofinanced by the European Regional Development Fund (ERDF), in which the authors of CO<sub>2</sub>ZW® have participated, a complementary version of the CO<sub>2</sub>ZW® has been integrated into a toolkit for the 'Management of Industrial Areas'. For this integration, several amendments (see Appendix B) have been made, which have resulted in the 'CO<sub>2</sub>ZW® Management in Industrial Areas' tool. As a result of these efforts, at the moment the following versions are available: CO<sub>2</sub>ZW® v1.1. (English, Spanish, Catalan) and CO<sub>2</sub>ZW® Management in Industrial Areas'.

The different versions of the tool have been widely used by waste managers, public authorities, consultants and academics, and they have been presented in several waste management forums and in scientific papers. So far, CO<sub>2</sub>ZW® has been applied to more than 1000 municipalities throughout Europe, and the number of CO<sub>2</sub>ZW® users registered in the Sostenipra Platform are over 500 (registered users can always check for the last version in the Platform, and receive an email at the moment that there is a new version or instructions). In addition, different countries are showing interest in either translating it or adapting it into their local context.

In light of the rapid evolution of the tool and taking into account the market acceptance and demand, the Sostenipra research group has developed this updated User Guide, based on the previously published ones, in order to clarify a series of relevant aspects and to answer some of the questions that have arisen so far. This task has been possible thanks to funding provided by the ECO-SCP-MED project.

Finally, we hope you enjoy using the tool and make good use of it.

- CO<sub>2</sub>ZW® team of authors.

# Assistance on the Use of CO<sub>2</sub>ZW®

The Sostenipra research group is proud of the CO<sub>2</sub>ZW® tool and is continuously looking for opportunities to improve it and spread its use all over the World. However, it is not in its hands to provide free assistance on the use of CO<sub>2</sub>ZW® to the increasing community of users.

However, different services are available at request, which will be managed by inèdit, spin-off company from the Sostenipra research group (and part of the CO<sub>2</sub>ZW® team of authors), and always under the approval of Universitat Autònoma de Barcelona (UAB). These services are summarized as follows:

- Assistance on the use and interpretation of CO<sub>2</sub>ZW®
- Application of CO<sub>2</sub>ZW® in specific case studies (either municipal, regional, national, or other levels)
- Verification of the calculations obtained thanks to CO<sub>2</sub>ZW® and verification of the input data used throughout the tool. This process can result in a verified carbon footprint label, with inèdit-UAB as a third party verifying the results.
- Training on the CO<sub>2</sub>ZW®. Inèdit is recognized as the official trainer of the methodology, either by online means (webinars, etc.) or face-to-face.
- Adaptation of CO<sub>2</sub>ZW® to new countries.
- Assistance on the translation of CO<sub>2</sub>ZW® and related User Guide (a set of Translation Guidelines are available on demand).

In order to obtain more information on any of these assistance services, please do not hesitate to contact [software@ineditinnova.com](mailto:software@ineditinnova.com) .

# 1) Introduction

The Carbon Footprint Tool for Waste management in Europe (from now on, CO<sub>2</sub>ZW<sup>®</sup>) was initially developed by the Sostenipra Research Group (<http://www.sostenipra.cat>) with funding provided by the European Commission via the Zero Waste Project<sup>1</sup> (1G-MEDo8-533). CO<sub>2</sub>ZW<sup>®</sup> provides a means of calculating the greenhouse gas (GHG) emissions (in carbon dioxide equivalents) emanating from the waste operations of European municipalities. The Tool, in this version, is an Excel<sup>®</sup>-based calculator which, with the input of municipality-specific waste data (or national data as a default), allows the user to obtain a municipality-level carbon footprint of waste treatments (infrastructures are not included). The user will be able to use this calculator to support GHG monitoring and reporting initiatives as well as to provide an estimation of potential GHG reductions (or additions) associated with management and technological changes in local waste operations.



*Register of Community Trade Marks No 010842789*

**NOTE:** The calculator has been designed to function most effectively at the municipality scale, however it can be used at any scale (including state, country and region) if sufficient data is available.

This user guide aims to provide simple step-by-step instructions for a successful application of the CO<sub>2</sub>ZW<sup>®</sup> calculator. Brief methodological notes have been included throughout to ensure that the user understands the key assumptions and algorithms behind the scenes. A glossary of terms and a list of abbreviations can also be found at the end of the document.

## Who should use the CO<sub>2</sub>ZW<sup>®</sup> Carbon Footprint Tool?

It is envisaged that the output from CO<sub>2</sub>ZW<sup>®</sup> can be used as a guide for driving local government policy in the context of waste sector operations. Thus, the intended users of CO<sub>2</sub>ZW<sup>®</sup> are solid waste managers (as well as academics and consultants working in the solid waste field) with access to comprehensive and up-to-date waste management data at either a local or, if not possible, regional or national level.

## How can European municipalities use CO<sub>2</sub>ZW<sup>®</sup>?

Any municipality can use the CO<sub>2</sub>ZW<sup>®</sup> Carbon Footprint tool, provided that they have access to local waste management data. This also applies to municipalities outside of Europe, however all default values built in to the calculator are based on a European context. Before getting deep into the CO<sub>2</sub>ZW<sup>®</sup> calculator, the following checklist provides an indication of the data required as input into the calculator.

- The total **amount of waste** generated for the desired study year (or alternatively the population within the study area for the same year);
- The **typical composition of municipal solid waste** (MSW) generated within the study area (default values for Greece, Italy, Slovenia, Spain and the EU27 average are provided if not known at the municipality level);
- The **percentage of impurities** typically found within the source-separated organic fraction (default values are provided should no information be available);
- The **fractions of source-separated** glass, plastic, metals, paper and cardboard, and organic material (as a percentage of the total for each respective material within the total MSW stream) that have been collected separately and processed in appropriate facilities (national default values are provided if not known at the municipality level);
- The **amount of biogas** captured from landfills;
- The **greenhouse gas emission** factor for the local electricity mix.

In addition, the use of **local data** is also desirable for the following items:

- **Characteristics** of waste treatment plants, including:
  - the efficiency of recycling installations for paper and cardboard, glass, plastics and metals.
  - the efficiency of composting plants.
  - the efficiency of mechanical-biological treatment (MBT) plants.
  - the destination of the residue from MBT.
- **Destination** (treatment) of the mixed general waste;
- **Destination** (treatment) of the source-separated organic fraction;

With this data, and following the step-by-step instructions provided in ‘*Section 3. Using the calculator*’, it is possible to obtain an estimation of the carbon footprint of any municipality. For many of these items, default values for the Zerowaste project partners’ countries (Greece, Italy, Slovenia, Spain)<sup>2</sup> are automatically provided and should be used if more specific data for the study area is unavailable for the user.

For users seeking to apply this calculator within a country external to the Zerowaste project; it is advisable to use location specific data where available in order to integrate its own characteristics and features to the calculation<sup>3</sup>. Otherwise, default values based on European averages and estimations from the authors have also been provided.

**NOTE:** The default values for each country (as well as the European average values) are shown in Appendix A.

## 2) Accessing the calculator

### How to download the calculator

The calculator can be accessed after registration in the following web page: <http://sostenipra.ecotech.cat>. At the moment of registration, the option 'CO<sub>2</sub>ZW® CARBON FOOTPRINT TOOL OF WASTE MANAGEMENT IN EUROPE' should be clicked. After registration, you will receive an e-mail containing a link (<http://sostenipra.ecotech.cat/downloads/CO2ZW®.php>) that you should follow.

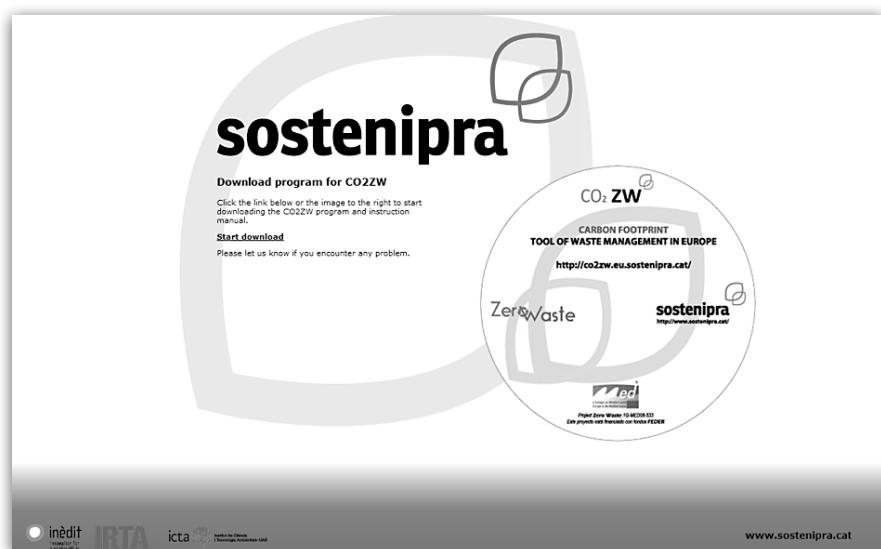


Figure 1. Homepage of CO<sub>2</sub>ZW®.

Then, you will be able to log in (the system may require your username and password, depending on the configuration of your internet browser) and download the calculator.

### Which Microsoft Excel® versions support the calculator?

The CO<sub>2</sub>ZW® calculator was developed in Microsoft Excel® 2007 and it is compiled in an executable (.exe) file for protection reasons. To open it, it is necessary to have Microsoft Excel® installed in the computer (version 2007 or any version more recent). In case that your Firewall or Antivirus prevents CO<sub>2</sub>ZW® to open, omit the warning message and go ahead (this warning message may appear because CO<sub>2</sub>ZW® is compiled in a file with .exe extension).

If Microsoft Excel® asks if you would like to activate macros, please select "Yes".

## 3) Using the calculator

The calculator has been designed in a user-friendly format that follows a logical order for the input of data. The following section provides a step-by-step guide for successful application of the CO<sub>2</sub>ZW® Carbon Footprint Tool.

Please note that the **Read Me** tab in the calculator also provides instructions for its use.

### Step 1: System of study

On the **START** page, go to *Step 1 - System of Study* and select the country corresponding to the study area from the drop-down box provided.

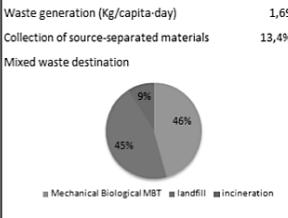
1) SYSTEM OF STUDY

Select your COUNTRY

Spain

Country profile (informative)

Waste generation (Kg/capita-day)	1,69
Collection of source-separated materials	13,4%
Mixed waste destination	



Mechanical Biological MBT    landfill    incineration

Indicate the name of the study area (municipality, region, ...)

Study Area

Indicate the study year

Please write here

*Note: The 'Country profile (informative)' section displays data for Spain. The pie chart shows the distribution of mixed waste destination: Mechanical Biological MBT (45%), landfill (46%), and incineration (9%).*

Figure 2. System of study section.

#### METHODOLOGICAL NOTE 1 +

The country selection establishes a set of default values (at the national level) that the user can choose to use for their study area if specific values are not available. These are entered automatically and must be changed manually by the user if they wish to enter alternative values. The cells which may be changed are coloured yellow within the calculator. Selecting "Others" from the drop-down box provides a set of European-average default values obtained from different sources. If the user's study area is not within Greece, Italy, Slovenia or Spain (national default values provided by the project partners) then the default values will be based on these European averages unless specific data for the study region is entered.

For clerical purposes, enter the name of the municipality (or area of study) that will be the focus of the calculation as well as the study year. If you have selected "Other" for country, then please also enter the country name in this box.

## Step 2: System description

On the **START** page, go to **Step 2 - System description**. Here you will be guided through a series of steps for entering relevant system parameters into the calculator. In most cases the calculator will ask you whether the data it requires is available. If you have the relevant data; click “Yes”, and enter the data in the space provided. If this data is unavailable, select “No”. In this situation the calculator will revert to default values based on national averages for the specific country (or for Europe if the country is not specified). All system parameters (system specific or default) can be reviewed in the section “*Summary of system parameters*” at the bottom of the page.

**NOTE:** Wherever there is a Yes/No question pertaining to the availability of data, only select “Yes” if you have all of the relevant data available. These questions generally refer to the breakdown/composition of a total and it is important that the entered fractions sum to 100%. In sections where composition is not required, you may choose to enter your own figures, or leave the space as it is, in which case the calculator will revert to default values for that particular value only. If the user wishes to use these default values then it is important to leave these spaces in their original form (i.e. with the phrase “*Please write here*” still intact) to avoid any calculation problems.

### Total Waste Generation

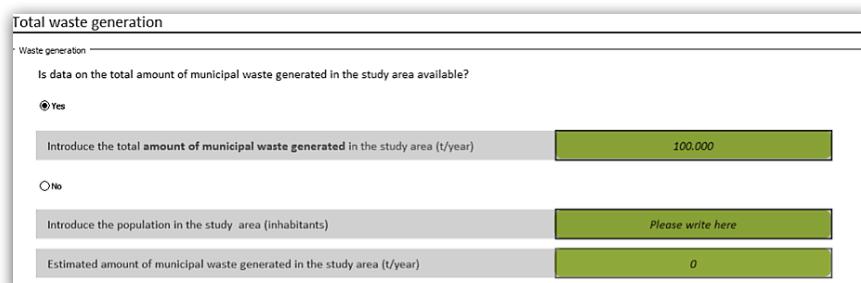


Figure 3. Total waste generation section.

In this section the user must enter the actual value for waste generation in the system over the study period. If this information is not available, the calculator will estimate the waste quantity based on the study area population.

#### + METHODOLOGICAL NOTE 2

The MSW generation estimate is based on the default waste generation per capita for the country selected, applied to population within the study area.

### Mixed General Waste Flows

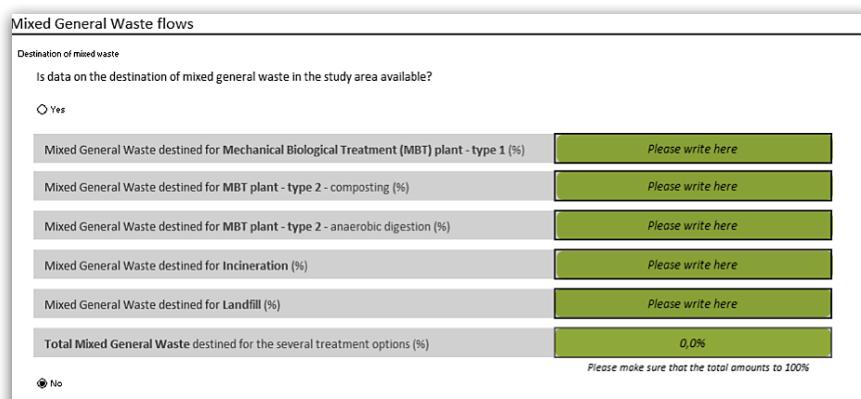


Figure 4. Total waste generation section.

In this section the user must allocate the mixed general waste to four types of waste handling facilities.

**NOTE:** There are two types of Mechanical Biological Treatment (MBT) plant available for the mixed general waste. MBT Type 1 plants receive mixed general waste only and include sorting processes and aerobic composting for residual materials. MBT Type 2 plants receive mixed general waste and source-separated organic matter. Operations include sorting processes and both aerobic and anaerobic treatment of recovered organic materials. The efficiency of MBT type 2 plants is higher than MBT type 1 (performance values can be introduced manually later).

## Collection of Source-Separated Materials

In this section the user is required to input the amount of source-separated materials collected separately from the mixed general waste stream over the study period.

Collection of source-separated materials

If data on the amount of source-separated collected materials is available, introduce it in the corresponding cells. Please, leave the other cells unaltered if you have entered data and you wish to revert to the default values, please reenter *Please write here* in the corresponding cells.

Collection of source-separated glass	Select units ton/year	<i>Please write here</i>
Collection of source-separated plastic		<i>Please write here</i>
Collection of source-separated metals		<i>Please write here</i>
Collection of source-separated paper and cardboard		<i>Please write here</i>
Collection of source-separated organic matter		<i>Please write here</i>
Collection of other source-separated materials		<i>Please write here</i>

Figure 5. Water source-separation.

**NOTE:** The user may choose to enter data in all cells, or for just a selection of cells, however it is important that the same units are always used.

In the “*waste source-separation*” box, the user may choose to enter the data as either a percentage of the total mass for each respective waste fraction (i.e. 20% for source-separated glass would imply that out of the entire glass quantity within the system’s MSW flows, 20% is collected via source-separated collection) or as the total mass (in tonnes) for the source-separated fraction. It is important that the user selects the set of units that they would prefer to use from the drop-down list provided.

Is data on the destination of source-separated organic matter in the study area available?

Yes

Source-separated organic fraction destined for MBT (composting) (%)	<i>Please write here</i>
Source-separated organic fraction destined for windrow composting (%)	<i>Please write here</i>
Source-separated organic fraction destined for tunnel composting (%)	<i>Please write here</i>
Source-separated organic fraction destined for MBT (biomethanization) (%)	<i>Please write here</i>
Source-separated organic fraction destined for biomethanization plant (%)	<i>Please write here</i>
Total source-separated organic fraction destined for the several treatment options (%)	0,0%

No

*Please make sure that the total amounts to 100%*

Figure 6. Organic matter destination.

In the “*Organic matter destination*” box, the user must also specify the proportions of the source-separated organic fraction that are treated in the specialised organic material processing plants.

**NOTE:** Both the MBT (biomethanization) and the biomethanization plant utilise the same process, however the MBT (biomethanization) plant is integrated into a larger facility that has other waste treatment lines.



### METHODOLOGICAL NOTE 3

This tool assumes a waste management system where the collection of source-separated materials is promoted by the use of a series of different colour-coded collection containers (either communal or per household) or pneumatic systems that allow the public to dispose their glass, plastics, metals, paper and cardboard and organic materials separately. These categories of source-separated collection are reasonably common throughout Europe, but can vary from country to country, with some nations (and even different regions within one country) employing a variety of different collection systems.



### What should be done if the source-separated collection categories within the system of study do not match the ones provided?

There are three likely reasons for such an issue to arise:

1. The waste collection system provides facilities for separating the recyclable materials into even further categories (e.g. in some countries, glass is separated according to colour);
2. The local collection system does not provide facilities for separate collection of certain materials (e.g. in some countries, glass is separated according to colour);
3. The recyclable material may be collected in commingled recycling bins (e.g. paper, glass and plastic collected together) and separated downstream in a specific facility.

Table 1 provides some suggestions to assist the user in manipulating his/her data to account for any such differences.

REASON FOR DEVIATION	HOW TO MANIPULATE THE DATA
System has more source-separation categories	Generally the excess categories will simply be one of the five accounted for in the Tool, but broken down into further sub-categories (e.g. clear, green and brown glass). If this is the case, simply aggregate the percentages of these sub-categories to fit the five categories of glass, plastic, metals, paper & cardboard and organic materials.
Some materials are not source-separated	If any of the five categories of source-separated waste are not collected separately in the specific study area, simply adjust the relevant source-separation percentage for that category to 0%.
Commingled recycling	Use downstream data or empirically-derived assumptions to break these quantities down into their individual components (e.g. in Ragusa, Italy, glass and metal (cans) is collected together in one container; however the percentage contribution of each is known). If it is not possible to obtain data or use relevant assumptions for isolating these materials into the categories required then simply revert to the default values provided.

Table 1. Methods for fitting differing data sets to the format required by CO<sub>2</sub>ZW®.

## How should the source-separated Tetra Paks be allocated?



According to Tetra Pak, their products are typically comprised of aluminium (5%), paper (74%) and plastic (21%)<sup>4</sup>. If the user has specific data for the amount of tetra-paks recovered through the source-separation process (by weight), then it is recommended that he/she applies these percentages to his/her quantity and allocates the results to the relevant categories.

E.g. Source-separation results in  $X$  tonnes of tetra-pak each year. Therefore,  $0.05X$  is allocated to the source-separated metals category,  $0.74X$  to paper and  $0.21X$  to plastic.

## Characteristics of Waste Treatment Plants

Under the section, “Characteristics of waste treatment plants”, the user is required to enter specific information related to the performance of the waste treatment plants within the system, as well as the methods by which residual (non-recovered) waste leaving the plants is disposed.

Data specific to the study area is preferred, however default values have also been provided (refer to Appendix A) should relevant statistics not be available. If the user wishes to use these default values then it is important to leave these spaces in their original form (i.e. with the phrase “Please write here” still intact) to avoid any calculation problems. Furthermore, if any of the listed installations do not exist in the system of study, the user should also leave these cells unaltered. The calculator will automatically remove these from the carbon footprint calculations since they will be marked as 0% in the Mixed General Waste flows section.

Characteristics of Waste Treatment Plants	
<b>Waste treatment plants</b> If data on the following treatment plants is available, please introduce it where appropriate. Please, do not alter the remaining cells.	
<b>Recycling installations</b>	
Recycling efficiency of source-separated glass in recycling plant (%)	<input type="text" value="Please write here"/>
Recycling efficiency of source-separated plastic in recycling plant (%)	<input type="text" value="Please write here"/>
Recycling efficiency of source-separated metals in recycling plant (%)	<input type="text" value="Please write here"/>
Recycling efficiency of source-separated paper and cardboard in recycling plant (%)	<input type="text" value="Please write here"/>
<b>Source-separated organic fraction treatment plants</b>	
Average compost production (% compost/organic fraction)	<input type="text" value="Please write here"/>

**Recycling efficiency** refers to the percentage of source-separated material that is expected to be recovered / recycled in the processing facility.

**Average compost production** refers to the fraction of the source-separated organic material that is effectively converted into compost product.

Figure 7. Waste treatment plants section.

MBT 1 (treating mixed solid waste)	
Recovery of materials (plastic, metals, paper...) (% of input waste)	<input type="text" value="Please write here"/>
Net diversion of organic matter (% of the total organic matter in the waste input)	<input type="text" value="Please write here"/>
Net organic matter recovery (in the form of biostabilised production) (% of input waste)	<input type="text" value="Please write here"/>
Total residual waste (% of input waste)	<input type="text" value="Please write here"/>
<b>MBT 2 (mixed solid waste line)</b>	
Recovery of materials (plastic, metals, paper...) (% of input waste)	<input type="text" value="Please write here"/>
Net diversion of organic matter (% of the total organic matter in the waste input)	<input type="text" value="Please write here"/>
Net organic matter recovery (in the form of biostabilised production) (% of input waste)	<input type="text" value="Please write here"/>
Total residual waste (% of input waste)	<input type="text" value="Please write here"/>

**Recovery of materials** in the MBTs refers to the amount (as a percentage) of mixed general waste that is recovered for reuse / recycling following the sorting processes.

**Net diversion of organic matter** refers to the amount of organic matter (as a percentage of total organic matter in the mixed general waste entering the MBT) that is recovered at the facility and prevented from leaving the plant as residual waste.

Figure 8. MBT 1 & 2 sections.

Residue from MBT plant

In case that there is waste destined for MBT, is data on the destination of the residual fraction from MBT in the study area available?

Yes

Residual waste to landfill (%)	<i>Please write here</i>
Residual waste to incineration (%)	<i>Please write here</i>
Residual waste to Refuse Derived Fuel (RDF) production (%)	<i>Please write here</i>
Total residual waste from MBT destined for the several treatment options (%)	0,0%

*Please make sure that the total amounts to 100%*

No

Figure 9. Residue from MBT plant section.

**Net organic matter recovery** (in the form of biostabilised product) refers to the total amount of organic matter (as a percentage of the mixed general waste entering the MBT) that is processed and converted into biostabilised product (see glossary) within the MBT.

**Total residual waste** refers to the amount (as a percentage) of the mixed general waste entering the MBT that is not recovered at the facility and is subsequently sent for final disposal (e.g. landfill, incineration or conversion to refuse derived fuel).

## Transportation of waste

The user can choose whether or not they want to include GHG emissions from transportation in their carbon footprint calculation. If the user chooses “Yes”, then he/she must specify the tkm (tons-kilometre) for both waste collection and inter-urban waste transportation specific to their study area. This is essentially a multiplication of the distances travelled by waste collection vehicles to the treatment/disposal facilities (km) by the total mass of the waste collected (tons).

Transportation of waste

Maste transportation

Do you wish to include the carbon footprint from the transportation of waste? Note: Only select “Yes” if you have the relevant data available.

Yes

Introduce the amount of tkm (tons-kilometre) associated to all generated waste. Please, notice that there is a differentiation between urban waste collection (including compression systems, stops, etc.) and inter-urban transportation of waste (e.g. between waste transfer facility and MBT, or MBT and landfill). Please introduce a zero whenever you do not have data or you do not wish to calculate one of the two transportation subsystems.

Transportation of waste - urban waste collection (tkm)	<i>Please write here</i>
Default emission factor (g CO <sub>2</sub> eq/tkm) 1.310 The user may change the factor if more-specific data is available	
Transportation of waste - inter-urban waste transportation (tkm)	<i>Please write here</i>
Default emission factor (g CO <sub>2</sub> eq/tkm) 124 The user may change the factor if more-specific data is available	

No

Figure 10. Waste transportation section.

Urban waste collection refers to the collection of waste from urban disposal points, whilst inter-urban waste transportation refers to the transport of residual material from MBTs to landfill (or alternative destination).

**NOTE:** The default emission factors provided reflect the entire life cycle impacts of the waste transportation. They account for emissions related to the operation of the vehicles (fuel consumption and the extraction and refining of these fuels) as well as the emissions implicated in vehicle and road construction and maintenance.

The emission factor for urban waste collection considers the waste collection vehicle to be a 21 ton capacity diesel run waste collection and hydraulic compression vehicle. Air emissions from fuel combustion are influenced by stop & go driving, tyre abrasion, brake lining abrasion and road abrasion<sup>5</sup>.

The emission factor for inter-urban waste transportation considers the waste transportation vehicle to be a diesel run lorry (with capacity greater than 16 tons). This vehicle does not require stop & go driving<sup>6</sup>.

Both emission factors consider a useful lifetime of 540,000 tkm/vehicle.

## Step 3: Composition of Municipal Solid Waste (MSW)

In the **CONTROL PANEL** tab, go to *Step 3- Typical Composition of Municipal Solid Waste*.

Under the heading “*Municipal Solid Waste (total generation)*”, the typical composition of MSW in the selected country is provided (in the case of “other” countries, the European average is assumed).

These cells (coloured yellow) may all be altered if the user wishes to use more specific information for their study area, however it is important that the total sums 100%. The biogenic carbon content and low heating value have been obtained from a variety of recognised sources and are fixed in the calculator.

Under the heading “*Source-separated collection*”, a default value is provided for the impurities typically found within the source-separated organic waste stream. This cell (coloured yellow) may also be altered if more specific information is available.

<b>Municipal Solid Waste (total generation)</b>			
Overall waste composition	Proportion of total MSW (%)	Biogenic carbon content	Low Heating Value (MJ/Kg)
Organic material	44,0%	100%	4,0
Paper and cardboard	21,2%	100%	11,5
Plastic	10,6%	0%	31,5
Glass	6,9%	0%	0
Metals	4,1%	0%	0
Wood	1,0%	100%	9
Textiles	4,8%	80%	14,6
Rubber and hide	1,0%	80%	27,2
Other	6,2%	0%	8,4
<b>TOTAL</b>	<b>100%</b>		

Figure 11. Municipal solid waste section.

**NOTE:** The organic material component comprises both kitchen waste and garden waste. Garden waste should not be included with wood.

Source-separated collection	
Please, indicate the impurities of the source-separated organic fraction (if available)	
Impurities in organic fraction	20%

Figure 12. Source-separated collection section.

### WHAT SHOULD YOU DO IF YOU WANT TO ENTER A SPECIFIC MSW COMPOSITION FOR YOUR STUDY AREA AND YOUR DATA IS COMPILED UNDER DIFFERENT WASTE CATEGORIES TO THOSE PROVIDED?

The composition provided is consistent with typical MSW composition reporting across Europe (and globally). It should always be possible to allocate domestic wastes to the categories provided, even if they come under different names. It is up to the user to make their data fit this composition; otherwise they should revert to the

provided default values (based on national averages). Note that the “other” category is used to accommodate waste fractions not represented in this breakdown. Examples of wastes typically found within the “other” category include ceramics, porcelain, batteries, cellulose (diapers) and small electronic waste.

#### + METHODOLOGICAL NOTE 4

The compositions of other waste flows in the system (e.g., the mixed general waste and the residual material leaving the MBT plants) are derived from this MSW composition. The compositions of these waste streams are not shown in the calculator but are utilised in a number of in-built algorithms.

The mixed general waste composition is derived by simply subtracting the source-separated collection materials (by mass) from the MSW stream.

The composition of the residual material leaving the MBT plants is derived by subtracting the amount of materials recovered (by mass) from the mixed general waste entering the plant as well as the amount of organic matter degraded (by mass) within the plant.

#### + METHODOLOGICAL NOTE 5

The impurities within the organic fraction have an impact on the final carbon footprint calculation as they affect the emissions of the biological degradation of composting and biomethanization processes. Therefore, the proportion of impurities introduced in the editable cell affects the resulting emissions of the source-separated organic fraction.

Additionally, the level of impurities affects the efficiency of the composting/digestion process. However, no automatic relationship is provided in the calculator.

## Step 4: Performance indicators

In the **CONTROL PANEL** tab, go to *Step 4 - Performance Indicators*.

The numbers shown in this section are generated from data entered in the previous 3 steps. It is important, however, to compare these waste management performance indicators with any targets prescribed by law or chosen voluntarily.

The following performance indicators are informative, and refer to the European Waste Management Framework.

Total recycling rate	30%
Biodegradables to landfill (t)	41.205
Mixed general waste direct to landfill (t)	39.176

Figure 13. Performance indicators section.

**NOTE:** This step is purely informative and can be used as an assessment of the efficiency and environmental compliance of the waste management system. It does not have any outcome on the carbon footprint calculation.

#### + METHODOLOGICAL NOTE 6

Targets should be consistent with those prescribed in the European Waste Management Framework. These include:

- Recover/recycle a minimum of 50% of household wastes (MSW) by 2020 (EU Waste Directive (2008/98/EC)).
- Reduce biodegradable waste going to landfill to 35% of 1995 values by 2020 (EU Landfill Directive (99/31/EC))- this includes paper, cardboard, food, garden waste and organic textiles (To determine whether the system complies with the Landfill Directive targets, the user will need to obtain the amount of biodegradable waste going to landfill from their study area in 1995).
- Only residual waste that has been subjected to treatment (i.e. pass through an MBT) may be landfilled. This may not apply to inert waste for which treatment is not technically feasible (EU Landfill Directive (99/31/EC)).



The Tool calculates these performance indicators according to the following:

- **Total recycling rate**, calculated according to Calculation Method 4 in the European Commission Decision document 13097/11. According to Article 3 (6) in this document, the target considers the aerobic and anaerobic treatment of organic materials to also be included as recycling.
- **Biodegradables to landfill** is simply a summation of the biodegradable components of three flows: (1) Mixed general waste destined directly to landfill, (2) residue from MBT plants destined to landfill and (3) residue from RDF plants destined to landfill.

## Step 5: Key Parameters Influencing the Global Warming Potential of the Waste Sector

In the **CONTROL PANEL** tab, go to *Step 5 - Key Parameters Influencing the Global Warming Potential of the Waste Sector*.

These inputs strongly influence the global warming potential of the waste sector and are considered key parameters in CO<sub>2</sub>ZW<sup>®</sup>. The final carbon footprint calculation is highly sensitive to each of them and it is therefore recommended to introduce values specific to the study area in place of the default national averages (with the exception of the characterisation factors, which are global) if they have such information available.

Default values are provided for landfill biogas capture and the GHG emissions associated with the electricity mix based on country-specific data. The user may choose to alter these values (in the yellow coloured cells) should he/she deem other figures to be more suitable for the local system.

The user must also select which IPCC global warming potential characterisation factors he/she wishes to use. The dates in the drop-down list correspond to the following characterisation factors.

These are average values for your selected country for two key parameters influencing the global warming potential of the waste sector. These cells may be altered if more specific data pertaining to the study area is available.	
Average landfill biogas capture	17%
Electricity global warming potential (Kg CO <sub>2</sub> eq/kWh)	0,240
Greenhouse Gas Characterization Factors	<i>IPCC 4th Assessment Report</i>

Figure 14. Key parameters influencing the GWP section.

GAS	IPCC 1996	IPCC 2001	IPCC 2007
Carbon Dioxide (CO <sub>2</sub> )	1	1	1
Methane (CH <sub>4</sub> )	21	23	25
Nitrous Oxide (N <sub>2</sub> O)	310	296	298

Table 2. Global warming potential characterisation factors for a 100-year time horizon.

**NOTE:** The drop-down list corresponds to alternative values for carbon dioxide, methane and nitrous oxide only. Since the other greenhouse gases are significantly less abundant than these three main gases, CO<sub>2</sub>ZW<sup>®</sup> utilises the characterisation factors from The Fourth Assessment Report (IPCC 2007) as the default values for these in each of the available options.

## Step 6: Methodological Approach for the Estimation of Emissions from Landfills

In the **CONTROL PANEL** tab, go to *Step 6 - Methodological Approach for the Estimation of Emissions from Landfills*.

From the options provided, the user must select his/her preferred methodological approach for the estimation of landfill GHG emissions. Note that Option A has two alternatives depending on data availability, whilst for Option B the user must select the most appropriate climate category for their system from the drop-down box provided. The methodology behind each of these options is discussed in Methodological Note 7.

Figure 15. Methodological approach section.

### **+** METHODOLOGICAL NOTE 6

The two options available represent alternative methodologies for establishing the GHG emissions from landfills.

#### Option A

As its name suggests, the IPCC guidelines option follows an IPCC-developed methodology (<http://www.ipcc-nggipiges.or.jp/public/2006gl/vol5.html>) where, acknowledging that waste degrades slowly over time, the GHG emissions emanating from landfills in a given year (the calculator uses 2009 as its chosen year) are calculated based on the estimated degradation rate of all previously disposed waste that has been deposited in those landfills over time. Typically, the methodology uses between 35 and 50 years of historical waste deposition data to calculate the emissions for the chosen year. This is the preferred method for establishing GHG emissions from landfills. The user should refer to the IPCC document above to ensure that local landfill characteristics are introduced correctly.

When historical data is not available, the calculator employs a rough simplification of the IPCC method (not recommended by the IPCC) where the national landfill emissions reported in the national inventory reports (NIR) for the study year (calculated according to the IPCC methodology mentioned above) is divided by the total amount of waste landfilled nationally for the same year to give a ratio with the units kg CO<sub>2</sub>-eq / tonne of waste landfilled. This national ratio is then multiplied by the waste landfilled within the system being studied to provide an estimate of annual emissions emanating from the landfill. This method assumes that national landfilling practices are representative of the area being studied. The user is not required to obtain this information themselves. The calculator utilises default values based on a country's NIRs to calculate the emissions/waste ratio and all the user needs to input is the study year required. It is important to note that this represents a rough simplification and may have a high level of uncertainty.

*Note: This alternative calculation under this option is not valid for study areas where landfills have been recently built (i.e. less than 35 years of waste deposition) since they would over represent the amount of emissions emanating from these landfills. This method assumes that all landfills (and their accumulated emissions) have existed for the same amount of time as the national average. If the user's study area consists of a new landfill, use either the IPCC method or the future emissions option discussed below.*



## Option B

The future emissions of current landfilled waste option differs from Option A in that it accounts for the expected future GHG emissions from the waste generated during the study period only. It is an adaptation of the IPCC methodology, using the IPCC calculation to establish all future emissions associated with one year of landfilled waste. Based on the composition of the waste landfilled in the study year, this method estimates the emissions anticipated to take place over a period of 50 years, utilising the default values in-built in the IPCC calculator (excluding climate zone which is selected by the user).

For both options, CO<sub>2</sub>ZW<sup>®</sup> assumes that within Europe, 100% of landfills are classified as "managed landfills".

## WHICH ARE THE IMPLICATIONS OF THE METHODOLOGY SELECTION IN THE FINAL CARBON FOOTPRINT RESULT?

For **Option A**, landfill emissions for the study year are estimated based on the degradation of waste landfilled in previous years, in addition to the waste landfilled within the study period. Therefore, the final carbon footprint result will represent the total GHG emissions from the waste sector (including landfills) within the study area over a given year. This is the value that would characterise the waste sector in a local GHG inventory.



Figure 16. Visualisation of Option A: Total landfill GHG emissions in 2009.

For **Option B**, the estimated landfill emissions account for future emissions from the waste landfilled during the study period only. It is feasible that these emissions could be realised over a period of 50 years. Therefore the final carbon footprint result will represent the total GHG emissions associated with the waste itself over its lifetime<sup>7</sup>. As a consequence, this value cannot be used to form the GHG inventory for the waste sector for the study year. Nevertheless, this option is useful for situations where the user wants to use the calculator to investigate different waste handling scenarios as it does not account for the impact of past waste management practices.



Figure 17. Visualisation of Option B: Future GHG emissions from waste landfilled in 2009.

## Step 7: CO<sub>2</sub> eq Credits for Material and Energy Recovery

In the **CONTROL PANEL** tab, go to *Step 7 - CO<sub>2</sub> eq Credits for Material and Energy Recovery*.

This section presents the CO <sub>2</sub> eq credits for material and energy recovery within the waste sector. Default values are suggested.	
<b>Credits for material and energy recovery</b>	
Compost (mineral fertiliser substitution)	88 Kg CO <sub>2</sub> eq/t
Mixed metals	2,469 Kg CO <sub>2</sub> eq/t
Mixed plastics	1,653 Kg CO <sub>2</sub> eq/t
Paper and cardboard	634 Kg CO <sub>2</sub> eq/t
Glass	200 Kg CO <sub>2</sub> eq/t
Slag	3 Kg CO <sub>2</sub> eq/t
RDF for cement/thermal power plant	0 Kg CO <sub>2</sub> eq/t
RDF for cogeneration	0 Kg CO <sub>2</sub> eq/t
Heat	0.274 Kg CO <sub>2</sub> eq/kWht
Electricity	0.240 Kg CO <sub>2</sub> eq/kWhe
<b>Carbon sequestration*</b>	
Compost (C fixation)	48 Kg CO <sub>2</sub> eq/t
Biostabilised product (C fixation)	48 Kg CO <sub>2</sub> eq/t
Landfill (C sequestration)	314 Kg CO <sub>2</sub> eq/t

\*Credits for carbon sequestration are considered only at informative level but will not be included in the final carbon footprint

Figure 18. CO<sub>2</sub> eq credits section.

**NOTE:** The “Carbon sequestration” section table is purely informative and does not impact upon the final carbon footprint calculation of the waste sector. It merely provides an indication of the amount of GHGs that can be delayed from entering the atmosphere as a result of fixing carbon via these three processes. There is a large degree of uncertainty surrounding the extent to which carbon is sequestered by these processes and as a consequence the figures provided should not be considered definitive.

The references utilised in determination of credits are listed below:

- AEA Technology. 2001. Solid Waste Management and Greenhouse Gases. A Life-Cycle Assessment of Emissions and Sinks.
- Prognos. 2008. Resource savings and CO<sub>2</sub> reduction potential in Europe and the possible contribution to the CO<sub>2</sub> reduction target in 2020. Available at <http://www.prognos.com/>
- US EPA. 2006. Solid Waste Management and Greenhouse Gases. A Life-Cycle Assessment of Emissions and Sinks.
- Jungbluth, N. 2007. EcoInvent Report No. 6-IV. Swiss Centre for Life Cycle Inventories, Dübendorf.
- Mandredi, S., Toninin D., Christensen, T. & Scharff, H. 2009. Landfilling of waste: accounting of greenhouse gases and global warming contributions. *Waste Management and Research* 27:825-836
- Boldrin et al., 2009, Composting and compost utilization: accountng of greenhouse gases and global warming contributions. *Waste Management and Research*.
- Doka, G. 2009. Life Cycle Inventories of Waste Treatment Services. EcoInvent Report No. 13. Swiss Centre for Life Cycle Inventories, St. Gallen.

The values associated with each product in the “*Credits for material and energy recovery*” section reflect the amount of greenhouse gas (in carbon dioxide equivalents) that is likely to be prevented from entering the atmosphere as a result of recovering and recycling these products from the waste stream. In essence, the numbers account for the emissions saved through reducing the need to produce new products from raw materials (e.g. 1 kg of recycled paper implies that 1 kg of new paper is not required within the economy or for every kWh of electricity produced from waste treatment processes, 1 kWh of electricity from the electricity mix is offset).

The values for “carbon sequestration” reflect the amount of carbon prevented from entering the atmosphere as a result of embedding it in compost, biostabilised products, or the ground (in the case of landfilling). Unlike the direct offsets from the use of recycled products mentioned above, these savings are mainly temporary, in that over time the carbon is likely to eventually find its way into the atmosphere.

## Step 8: Results & Graphs

Based on data entered in the **START** page and **CONTROL PANEL**, the calculator will provide the user with a figure for the total annual GHG emissions emanating from the waste sector for their area of study.

The Table of Results provides a breakdown of where the GHGs (both direct and indirect) come from within the system. These are also represented graphically. In addition, the Tab ‘PDF’ allows the export as a ‘PDF’ or print the results in 2 A4 pages.

**NOTE:** Definitions of direct, indirect and avoided emissions, in the context of CO<sub>2</sub>ZW®, are provided in the glossary.

RESULTS FOR		Study Area	ACCORDING TO DATA PROVIDED BY			John Smith
TOTAL EMISSIONS		75.242 t CO <sub>2</sub> eq/year	Relative emissions		0,75 t CO <sub>2</sub> eq/ton-year	
GENERATED EMISSIONS	73.596	368	736			
AVOIDED EMISSIONS	-11.051	-55	-111			
<b>Table of results</b>						
FLOW OF WASTE	Quantity of waste (t/year)	DIRECT Impact (A)	INDIRECT Impact (B)	AVOIDED Impact (C)	(A+B+C)	Sequestered emissions (informative)
TOTAL RECYCLING FROM SOURCE-SEPARATED COLLECTION		422	72	-5.548	-5.053	-10
Paper and Cardboard, Plastics, Glass and Metals	9.734	19	44	-5.497	-5.434	
Organic materials destined for aerobic compost production	2.607	392	19	-10	393	>10
Organic materials destined for anaerobic digestion	594	10	10	-33	-12	
TOTAL MIXED GENERAL WASTE TO MBT		3.170	692	-3.516	346	-133
Total waste processed at Mechanical Biological treatment (MBT) plants	39.548	3.170	692		3.062	
Mechanical Biological Treatment (MBT) outputs						
Credits for the recovery of materials and energy (without RDF production)				-3.516	-3.516	-133
Refuse Derived Fuels (RDF)			0	0	0	
TOTAL WASTE TO INCINERATION		3.234	164	-1.387	2.011	0
Incineration plant	8.843	3.234	164	-1.387	2.011	
TOTAL WASTE TO LANDFILL		65.388	454	-600	65.242	-20.551
Landfill	65.356	65.308	454	-600	65.242	-20.551
<b>TOTAL</b>		<b>77.214</b>	<b>1.382</b>	<b>-11.051</b>	<b>62.545</b>	<b>-20.694</b>
		Transportation	0	0,0%		

Figure 19. Table of results.

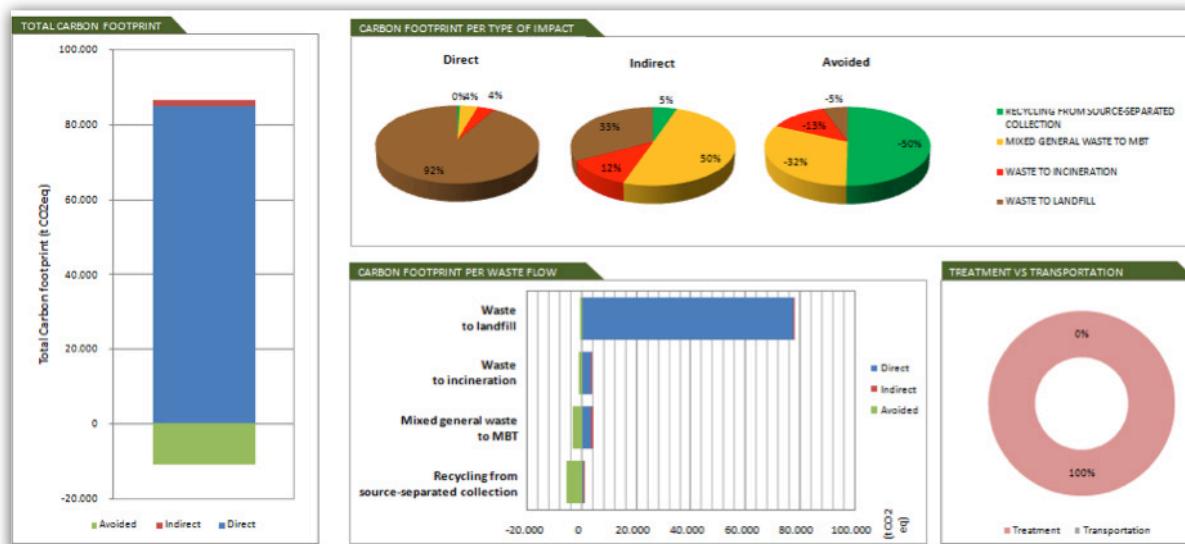


Figure 20. Result graphics.

## 4) Abbreviations

CO <sub>2</sub> ZW®	Carbon Footprint Tool for Waste Management in Europe
GHG	Greenhouse Gas
IPCC	Intergovernmental Panel on Climate Change
MBT	Mechanical Biological Treatment Plant
MSW	Municipal Solid Waste
NIR	National Inventory Reports
RDF	Refuse Derived Fuel

## 5) Glossary

<b>Aerobic composting</b>	The use of oxygen (generally in open air) to biologically decompose waste materials for the production of compost.
<b>Avoided emissions</b>	GHG emissions that have been abated from the system as a result of utilising recovered and recycled products (both material and energy) from the system's various waste flows in lieu of the same products made from virgin materials.
<b>Biomethanisation</b>	The process of decomposing waste materials or biomass with anaerobic bacteria (absence of oxygen) to produce biogas.
<b>Biostabilised product</b>	Product from the composting of mixed waste that contains a mixture of inert and biodegradable fractions. It is commonly used as filling material for road construction or landscaping.
<b>CO<sub>2</sub>-eq Credits</b>	In CO <sub>2</sub> ZW®, carbon dioxide equivalent credits (or carbon credits) refer to GHG emissions which can be deducted from the total carbon footprint of the system being studied as a result of emission-reducing activities within the waste sector. For example, for every ton of aluminium recycled there is a reduced need (one ton) for virgin aluminium production. Thus the GHG emissions that would otherwise be emitted in the production of one ton of virgin aluminium are allocated to the system as credits.
<b>Carbon footprint (also global warming potential and greenhouse gas emissions)</b>	A carbon footprint is a measure of the impact our activities have on the environment, and in particular climate change. In terms of waste management, the carbon footprint is a measurement of all greenhouse gases associated with waste sector operations and has units of tonnes (or kg) of carbon dioxide equivalent. In CO <sub>2</sub> ZW®, the term "carbon footprint" is interchangeable with "global warming potential" and "greenhouse gas emissions".
<b>Carbon sequestration</b>	The capture of carbon dioxide (CO <sub>2</sub> ). This may occur naturally or anthropogenically through biological, chemical or physical processes.
<b>Commingled recycling bin</b>	A collection system where different classifications of recyclable materials (e.g. glass, plastic and paper) are collected together in one container for separation downstream.

<b>Direct emissions</b>	GHG emissions that take place directly in the system's waste management facilities and are associated with their operation. Examples include the combustion of fossil fuels, the incineration of waste and biological degradation processes.
<b>Global warming potential</b>	See carbon footprint.
<b>Greenhouse gas</b>	Any of the atmospheric gases that contribute to the greenhouse effect by absorbing infrared radiation produced by solar warming of the Earth's surface. The six Kyoto greenhouse gases are: carbon dioxide (CO <sub>2</sub> ), methane (CH <sub>4</sub> ), nitrous oxide (N <sub>2</sub> O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF <sub>6</sub> ).
<b>Indirect emissions</b>	GHG emissions that take place outside of the system's waste management facilities but are associated with their operation. Examples include emissions related to the consumption of imported electricity, heat and materials.
<b>Mechanical Biological Treatment</b>	A combination of mechanical and biological processes for separating mixed waste streams into individual streams for recovery, recycling or final disposal.
<b>Municipal Solid Waste</b>	Refers to all types of waste generated in a household. Can also include waste considered similar to household waste (e.g. waste generated in small offices).
<b>National Inventory Report</b>	Contains a country's national greenhouse gas emission estimates on an annual basis. NIRs generally compile historical estimates for years preceding the date of publication.
<b>Refuse Derived Fuel</b>	A fuel produced by shredding and dehydrating solid waste through the application of waste conversion technology.
<b>Residual waste/materials</b>	The waste remaining following material recovery processes.
<b>Tunnel composting</b>	Totally enclosed in-vessel composting to allow for controlled aeration.
<b>Windrow composting</b>	The production of compost by piling organic matter or biodegradable waste in long rows.

# Appendix A: List of default values

## Waste generation

Country	Waste generation rate (kg/person·day)
Greece (1)	1.43
Italy (2)	1.55
Slovenia (2)	1.11
Spain (2)	1.69
Catalonia (3)	1.35
European average (4)	1.42

(1)ERS estimations for 2010 according to official figures (ERS, 2011)

(2)Data from National Inventory Reports

(3)Catalan Agency for Waste (2012)

(4)Eurostat. Statistics in focus. 31/2011. Environment and Energy. Author: Karin Blumenthal.

## Mixed general waste destination

Country	MBT1	MBT2	Landfill	Incineration
Greece (1)	17%	0%	83%	0%
Italy (2)	0%	30.7%	56%	13.3%
Slovenia (3)	0.0%	0.0%	98.3%	1.7%
Spain	39.4%	6.4%	45.2%	9.1%
Catalonia (4)	0.6%	49.7%	38.2%	11.5%
European average (5)	6.2%	2.0%	55.5%	36.3%

(1) Data from Gentil et al. 2009 (2) Data from experts (3) Data from National Inventory Report (4) Catalan Agency for Waste (2012) (5) Averages taken from a selection of six EU countries in Gentil et al., 2009. Global warming factor of municipal solid waste management in Europe. Waste Management & Research 2009 27: 850

## Source-separated waste collection

Country	Total recovery	Glass	Plastic	Metal	Paper & Cardboard	Organic materials	Other
Greece (3)	17%	51%	20%	45%	42%	4.2%	0%
Italy (1)	33.1%	81.8%	16.0%	45.5%	38.1%	35.1%	19.1%
Slovenia (2)	27.9%	8%	5%	0%	20%	37%	0%
Spain	13.4%	43.2%	11.4%	18.9%	22.5%	7.1%	4.3%
Catalonia (3)	39.1%	64.7%	26.7%	13.0%	48.7%	36.4%	40.7%
European average (4)	35.1%	42.5%	28.3%	50.5%	49.0%	41.5%	0.0%

(1) Data calculated from ISPRA (2009) (2) Data from Bistra, assumed to be representative of Slovenia, and from National Inventory Report (3) Catalan Agency for Waste (2012) (4) Averages taken from a selection of six EU countries in Gentil et al., 2009. Global warming factor of municipal solid waste management in Europe. Waste Management & Research 2009 27: 850

## Recycling efficiency

Country	Glass	Plastic	Metal	Paper & Cardboard
Greece (1)	99%	80%	99%	95%
Italy (2)	97.5%	67.3%	76.9%	93.5%
Slovenia (2)	97.5%	67.3%	76.9%	93.5%
Spain	96.0%	54.7%	54.7%	92.0%
Catalonia (3)	98.0%	65.0%	98.0%	95.0%
European average (2)	97.5%	67.3%	76.9%	93.5%

(1) Data from Ecorec (2) There was no data publicly available. For this reason, an average between Spanish and Greek data was considered. (3) Catalan Agency for Waste (2012).

## Mechanical Biological Treatment (MBT) performance

	MBT1 Performance				MBT2 Performance			
	Material recovery	Organic matter diversion	Organic matter recovery	Residue	Material recovery	Organic matter diversion	Organic matter recovery	Residue
<b>General estimation (1)</b>	3.7%	80.0%	7.4%	63.4%	4.5%	85.0%	7.4%	57.0%
<b>Catalonia (2)</b>	16.0%	0%	0%	83.5%	7.6%	84.6%	0%	69.4%

(1) Data from experts. (2) Catalan Agency for Waste (2012)

## Electricity mix and biogas capture

Country	GWP Electricity Mix (kg CO <sub>2</sub> /kWh)	Biogas capture (%)
Greece	1.03 (1)	60.0% (2)
Italy	0.65 (1)	48.1% (2)
Slovenia	0.50 (1)	36.8% (2)
Spain	0.24 (4)	17.2% (2)
Catalonia	0.30 (5)	30.0% (6)
European average	0.50 (1)	38.7% (3)

(1) Data from EcoInvent (2) Data derived from National Inventory Reports (3) From European National Inventory Report 2009 (based on EU-27) (4) Data from 'Comisión Nacional de la Energía' for 2010 ([www.cne.es](http://www.cne.es)) (5) OCCC, 2013 (6) Catalan Agency for Waste (2012)

## MSW composition (prior to source-separated collection)

Waste fraction	Greece (3)	Italy (1)	Slovenia (2)	Spain (1)	Catalonia (5)	European average (4)
Organic material	43%	32.8%	37.0%	44.0%	36.0%	31.0%
Paper & cardboard	23%	23.9%	20.5%	21.2%	18.0%	18.0%
Plastic	13%	11.8%	10.0%	10.6%	10.2%	12.0%
Glass	3.8%	6.4%	7.0%	6.9%	7.0%	5.0%
Metals	4.3%	2.3%	5.6%	4.1%	6.4%	3.0%
Wood	1.3%	1.6%	4.2%	1.0%	2.5%	3.3%
Textiles	2.3%	3.0%	6.8%	4.8%	4.0%	4.0%
Rubber and hide	0.1%	0.0%	0.5%	6.2%	3.9%	3.3%
Other	5.7%	18.0%	8.4%	6.2%	12%	20.3%
Total	100.0%	100.0%	100.0%	100.0%	100%	100%

(1) Data from National Inventory Reports (2) Data from Bistra. (3) Data from ECOREC. (4) Data from Sander, K. (2008): Climate protection potentials of EU recycling targets. Ökopoll GmbH. Accessed March 2012 from: <http://www.eeb.org/publication/documents/RecyclingClimateChangePotentials.pdf>. Composition provided for EU-27 countries based on 2007 OECD data. In this document, the category "other combustibles" was assumed to comprise one-third "wood", one-third "rubber and hide" and one-third "other". (5) Catalan Agency for Waste (2012)

## Impurities in source-separated organic fraction

Country	Impurities in source-separated organic fraction
Greece (1)	15%
Italy (2)	10%
Slovenia (2)	10%
Spain	20%
Catalonia (3)	15%
European average (4)	7%

(1) Data not available. It was assumed an average value between Italy and Spain. (2) Data provided by partners. (3) Catalan Agency for Waste (2012) (4) Bidlingmeir et al., 2004. Separate Collection and Biological Waste Treatment in the European Community. Environmental Science and Biotechnology. 3: 307-320 . This document provides a range for impurities between 2 and 12%, so this value represents the mid-point of this range.

# Appendix B: CO<sub>2</sub>ZW® Management in Industrial Areas

## Overview

Industrial managers will be able to use CO<sub>2</sub>ZW® to quantify the carbon footprint of the wastes from industrial areas. The first step will be to select the country where the industrial area is located (if the country is not in the list, then the user will need to select 'European average'). In addition, essential information required by the tool to proceed with calculations will be the amount (tons) of waste generated by the industrial area. Besides, it will be desirable that the user also introduces the characterization of the waste generated in the industrial area in the control panel and the specific selective collection rates. Finally, and if available by the user, it will be possible to introduce more 'industrial area'-specific data, such as the destination of the generated waste (landfill, incineration, etc.), the efficiency of waste treatment plants and the waste transportation distances. A User Guide is provided with the tool.

## Adaptation to the specifications of industrial areas

The following list includes the assumptions made when adapting the CO<sub>2</sub>ZW® v1.1. tool for the management of industrial areas:

- The **basic level of analysis** will be the industrial area or industrial park (instead of the municipality). For this reason, no reference will be made to the inhabitants of the study area. Instead, the user will need to indicate the amount of generated waste (in tons).
- The **fractions of waste** included in the tool will be those with similar characteristics to municipal solid wastes (MSW). In particular, the selective collection of plastics, glass, metals and paper/cardboard will be considered.
- In the case that **other waste fractions are collected separately** (e.g. clothes), their (avoided) impact will not be accounted for by the tool. Similarly, specific hazardous waste fractions will not be included in the tool, such as used oils, batteries, fluorescents and others. These specific waste fractions will be considered in future works and will be indicated along the recommendations for future actions in the Mediterranean area (last stage of the project).
- In the event that the user of the tool (the industrial manager) has data on the **average composition of the generated waste**, he/she will be able to introduce it into the tool, considering the following fractions: organic material, paper and cardboard, plastic, glass, metals, wood, textiles, rubber and hide, and other. If possible, average 'industrial area' waste characterizations will be introduced by default to the tool.

# Appendix C: References & document notes

(1) Partner countries participating in this project include Greece, Italy, Slovenia and Spain.

(2) Additionally, an scenario for Catalonia (2012) has been added in the version 1.1 of the tool, thanks to data provided by Agència de Residus de Catalunya (ARC), the Catalan Agency for Waste.

(3) It is worth mentioning that MBT plants can be considered, in the CO<sub>2</sub>ZW<sup>®</sup> tool, as a flexible waste treatment facility that can be adapted to most European contexts (in order to include other waste treatment facilities such as dry-humid fraction separation). Thus, the user may customize their efficiency in order to adapt it to local practices.

(4) Source:

[http://www.tetrapak.com/Document%20Bank/environment/climate/lifecycle\\_envprofile\\_liqfoodpack.pdf](http://www.tetrapak.com/Document%20Bank/environment/climate/lifecycle_envprofile_liqfoodpack.pdf). Note: this statistic is specific for the Tetra Brik Aseptic (TBA) container, usually used as packaging for juices and is not the general composition of all Tetra Paks. Should the user require data for other Tetra Pak types then it is recommended that they investigate the link provided above.

(5) EcoInvent Database available at: <http://www.ecoinvent.org/database/>

(6) EcoInvent Database available at: <http://www.ecoinvent.org/database>

(7) The Tool considers that only landfill emissions associated with the waste collected during the study period are incurred over a period of time beyond this period. All other emissions, such as those incurred at the MBT plants, incineration plants and through transportation, are incurred within the study period.



Authors:



[www.sostenipra.cat](http://www.sostenipra.cat)

Financial support:



Projet cofinancé par le Fonds Européen  
de Développement Régional (FEDER)  
Project cofinanced by the European Regional  
Development Fund (ERDF)

