



UNIVERSITE CHOUAIB
DOUKKALI



National Technical
University of Athens



Faculté des Sciences El Jadida

**Development of Domestic Solid Waste Management
Schemes for Small Urban Communities in Morocco
WASTESUM (LIFE06 TCY/MA/000254)**



**Deliverable 20C
Life Cycle Inventory manual**

December 2008

Manual of LCI Database

Introduction

The database is modeled on Microsoft Excel, is fully adjustable, and user can choose between default values that have been sourced from literature and public databases, or enter values which have been collected on site. In that way, the model can be used for any spatial and temporal conditions and activity data.

Structure

The excel spreadsheet is divided into 14 tabs, namely:

1. Intro
2. Wizard
3. Activity Input
4. Transportation Input
5. Mobile Equipment Input
6. Landfill Gas
7. Landfill Gas Flaring
8. Leachate
9. Leachate Treatment
10. Composting
11. Electricity and Water Consumption
12. Summarized Results
13. Analytical Results
14. Characterized and Normalized Results

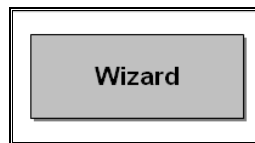
Tabs 3 through 11, allow user to insert the necessary data to the model (MSW production, characteristics of vehicles used for collection and transportation etc).

Since not all data is accessible, LCI database is providing default values for various emission factors and parameters which have been sourced from literature and public databases. The user can enter his own measured values (emission factors, landfill gas parameters etc), however it is strongly recommended that user-specified values to be base on proper, site-specific measurements.

Please note that all fields that have to be set by the user are colored white with a red distinct number next to each field. On each tab, detailed instructions are given, while the function of each tab is presented briefly.

1. Intro

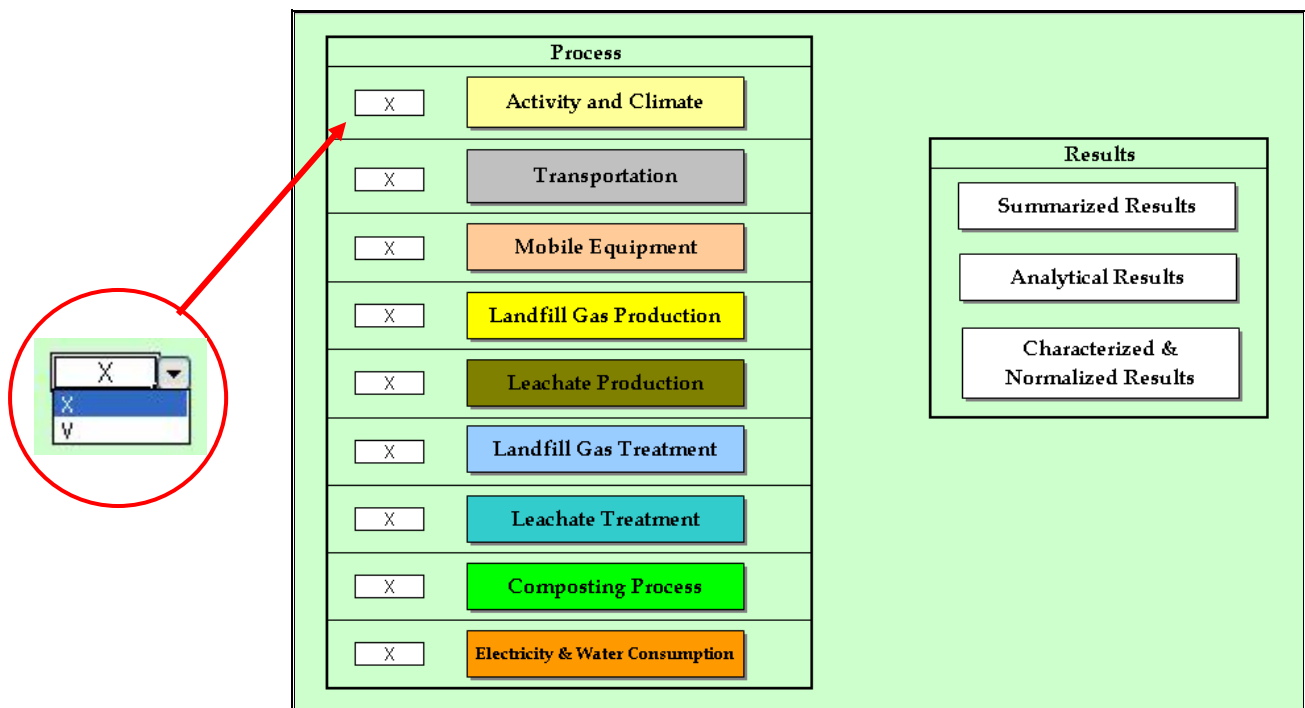
In these tab, information about the model is presented and system boundaries are identified. Moreover, a link to Wizard tab is provided (snapshot 1).



Snapshot 1

2. Wizard

Wizard tab, functions as a user guide, providing links for all tabs (snapshot 2). In this way, user can access directly to any process or result. The user can also check every process for which the appropriate input data have been entered, by changing the “X” sign to a “V” sign in the drop down list provided next to each link button.



Snapshot 2

Moreover, in all tabs there is a “Back to Wizard” button (snapshot 3), which leads directly to the Wizard tab.



Snapshot 3

3. Activity Input

This tab, allows user to provide general and activity data (snapshot 4).

General Data Input		MSW Composition Data Input		MSW Amount to Composting Input	
City Name	Azemmour	MSW Composition		Fraction of Total MSW to Composting	
Year of Data Collection	2008	Type	(%)	Type	(%)
Waste & Landfill Data Input		Food	70	Food	70
Waste Density (m ³ /tn)	1.5	Garden	8	Garden	60
Total MSW production (tn)	10,648	Paper and cardboard	3	Paper and cardboard	60
Biogas Flaring	YES	Wood	2	Wood	0
Leachate Aeration Treatment	YES	Glass	6	Glass	0
Climate Data Input		Metals	7	Metals	0
Mean Annual Temperature (oC)	17	Plastics	2	Plastics	0
Mean Annual Precipitation (mm)	400	Other	2	Other	0
		Total	100		

Snapshot 4

Data are divided into 19 fields as follows:

Field 1: The name of the city under examination

Field 2: The year in which all data have been collected.

Field 3: The average density of the waste in m³ / tn.

Field 4: The total municipal solid waste (MSW) amount that have been produced in the city, in the year specified in field 2. The amount is given in tones.

Field 5: According to the examined management plan, the user is able to select whether the produced landfill gas is treated by flaring or not (in case of an uncontrolled landfill). It should be mentioned that LCI database provides

estimations only for flaring, thus estimations for any other treatment, such as energy recovery, is not provided in this model.

Field 6: According to the management plan, the user is able to select whether the produced leachate is treated by aeration or not (in case of an uncontrolled landfill). It is important to mention that LCI database provides estimations only for aeration, thus estimations for any other treatment, such as reverse osmosis etc, is not provided in this model.

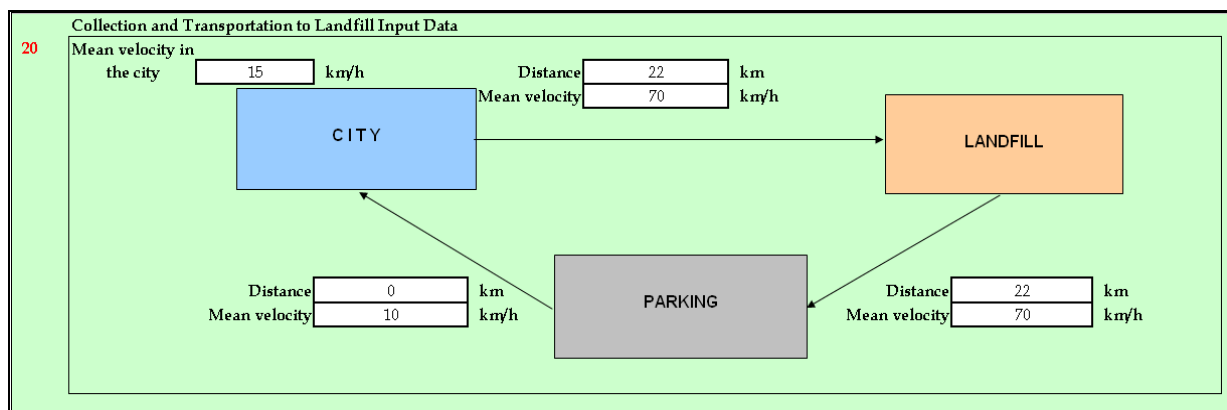
Fields 7-8: The mean annual temperature (°C) and precipitation (mm) of the city.

Fields 9-16: The composition of the MSW.

Fields 17-19: In case where composting process is selected, the user has to identify the percentage of the organic waste that is used as feedstock. The types of organic wastes that can be used for composting are only food, paper and garden waste. For instance, if the total annual production of paper is 1000 tn, and 500 are diverted to composting, a 50 % value is using. The model calculates automatically the remaining percentages that are led to landfill.

4. Transportation Input

This tab, allows user to provide collection and transportation data. In field 20 (snapshot 5), the user sets the distance and the mean velocity of the vehicles between the city, the landfill site and the parking lot (legs). In case the parking is in the city, then the distance between the parking and the city should be set to zero.



Snapshot 5

It is very important to mention that in case the distance between two locations is zero, the velocity must be set equal to 10. .

In field 21 (snapshot 6), user provides the characteristics of the vehicles which collect and transport the waste to landfill. The user has first to divide the fleet into teams of vehicles with the exact same characteristics, presented in the head row (apart from Name / Brand). Alternatively, the user can enter one team (with all vehicles) and use average values, a practice that is strongly not recommended.

21	FLEET	Name / Brand	Type of Vehicle	Type of Fuel	Average Capacity [tn MSW]	Working Days/Year	Collections (trips) per working day	Average distance travelled in the city per trip [kny/trip]	Number of Vehivles (Same Characteristics)	tn MSW transported to Landfill per year	Total (tn MSW) for Landfill
	1	Renault	RT >20-26t Euro-1	Diesel	17	365	1	16	1	6205	4,728
	2	Mitsubishi	RT >14-20t Euro-1	Diesel	4.5	365	1	7	1	1642.5	Average Load Factor 60%
	3									0	
	4									0	
	5									0	
	6									0	
	7									0	
	8									0	
	9									0	
	10									0	
	SUM									7,848	

Snapshot 6

For each team, the user provides the name, the type of vehicle(s) and the type of fuel the vehicle runs on, in the first three columns. The types of vehicles are based on EU legislation and presented in the following table.

Vehicle type	Class	Legislation
Heavy Duty Vehicles	Rigit <=7.5 t	Conventional
	Rigit 7.5 - 12 t	EURO I - 91/542/EEC Stage I
	Rigit 12 - 14 t	EURO II - 91/542/EEC Stage II
	Rigit 14 - 20 t	EURO III - 99/96/EC Stage I
	Rigit 20 - 26 t	EURO IV - 99/96/EC Stage II EURO V - 99/96/EC Stage III

Snapshot 7

Field 24: The user determines the site where the mobile equipment is operating (landfill or composting site)

Field 25: The user enters the type of mobile equipment used (excavators, compactors, tractors etc). This parameter does not affect the calculations, and it is considered a label to help user identify quickly each mobile equipment.

Fields 26 - 28: The user enters the type of fuel that the mobile equipment is using to operate. Fuel can be either gasoline or diesel. Then the user enters the type of engine. A list of diesel engine types is given below:

- NADI : Naturally Aspirated Direct Injection
- TCDI: Turbo-Charged Direct Injection
- ITCDI: Intercooled Turbo-Charged Direct Injection
- NAPC: Naturally Aspirated Prechamber Injection
- TCPC: Turbo-Charged Prechamber Injection
- ITCPC: Intercooled Turbo-Charged Prechamber Injection

Most of the vehicles are equipped with diesel engines, but there are some, mainly small mobiles such as Forklifts, that can be powered by 2-stroke (2SG) or 4-stroke (4SG) gasoline engines.

In field 28, user enters the NRMM stage of the mobile. According to CORINAIR approach, the vehicle population is split into different power ranges. This approach also allows one to take into account the EU legislative steps, which are currently in preparation at EU level. After 1998, the EU introduced Non-Road Mobile Machinery Exhaust Emissions directive (NRMM) to control emissions from off-road diesel mobiles. NRMM and its amendments enforce different regulations (stages) to mobiles, based on the year of manufacture. Stage I refers to mobiles and machinery have been produced between July 1998 and January 2001, Stage II between January 2001 and January 2006 and Stage IIIa after January 2006.

The following table summarizes EU regulations and implementation dates for non-road vehicles and industrial machinery.

NRMM Stage	Date of Manufacture
Uncontrolled	Prior to 1/7/98
Stage I	1/7/98
Stage II	1/1/01
Stage IIIa	1/1/06

Field 29: The user enters the age of the mobile equipment.

Field 30: The user enters the number of mobiles which have the exact same characteristics (same engine, same age, same working hours, horsepower etc).

Field 31 - 33: In these fields, the user sets the working hours of the mobile equipment during a day, the working days per year as well as the average horsepower of the mobile in hp.

Fields 34-35: The user enters the sulphur content in diesel and gasoline in ppm (snapshot 8).

Fuel Specifications Data Input		
	ppm	(kg S / kg fuel)
Gasoline Sulphur Content	500	0.0005
Diesel Sulphur Content	50	0.00005

Snapshot 8

6. Landfill Gas

This tab, allows the user to provide data for the estimation of the produced landfill gas (snapshot 9).

Model Parameters Data Input		
Parameter	Measured Values	Database
Average Methane Generation Rate, k [years-1]		0.035
Potential Methane Generation Capacity, Lo [m3/Mg]		Cellulose Content 40% -50%
NMOC Concentration [ppmv as hexane]		Inventory Co-disposal
Methane Content [% volume]		50

Estimated Cellulose Content
81%

Snapshot 9

Field 36 - 39: The Methane Generation Rate, k, determines the rate of methane generation resulting from the biodegradation of the organic load of the MSW that has been disposed of in the landfill. The higher the value of k, the faster the methane generation rate increases. The value of k is estimated automatically by the model.

The potential Methane Generation Capacity Lo, depends only on the type and composition of waste placed in the landfill, and the higher the cellulose content of the waste, the higher the value of Lo. Food, textiles, paper, wood, and horticultural waste have the highest Lo value on a dry basis, while inert materials such as glass, metal and plastic have no Lo value. An average cellulose content is estimated and suggested by the model. Default concentration for the Non-Methane Organic Compounds inventory is 600 ppmv [USEPA, AP 42] where co-disposal of hazardous waste has either not occurred or is unknown and 2,400 ppmv where co-disposal of hazardous waste has occurred.

As shown in the snapshot, the user can enter his own measured values. However it is strongly recommended that the user-specified values should be based on proper site-specific measurements.

7. Landfill Gas Flaring

This tab, provides data for calculations emissions from landfill gas flaring (snapshot 10).

Flaring Data Input		
Parameter	Default Values	Mesured Values
Emissions NO2 [kg/10 ⁶ m ³ CH ₄]	631	
Emissions CO [kg/10 ⁶ m ³ CH ₄]	737	
Emissions PM [kg/10 ⁶ m ³ CH ₄]	238	
Efficiency of collection system [%]	75	
Mass of S from landfill gas [g/Mg landfill gas]	66.80	

Snapshot 10

The user can set his own measured values. However it is strongly recommended that user-specified values should be base on proper, site-specific measurements. For more information please refer to the LCI technical report (section 3).

8. Leachate

This tab, provides data for calculating emissions from leachate (snapshot 11).

Water Emissions and Pollutant Concentration Factors Input			
Type of Waste		Water (Leachate) Production [%] Default	Water (Leachate) Production [%] Measured Values
Slowly degrading waste	Paper/textile waste	3.42	
	Wood/ straw/ rubber waste	3.42	
Moderately degrading waste	Garden and park waste	4	
Rapidly degrading waste	Food waste/ sewage sludge	5.94	
Bulk MSW or Industrial Waste	Mixed composition	3	

Pollutant	Concentration [gr/lit Leachate] Default	Concentration [gr/lit Leachate] Measured Values
BOD	40	
COD	50	
NH ₃	0.05	

Snapshot 11

The user can enter his own measured values. However it is strongly recommended that the user-specified values should be based on proper site-specific measurements. For more information please refer to the LCI technical report (section 3).

9. Leachate Treatment

This tab, provides data for calculating emissions resulting from leachate treatment and includes aeration treatment only (snapshot 12).

Aeration Treatment of Leachate Data Input			
Parameter	Default Values	Mesured Values	
Emissions CO2 [gr/gr COD]	2.706		53
Emissions NO2 [gr/gr NH3]	1.375		54
Efficiency of COD removal [%]	75		55
Efficiency of NH3 removal [%]	80		56

Snapshot 12

The user can enter his own measured values. However it is strongly recommended, that the user-specified values should be base on proper site-specific measurements. For more information please refer to the LCI technical report (section 3).

10. Composting

This tab, provides data for calculating emissions from composting processes (snapshot 13).

User Data Input			
Parameter	Default Values	Mesured Values	
Emissions CH4 [kgr/tn MSWc]	4.00		
Emissions N2O [kgr/tn MSWc]	0.30		
Compost Production [tn Compost/tn MSWc]	0.37		
Fertilizer Subsitute from Compost [kg Fertilizer/tn Compost]	70.00		
CO2 Emissions from production of Fertilizer [gr CO2/kg Fertilizer]	200.00		
N2O Emissions from production of Fertilizer [gr CO2/kg Fertilizer]	120.00		
CH4 Emissions from production of Fertilizer [gr CO2/kg Fertilizer]	10.00		

Snapshot 13

The user can enter his own measured values. However it is strongly recommended that the user-specified values should be base on proper site-specific measurements. For more information please refer to the LCI technical report (section 3).

11. Electricity and Water Consumption

This tab, allows the user to enter data for electricity and water consumption in the landfill and the composting site (snapshot 14).

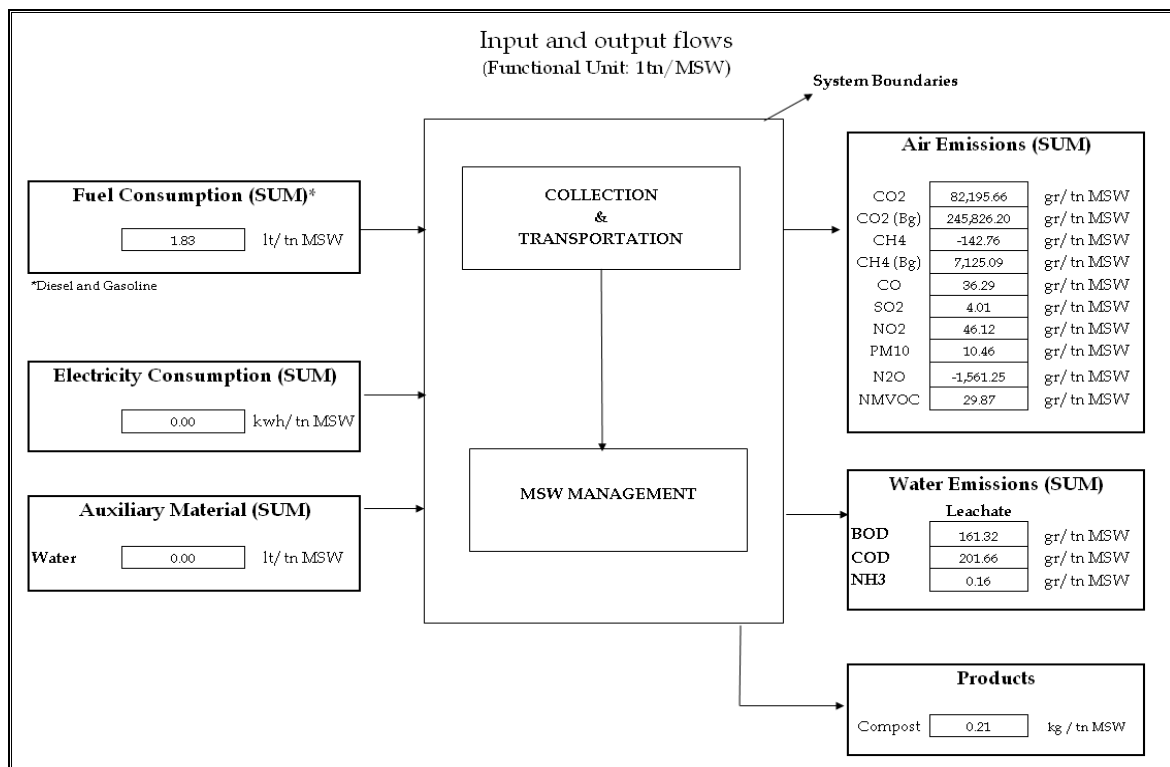
Electricity Data Input		
	Landfill	Composting
Electricity Usage per Year (kwh/ year)	0	0
Water Consumption (m3 / year)	0	0

Snapshot 14

Values for both electricity and water consumption, represent the total amount for the year specified in field 2 (the year that the data has been collected).

12. Summarized Results

This tab, provides a summarized visual report of all input and output flows of the system, based on the input data that the user has provided. The user can review and print the results. A sample is given in snapshot 15.



Snapshot 15

13. Analytical Results

This tab, provides an analytical report of all input and output flows of the system, based on the input data that the user has provided. The user can review and print the results. A sample is given in snapshot 16.

	Transpostatio n to Landfill	Transpostatio n to Composting	Landfilling				Composting			TOTAL	Units	
			Mobile Equipment	Leachate	Biogas	Electricity Consumption	Process	Mobile Equipment	Electricity Consumption			
Co-Product								0.21				kg Compost / tn MSW
Air Emissons												
CO2	1,390.89	948.46	1,631.38		80,781.45	0.00	-2,880.08	323.57	0.00	82,196		gr/tn MSW
CO2 (Bg)				1,637.04	13,449		230,740.00			245,826		gr/tn MSW
CH4	0.05	0.04	0.95				-144.00	0.20	0.00	-142.76		gr/tn MSW
CH4 (Bg)					4,901.09		2,224.00			7,125.09		gr/tn MSW
CO	3.49	2.36	11.75		16.24	0.00		2.44	0.00	36.29		gr/tn MSW
SO2	0.04	0.03	0.05		3.87	0.00		0.01	0.00	4.01		gr/tn MSW
NO2	14.78	10.00	5.43	0.89	13.91	0.00		1.13	0.00	46.12		gr/tn MSW
PM10	0.71	0.49	3.30		5.25			0.71		10.46		gr/tn MSW
NzO							-1,561.25			-1,561.25		gr/tn MSW
NMVOOC	1.27	0.85	22.86		0.00			4.89		29.87		gr/tn MSW
1,2,3-Trimethyl Benzene	0.00	0.00	0.07					0.02		0.09		gr/tn MSW
1,2,4-trimethylbenzene	0.01	0.01	0.20					0.04		0.27		gr/tn MSW
1,3-Butadiene	0.04	0.03	0.79					0.17		1.03		gr/tn MSW
1-butene	0.03	0.02	0.48					0.10		0.62		gr/tn MSW
1-hexene	0.02	0.01	0.36					0.08		0.47		gr/tn MSW
1-pentene	0.01	0.01	0.24					0.05		0.31		gr/tn MSW
3-Methylhexane	0.00	0.00	0.08					0.02		0.11		gr/tn MSW
Acetaldehyde	0.05	0.04	0.95					0.20		1.24		gr/tn MSW
Acetone	0.02	0.01	0.36					0.08		0.47		gr/tn MSW
Acetylene	0.05	0.04	0.95					0.20		1.24		gr/tn MSW
Acrolein	0.02	0.02	0.42					0.09		0.55		gr/tn MSW
Benzaldehyde	0.02	0.01	0.33					0.07		0.43		gr/tn MSW
Benzene	0.00	0.00	0.02		0.00			0.00		0.02		gr/tn MSW
Butane	0.00	0.00	0.04					0.01		0.05		gr/tn MSW
Butyraldehyde	0.01	0.01	0.21					0.04		0.27		gr/tn MSW
Decane	0.02	0.02	0.43					0.09		0.56		gr/tn MSW
Ethane	0.00	0.00	0.01		0.00			0.00		0.01		gr/tn MSW
Ethylbenzene	0.01	0.00	0.12		0.00			0.03		0.16		gr/tn MSW
Ethylene	0.16	0.11	2.86					0.61		3.73		gr/tn MSW
Formaldehyde	0.08	0.05	1.43					0.31		1.87		gr/tn MSW
Isobutane	0.00	0.00	0.03					0.01		0.04		gr/tn MSW
Isobutene	0.02	0.02	0.40					0.09		0.53		gr/tn MSW
Isopentane	0.02	0.01	0.29					0.06		0.37		gr/tn MSW
Pentane	0.00	0.00	0.02		0.00			0.00		0.02		gr/tn MSW
Propane	0.00	0.00	0.02		0.00			0.01		0.03		gr/tn MSW
Propionaldehyde	0.02	0.01	0.30					0.06		0.39		gr/tn MSW
Propylene	0.04	0.03	0.71					0.15		0.93		gr/tn MSW
Styrene	0.01	0.00	0.13					0.03		0.17		gr/tn MSW
Toluene	0.00	0.00	0.00		0.00			0.00		0.00		gr/tn MSW
Water Emissons												
BOD				161.32						161.32		gr / tn MSW
COD				201.66						201.66		gr / tn MSW
NH3				0.16						0.16		gr / tn MSW
Produced Electricity										0.00		Mj / tn MSW
Produced Heat										0.00		Mj / tn MSW
Fossil Fuels												
Coal						0.00			0.00	0.00		Mj / tn MSW
Oil						0.00			0.00	0.00		Mj / tn MSW
Gas						0.00			0.00	0.00		Mj / tn MSW
* Fuel	0.60	0.41	0.68					0.14		1.83		lt/ tn MSW
Renewable Resources										0.00		
Hydro						0.00			0.00	0.00		
Wind						0.00			0.00	0.00		Mj / tn MSW
Water Consumption				0.00			0.00			0.00		m3 / tn MSW

Snapshot 16

14. Characterized and Normalized Results

This tab, provides a report with characterized and normalized data. More specifically, the report contains tables and graphs of the estimated emissions against the functional unit for each phase of the selected MSW management plan.. The user can review and print the results.

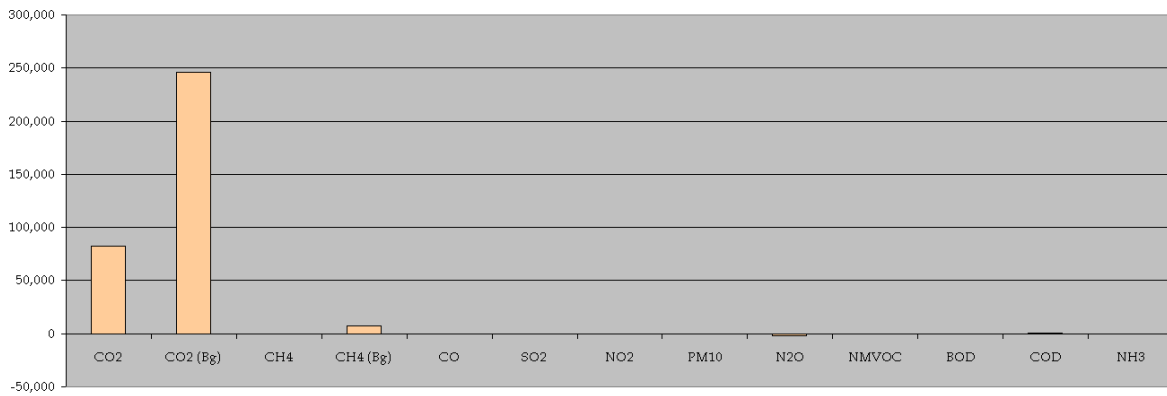
Samples are given in snapshots 17,18 and 19.

Back to Wizard

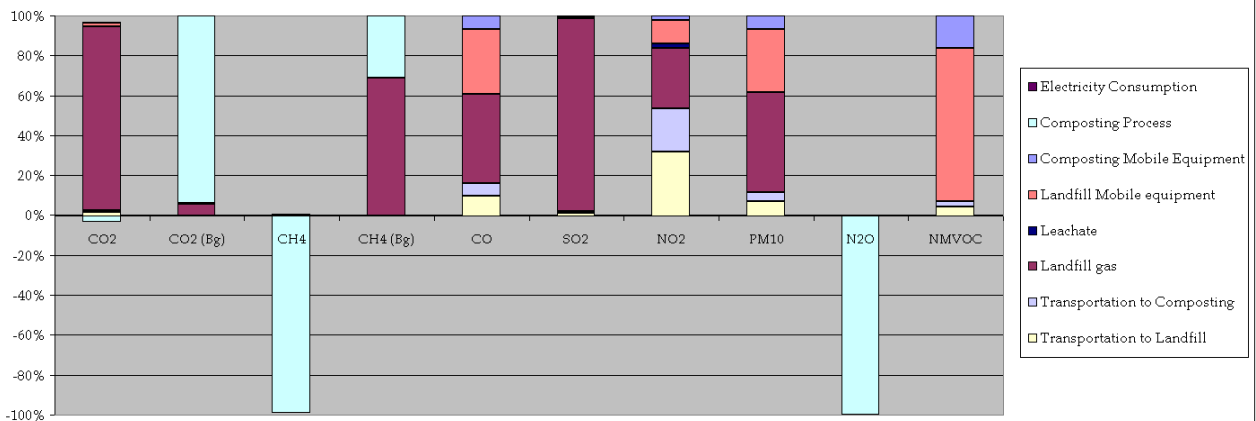
Emission Results

Pollutant	unit	Transportation to Landfill	Transportation to Composting	Landfill gas	Leachate	Landfill Mobile equipment	Composting Mobile Equipment	Composting Process	Electricity Consumption	SUM
CO2	gr/ tn MSW	1,390.89	948.46	80,781.45	0.00	1,631.38	323.57	-2,880.08	0.00	82,195.66
CO2 (Bg)	gr/ tn MSW	0.00	0.00	13,449.16	1,637.04	0.00	0.00	230,740.00	0.00	245,826.20
CH4	gr/ tn MSW	0.05	0.04	0.00	0.00	0.95	0.20	-144.00	0.00	-142.76
CH4 (Bg)	gr/ tn MSW	0.00	0.00	4,901.09	0.00	0.00	0.00	2,224.00	0.00	7,125.09
CO	gr/ tn MSW	3.49	2.36	16.24	0.00	11.75	2.44	0.00	0.00	36.29
SO2	gr/ tn MSW	0.04	0.03	3.87	0.00	0.05	0.01	0.00	0.00	4.01
NO2	gr/ tn MSW	14.78	10.00	13.91	0.89	5.43	1.13	0.00	0.00	46.12
PM10	gr/ tn MSW	0.71	0.49	5.25	0.00	3.30	0.71	0.00	0.00	10.46
N2O	gr/ tn MSW	0.00	0.00	0.00	0.00	0.00	0.00	-1,561.25	0.00	-1,561.25
NMVOC	gr/ tn MSW	1.27	0.85	0.00	0.00	22.86	4.89	0.00	0.00	29.87
BOD	gr / tn MSW				161.32					161.32
COD	gr / tn MSW				201.66					201.66
NH3	gr / tn MSW				0.16					0.16

Summary of Emissions [gr / tn MSW]



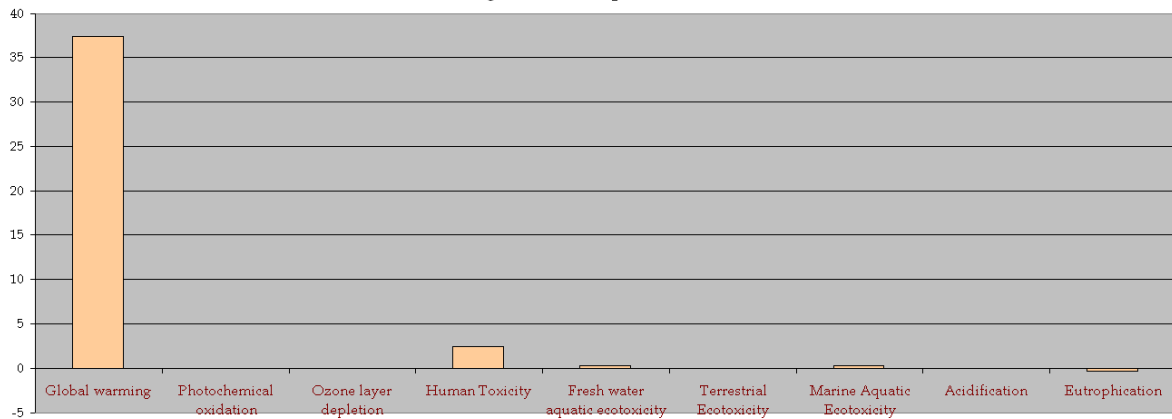
Contribution of each phase in Air Emission Results



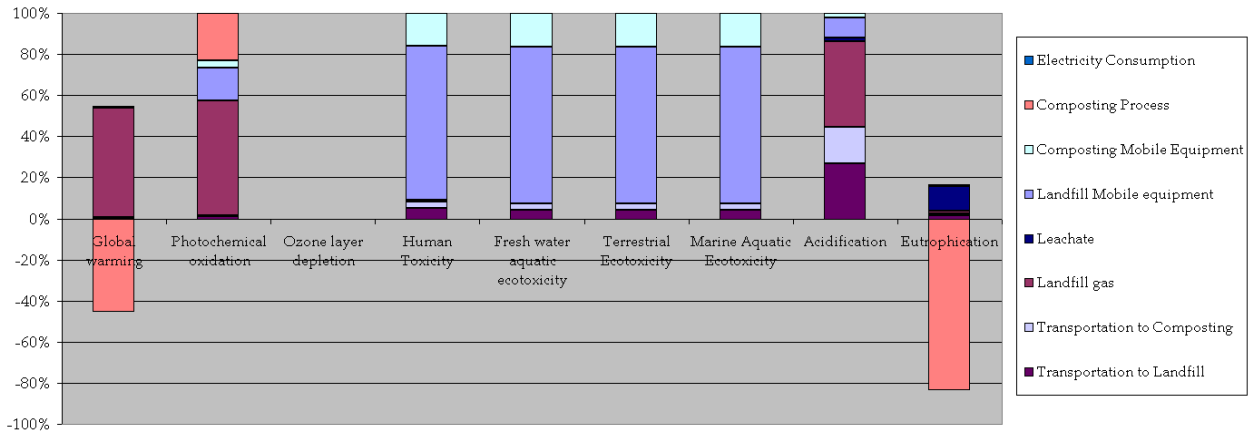
Characterized Results

	unit	Transportation to Landfill	Transportation to Composting	Landfill gas	Leachate	Landfill Mobile equipment	Composting Mobile Equipment	Composting Process	Electricity Consumption	SUM
Global warming	[kg CO2 eq.]	1.3922	0.9493	217	1.6370	1.6552	0.3287	-185	0.0000	37
Photochemical oxidation	[kg ethylene eq.]	0.0006	0.0004	0.0300	0.0000	0.0085	0.0018	0.0125	0.0000	0.0537
Ozone layer depletion	[kg CFC-11 eq.]	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Human Toxicity	[kg 1,4-2-ch-benzene eq.]	0.1189	0.0796	0.0214	0.0011	1.8159	0.3880	0.0000	0.0000	2.4249
Fresh water aquatic ecotoxicity	[kg 1,4-2-ch-benzene eq.]	0.0128	0.0086	0.0000	0.0000	0.2307	0.0493	0.0000	0.0000	0.3015
Terrestrial Ecotoxicity	[kg 1,4-2-ch-benzene eq.]	0.0005	0.0003	0.0000	0.0000	0.0082	0.0018	0.0000	0.0000	0.0107
Marine Aquatic Ecotoxicity	[kg 1,4-2-ch-benzene eq.]	0.0134	0.0090	0.0000	0.0000	0.2409	0.0515	0.0000	0.0000	0.3148
Acidification	[kg SO2 eq.]	0.0074	0.0050	0.0116	0.0004	0.0028	0.0006	0.0000	0.0000	0.0279
Eutrophication	[kg PO4-3 eq.]	0.0074	0.0050	0.0070	0.0613	0.0027	0.0006	-0.4215	0.0000	-0.3376

Summary of Characterized Results
[kg Substance eq. / tn MSW]



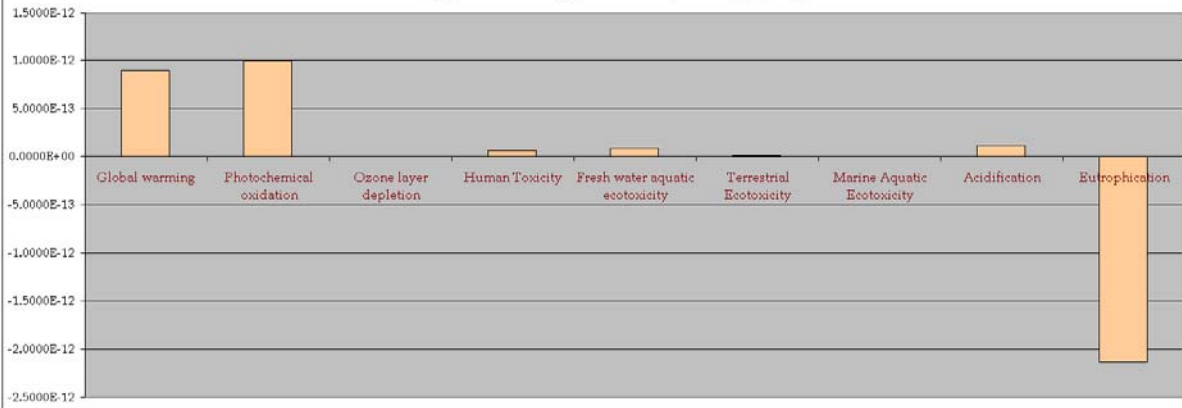
Contribution of each phase in Characterized Results



Normalized Results

	unit	Transportation to Landfill	Transportation to Composting	Landfill gas	Leachate	Landfill Mobile equipment	Composting Mobile Equipment	Composting Process	Electricity Consumption	SUM
Global warming		3.3268E-14	2.2686E-14	5.1797E-12	3.9119E-14	3.9553E-14	7.8536E-15	-4.4301E-12	0.0000E+00	8.9199E-13
Photochemical oxidation		1.0124E-14	6.7834E-15	5.5190E-13	0.0000E+00	1.5995E-13	3.3291E-14	2.2935E-13	0.0000E+00	9.8741E-13
Ozone layer depletion		0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
Human Toxicity		3.1161E-15	2.0867E-15	5.5985E-16	2.7906E-17	4.7594E-14	1.0170E-14	0.0000E+00	0.0000E+00	6.3554E-14
Fresh water aquatic ecotoxicity		3.6952E-15	2.4697E-15	0.0000E+00	0.0000E+00	6.6381E-14	1.4186E-14	0.0000E+00	0.0000E+00	8.6731E-14
Terrestrial Ecotoxicity		4.1873E-16	2.7986E-16	0.0000E+00	0.0000E+00	7.5221E-15	1.6025E-15	0.0000E+00	0.0000E+00	9.8282E-15
Marine Aquatic Ecotoxicity		6.9053E-17	4.6153E-17	0.0000E+00	0.0000E+00	1.2405E-15	2.6509E-16	0.0000E+00	0.0000E+00	1.6208E-15
Acidification		3.1161E-14	2.1079E-14	4.8978E-14	1.8576E-15	1.1624E-14	2.4113E-15	0.0000E+00	0.0000E+00	1.1671E-13
Eutrophication		4.6663E-14	3.1564E-14	4.3914E-14	3.8742E-13	1.7137E-14	3.5584E-15	-2.6623E-12	0.0000E+00	-2.1320E-12

Summary of Normalized Results
[kg Substance eq. / tn MSW per Cap / year]



Normalized Results for each phase
[kg Substance eq. / tn MSW per Cap / year]

