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BASE IMPACTS® DATA DOCUMENTATION

CATEGORY: END OF LIFE TREATMENT

3 levels of documentation are available for the datasets in Base Impacts®:

- A **general documentation** explaining general information on the datasets and data general requirements
- A **sectorial documentation:** one document per sector describing the available datasets and their characteristics (technological representativeness, geographical representativeness), and providing the information on the datasets in a common layout. Information comes from the consultation specifications, the dataset commissioner technical proposal and the metadata
- The **datasets metadata** can be viewed directly in the datasets sheets. They include more detailed information (flow diagrams, Etc.)

This document is the category documentation for end of life treatment.

CONTENTS

A. PRESENTATION OF THE END OF LIFE TREAMENT DATASETS

1. List of available datasets

The following datasets are available:

Technological representativity		Geographical representativity	Dataset type
Waste incineration	Untreated wood	France, Europe	Partly terminated system
	Biodegradable waste	France, Europe	Partly terminated system
	Ferrous metal waste	France, Europe	Partly terminated system
	Plastic waste	France, Europe	Partly terminated system
	Glass waste	France, Europe	Partly terminated system
	Paper waste	France, Europe	Partly terminated system
	Textile waste	France, Europe	Partly terminated system
	Particle board	France, Europe	Partly terminated system
	Plastics (PA6, PA6.6, PAN)	France, Europe	Partly terminated system
	Plastics (PA6 GF30, PA6.6 GF30)	France, Europe	Partly terminated system
	Plastics (PE, PP, PB, PS)	France, Europe	Partly terminated system
	Plastics (PET, PMMA, PC)	France, Europe	Partly terminated system
	Plastics (PVC rigid)	France, Europe	Partly terminated system
	Municipal solid waste (MSW)	France, Europe	Partly terminated system
Landfill	Biodegradable waste	France, Europe	Partly terminated system
	Glass/inert waste	France, Europe	Partly terminated system
	Textiles	France, Europe	Partly terminated system
	Wood products (OSB, particle board)	France, Europe	Partly terminated system
	Municipal household waste	France AT, DE, IT, LU, NL, SE, CH BE, DK ES, GR, PT FR, UK, FI, NO, IR	Partly terminated system

Table 1 : Available datasets

2. Advice for use of available datasets

2.1. Scope for aggregation

The data available in the Base IMPACTS® result from aggregated inventories, and can therefore be used separately.

2.2. Modeling the benefits of energy recovery

The incineration datasets represent end of-life inventories for the thermal treatment of waste in an average Municipal Solid Waste Incinerator (MSWI). The data set includes the emissions and resource consumption for the thermal treatment of waste, but the benefits associated with the use of the exported energy (electricity and steam) is outside the system boundaries and needs to be modeled by the user (system expansion, use within the product system etc.).

This needs to be modeled separately, by linking the dataset with the national electricity and heat datasets, using the formulas from BP X30-323-0; all necessary parameters are provided in the metadata:

Impact of incinerated fraction

= Impact of incineration

– yield of heat production x LHV x impact heat

– yield of electricity production x LHV x impact electricity

With LHV: Lower Heating Value

A system expansion is used in case of scrap recovery. This means that in case of incineration with scrap recovery, a credit is included. Scraps are in majority iron based, so a specific iron-ore mix is credited to the process.

B. SCOPE OF THE DATASETS

1. Reference flow, functional unit

The processes are provided for 1 kg of waste entering the waste treatment facility.

2. System boundaries

2.1. General foreground system boundaries

Cut-off rules for each unit process: All elements available in the model as input parameters are specified for the incineration good and therefore included. Cut-off rules for each unit process: Coverage of at least 95% of mass and energy of the input and output flows, and 98% of their environmental relevance (according to expert judgment).

2.2. Dataset-specific foreground system boundaries

2.2.1. Waste incineration

The datasets represent an end of-life inventory for the thermal treatment of a specific waste in an average municipal solid waste incinerator (MSWI). This data set can be used for the incineration of the mentioned and specified waste.

Comments on the "waste fractions" vs "average household waste" datasets

The "waste fractions" dataset represent the incineration of a specific waste fraction incinerated in an average MSWI. The thermal treatment of a specific waste fraction like paper or plastic or even specific wastes like Polyamide 6 is not done in reality in a MSWI. The waste is always homogenized to obtain a relative constant calorific value around 10-12 MJ/kg and to comply with the emission standards. Nonetheless the used model allows to attribute the emission, resource consumption of auxiliaries, the energy production as well as the scrap production to a specific waste incinerated based on the elementary composition. The elementary composition of each waste fraction is provided in the online metadata.
In the "average household waste" datasets, the share of waste fractions and the calculated elementary composition of the MSW represent the average waste that is landfilled or incinerated in France / Europe, i.e. without waste from separate collection.

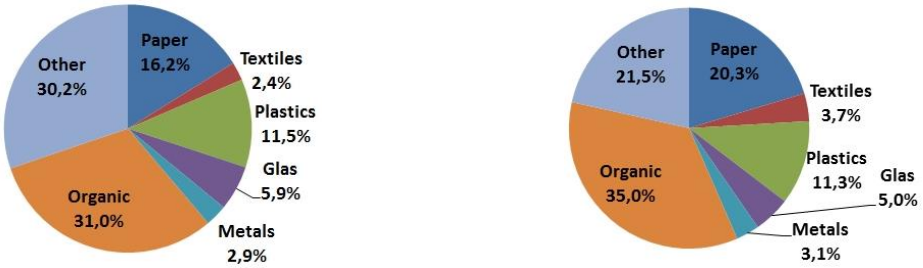

Figure 1 : Average waste that is incinerated in France / in Europe

System boundaries

The data set includes the emissions and resource consumption for the thermal treatment of waste.

A system expansion is used in case of scrap recovery.

The behaviour of bottom ash and air pollution control residues on a landfill is considered.

All utilities used in the waste incineration plant, the operation of the underground deposit and the landfill for bottom ash and air pollution control (APC) residues as well as the recycling of the recovered ferrous metal scrap are included in the system.

Infrastructure of incineration plant and electricity generation is considered.

The use of the exported energy (electricity and steam) is outside the system boundaries and needs to be considered by the user (system expansion, use within the product system etc.).

Waste collection, transport, intermediate storage and pre-treatment are not included in the inventory.

Incineration model and NOx removal technology

The data set is modeled with typical technology used in France or in Europe to meet the legal requirements.

- In dry flue gas treatment (FGT) systems, the flue gas treatment system uses a dry technology with adsorbent and a SNCR (Selective Non-Catalytic Reduction) system for NOx-reduction. The NOx reducing agent ammonia is directly injected into the furnace and reacts with the NOx to nitrogen and water. The flue gas is conditioned, adsorbents added and filtered with fabric filters. Lime milk and small parts of hearth furnace coke are used as adsorbents; a part of the adsorbents is re-circulated. The fly ash together with the adsorbent is mixed together with the boiler ash (treatment of APC residues see below).
- In wet flue gas treatment (FGT) system, the flue gas treatment system uses a pre-dusting stage and an additional downstream deduster both fabric filters and wet scrubbers to clean the flue gas. After leaving the pre-dedusting stage used to reduce the dust load before the wet scrubbers, the flue gas is feed into the water of the first wet scrubber. Mainly HF and HCl are removed in the first stage. The deposition of sulphur dioxide in the very acid medium of the first stage (pH 0-1) is low and requires a second wet scrubber to remove SO2. Lime milk, hearth furnace coke and trass are used as adsorbents in the filters and scrubbers. A purification of the brine from the first scrubber to hydrochloric acid and the sulphate slurry from the second scrubber to gypsum is not done. All residues are treated together as APC residues (see below). As final treatment stage the flue gas passes a SCR system to reduce NOx. Due to the quenching of the flue gas in the wet scrubber and the temperature requirements of the SCR catalyst the flue gas has to be reheated.

The following data was used for France and Europe datasets:

	Flue gas treatment and NOx removal technology	Data source
France	55% dry FGT and SNCR for NOx removal 45% wet FGT and SCR for NOx removal	*[Girus/ADEME]*
Europe	67% dry FGT and SNCR for NOx removal, 33% wet FGT and SCR for NOx removal	*[BREF, 2006]*

Heat and electricity generation
The plant consists of an incineration line fitted with a grate and a steam generator. The average efficiency of the steam production is about 80%. Produced steam is used internally as process-steam and the balance is used to generate electricity or exported as heat to industry or households.

The following data was used for France and Europe datasets:

	Net efficiency of the plant	Share of energy exported as electricity / heat	Data source
France	38,4%	34% electricity 66% thermal energy	*[French energy statistic of the Ministère de l'écologie, du développement durable et de l'énergie (2011)]*
Europe	40,8%	28% electricity 72% thermal energy	*[CEWEP Energy Report III (2012)]*

Emissions

For France,
For the emissions HCl, HF, NOx, VOC, N2O, CO, NH3, SO2, dust, dioxin and the heavy metals As, Cd, Co, Cr, Ni and Pb mean emission values per cubic meter of cleaned flue gas published in the BREF document "Waste Incineration" of the European Commission are used. Due to the wide range of emissions for some elements and substances the mathematical mean values are adjusted with additional real plant data. The emission of all other elements and the distribution of all elements and substances into the different residues are calculated by means of transfer coefficients (see model description in the online metadata).

For Europe
Efficiencies of the different flue gas treatment stages (filter, scrubber, SCR, SNCR etc.) and transfer coefficients (fate of e.g. heavy metals) are taken from the treatment of MSW in an average European MSWI. The emissions are then calculated based on the elementary composition of the specific waste and the flue gas treatment efficiencies respectively the transfer coefficients for average municipal solid waste.

The emissions of incineration per ton of wet waste are provided in the online metadata.

Treatment of residues

<u>Bottom ash</u>
The bottom ash is approximately 220kg/t of MSW (approximately 200 kg/t of MSW without ferrous metal scrap).
The bottom ash) is quenched and a three month ageing process is done to stabilize the bottom ash.
Some of the produced bottom ash after metal recovery and ageing is reused as construction material (and will leave the system as bottom ash for reuse).
The rest is disposed on a landfill. To consider the transfer of elements of the bottom ash into ground water, water bodies or air leachate tests for bottom ash and standard leakage rates for landfills are used.

<u>Air-pollution control (APC) residues</u>

According to the current situation in Europe, APC residues (40kg/t of MSW) including boiler ash, filter cake and slurries are disposed in salt mines or landfills. The disposal in salt mines without free water and contact to ground water reservoirs was modelled as emission free. The operation of the underground deposit is included. The landfill was modelled similar to the bottom ash using leachate test data for APC residues. Transports for bottom ash and APC residues independent of the different routes are considered.

The following data was used for France and Europe datasets:

	Use of bottom ash after metal recovery	Disposal of APC residues
France	82,5% reuse as construction material 17,5% landfill	24% in salt mines 76% in landfills
Europe	60% reuse as construction material 40% landfill	43% in salt mines 57% in landfills

Other

The transfer coefficients for the elements (used to allocate the different elements and substances to the different mediums air, bottom ash, air pollution control residues) and the energy and utility consumption of the waste-to-energy plant are determined based on industry data (real plant data) and a comprehensive literature research.
The transfer coefficients of some heavy metals are extrapolated from elements with comparable behavior.

Limits of the modeling

It should be considered that this data set is an approximation to reality. The used model of an average European Waste to Energh (WtE) plant and the average composition of MSW do not exist in reality and efficiencies, emission values, transfer coefficients and elementary composition will differ if a specific WtE plant is used.

2.2.2. Landfill of waste

The datasets represent the landfill of waste in France or in Europe. The datasets can be used to characterise the treatment of defined waste fractions in a representative manner within user specific product LCAs.

Comments on the “waste fractions” vs “average household waste” datasets

The “waste fractions” dataset represent the landfill of a specific waste fraction. The elementary composition of each waste fraction is provided in the online metadata.

In the “average household waste” datasets, the share of waste fractions and the calculated elementary composition of the MSW represent the average waste that is landfilled or incinerated in France / Europe, i.e. without waste from separate collection. The following data was used:

	LANDFILL				
	ES, GR, PT	BE, DK	FR, UK, FI, NO	AT, DE, IT, LU, NL, SE, CH	FR
Paper	18%	14%	23%	18%	30%
Textiles	5%	2%	4%	4%	5%
Plastics	11%	11%	12%	11%	13%
Glas	5%	3%	6%	4%	6%
Metals	3%	2%	3%	3%	3%
Organic	44%	38%	34%	40%	29%
Other/ inert	13%	29%	18%	19%	14%

System boundaries

The effort for sealing materials (clay, mineral coating, PE film) and diesel for the compactor is included in the dataset. Site is including landfill gas treatment, leachate treatment, sludge treatment and deposition.

Collection, transport and pre-treatment are not included.

The data set is partly terminated and lists the elementary flows and generated energy product (electricity) from landfill gas utilisation.

Only environmental impacts of the landfill process occurring within 100 years are considered.

Technology description

The data set represents a typical municipal waste landfill with surface and basic sealing meeting European limits for emissions, with landfill height 30 m, landfill area 40.000 sqm, with a 100 years deposit.

Landfill gas production calculated according to [WEBER]. Distribution of landfill gas: 22 % flare, 28 % used, 50 % emissions [KRUEMPELBECK]. Use of landfill gas represents industrial country standard. Average landfill gas composition and amount for stable methane phase. [Thomé-Kozmienski]. Precipitation data from [BAUMGARTNER & LIEBSCHER] (660 mm/a). A rate of 60 % transpiration/run off is assumed.

Landfill leachate: exponential solubility of fluids is assumed. Solubility factors are used for different solubility calculations. [Finnveden]. Leachate and landfill body are assumed to be homogeneous. Landfill body is saturated. No circulation of leachate. Basic sealing effectively for leachate: 70 %. Leachate treatment includes active carbon and flocculation/precipitation processing. Sludge treatment and deposition is included.

The sealing contains gravel, sand, clay and polyethylene film as most relevant processes. Gravel and sand are used as filter layers, PE film as waterproofed sealing and clay as mineral coverage in the surface and basic sealing. Gravel, sand and clay are mined from dry quarry. The basis for the production of polyethylene film is crude oil. All manufacturing processes of the sealing materials are considered.

The transfer coefficients for transfer of elements from the input to the final destination (gas, water or sludge) are partly extrapolated from comparable chemical elements (same main group: e.g. Ga -> Tl).

2.3. Background system boundaries

Background system boundaries follow the rules defined by PE International.

C. DATA SOURCES AND QUALITY

1. Data quality requirements

Quality requirements for Base Impacts® datasets are detailed in the general Base Impacts® documentation. No specific quality requirements were set for the end of life treatment datasets.

2. Types and sources of data

The inventory is mainly based on industry data and is completed, where necessary, by secondary data.

The datasets were created with the use of the following elements and references:

For municipal incineration:

- Zusammensetzung und Schadstoffgehalt von Siedlungsabfällen, 2003
- IPPC - Reference Document on the Best Available Techniques for Waste Incineration, 2006
- Modelling waste incineration for life-cycle inventory analysis in Switzerland, 2001
- Management of APC Residues from WtE Plants - An overview of important management options, 2003
- ISWA paper on handling of APC residues, 2003
- Management of Bottom Ash from WtE Plants, International Solid Waste Association, 2006
- Transfer coefficients, residues and technology of modern waste incinerators, 2007
- Heavy metals in waste incineration, 1993
- CEWEP Energy Report III (Status 2007-2010), 2012
- Eurostat - Treatment of waste 2008
- Usines d´incinération d´ordures ménagères (UOIM)
- La gestion des REFIOM des UIOM françaises
- CEWEP Country Report 2010 - France
- Production et distribution d´électricité - année 2009

For landfill:

- Product Specific Emissions from Municipal Solid Waste Landfills, Part I, 1998
- Product Specific Emissions from Municipal Solid Waste Landfills, Part II, 1998
- Solid Waste Treatment Within the Framework of Life Cycle Assessment - Metals in MSW Landfills
- Minimierung von Emissionen der Deponie, 1990
- Deponie 3 - Ablagerung von Abfällen, 1989
- Untersuchung zum langfristigen Verhalten von Siedlungsabfalldeponien, 2000
- Zusammensetzung und Schadstoffgehalt von Siedlungsabfällen, 2003
- Abfallwirtschaft - Handbuch für Praxis und Lehre, 2000
- Sickerwasserreinigung, 1994
- Produktion und Nutzung von Deponiegas, 1993
- Behandlung von Deponiesickerwässern in Bayern. Grundlagen, Forschung und Praxis, 2002

- Elution von Stoffen aus Recycling-Materialien im Bauwesen, 2003
- Implementation of the landfill directive in the 15 member states of the European Union, 2005
- Waste generated and treated in Europe: Data 1990-2001, 2003
- Fachbeitrag Deponiebau, 2001
- Analysen, Berichte - Umwelt Schweiz 2002, 2002
- Statistical Yearbook of Norway 2005, 2005

3. Data quality

3.1. Technological representativeness

3.2. Time-related coverage

- Incineration: Data collection period: 2006-2012, Reference year 2009, annual average
- Landfill: Reference year 2011, annual average

3.3. Geographical coverage

- Incineration: France and Europe (representing EU-27 + Switzerland and Norway).
- Landfill: France and Europe (with 4 geographical areas).

3.4. Precision

3.5. Completeness

3.6. Consistency

4. Multi-functionality and allocation procedure

4.1. Foreground system allocation procedure

The benefits associated with the use of the exported energy (electricity and steam) is outside the system boundaries

A system expansion is used in case of scrap recovery (see 2.2).

4.2. Background system allocation procedure

Background system allocation procedure follows the rules defined by PE International.

D. CRITICAL REVIEW

All Base Impacts® datasets follow the ILCD Entry Level requirements, which require a review either internal with public report or external.

The datasets were reviewed by internal critical review:

- **Raw data**: Validation of data sources, Sample tests on calculations, Cross-check with other source, Expert judgement
- **Unit process(es), single operation** : Validation of data sources, Sample tests on calculations, Energy balance, Element balance, Cross-check with other source, Cross-check with other data set, Expert judgement, Mass balance, Compliance with ISO 14040 to 14044
- **Unit process(es), black box**: Validation of data sources, Sample tests on calculations, Energy balance, Element balance, Cross-check with other source, Cross-check with other data set, Expert judgement, Mass balance, Compliance with ISO 14040 to 14044
- **LCI results or Partly aggregated system**: Validation of data sources, Sample tests on calculations, Energy balance, Element balance, Cross-check with other source, Cross-check with other data set, Expert judgement, Mass balance, Compliance with ISO 14040 to 14044
- **LCIA results**: Cross-check with other source, Cross-check with other data set, Expert judgement
- **Documentation** : Expert judgement, Compliance with ISO 14040 to 14044
- **Life cycle inventory methods**: Compliance with ISO 14040 to 14044

E. REPORTS FOR MORE INFORMATION

The following documents should be used for more information:

- Gabi Modelling Principles 2013 ;
- General Base Impacts® documentation
- Review report, available in the metadata of each dataset.

F. ADMINISTRATIVE INFORMATION

1. Commissioner

PE International.

2. Dataset modeler

PE International.