Documentation of changes implemented in the ecoinvent database v3.9.1 (2022.12.15)

FitzGerald D. & Sonderegger T.

Table of Contents

Citation:

FitzGerald D. & Sonderegger T. (2022). Documentation of changes implemented in the ecoinvent database v3.9.1. ecoinvent Association, Zürich, Switzerland.

1 Introduction

After version 3.9 was published in October 2022, some issues were found, which led to the publication of version 3.9.1.

The main corrections that were made for v3.9.1 concern characterization factors of certain LCIA methods, and the variance value of lognormal uncertainty distributions. Other changes were made which either result in limited changes in LCIA scores or concern the meta data fields.

This report details all changes done from v3.9 to v3.9.1, with an overview of the effects those updates have on the LCIA scores. Based on the information provided in this report and the annexes, users working with v3.9 can determine whether their work is affected by the updates brought by v3.9.1 or not.

The main indicators for which there are changes in scores between v3.9 and v3.9.1 are summarized below. In case you are using one of those for your work, **we strongly recommend switching to v3.9.1**. A more detailed overview of the changes in scores is provided in the annex excel file “Overview of changes in scores between v3.9 and v3.9.1”, which shows the changes in scores for all indicators.

LCIA indicators with significant changes compared to v3.9:

- EF v3.0 and v3.1
    - human toxicity: carcinogenic
    - ecotoxicity: freshwater
    - eutrophication: marine
    - human toxicity: non-carcinogenic
- Climate change indicators in ReCiPe (including endpoints), TRACI and EPS
- Indicators that assess the emission of “Mercury II” to air:
  CML (terrestrial ecotoxicity), human toxicity in EDIP, USEtox, and TRACI, emissions to air in Ecological Scarcity

2 Description of changes

2.1 Impact assessment methods

The main task in implementing impact assessment methods is mapping the ecoinvent elementary exchanges list to method elementary exchanges lists. This includes assumptions concerning many aspects, for example, flow names, compartment and sub-compartment mapping choices. These assumptions are documented in the LCIA implementation report (Sonderegger & Stoikou 2022). The result of the implementation is available in a series of spreadsheets, showing the explicit mapping between the nomenclature of the database and each LCIA method. This section discusses some changes made to these implementation files.

2.1.1 Changes in indicator names and indicator unit names

Some indicator names and indicator unit names needed to be updated. These changes are shown in Table 1 and Table 2, respectively.

Table 1. Changes in indicator names.

Method name	Category name	Indicator Name in 3.9	Indicator Name in 3.9.1
ReCiPe 2016 v1.03, midpoint (H)	climate change	global warming potential (GWP1000)	global warming potential (GWP**100**)
ReCiPe 2016 v1.03, midpoint (I)	climate change	global warming potential (GWP1000)	global warming potential (GWP**20**)
ReCiPe 2016 v1.03, midpoint (H) no LT	climate change no LT	global warming potential (GWP1000) no LT	global warming potential (GWP**100**) no LT
ReCiPe 2016 v1.03, midpoint (I) no LT	climate change no LT	global warming potential (GWP1000) no LT	global warming potential (GWP**20**) no LT

Table 2. Changes in indicator unit names.

Method name	Category Name	Indicator Name	Unit in 3.9	Unit in 3.9.1
ReCiPe 2016 v1.03, midpoint (E)	ionising radiation	ionising radiation potential (IRP)	kg Co-60-Eq	**kBq** Co-60-Eq
ReCiPe 2016 v1.03, midpoint (H)	ionising radiation	ionising radiation potential (IRP)	kg Co-60-Eq	**kBq** Co-60-Eq
ReCiPe 2016 v1.03, midpoint (I)	ionising radiation	ionising radiation potential (IRP)	kg Co-60-Eq	**kBq** Co-60-Eq
ReCiPe 2016 v1.03, midpoint (E) no LT	ionising radiation no LT	ionising radiation potential (IRP) no LT	kg Co-60-Eq	**kBq** Co-60-Eq
ReCiPe 2016 v1.03, midpoint (H) no LT	ionising radiation no LT	ionising radiation potential (IRP) no LT	kg Co-60-Eq	**kBq** Co-60-Eq
ReCiPe 2016 v1.03, midpoint (I) no LT	ionising radiation no LT	ionising radiation potential (IRP) no LT	kg Co-60-Eq	**kBq** Co-60-Eq
TRACI v2.1	particulate matter formation	particulate matter formation potential (PMFP)	PM2.5-Eq	**kg** PM2.5-Eq
TRACI v2.1 no LT	particulate matter formation no LT	particulate matter formation potential (PMFP) no LT	PM2.5-Eq	**kg** PM2.5-Eq

2.1.2 Changes in methods

There were two main issues with methods identified after publication of v3.9: better mapping options for EF methods based on the elementary exchanges naming update for v3.9, and the inconsistent use of CFs for “Carbon dioxide, non-fossil”.

2.1.2.1 EF

Issues for EF methods were tackled by running our mapping algorithm and see where we can improve the GLAD mapping used as basis for EF method implementation. The main differences are more concise matches for metals with specific oxidation states, some more or improved matches for agrochemicals (for details, see Change Report Annex). Further changes include the removal of mapping group flows to individual substances (“Diphenylether compounds” to “Diphenyl ether” and “Amine oxides” to “Dodecyl(dimethyl)amine oxide”) since this could potentially lead to a wrong characterization of group flows, and the removal of the mapping “Nitrogen” to “Nitrogen, total (excluding N2)” as “Nitrogen” is referring to N or N2. The latter change results in major changes of scores for marine eutrophication as only “Nitrogen, total (excluding N2)” has a CF for this impact category.

2.1.2.2 ReCiPe

The wrong indicator naming (Table 1) caused mistakes in the mapping. Furthermore, “Carbon dioxide, non-fossil” was mistakenly assigned a CF, which was corrected for v3.9.1.

2.1.2.3 EPS

As for ReCiPe, “Carbon dioxide, non-fossil” was mistakenly assigned a CF, which was corrected. Furthermore, the CF for the land use flow “Occupation, unspecified” was missing.

2.1.2.4 TRACI

As for ReCiPe, “Carbon dioxide, non-fossil” was mistakenly assigned a CF, which was corrected.

2.1.2.5 CML

The CF for “Particulate Matter, > 2.5 um and < 10um” was missing from the previous implementation.

2.1.3 Changes for future inventory changes

There are some mistakes in the use of sub-compartments, which affect scores. In the concerned datasets, the sub-compartments need to be changed from “air/low population density, long-term” to “air/non-urban air or from high stacks”. This affects the CML, EF (including EN15804), ReCiPe, and TRACI methods. In order to have methods ready once these mistakes are corrected, CFs for (some of) the substances listed in Table 3 were added for these methods.

Table 3. Substances added for the sub-compartment “non-urban air or from high stacks”.

Substance Name	Old Sub-compartment	New Sub-compartment

Deltamethrin	low population density, long-term	non-urban air or from high stacks
Diflufenzopyr	low population density, long-term	non-urban air or from high stacks
Dimethoate	low population density, long-term	non-urban air or from high stacks
Ethalfluralin	low population density, long-term	non-urban air or from high stacks
Fluxapyroxad	low population density, long-term	non-urban air or from high stacks
Glufosinate ammonium	low population density, long-term	non-urban air or from high stacks
Saflufenacil	low population density, long-term	non-urban air or from high stacks
Triallate	low population density, long-term	non-urban air or from high stacks
Tribenuron-methyl	low population density, long-term	non-urban air or from high stacks

2.2 Changes in Undefined data

2.2.1 Emission of mercury in “market for natural gas, high pressure”, JP

In version 3.9, the dataset “market for natural gas, high pressure” in JP (Japan) had a wrong amount for the emission of “Mercury II” to air with the subcompartment “urban air close to ground”. The amount, which was 4.075E-07 kg in version 3.9, has been corrected to 4.075E-13 for version 3.9.1. The markets for “natural gas, high pressure” in other geographies did not have that issue and therefore did not require any change.

2.2.2 ISIC

For four datasets, the ISIC code used in v3.9 did not correspond to one of the official codes from the International Standard Industrial Classification of All Economic Activities (United Nations Statistics Division, 2007). They were therefore replaced for v3.9.1 with the codes shown in **Table 4**.

Table 4. Datasets for which the ISIC code was updated from v3.9 to v3.9.1.

Activity Name	Geography	Time Period	Old ISIC Classification	New ISIC Classification
transmission network construction, electricity, high voltage direct current land cable	GLO	1998-2012	4220a: Construction of utility projects for electricity production, except for liquid fuels	4220:Construction of utility projects
transmission network construction, electricity, high voltage direct current land cable	RER	1998-2012	4220a: Construction of utility projects for electricity production, except for liquid fuels	4220:Construction of utility projects
transmission network construction, electricity, high voltage direct current subsea cable	GLO	1998-2012	4220a: Construction of utility projects for electricity production, except for liquid fuels	4220:Construction of utility projects
transmission network construction, electricity, high voltage direct current subsea cable	RER	1998-2012	4220a: Construction of utility projects for electricity production, except for liquid fuels	4220:Construction of utility projects

2.2.3 Prices

Seven intermediate exchanges were identified as having an inaccurate price, which distorted some economic allocation factors in the system model “Allocation at the point of substitution” (APOS). New prices were estimated based on the prices of the input materials in the processes that produce those products. They are shown in **Table 5**.

Since these products are not involved in economic allocation in the two system models “Allocation, cut-off by classification” (cut-off) and “Allocation, cut-off, EN15804” (EN15804), the updated prices did not cause any change in LCIA scores for those system models from v3.9 to v3.9.1.

Table 5. Updated prices for v3.9.1.

Product	Price in v3.9 (EUR2005)	Price in v3.9.1 (EUR2005)
transmission network, electricity, high voltage direct current aerial line	4	55195.53557
transmission network, electricity, high voltage direct current land cable	4	105790.4428
transmission network, electricity, high voltage direct current subsea cable	4	106642.5024
vinasse, from fermentation of sugar beet	0.012	0.000292
vinasse, from fermentation of sugar beet molasses	0.027	0.00678
vinasse, from fermentation of sugarcane	0.027	0.001754
vinasse, from fermentation of sweet sorghum	0.073	0.000648

2.3 Changes unit process data of linked system models

Unless stated otherwise, the changes described in this section concern all linked system models published in v3.9, namely: “Allocation, cut-off by classification” (cut-off), “Allocation, cut-off, EN15804” (EN15804) and “Substitution, consequential, long-term” (consequential).

2.3.1 Variance

The variance value for amounts that have a lognormal distribution was wrong in v3.9 for all amounts that use that distribution type. This concerns all four types of quantitative fields, namely, amounts of exchanges, production volumes, properties and parameters. The wrong variance values were in all cases higher than their correct value. This has been corrected for v3.9.1.

The variance with pedigree uncertainty was correct in v3.9 and was therefore not changed for v3.9.1.

2.3.2 Exchange meta data

Exchanges in the unit processes of all three system models published in v3.9 were missing part, or all, of the contents of their meta information fields. The main fields for which the information was not transferred from the Undefined datasets to the linked datasets are the following:

- exchange variable name
- exchange mathematical relation
- exchange comment
- formula
- CAS number
- synonyms
- tags
- source

- uncertainty comment
- production volume variable name
- production volume mathematical relation
- production volume comment
- production volume source
- production volume uncertainty
- property variable name
- property mathematical relation
- property comment
- property source
- property uncertainty

These meta data fields have been restored in v3.9.1. The missing meta data has no consequence on the LCIA results in v3.9.

2.3.3 Market groups for electricity in US

For the three electricity voltage levels (high, medium, and low), the market with the geography US-PR (Puerto Rico) has been added as supplier to the market group for the US. This resulted in a very minor decrease (-0.45%) in the shares supplied by the other markets in the US.

2.3.4 Removal of datasets producing a recyclable material

In the cut-off and EN15804 system models, some datasets were introduced in v3.9 with a recyclable material as positive reference product. These datasets were not meant to exist, given that they are inconsistent with the linking rules of those two system models, and have therefore been removed for v3.9.1. The lists of datasets removed from the cut-off and EN15804 system models are shown in **Table 6** and **Table 7** respectively.

Table 6. Datasets which were producing a recyclable in the cut-off system model in v3.9.

Activity Name	Geography	Reference Product
fibre and fabric waste, polyester to generic market for waste polyethylene terephthalate	GLO	fibre and fabric waste, polyester
treatment of blast furnace slag, residual material landfill	RoW	blast furnace slag
treatment of blast furnace slag, residual material landfill	US	blast furnace slag
treatment of waste newspaper, municipal incineration	CH	waste newspaper
treatment of waste newspaper, sanitary landfill	CH	waste newspaper
treatment of waste packaging paper, municipal incineration	CH	waste packaging paper
treatment of waste packaging paper, open burning	GLO	waste packaging paper
treatment of waste packaging paper, open dump, dry infiltration class (100mm)	GLO	waste packaging paper
treatment of waste packaging paper, open dump, hyperarid infiltration class (-250mm)	GLO	waste packaging paper
treatment of waste packaging paper, open dump, moist infiltration class (300mm)	GLO	waste packaging paper
treatment of waste packaging paper, open dump, very wet infiltration class (1000mm)	GLO	waste packaging paper
treatment of waste packaging paper, open dump, wet infiltration class (500mm)	GLO	waste packaging paper

Activity Name	Geography	Reference Product
treatment of waste packaging paper, unsanitary landfill, dry infiltration class (100mm)	GLO	waste packaging paper
treatment of waste packaging paper, unsanitary landfill, hyperarid infiltration class (-250mm)	GLO	waste packaging paper
treatment of waste packaging paper, unsanitary landfill, moist infiltration class (300mm)	GLO	waste packaging paper
treatment of waste packaging paper, unsanitary landfill, very wet infiltration class (1000mm)	GLO	waste packaging paper
treatment of waste packaging paper, unsanitary landfill, wet infiltration class (500mm)	GLO	waste packaging paper

Table 7. Datasets which were producing a recyclable material in the EN15804 system model in v3.9.

Activity Name	Geography	Reference Product
cement production, CEM II/A	CA-QC	blast furnace slag
cement production, CEM II/A	CH	blast furnace slag
cement production, CEM II/A	CH	silica fume, densified
cement production, CEM II/A	Europe without Switzerland	silica fume, densified
cement production, CEM II/A	RoW	blast furnace slag
cement production, CEM II/A	RoW	silica fume, densified
cement production, CEM II/B	Europe without Switzerland	silica fume, densified
cement production, CEM II/B	RoW	silica fume, densified
cement production, CEM V/A	CH	silica fume, densified
cement production, CEM V/A	Europe without Switzerland	silica fume, densified
cement production, CEM V/A	RoW	silica fume, densified
cement production, CEM V/B	CH	silica fume, densified
cement production, CEM V/B	Europe without Switzerland	silica fume, densified
cement production, CEM V/B	RoW	silica fume, densified
fibre and fabric waste, polyester to generic market for waste polyethylene terephthalate	GLO	fibre and fabric waste, polyester
treatment of blast furnace slag, residual material landfill	RoW	blast furnace slag
treatment of blast furnace slag, residual material landfill	US	blast furnace slag
treatment of waste newspaper, municipal incineration	CH	waste newspaper
treatment of waste newspaper, sanitary landfill	CH	waste newspaper

2.3.5 “treatment of metal scrap, mixed, for recycling, unsorted, sorting”

The dataset “treatment of metal scrap, mixed, for recycling, unsorted, sorting”, which is modelled as a combined production, was wrongly subdivided in the EN15804 system model in v3.9. This has been corrected for v3.9.1.

2.3.6 End year in EN15804

The end year of the time period of the datasets in EN15804 in v3.9 was not consistent with the rule for the end year of linked datasets. This was corrected for v3.9.1.

2.3.7 Geography of suppliers in consequential

For some inputs from technosphere, the datasets that supply a specific consuming geography was changed in the consequential system model. The list of affected datasets and inputs from technosphere, as well as the supplying datasets of these inputs in v3.9.1, is given in **Table 8**.

In the case of the dataset “tantalum mine operation and beneficiation” in RW, the input of electricity was completely missing in v3.9.

Table 8. Datasets for which the supplying dataset of an input from technosphere was changed for v3.9.1. The last two columns contain the supplying dataset used in v3.9.1.

Activity Name	Geography	Reference Product	Supplied Exchange	Supplying Activity Name	Supplying Geography
aluminium hydroxide production	IAI Area, Russia & RER w/o EU27 & EFTA	aluminium hydroxide	heat, district or industrial, natural gas	market for heat, district or industrial, natural gas	RoW
aluminium oxide production	IAI Area, Russia & RER w/o EU27 & EFTA	aluminium oxide, metallurgical	heat, district or industrial, natural gas	market for heat, district or industrial, natural gas	RoW
aluminium production, primary, ingot	IAI Area, Russia & RER w/o EU27 & EFTA	aluminium, primary, ingot	argon, liquid	market for argon, liquid	RoW
aluminium production, primary, ingot	IAI Area, Russia & RER w/o EU27 & EFTA	aluminium, primary, ingot	chlorine, liquid	market for chlorine, liquid	RoW
aluminium production, primary, ingot	IAI Area, Russia & RER w/o EU27 & EFTA	aluminium, primary, ingot	corrugated board box	market for corrugated board box	RoW
aluminium production, primary, ingot	IAI Area, Russia & RER w/o EU27 & EFTA	aluminium, primary, ingot	heat, district or industrial, natural gas	market for heat, district or industrial, natural gas	RoW
aluminium production, primary, ingot	IAI Area, Russia & RER w/o EU27 & EFTA	aluminium, primary, ingot	nitrogen, liquid	market for nitrogen, liquid	RoW
aluminium production, primary, liquid, Söderberg	IAI Area, Russia & RER w/o EU27 & EFTA	aluminium, primary, liquid	inert waste	market for inert waste	RoW
aluminium production, primary, liquid, Söderberg	IAI Area, Russia & RER w/o EU27 & EFTA	aluminium, primary, liquid	pitch	market for pitch	RoW
aluminium production, primary, liquid, Söderberg	IAI Area, Russia & RER w/o EU27 & EFTA	aluminium, primary, liquid	scrap steel	market for scrap steel	RoW
aluminium production, primary, liquid, prebake	IAI Area, Russia & RER w/o EU27 & EFTA	aluminium, primary, liquid	inert waste	market for inert waste	RoW
aluminium production, primary, liquid, prebake	IAI Area, Russia & RER w/o EU27 & EFTA	aluminium, primary, liquid	pitch	market for pitch	RoW
aluminium production, primary, liquid, prebake	IAI Area, Russia & RER w/o EU27 & EFTA	aluminium, primary, liquid	scrap steel	market for scrap steel	RoW
anode production, paste, for aluminium electrolysis	IAI Area, Russia & RER w/o EU27 & EFTA	anode, paste, for aluminium electrolysis	fly ash and scrubber sludge	market for fly ash and scrubber sludge	RoW
anode production, paste, for aluminium electrolysis	IAI Area, Russia & RER w/o EU27 & EFTA	anode, paste, for aluminium electrolysis	heat, district or industrial, natural gas	market for heat, district or industrial, natural gas	RoW
anode production, paste, for aluminium electrolysis	IAI Area, Russia & RER w/o EU27 & EFTA	anode, paste, for aluminium electrolysis	pitch	market for pitch	RoW

Activity Name	Geography	Reference Product	Supplied Exchange	Supplying Activity Name	Supplying Geography
anode production, prebake, for aluminium electrolysis	IAI Area, Russia & RER w/o EU27 & EFTA	anode, prebake, for aluminium electrolysis	fly ash and scrubber sludge	market for fly ash and scrubber sludge	RoW
anode production, prebake, for aluminium electrolysis	IAI Area, Russia & RER w/o EU27 & EFTA	anode, prebake, for aluminium electrolysis	pitch	market for pitch	RoW
anode production, prebake, for aluminium electrolysis	IAI Area, Russia & RER w/o EU27 & EFTA	anode, prebake, for aluminium electrolysis	scrap steel	market for scrap steel	RoW
deep well drilling, for deep geothermal power	WECC	deep well, drilled, for geothermal power	cement, Portland	market for cement, Portland	US
electricity production, natural gas, combined cycle power plant	HR	electricity, high voltage	natural gas, high pressure	market group for natural gas, high pressure	Europe without Switzerland
electricity production, natural gas, conventional power plant	HR	electricity, high voltage	natural gas, high pressure	market group for natural gas, high pressure	Europe without Switzerland
heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical	HR	heat, district or industrial, natural gas	natural gas, high pressure	market group for natural gas, high pressure	Europe without Switzerland
heat and power co-generation, natural gas, conventional power plant, 100MW electrical	HR	heat, district or industrial, natural gas	natural gas, high pressure	market group for natural gas, high pressure	Europe without Switzerland
market for electricity, medium voltage, aluminium industry	IAI Area, Russia & RER w/o EU27 & EFTA	electricity, medium voltage, aluminium industry	sulfur hexafluoride, liquid	market for sulfur hexafluoride, liquid	RoW
tantalum mine operation and beneficiation	RW	tantalum concentrate, 30% Ta2O5	electricity, medium voltage	market group for electricity, medium voltage	RAF

3 Effects of changes on LCIA scores

The changes made to the characterization factors (CFs) described in section 2.1 are the main drivers of changes in scores between v3.9 and v3.9.1. Therefore, it is primarily the indicators for which CFs were updated that have noticeable changes in scores. An overview of the number of datasets that have changes in scores and the magnitude of the changes are provided in the annex excel file “Overview of changes in scores between v3.9 and v3.9.1”. This file contains one sheet per system model, which shows the relative changes in scores for all indicators calculated for each system model. A summary of these changes is given below for each system model.

The correction made to the emission of “Mercury II” to air in the “market for natural gas, high pressure” in JP has also caused some significant changes in the scores of indicators that assess human toxicity and emissions of heavy metals to air. However, these changes are constrained to the datasets that are directly or indirectly supplied by that market.

3.1 Allocation, cut-off

For 85 indicators out of the 710 calculated in cut-off, the score changed by more than 5% for at least 1% of the datasets.

The biggest changes concern the EF v3.0 and v3.1 indicators for “human toxicity: carcinogenic", due to the changes in CFs. The score for the vast majority of datasets decreased compared to v3.9.

The removal of CFs for the emission of “Carbon dioxide, non-fossil” in the climate change indicators in ReCiPe, TRACI and EPS has also caused significant decreases in scores for those indicators, including the “total” indicators in the ReCiPe method. Up to 28% of the datasets have a decrease of at least 5%.

The only indicators for which a significant part of the datasets have an increase in score are those for “ecotoxicity: freshwater” in EF v3.0 and v3.1. This is also due to the changes in CFs, mentioned in section 2.1.2.1.

The removal of the CFs for emissions of Nitrogen in the EF v3.0 and v3.1 indicator “eutrophication: marine” caused roughly 10% of the datasets to have a decrease in score by 5% or more.

Finally, the correction of the emission of “Mercury II” to air in the “market for natural gas, high pressure” in JP resulted in score decreases for indicators that assess human toxicity in EDIP, USEtox and TRACI, the indicator for terrestrial ecotoxicity in CML, and emissions to air in Ecological Scarcity. These changes concern only up to 1% of the datasets.

3.2 Allocation, EN15804

In the EN15804 system model, for 10 out of 61 indicators at least 1% of the datasets have a change in score of 5% or more. Similarly to cut-off, the “human toxicity: carcinogenic” indicators for the EF v3.0 and v3.1 methods (as implemented for EN15804) show the biggest changes. They affect 64% of the datasets, and the scores are mostly decreasing compared to v3.9.

The only indicator in EN15804 that is affected by the change of the CFs for “Carbon dioxide, non-fossil” is the climate change indicator in TRACI, for which 26% of the datasets have a decrease in score of 5% or more.

The other indicators that have decreases in scores in the EF methods are those for marine eutrophication (due to the removal of the CFs for Nitrogen) and human toxicity: non-carcinogenic.

The indicator “human toxicity: non-carcinogenic” in TRACI shows some decreases in scores due to the correction of the emission of Mercury II in the “market for natural gas, high pressure” in JP. This concerns roughly 1% of the datasets.

Similar to cut-off, the only indicator for which scores increased significantly is “ecotoxicity: freshwater” in EF v3.1, caused by the updates in CFs.

3.3 Consequential

In the consequential system model, for 100 indicators out of 710 at least 1% of the datasets have a change in score of 5% or more. More indicators and a higher number of datasets are affected compared to cut-off. This stems from the higher sensitivity of the consequential system model to changes in amounts (both CFs and exchange amounts), which is a side-effect of substitution.

This is for example the case of the indicator “biotic resources” in Ecological Scarcity, for which no changes were made to the CFs, but it still changed significantly for the majority of datasets.

The other changes in scores follow mostly the same pattern as in cut-off, with the indicators for “human toxicity: carcinogenic" in EF v3.0 and v3.1, and indicators for climate change in ReCiPe, TRACI and EPS showing the biggest changes. Most changes for these indicators are decreases in scores, but due to substitution, close to 10% of the datasets show an increase in score.

Similar to cut-off, the indicator for freshwater ecotoxicity in EF v3.1 significantly increases compared to v3.9 for close to 30% of the datasets, due to the changes described in section 2.1.2.1.

4 References

Sonderegger T., Stoikou N. (2022). Implementation of life cycle impact assessment methods in the ecoinvent database v3.9 and v3.9.1. ecoinvent Association, Zürich, Switzerland.

United Nations Statistics Division (2007). International Standard Industrial Classification of All Economic Activities Revision 4, Series M: Miscellaneous Statistical Papers, No. 4 Rev. 4, New York: United Nations. ST/ESA/STAT/SER.M/4/REV.4