Documentation of impact assessment methods implemented in the ecoinvent database v3.8 (2021.09.21)

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1 Executive summary

ecoinvent publishes the result of its own work as cumulative life cycle inventories (LCIs): a long list of emissions to the environment and natural resource consumption, resulting from human activities from the cradle to the grave of a product. In addition, life cycle impact assessment (LCIA) scores are calculated and published, with the help of characterization factors (CFs) provided by LCIA method developers.

This report documents the assumptions made by ecoinvent in the implementation of the LCIA methods concerning many aspects: substance name, compartment and subcompartment correspondence choices, long-term and short-term emission treatment, fossil and non-fossil greenhouse gas emissions and natural resources. A brief description of the implemented methods is available, including specific assumptions applicable to each of them.

The result of the implementation is available in a series of spreadsheets, showing the explicit correspondence between the nomenclature of the database and each LCIA method. Most of the relevant information is found in the spreadsheets, and only brief descriptions about what cannot be easily expressed in a spreadsheet are included in the written report. The complete set of files is available on request at support@ecoinvent.org.

2 Introduction

ecoinvent specializes in the life cycle inventory (LCI) phase of life cycle assessment (LCA). The data gathered is available under the form of unit processes (direct emissions and resource consumption by a human activity, and its connection to other human activities) and cumulative LCI (sum of direct and indirect emissions and resource consumption by a human activity).

The life cycle impact assessment phase (LCIA) of an LCA depends on extensive knowledge in very different areas of the natural and health sciences, depending on the cause-and-effect chain between emission and impact on the so-called damage categories or areas of protection (e.g., human health or ecosystem quality). The development of an impact model requires input from meteorology, chemistry, hydrology, pedology, ecology, biology, geology, and many other specializations. ecoinvent uses the end product of those models, the so-called characterization factors (CFs), to calculate impact scores of the cumulated LCI results of each dataset.

An LCIA score is calculated with the following equation:

$$h_i = \sum_k g_k \cdot CF_{i,k}$$

where $CF_{i,k}$ stands for the CF of substance k in the impact category i, g_k stands for the quantity of substance k emitted/consumed by the life cycle of the system considered, and h_i is the LCIA score for category i.

Many problems arise when mapping CFs from different methods to a database, such as:

- Different naming conventions are used to refer to the same elementary exchanges (EEs)
- The same EE name bears different meaning in the database and the different methods
- The database does not provide the necessary EE for the full implementation of the methods

This report's purpose is to communicate the choices made by ecoinvent in this context. There is no consensus about the completion of this task, beside common sense. The implementation made by ecoinvent may differ from implementations provided by LCA software, eco-design tools, case studies, etc. This is why the documentation of the implementation has to be careful, detailed and extensive.

Section 4 describes overarching assumptions, applicable to every method unless explicitly contradicted. Section 5 and following provide a short description of methods, specific assumptions and exceptions to overarching assumptions. Thereby, the focus is on the IPCC method (as it is widely used and its implementation comes with several assumptions) and on new methods. Details about other method implementations can be found in previous implementation reports as indicated in the Database Overview file (go to the “Data Releases” section on the website, use the link to the current database version and there you find it under “Relevant Documents & Files”).

The result of the implementation is not found in the present document, but presented in a series of spreadsheets, available on request at support@ecoinvent.org.

3 Supporting files

This section summarizes the content of the different files, supporting the steps of the implementation of the LCIA methods.

3.1 Standard method files

The website of ecoinvent does not host the files provided by the method developers. Those are all presented in different formats (spreadsheet or xml files) and have been downloaded from the website of the developers or obtained via e-mail. Instructions on how to obtain them are given in each method's section.

ecoinvent has developed a common "standard" spreadsheet format. One standard file is produced for each method. The file contains information on the EEs such as name, CAS number, formula, synonyms, unit, compartment, and subcompartment, and the name of each impact category, as published by the method developers (see Figure 1). The cells below impact category names show the CFs for each EE. An empty cell indicates no CF reported by the developers.

Figure 1 Screen capture of "CML v4.8 2016_standard.xlsx"

name	CAS	formula	synonyms	unit	direction	compartn	subcompartment	abiotic depletion (elements, ultimate ultimate reserv	abiotic depletion (fossil fuels)	global warming (GWP100)	ozone layer depletion (ODP steady state)	human toxicity (HTP inf)
-(CF2)4CH(OH)-	16621-87-7			kg	emission	air	unspecified			13		
(CF3)2CFOCH3	22052-84-2			kg	emission	air	unspecified			363		
(CF3)2CHOCH3	13171-18-1			kg	emission	air	unspecified			14		
(CF3)2CHOCHF2	26103-08-2			kg	emission	air	unspecified			2620		
(HFE-7100)	163702-07-6(n-HFE-7100)			kg	emission	air	unspecified			486		
1,1,1-trichloroethane	71-55-6			kg	emission	air	unspecified			160	0.12	16.4443
1,1,1-trichloroethane	71-55-6			kg	emission	soil	agricultural					16.0331
1,1,1-trichloroethane	71-55-6			kg	emission	soil	industrial					15.7051
1,1,1-trichloroethane	71-55-6			kg	emission	water	ocean					9.64874
1,1,1-trichloroethane	71-55-6			kg	emission	water	surface water					16.2433
1,2,3,4-tetrachlorobenzene	634-66-2			kg	emission	air	unspecified					50.0227

3.2 Category mapping file

The ecoQuery website reports scores by specifying the name of the method, the impact category and the indicator. It is necessary to establish an unambiguous correspondence between the name of category/indicator in the ecoQuery system and the name of the category within a method, as published by the developers. Also, different methods use different conventions for the name of their units. The file "category_mapping_v3.X.xlsx" contains this correspondence and the indicator units (see Figure 2).

Figure 2 Screen capture of "category_mapping_3.5.xlsx"

	A	B	C	D	E	F	G	H	I
1	method name in ecoinvent	category name in method	unit in method	category name in ecoinvent	indicator name in ecoinvent	unit in ecoinvent	previous category name	previous indicator name	note
65	ILCD 1.0.8 2016 midpoint no LT	Freshwater ecotoxicity	CTUe	ecosystem quality	freshwater ecotoxici	CTUh.m3.yr			new method
66	ILCD 1.0.8 2016 midpoint no LT	Freshwater eutrophication	kg P eq	ecosystem quality	freshwater eutrophi	kg P-Eq			new method
67	ILCD 1.0.8 2016 midpoint no LT	Marine eutrophication	kg N eq	ecosystem quality	marine eutrophicatic	kg N-Eq			new method
68	ILCD 1.0.8 2016 midpoint no LT	Ionizing radiation E (interim)	CTUe	ecosystem quality	ionising radiation	mol N-Eq			new method
69	ILCD 1.0.8 2016 midpoint no LT	Human toxicity, non-cancer effects	CTUh	human health	non-carcinogenic eff	CTUh			new method
70	IPCC 2007	GWP100	kg CO2-Eq	climate change	GWP 100a	kg CO2-Eq	climate change	GWP 100a	
71	IPCC 2007	GWP20	kg CO2-Eq	climate change	GWP 20a	kg CO2-Eq	climate change	GWP 20a	
72	IPCC 2007	GWP500	kg CO2-Eq	climate change	GWP 500a	kg CO2-Eq	climate change	GWP 500a	
73	IPCC 2007 no LT	GWP100	kg CO2-Eq	climate change	GWP 100a	kg CO2-Eq	climate change	GWP 100a	
74	IPCC 2007 no LT	GWP20	kg CO2-Eq	climate change	GWP 20a	kg CO2-Eq	climate change	GWP 20a	
75	IPCC 2007 no LT	GWP500	kg CO2-Eq	climate change	GWP 500a	kg CO2-Eq	climate change	GWP 500a	
76	IPCC 2013	GTP100	kg CO2-Eq	climate change	GTP 100a	kg CO2-Eq	climate change	GTP 100a	
77	IPCC 2013	GTP20	kg CO2-Eq	climate change	GTP 20a	kg CO2-Eq	climate change	GTP 20a	
78	IPCC 2013	GWP100	kg CO2-Eq	climate change	GWP 100a	kg CO2-Eq	climate change	GWP 100a	
79	IPCC 2013	GWP20	kg CO2-Eq	climate change	GWP 20a	kg CO2-Eq	climate change	GWP 20a	
80	IPCC 2013 no LT	GTP100	kg CO2-Eq	climate change	GTP 100a	kg CO2-Eq	climate change	GTP 100a	
81	IPCC 2013 no LT	GTP20	kg CO2-Eq	climate change	GTP 20a	kg CO2-Eq	climate change	GTP 20a	
82	IPCC 2013 no LT	GWP100	kg CO2-Eq	climate change	GWP 100a	kg CO2-Eq	climate change	GWP 100a	
83	IPCC 2013 no LT	GWP20	kg CO2-Eq	climate change	GWP 20a	kg CO2-Eq	climate change	GWP 20a	

3.3 Compartment and subcompartment mapping file

The nomenclature of compartment and subcompartment may vary, depending on the method. It was necessary to establish an explicit correspondence between ecoinvent's nomenclature and each method's nomenclature. This information is contained in the file "compartment_mapping_3.X.xlsx (see Figure 3).

This file also serves another purpose. Some methods do not provide CFs for specific subcompartments, but the CFs from another subcompartment would be appropriate. This file indicates the mapping algorithm in which subcompartment to look for the CF to associate to an exchange.

Figure 3 Screen capture of "compartment_mapping_3.5.xlsx"

	A	B	C	D	E	F	G
1	method name in ecoinvent	compartment name in ecoinvent	subcompartment name in ecoinvent	compartment name in method	subcompartment name in method 1	subcompartment name in method 2	subcompartment name in method
140	IPCC 2013	air	urban air close to ground	air	unspecified	N/A	N/A
141	IPCC 2013	air	indoor	N/A	N/A	N/A	N/A
142	IPCC 2013	air	low population density, long-term	air	unspecified	N/A	N/A
143	IPCC 2013	air	unspecified	air	unspecified	N/A	N/A
144	IPCC 2013	air	non-urban air or from high stacks	air	unspecified	N/A	N/A
145	IPCC 2013	air	lower stratosphere + upper troposp	air	unspecified	N/A	N/A
146	IPCC 2013	direct human uptake	unspecified	N/A	N/A	N/A	N/A
147	IPCC 2013	economic	primary production factor	N/A	N/A	N/A	N/A
148	IPCC 2013	natural resource	in air	N/A	N/A	N/A	N/A
149	IPCC 2013	natural resource	land	N/A	N/A	N/A	N/A
150	IPCC 2013	natural resource	biotic	N/A	N/A	N/A	N/A

3.4 Name mapping files

An explicit mapping between ecoinvent's EE nomenclature and the method's nomenclature was established. This correspondence is mainly based on EEs names, CAS numbers, formulas, and synonyms, sometimes also on expert judgement and a collaboration with the method developers. These files are available on request at support@ecoinvent.org.

3.5 Mapped characterization factors files

The result of the mapping algorithm is displayed for each method in files named "(method_name)_mapped_3.X.xlsx" (see Figure 4). The file provides the mapping of EE name, compartment and subcompartment between ecoinvent and the method, the ecoinvent names of impact categories and indicators (in the format "category//indicator") and the CFs. Only implemented categories are shown. The CF is displayed in the unit of the ecoinvent exchange.

The column "status" can contain one of the following three values:

- "mapped": a match has been established between ecoinvent and the method for the exchange
- "ecoinvent orphan": the exchange exists in ecoinvent but not in the method

The column "conversion_factor" indicates the ratio of the CF as found in this file and as found in the original method file. This conversion was necessary in cases where the unit of the exchange and/or the category was different in the method and ecoinvent.

Figure 4 Screen capture of the file "CML v4.8 2016_mapped_3.8.xlsx"

name	compartment	subcompartment	unit	conversion_factor	status	method_name	method_compartment	method_subcompartment	method_unit	human toxicity//human toxicity (HTP inf)	ecotoxicity: freshwater//freshwater aquatic ecotoxicity (FAETP inf)	ecotoxicity: marine//marine aquatic ecotoxicity (MAETP inf)	ecotoxicity: terrestrial//terrestrial ecotoxicity (TETP inf)	photochemical oxidant formation//photochemical oxidation (high NOx)	acidification//acidification (incl. fate, averag Europ
1-Pentene	air	low popul	kg	1	mapped	1-pentene	air	unspecifie	kg					0.977	
1-Pentene	air	lower stra	kg	1	mapped	1-pentene	air	unspecifie	kg					0.977	
1-Pentene	air	non-urbar	kg	1	mapped	1-pentene	air	unspecifie	kg					0.977	
1-Pentene	air	unspecifie	kg	1	mapped	1-pentene	air	unspecifie	kg					0.977	
1-Pentene	air	urban air (	kg	1	mapped	1-pentene	air	unspecifie	kg					0.977	
2,4-D	air	non-urbar	kg	1	mapped	2,4-d	air	unspecifie	kg	6.638457455	38.70264593	5.281333499	0.596861512		
2,4-D	soil	agricultur	kg	1	mapped	2,4-d	soil	agricultur	kg	46.95248552	29.49533085	0.166268447	1.57851244		

4 General assumptions

Elementary exchanges (EEs) in ecoinvent are identified by a name (e.g., “Carbon dioxide, fossil”, always starting with a capital letter), a compartment and a subcompartment.

4.1 General rules for subcompartment

As described in section 3.3, there is no general rule for subcompartment mapping between ecoinvent and the different methods. The mapping algorithm follows the instructions given by the method developers. For each ecoinvent subcompartment, the method developers have specified a sequence of one, two or three subcompartments from their method. If a CF for a substance is not found in the first specified subcompartment, the algorithm looks for a CF in the second or third subcompartment. The result of the algorithm, different for each substance among a method, can be consulted in the mapped file. For more details about the files, please read section 3.

Because fate and exposure of emissions is highly dependent on the compartment of emission, it is not appropriate to use the CFs of another compartment to characterize an exchange.

4.1.1 Assessment for long-term emissions

Long-term emissions are defined as emissions that will transfer from the technosphere to the environment more than 100 years after the use of the process in the considered life cycle. This is different from long-term impacts that would be caused, for example, by the bioaccumulation of a pesticide in the food chain. This impact is taken into account if the LCIA method developers judged it was relevant to include them and had the available data to do so. An emission is classified as “long-term” in ecoinvent based on the moment where it is released in the environment, not the moment where it causes its impact. LCIA methods often discount impacts happening many decades after emission by using different archetypes: “hierarchist”, “egalitarian” and “individualist”, each integrating impacts over different time horizon.

LCA experts have not yet reached a consensus about the inclusion or exclusion of long-term emissions. Until the debate is settled, long-term emissions are reported separately via subcompartments explicitly labeled “long-term”, allowing practitioners to test the influence of their inclusion/exclusion. ecoinvent provides some methods with and without CFs for long-term emissions. Those methods are clearly labelled “no LT” (or “w/o LT”) on the ecoQuery website.

Since long-term emissions are in the environment 100 years less than short term emissions, their CF should be lower. However, most methods do not provide the distinction between the two types of emission. In this case, two options are possible:

- Attribute the same CF to both short term and long-term emissions, leading to an over-estimation of the impacts
- Attribute no CF to the long-term emission, leading to an under-estimation of the impacts.

The first option has been retained. As mentioned above, the results without long-term emissions are available in methods explicitly labelled as such. It is strongly recommended, in the interpretation phase of an LCA, to test the sensitivity of conclusions to the two scenarios.

4.2 Emissions to air

4.2.1 Noise

The version 3.8 of ecoinvent does not report noise. Even if some methods publish CFs for noise, they are not being implemented for now.

4.2.2 Fossil and non-fossil CO, CO_2 and methane emissions in global warming methods

To understand the choice of CFs for CO, CO_2 and methane, it is necessary to know how their fossil and non-fossil emissions/uptakes are modelled in the database. The table below shows the list of exchanges to untangle, and the solution retained for them.

Table 1 General assumptions for carbon sources and sinks

Exchange name	Mapping rule
Carbon dioxide, fossil	Mapped with carbon dioxide fossil CF
Carbon dioxide, non-fossil	Should be zero
Carbon monoxide, fossil	Mapped with carbon monoxide fossil CF
Carbon monoxide, non-fossil	Could be larger than zero if enough information is provided
Carbon dioxide, from soil or biomass stock	Mapped with carbon dioxide fossil CF
Carbon monoxide, from soil or biomass stock	Mapped with carbon monoxide fossil CF
Methane	Mapped with methane fossil CF
Methane, fossil	Mapped with methane fossil CF
Methane, non-fossil	Could be larger than zero if enough information is provided
Methane, from soil or biomass stock	Mapped with methane fossil CF
Carbon dioxide, in air	Should be zero
Carbon, organic, in soil or biomass stock	Mapped with carbon dioxide fossil CF, with a negative sign

Even if original datasets are carbon balanced, LCIs are rarely carbon balanced due to the unavoidable distortions introduced by allocation. Carbon corrections are not applied in the version 3.5 of ecoinvent. In these conditions, using negative CFs for carbon uptakes and positive CFs for non-fossil carbon emissions would lead to unreliable GWP scores, particularly for agriculture and wood products.

Fossil emissions essentially originate from combustion processes, where it is known that the fuels are fossil or not. Often, furnaces use a mix of fuels to produce electricity and/or heat. This mix may include organic material like wood residues or oil residues from plants. In this case, the dataset will emit both fossil and non-fossil emissions. Non-fossil emissions also occur as transportation loss of bio-methane, animal exploitation, organic chemical production, flooding of reservoirs in hydroelectricity production and waste treatment operations.

The fixation of CO_2 by plants through photosynthesis is reported as a consumption of Carbon dioxide, in air. This EE is found in the natural resource compartment.

Emissions from soil or biomass stocks occur in agricultural forestry operations, flooding of reservoirs in hydroelectricity production and some land transformation datasets. These atoms of carbon would not have been emitted if not for the perturbation caused by human activities, so they are equivalent to fossil emissions in terms of impacts.

The EE “Carbon, organic, in soil or biomass stock” in the soil, agricultural subcompartment, represent long-term carbon capture. This capture occurs in land tenure datasets. It is assumed that this carbon will stay in the soil for a much longer period than a typical LCA time frame. It is considered permanently removed from the atmosphere and its CF is -1.

4.3 Natural resources

4.3.1 Land transformation and occupation

ecoinvent makes the distinction between land transformation (quantified in m^2) and land occupation (quantified in m^2*year). Datasets using land (typically, infrastructure) report what was the land type before the land use (EE with name “Transformation, from …”), and the intended state of the land after the life of the infrastructure (EE with name “Transformation, to …”). The CFs for the former are positive (a damage) and the CFs for the later are negative (a credit). Land use is balanced within datasets (the difference of “land transformed to” and “land transformed from” is zero). If a dataset returns the land to the same state as it was before, the transformation impact will be zero. If a dataset returns the land to a lesser quality, the negative CFs for the “Transformation, to” EE will be lower, and the net sum will be positive (a damage).

4.3.2 Metal extraction

The extraction of metals and other minerals in ores is recorded as the amount of target material that is contained in the ore. Furthermore, the description of the elementary flow shows also the content of material in the ore. The only method currently implemented in ecoinvent taking into account the concentration of target element in the ore is the cumulative exergy demand. For every other method, the CF is independent of the target element concentration.

4.3.3 Water use

Water use is modelled using water from the natural resource compartment, but also reports where this water is eventually pushed outside the boundary of the dataset’s activities. This is reported via emissions to water or air. Some datasets are intentionally not water balanced, for example cement production, where the water chemically reacts with the other components and is not released under the form of water after its use.

Table 2 Elementary exchanges for water sources and sinks

name	compartment	subcompartment
Water	air	all available
Water	water	all available
Water, cooling, unspecified natural origin	natural resource	in water
Water, in air	natural resource	in air
Water, lake	natural resource	in water
Water, river	natural resource	in water
Water, salt, ocean	natural resource	in water
Water, salt, sole	natural resource	in water
Water, turbine use, unspecified natural origin	natural resource	in water
Water, unspecified natural origin	natural resource	in ground
Water, unspecified natural origin	natural resource	in water
Water, well, in ground	natural resource	in water

Note that most datasets do not consume water from the biosphere, but display an input of tap water, and reject water, when appropriate, to a wastewater treatment process.

The issue here is similar to the carbon imbalance: allocation distorts the balance and simply applying positive CFs to water consumptions and negative CFs to water emission back to water would lead to unreliable water scores. However, ecoinvent rigorously reports water evaporation to air. This quantity represents the water that leaves the ecosystem without being available for its usual function, so the positive CFs can be applied on those EE.

4.3.4 Fossil fuels

The table below lists the fossil fuel resources.

Table 3 Fossil fuel elementary exchanges

name	compartment	subcompartment	unit
Oil, crude, in ground	natural resource	in ground	kg
Gas, mine, off-gas, process, coal mining	natural resource	in ground	m3
Gas, natural, in ground	natural resource	in ground	m3
Peat, in ground	natural resource	biotic	kg
Coal, brown, in ground	natural resource	in ground	kg
Coal, hard, unspecified, in ground	natural resource	in ground	kg

4.3.5 Other resources

Other resource exchanges are listed in Table 4. Nitrogen and oxygen consumption never contribute to impact scores but are used in some datasets to close the mass balance.

Table 4 General assumptions for carbon sources and sinks

name	compartment	subcompartment	unit
Wood, hard, standing	natural resource	biotic	m3
Wood, primary forest, standing	natural resource	biotic	m3
Wood, soft, standing	natural resource	biotic	m3
Wood, unspecified, standing	natural resource	biotic	m3
Energy, geothermal, converted	natural resource	in ground	MJ
Energy, gross calorific value, in biomass	natural resource	biotic	MJ
Energy, gross calorific value, in biomass, primary forest	natural resource	biotic	MJ
Energy, kinetic (in wind), converted	natural resource	in air	MJ
Energy, potential (in hydropower reservoir), converted	natural resource	in water	MJ
Energy, solar, converted	natural resource	in air	MJ
Uranium, in ground	natural resource	in ground	kg
Nitrogen	natural resource	in air	kg
Oxygen	natural resource	in air	kg

4.4 Radioactive emissions

The only substances contributing to impact categories measuring damage caused by radioactive substances have two distinctive characteristics: their name ends with the number representing their isotope (with the exception of “alpha”) and their unit is “kBq”.

4.5 Waste

Waste is not an elementary exchange in ecoinvent. Wastes are sent to waste treatment activities, who in turn have emissions to environment depending on the nature of the input and the treatment. These emissions will be characterized by the methods, but since wastes do not appear in the list of EE in ecoinvent, if a method reports CF for wastes, they won’t be taken into account in the implementation.

4.6 Normalization and weighting

ecoinvent implements the CF up to the endpoint reported by LCIA method developers. Transforming endpoint impact scores to normalized and weighted scores is a straight-forward operation, involving only multiplying or dividing scores by the normalization and weighting factors provided by the method developers. This task is left to the users, allowing them to choose the most appropriate sets and test the influence of this choice on the conclusions of their LCA.

4.7 Known errors and shortcomings of the methods

We do not correct any errors in the LCIA method unless they have been officially corrected by the developers. Known mistakes are described in the chapter for the specific method as well as known shortcomings.

There are over 250 000 CFs in the actual implementation. Typos or mistakes are unavoidable when dealing with such a large amount of data. In case of suspected mistakes, check the known issue page on the ecoinvent website to see if the mistake has already been reported. If it is not the case, contact the ecoinvent team through support@ecoinvent.org.

5 IPCC global warming potential

5.1 General information

Method versions	4, published in 2007 5, published in 2013
Sources of the CFs	Version 4: https://archive.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html#table-2-14 Version 5: http://www.climatechange2013.org/images/report/WG1AR5_Chapter08_FINAL.pdf http://www.climatechange2013.org/images/report/WG1AR5_Ch08SM_FINAL.pdf http://onlinelibrary.wiley.com/doi/10.1002/rog.20013/abstract
Revision of implementation	Annie Levasseur

5.2 Introduction

ecoinvent implements the CFs published by The Intergovernmental Panel on Climate Change (IPCC) in 2006 (AR4) and 2013 (AR5). The basic concepts of radiative forcing and GWP is the same for the two reports. However, the last report displays a sharp increase in complexity, considering more indirect mechanisms, and leaving the reader with some room for interpretation. The first section below introduces the common concepts. Information specific to each report is then discussed separately.

5.2.1 Radiative forcing and global warming potential

The planet receives heat from the Sun and loses heat to space through radiation. The balance of these two forces keeps the Earth within a stable range of temperature. Emissions of greenhouse gases (GHGs) changes this balance by favoring or hindering radiation, a phenomenon known as radiative forcing (RF), measured in W/m^2. Many gases increase the energy absorbed by the atmosphere (positive RF, global warming), but other gases decrease it (negative RF, global cooling).

The integral over a time horizon (H) of the RF curve following a pulse emission of 1 kg of a gas represents the energy (in $W.yr/m^2$) that has not escaped the atmosphere through radiation because of this emission. This quantity is known as the Absolute Global Warming Potential (AGWP). Dividing the AGWP of a gas by the AGWP of CO_2 for the same time horizon leads to the GWP of this gas, with units of kg equivalent of CO_2 per kg of gas emitted. This metric is used to express the effects on climate change of different emissions on a common scale.

$$GWP_i(H) = \frac{\int_0^H RF_i(t)dt}{\int_0^H RF_{CO_2}(t)dt} = \frac{AGWP_i(H)}{AGWP_{CO_2}(H)}$$

The GTP goes one step further in the cause and effect chain and is based on the change in global mean surface temperature (AGTP) at a chosen point in time after a pulse emission, relative to that of CO_2. The GTP takes into account more physical processes, like climate sensitivity and exchange of heat between the atmosphere and oceans. Values of GWP and GTP can be very different, especially for shorter time horizons, for gases whose effect on climate happens mostly within the first decade after emission. This happens because GTP is an instantaneous metric that expresses the magnitude of the temperature increase at a given point in time, compared to GWP, a cumulative metric. Instantaneous metrics are more relevant to assess climate impacts related to an absolute temperature such as heat waves or extreme weather events, while cumulative metrics are more relevant to assess climate impacts related to cumulative warming such as sea level rise. Moreover, moving further along the cause and effect chain produces a more societally relevant, yet more uncertain metric.

The IPCC warns that both GWP and GTP are dependent on the arbitrary selected time horizon. Although 20, 100 or 500 years are traditionally reported, and the Kyoto Protocol has chosen to focus on the 100 years horizon, there is no scientific argument for selecting one over the other. Depending on the goal and scope of the LCA and the value choices of the sponsors, different aspects of climate change might be emphasized. This will determine the selection of the time horizon and of GWP or GTP as the metric of choice. This choice is value-based and subjective to the decision-makers. The selection of a shorter time horizon implicitly gives more importance to short-term effects and less to future generations.

5.3 IPCC 2013 (Assessment Report 5: AR5)

5.3.1 Source tables for GWP and GTP

The IPCC only supplies values for air emissions, without specifying subcompartment. The same CF is assigned to an exchange emitted to air for all the subcompartments.

Values of GWP and GTP are scattered in many tables in the AR5 and the supplementary material. It is also clear from comparing the same CF, found in different tables, that some of them have been rounded. Table 5 shows the source for those metrics. Supporting spreadsheet “IPCC_mapped_3.5.xlsx” contains more detailed information about the source of CFs.

Table 5 Sources for GWP and GTP from AR5

Source table	Substances	Note
8.A.1	Carbon dioxide	See discussion below about fossil and non-fossil carbon dioxide, and from soil or biomass stock
8.A.4	Carbon monoxide	See discussion below about fossil and non-fossil carbon monoxide, and from soil or biomass stock
8.A.5	VOC	
8.SM.17	N_2O and methane	See discussion about fossil and non-fossil methane below
Hodnebrog et al.	Halocarbons, nitrogen fluoride, sulfur hexafluoride	AR5 report uses rounded values of the Hodnebrog paper.

5.3.2 Time horizons

In the AR5, metrics for the 500-year horizon are considered too uncertain and have not been published. Although the necessary information is available to calculate GWP and GTPs for this time horizon (through the form of parameters for RF curves), the calculation was not performed. Only metrics for 20 and 100 year time horizon are implemented.

5.3.3 Carbon-climate feedback

The AR5 includes two sets of GWP and GTP, with and without carbon-climate feedback (CCFB) loops for non-CO_2 gases. CCFB take into account that a changing climate will in turn change the fluxes of CO_2 between atmosphere, land and oceans (Friedlingstein et al. 2006). The IPCC states that ideally, all indirect effects should be taken into account (AR5, section 8.7.1.4, p.713): “Though uncertainties in the carbon cycle are substantial, it is *likely* that including the climate–carbon feedback for non-CO_2 gases as well as for CO_2 provides a better estimate of the metric value than including it only for CO_2.”

Unfortunately, the values of GWP and GTP with CCFB are not published for all gases. Only the values without CCFB are available for CO, NOx, SO_2, VOC and fossil methane. Until all CFs are available with CCFB, only the metrics without CCFB are implemented.

5.3.4 Well-mixed GHG and near-term climate forcers

Near-term climate forcers (NTCFs) have shorter lifetimes, relative to well-mixed GHGs (WMGHG). NTCFs include CO, HFCs, methane, VOCs, organic and black carbon, NOx and SO_2. Methane and HFCs are treated as WMGHGs because they have longer lifetimes compared to other NTCFs. They thus have enough time to get evenly distributed in the atmosphere and their impact does not depend on the location of emission. HFCs metrics are well agreed-upon and their implementation is straightforward. Metrics are taken from Hodnebrog et al. (2013). VOC, CO and are ozone precursors. Ozone formation depends on other factors, which is why the amount of radiative forcing of those substances varies with the geographic location of emission. Table 8.A.4 and 8.A.5 of the AR5 show different values for different regions. ecoinvent does not have the possibility to implement regionalized impact assessment yet, so the global values have been selected.

5.3.5 Sulfur dioxide, nitrous oxides and black carbon

The implementation of the CFs for SO_2, NOx and BC (black carbon, or sooth) is problematic in the context of ecoinvent. SO_2 and NOx CFs are negative for some time horizon, meaning that these emissions contribute to global cooling. On the other hand, the CFs for black carbon, or sooth, are positive and two orders of magnitude larger. Applying only the SO_2 and NOx CFs yields to an underestimation of the GWP scores, and sometimes, to a net negative GWP score. This is misleading and sends the message that the production of certain commodities, such as copper, is overall beneficial to the climate change problematic. Figure 5 shows the effect of the application of the SO_2 and NOx CFs. For each market activity of v3.2 allocation by cut-off classification, the GWP100 score was calculated with and without these CFs, and the ratio (with – without) / without is represented. For 95% of the cases, the GWP100 scores diminish between 2.3% and 74.3% (see table 6).

Application of CF for black carbon (BC) is currently impossible in ecoinvent, as the substance is not directly reported. However, the quantity of BC can be estimated as a percentage of the particulate matter smaller than 2.5 microns found reported in the inventory. For the rest of this analysis, it is assumed that 20% of these particulates are BC. Application of CF for BC would lead to an increase of the GWP100 scores between 1.4% and 57.3% for 95% of the cases. The magnitude of the effect is comparable to the one of the SO_2 and NOx. If both effects are taken into account simultaneously, the median of the net effect is close to zero. The assumption of proportion of sooth in particulate is somehow arbitrary and could greatly vary depending on the source of the emission. This issue should be addressed at the inventory level, not by a blanket assumption during impact assessment. However, applying only the NOx and SO_2 CFs, without the BC CFs would create a bias. This paradoxical effect, first described by economists in the 1950s, is known as the theory of the second best. In its original formulation, the theory states that when the optimal situation is impossible to attain, the second best situation is not necessarily the closest situation to the optimal one. In the present context, this means that since the inclusion of both NOx, SO_2 and sooth parameter is impossible, including only one or the other results in a less accurate model than the inclusion including none of them.

Figure 5 Effect of NOx, SO_2 and particulate on GWP100 scores

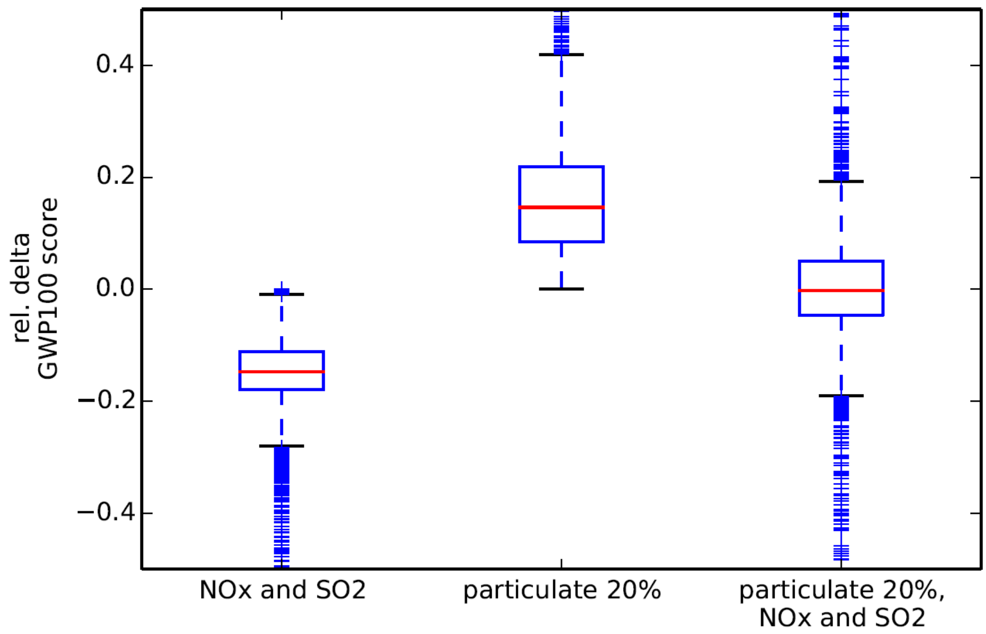
0.4
0.2
0.0
−0.2
−0.4
rel. delta
GWP100 score
NOx and SO2
particulate 20%
particulate 20%,
NOx and SO2

Table 6 Effect of NO_x, SO_2 and particulate on GWP100 scores

Percentile	relative delta, NO_x and SO_2	relative delta, particulate 20%	relative delta, particulate 20%, NO_x and SO_2
2.5	-0.743	0.014	-0.517
25	-0.179	0.085	-0.046
50	-0.147	0.146	-0.002
75	-0.111	0.219	0.05
97.5	-0.023	0.573	0.377

It was therefore decided to exclude both effects until all relevant information about BC is integrated in the database.

5.3.6 Non-fossil emissions

5.3.6.1 Carbon dioxide

Uptake of CO_2 by plants is accounted for in forestry and agriculture datasets by the elementary exchange “Carbon dioxide, in air”. This same carbon eventually goes back to the atmosphere under the form of methane, CO and CO_2. Every dataset releasing these substances differentiates between the fossil and non-fossil origin of the carbon. The net null effect of capturing a carbon atom and releasing it later is modelled by attributing null CFs to resource elementary exchanges “Carbon dioxide, in air” and the emission elementary exchanges “Carbon dioxide, non-fossil”.

Carbon atoms originally in the atmosphere under the form of CO_2 and fixed by plants are sometimes released in the atmosphere as CO or methane. These molecules eventually oxidize back to CO_2, but before going back to this more stable state, they will create a higher radiative forcing than if they would have stayed as CO_2. The net impact of releasing non-fossil CO and methane is therefore larger than zero.

5.3.6.2 Carbon monoxide

The AR5 contains CFs only for non-fossil carbon monoxide, i.e. the effect such emission has before it oxidizes to CO_2. To calculate the CF for fossil monoxide, the ratio of the molar masses of CO_2 and CO has been added to the CF found at table 8.A.4. The underlying assumptions of this operation is that all molecules of CO oxidize to CO_2 and the half-life of CO in the atmosphere is much smaller than the half-life of CO_2.

5.3.6.3 Methane

The AR5 reports CFs for methane, non-fossil at table 8.SM.17. The values for fossil methane are presented, rounded, at table 8.A.1. The footnote of table 8.A.1 indicates that the difference between fossil and non-fossil methane is calculated by Boucher et al (2009). The values are found at table 1, in the column “Indirect CO_2-induced fossil source”, and it is clear that the IPCC has chosen the lower bound to calculate the rounded CFs presented at table 8.A.1. Fossil methane CFs are calculated by adding the lower bound from Boucher et al. to the table 8.SM.17 values, without rounding.

Table 7 CFs for fossil and non-fossil carbon emissions in the implementation of IPCC2013

Substance name in ecoinvent	Source table	GWP20	GWP100	GTP20	GTP100
Carbon dioxide, in air	NA	0	0	0	0
Carbon dioxide, non-fossil	NA	0	0	0	0
Carbon dioxide, fossil	8.A.1	1	1	1	1
Carbon dioxide, from soil or biomass stock	8.A.1	1	1	1	1
Carbon dioxide, to soil or biomass stock	8.A.1	-1	-1	-1	-1
Carbon monoxide, fossil	8.A.4 + oxidation	9.2214 (7.65+1.5714)	4.0624 (2.491+1.5714)	6.4714 (4.9+1.5714)	1.9578 (0.3864+1.5714)
Carbon monoxide, from soil or biomass stock	8.A.4 + oxidation	9.2214 (7.65+1.5714)	4.0624 (2.491+1.5714)	6.4714 (4.9+1.5714)	1.9578 (0.3864+1.5714)
Carbon monoxide, non-fossil	8.A.4	7.65	2.491	4.9	0.3864
Methane, fossil	8.SM.17 + Boucher	84.6 (83.9+0.7)	29.7 (28.5+1.2)	68.5 (67.5+1)	5.7 (4.3+1.4)
Methane	8.SM.17 + Boucher	84.6 (83.9+0.7)	29.7 (28.5+1.2)	68.5 (67.5+1)	5.7 (4.3+1.4)
Methane, from soil or biomass stock	8.SM.17 + Boucher	84.6 (83.9+0.7)	29.7 (28.5+1.2)	68.5 (67.5+1)	5.7 (4.3+1.4)
Methane, non-fossil	8.SM.17	83.9	28.5	67.5	4.3

5.3.6.4 Emissions from soil or biomass stock

Agriculture, forestry, land transformation and hydropower datasets also report emissions of carbon through the elementary exchanges “Carbon dioxide, from soil or biomass stock”, “Carbon monoxide, from soil or biomass stock” and “Methane, from soil or biomass stock”. These emissions are treated as fossil emissions. Their CFs are therefore the same as their fossil counterpart, as they came from the atmosphere to the stock much earlier than the scope of any LCA, like fossil carbon.

5.3.7 Limitations

If agricultural, forestry or land use dominate the climate change score in an LCA, a careful foreground and background modeling based on primary data collection is strongly recommended.

There is a growing interest in using “dynamic LCA”, where the effects of temporarily storing carbon and delaying emissions are considered. However, its application requires extensive knowledge of case-specific information like time of sequestration and temporal profile of emission. ecoinvent, a background database, cannot take into account all the possible cases arising in LCAs. If the inclusion of dynamic effects is suspected to cause significant changes in the LCIA scores and conclusions of an LCA, its goal and scope should describe how those effects are taken into account, and the CFs applied to the ecoinvent database should be adapted.

5.4 IPCC 2007 (Assessment Report 4: AR4)

5.4.1 Introduction

The values for the GTP metric were not reported in the AR4. The definition of the GWP metric has not changed across the reports, but the inputs used for the calculation of the RF curves have been updated.

The IPCC has published a partial list of GWP in the Chapter 2 of AR4 (table 2.14), and a more complete list in an errata, available at: https://archive.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html#table-2-14.

Implementation remarks for emissions "from soil or biomass stock" and "carbon dioxide, in air", presented in the IPCC2013 section above also apply to the IPCC 2007 implementations. For the sake of continuity, GWP 500-year values have been implemented, but in light of the remarks made in the AR5 about this time horizon, their use is not recommended.

5.4.2 Carbon monoxide

The direct GWP of CO was considered small compared to its indirect GWP through its interaction with OH, CH_4, ozone and CO_2. The IPCC qualifies as large the uncertainty of the effects involving OH, ozone and CH_4. In the initial implementation of the IPCC 2007, those indirect effects were ignored, and it was assumed that each mole of CO emitted would quickly transform into one mole of CO_2 (its life time is between 3 to 4 months). With this simplification, it is possible to calculate the GWP of CO for all time horizons:

$$GWP_{CO} = \frac{1\ kg\ CO_2\ eq.}{kg\ CO_2} \times \frac{(12 + 16 \times 2)\ kg\ CO_2}{(12 + 16)\ kg\ CO} = 1.5714\ kg\ CO_2\ eq./kgCO$$

The GWP of CO, including the indirect effects, is estimated between 1.0 and 3.0 for the 100-year time horizon. For the sake of continuity, the 1.5714 value was kept for IPCC 2007.

5.4.3 Methane

In the fourth assessment report, the IPCC only provides values for non-fossil methane. For fossil methane, it is assumed that all the methane oxidizes quickly to CO_2. This simplification allows to do the same calculation as for carbon monoxide:

$$GWP_{CH4fossil} - GWP_{CH4non-fossil} = \frac{1\ kg\ CO_2\ eq.}{kg\ CO_2} \times \frac{(12 + 16 \times 2)\ kg\ CO_2}{(12 + 4)\ \ kg\ CH_4} = 2.75\ kg\ CO_2\ eq./\ kg\ CH_4$$

The 2.75 value is added to the GWP value for non-fossil methane for each time horizon. This value is not very far from the difference between fossil and non-fossil methane found in AR5, calculated with a more sophisticated model, and equal to 2.

Table 8 CFs for fossil and non-fossil carbon emissions in the implementation of IPCC2007

substance in ecoinvent	GWP 20	GWP 100	GWP 500
Carbon dioxide, in air	0	0	0
Carbon dioxide, fossil	1	1	1
Carbon dioxide, from soil or biomass stock	1	1	1
Carbon dioxide, to soil or biomass stock	-1	-1	-1
Carbon dioxide, non-fossil	0	0	0
Carbon dioxide, non-fossil, from calcination	0	0	0
Carbon dioxide, to soil or biomass stock	0	0	0
Carbon monoxide, fossil	1.5714	1.5714	1.5714
Carbon monoxide, from soil or biomass stock	1.5714	1.5714	1.5714
Carbon monoxide, non-fossil	0	0	0
Methane, fossil	72	25	7.6
Methane, from soil or biomass stock	72	25	7.6
Methane, non-fossil	69.25 (72 – 2.75)	22.25 (25 – 2.75)	4.85 (7.6 – 2.75)

5.5 References

Boucher Olivier, Pierre Friedlingstein, Bill Collins and Keith P Shine, (2009). The indirect global warming potential and global temperature change potential due to methane oxidation. Environment Research Letters. doi: 10.1088/1748-9326/4/4/044007. Online at stacks.iop.org/ERL/4/044007

Friedlingstein et al. (2006). Climate-Carbon Cycle Feedback Analysis: Results from the C[4]MIP Model Intercomparison. Journal of Climate, Volume 19, Issue 14, p.3337.
doi: http://dx.doi.org/10.1175/JCLI3800.1

Hodnebrog et al. (2013). Global warming potential and radiative efficiencies of halocarbons and related compounds: A comprehensive review. Reviews of Geophysics, Volume 51, Issue 2, p.300-378. doi: 10.1002/rog.20013

6 EF (ILCD methods)

6.1 General information

Method versions	v2.0 2018 v3.0 v3.0 EN15804
Method descriptions	v2.0 2018 / v3.0: https://eplca.jrc.ec.europa.eu/LCDN/developerEF.xhtml v3.0 EN15804: https://eplca.jrc.ec.europa.eu/LCDN/EN15804.xhtml
Sources of the CFs	v2.0 2018: As distributed via e-mail by the JRC on the 11th of April 2018 Small water patch sent via e-mail by the JRC on the 25th of April 2018 v3.0: https://eplca.jrc.ec.europa.eu/permalink/EF-LCIAMethod_CF(EF-v3.0).xlsx v3.0 EN15804: https://eplca.jrc.ec.europa.eu/permalink/EN_15804.xlsx

6.2 Introduction

The Environmental Footprint (EF) method was updated from version 2.0 to version 3.0. Furthermore, there is an EF v3.0 implementation for the EN 15804 standard, which differs in CFs for biogenic CO_2.

6.3 Implementation

The implementation of EF v3.0 (including EF v3.0 EN15804) is based on the mapping between the ecoinvent EE list and the EF EE list resulting from the GLAD project, in particular from the work of the nomenclature group[1]. The project output was not publicly available at the time this report was produced, but it was available to ecoinvent. Minor adjustments were made and documented in the supporting mapping file described in section 3.4.

For creation of the final mapped CF file all regionalized CFs were excluded, carbon exchanges were mapped as described in section 4.2.2, water assessment was implemented as described in section 4.3.3, lower heating values were used for energy carriers (section 6.3.2), and several additional CFs were calculated for mineral resources (section 6.3.3).

6.3.1 Biogenic CO_2

The difference between EF v3.0 and EF v3.0 EN15804 are the CFs for biogenic CO_2: Whereas biogenic CO_2 is neglected in EF v3.0 (CF = 0), biogenic uptake and release are characterized in EF v3.0 EN15804 with -1 and +1, respectively (EPLCA 2021).

6.3.2 Energy carriers: lower heating values

Following EN 15804:2012+A2:2019 (CEN/TC 350 2019), the net calorific value or lower heating value (LHV) is used for calculation of CFs for Depletion of abiotic resources – fossil fuels (ADP-fossil) for fossil resources. The values available for energy carriers in ecoinvent are the higher heating values (HHV) as applied for the Cumulative Energy Demand (CED) method (Hischier et al. 2010). These HHV were converted to LHV as shown in Table 9.

[1] https://www.lifecycleinitiative.org/resources-2/global-lca-data-network-glad-2/

Table 9 Conversion of Higher Heating Values (HHV) to Lower Heating Values (LHV) for different energy carriers

Exchange	Unit	HHV [MJ / Unit]	LHV [MJ / Unit]	Source
Coal, brown, in ground	kg	9.9	9.41	[1] d
Coal, hard, unspecified, in ground	kg	19.1	18.01	[1] a, bituminous
Gas, mine, off-gas, process, coal mining	m3	39.8	35.87	[2]
Gas, natural, in ground	m3	38.29	34.50	[2]
Oil, crude, in ground	kg	45.8	42.3	[1] b, crude oil
Peat, in ground	kg	9.9	9.76	[1] b, peat

[1] https://www.openlca.org/wp-content/uploads/2017/10/Calculation-of-energy-indicators-in-MJ-LHVs.pdf
[2] based on enthalpy of formation for methane, see also https://en.wikipedia.org/wiki/Heat_of_combustion

6.3.3 Additional CFs for minerals

In addition to CFs provided by the method developers, CFs for the minerals listed in Table X were calculated based on CFs for contained elements and the molecular weight. They were implemented in EF v3.0 and EF v3.0 EN15804.

Table 10 Minerals for which additional CFs were calculated based on CFs for contained elements and the molecular weight

Mineral	Formula	CF
Borax, in ground	$Na_2[B_4O_5(OH)_4]\cdot 8H_2O$	0.000484152
Chrysotile, in ground	$Mg_3(Si_2O_5)(OH)_4$	5.34357E-10
Colemanite, in ground	$Ca_2B_6O_{11}\cdot 5H_2O$	0.000673718
Diatomite, in ground	$SiO_2.nH_2O$	6.54411E-12
Dolomite, in ground	$CaMg(CO_3)_2$	2.66249E-10
Gangue, bauxite, in ground	$Al_2H_2O_4$	4.90266E-10
Gypsum, in ground	$CaSO_4\cdot 2H_2O$	3.594E-05
Kaolinite, in ground	$Al_2Si_2O_5(OH)_4$	2.30892E-10
Kieserite, in ground	$MgSO_4\cdot H_2O$	4.47161E-05
Magnesite, in ground	$MgCO_3$	5.82308E-10
Pyrite, in ground	FeS_2	0.000103181
Sodium chloride, in ground	NaCl	1.64607E-05
Sodium nitrate, in ground	$NaNO_3$	1.48768E-08
Sodium sulphate, various forms, in ground	Na_2SO_4	4.35814E-05
Spodumene, in ground	$LiAlSi_2O_6$	4.29051E-07
Sylvite, in ground	KCl	1.28953E-05
Talc, in ground	$Mg_3Si_4O_{10}(OH)_2$	3.92505E-10
Ulexite, in ground	$NaCaB_5O_6(OH)_6\cdot 5H_2O$	0.000569542

6.4 F v2.0 2018

Version 2.0 was already implemented in previous versions of ecoinvent. The method, the impact categories, and the indicators were renamed to be aligned with the implementation of v3.0 (details are documented in the Changes Report: go to the “Data Releases” section on the website, use the link to the current database version and there you find it under “Relevant Documents & Files”). Furthermore, CFs for new EEs were added as shown in Table 11.

Table 11 New elementary exchanges in version 3.8 and impact categories in EF v2.0 2018 for which they have CFs

Exchange	Impact category		
	Ecotoxicity freshwater	Human toxicity carcinogenic	Human toxicity non-carcinogenic
Azoxystrobin	x		
Beta-cyfluthrin	x		x
Carboxin	x		x
Chlorpyrifos	x		x
Chlortoluron	x		
Clethodim	x		
Deltamethrin	x		x
Dimethoate	x		x
Diquat dibromide	x		x
Ethalfluralin	x		
Fludioxonil	x		
Flumioxazin	x		
Glufosinate ammonium	x		x
Imazamox	x		
Imazethapyr	x		x
Imidacloprid	x		x
Metalaxyl-M	x		
Metribuzin	x		x
N-methyl-2-pyrrolidone	x	x	
Quizalofop-ethyl	x		x
Sethoxydim	x		x
Sulfentrazone	x		
Thiabendazole	x		x
Thiophanate-methyl	x		x
Thiram	x		x
Triallate	x		x
Tribenuron-methyl	x		x
Trifluralin	x	x	x

6.5 References

CEN/TC 350 (2019). CEN/TC 350 Sustainability of Construction Works - Environmental Product Declarations - Core Rules for the Product Category of Construction Products EN 15804:2012+A1:2013/A2:2019.

EPLCA (2021). EN 15804 reference package. https://eplca.jrc.ec.europa.eu/LCDN/EN15804.xhtml

Hischier R., Weidema B., Althaus H.-J., Bauer C., Doka G., Dones R., Frischknecht R., Hellweg S., Humbert S., Jungbluth N., Köllner T., Loerincik Y., Margni M. and Nemecek T. (2010). Implementation of Life Cycle Impact Assessment Methods. ecoinvent report No. 3, v2.2. Swiss Centre for Life Cycle Inventories, Dübendorf.

7 CML

7.1 General information

Method versions	v4.8 2016
Method description	https://www.universiteitleiden.nl/en/research/research-projects/science/cml-new-dutch-lca-guide
Source of the CFs	https://www.universiteitleiden.nl/en/research/research-output/science/cml-ia-characterisation-factors

7.2 Introduction

The CML impact assessment method (CML-IA) contains CFs for several baseline indicators and additional indicators. The implementation only considers the baseline indicators for the version 4.8 last updated in 2016.

7.3 Implementation

For creation of the final mapped CF file carbon exchanges were mapped as described in section 4.2.2 and lower heating values were used for energy carriers as for implementation of the EF methods (section 6.3.2).

8 Superseded and legacy methods

ecoinvent is keeping older versions of methods for legacy reasons. However, those methods are not maintained anymore. This means that:

- if an error is reported, it will not be corrected;
- if a new elementary exchange is added to ecoinvent, superseded and legacy methods will not be checked for a CF match with the new exchange.

The status of available methods is indicated in the Database Overview file (go to the “Data Releases” section on the website, use the link to the current database version and there you find it under “Relevant Documents & Files”)