User guide for LCADB.sudoe®

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Intellectual property:

Sostenipra - Sostenibilitat i prevenció ambiental Research group.
(www.sostenipra.cat)

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Introduction

This manual is a guideline for uploading a Life Cycle Inventory (LCI) analysis using the Life Cycle Assessment Data Base tool, which can be found in the following site: http://lcadb.sudoe.ecotech.cat/

An LCI can be best described as a model of one or more product or process systems [1]. A LCI involves creating an inventory of flows from and to nature for a product system and it is the first step when carrying out a Life Cycle Assesment (LCA). Inventory flows include inputs of water, energy, and raw materials, and releases to air, land, and water, as well as other environmental exchanges at every relevant stage (phase) in a product's life cycle.

The database format presented in this document was developed by Sostenipra Resarch Group (http://www.sostenipra.cat) in partnership with the Universidad de Aveiro, Ecole des Mines d'Alès, Montepellier SupAgro, INRA, UdG, IRSTEA and CATAR Agro Resources. The expected result of this project is to create an online and free LCA database with all inputs, outputs and flows from different unit processes for its usage in other projects and to have a compatible database with other tools such as the European Reference Life Cycle Data System (ELCD) and ECOINVENT. The main objective of this project is to develop a common database for LCI in the SUDOE region (Spain, Portugal and France) useful for projects and collaboration between the participant institutions. There are 9 topics covered in the database:

- Agriculture
- Construction
- Energy Production
- Manufacture process
- Services
- Transport
- Use and Consumption
- Waste treatment
- Water
- Forest and Forestry products

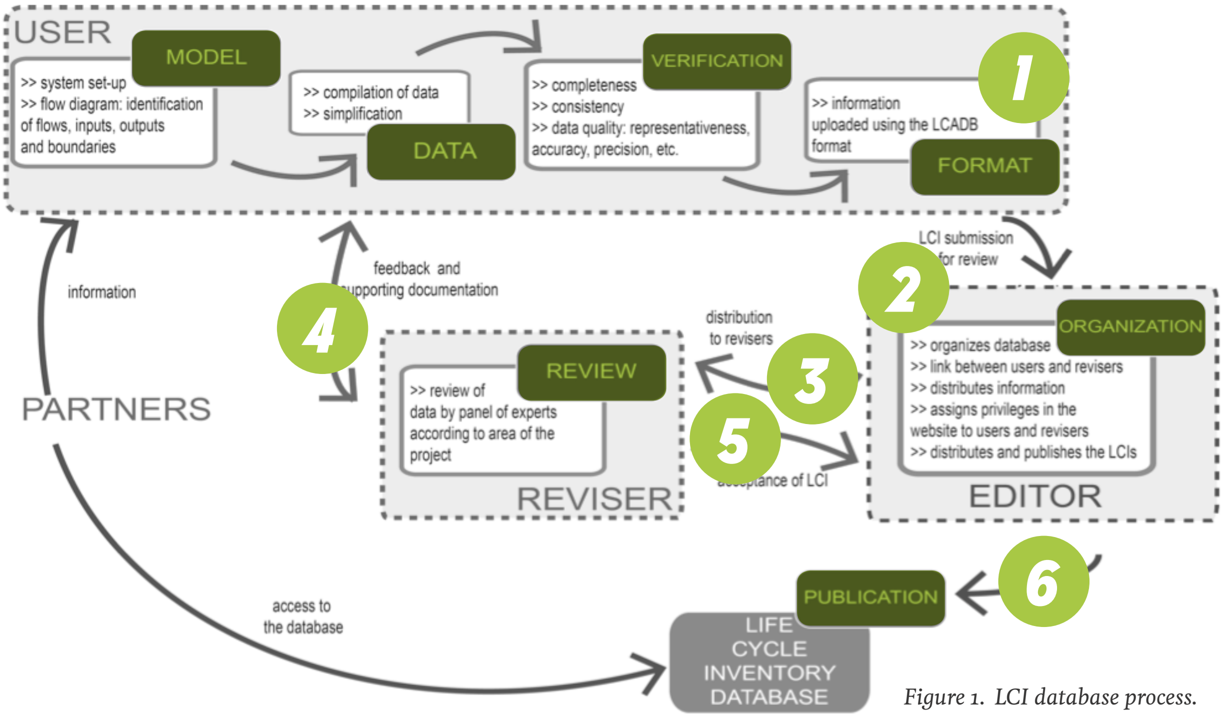


Figure 1. LCI database process.

1 First the user creates an inventory model:

- **MODEL:** A flow model of the technical system is made using data on inputs and outputs. The flow model is usually illustrated with a flow chart that includes the activities that are going to be assessed in the relevant supply chain and gives a clear picture of the technical system boundaries.

- **DATA**: The next step is to collect the input and output data needed for the construction of the model for all activities within the system boundary (including from the supply chain). This data should be relevant for the study and simplified when possible.

- **VERIFICATION**: When the LCI is completed, meaning all the data is compiled, it should be verified in terms of its consistency with the methodology and with the goal/scope of the overall project, the data quality should meet basic statistical requirements such as representativeness, accuracy, precision / uncertainty and completeness of the inventory[2].

- **FORMAT**: The data is uploaded in the online format through the website http://lcadb.sudoe.ecotech.cat/

It is important to notice that the choices and assumptions made during system modeling and the chosen data for the LCI, including the system boundaries and processes within these boundaries, are often decisive for the result of a LCA study. This is the reason why databases providing high-quality (e.g. transparent and consistent) data of frequently used commodities for LCI are helpful and required, particularly if one wants to apply LCA on a routine basis and to attain characteristics on the LCA suchs as reproducibility, information and data availability, precision and robustness, practicality, communicability, cost-effectiveness, coherence with other instruments.

2 The database is uploaded into the system and sent to the editor of the topic with the aim to be reviewed. The editors of the project organize the different LCIs, as they are the link between the revisers and users. A list of the editors per topic and the revisers can be found at the end of this document in the *APPENDIX A*.

3 The reviser receives the information and evaluates the content of the inventory. The points to be assessed are: complete submission of the data in each step (i.e. all required fields completed), nomenclature according the elemental flows from the International Reference Life Cycle Data System (ILCD - [2]), and the correct and sufficient information for the LCI.

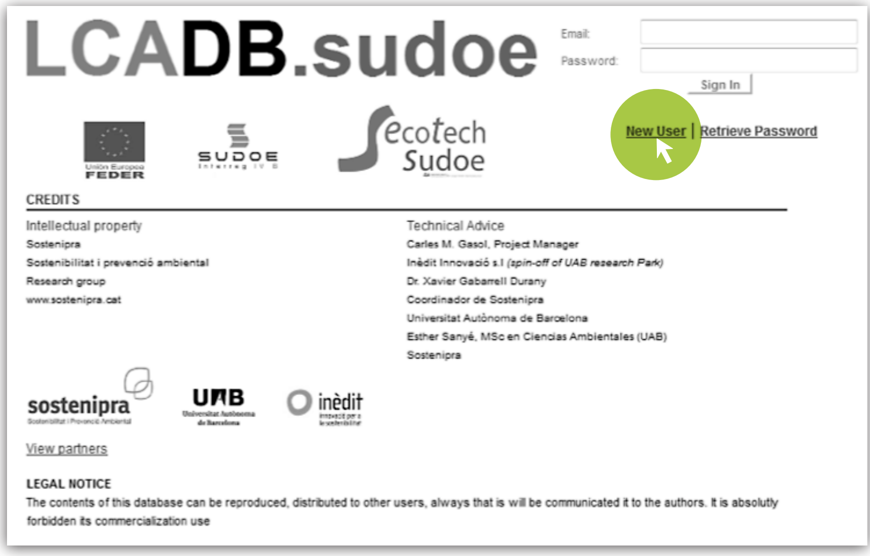
4 The reviser should contact the database author using the contact data provided in the format, in order to give feedback or in the case that further documentation and complementary information is required.

5 The reviser sets the status of the process: *accepted, need to be improved, denegated*. In any case the reviser notifies the editor about this decision.

6 The editor makes the inventory accessible to the partners and other users of the Life Cycle Assesment Data Base tool. The editor takes into consideration the user's request regarding the publication of the database (*public, public for partners, private, etc.)*

1) Registering as new user

Go to the website: http://lcadb.sudoe.ecotech.cat and click on "New User".



Then, register the user's data in each field and click on the sign up button.

Once the account is created a confirmation email will be sent to the address registered in order to activate the account.

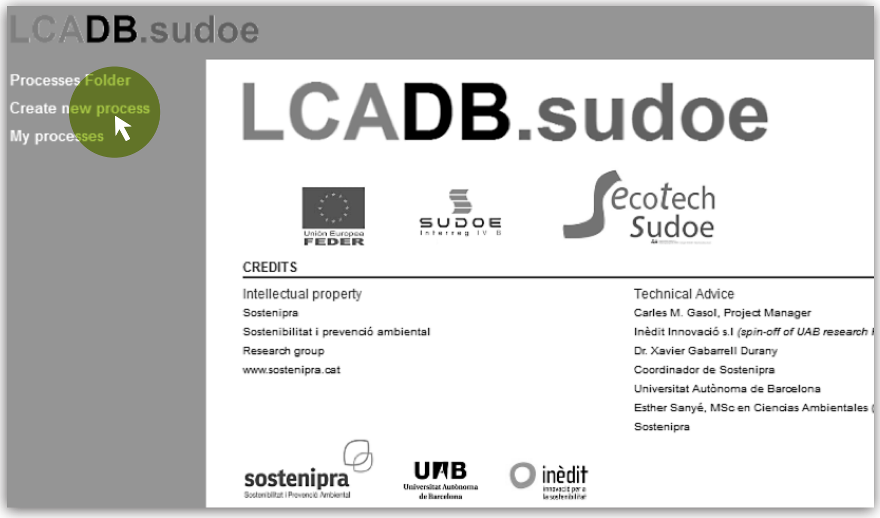
Use the email and password registered to log in into the system.

2) Creating a process

In order to create a LCI for a certain process the data should be compiled and tabulated in the correctly. As mentioned, this data will be the starting point to perform a LCA and thus quantify and evaluate the potential environmental impacts of goods and services through the process.

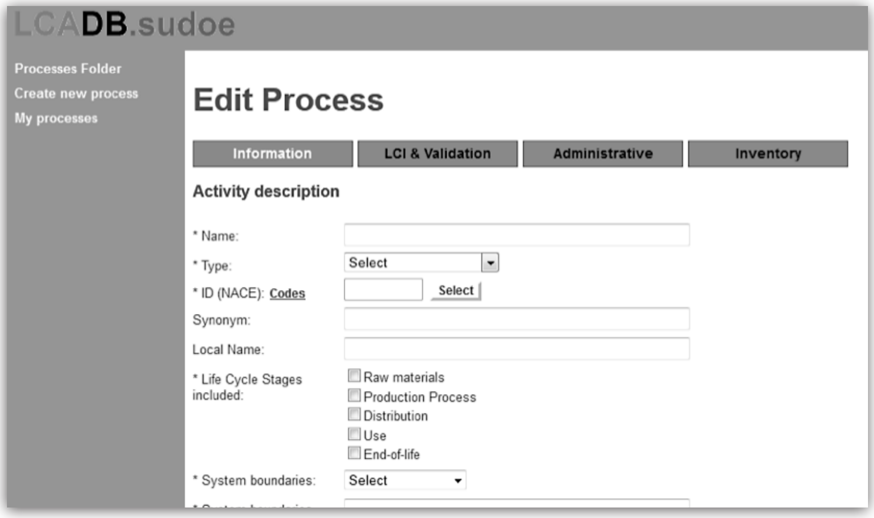
Once logged in on the LCADB.sudoe® website, a new process can be created by clicking on the "*create a new process*" option. Validate the action by clicking *OK* on the confirmation window.

Now, proceed by writing the proper information in each of the fields.



Step 01 - Information of the process

Activity description



This section includes all the relevant information of the project such as name, type, ID (NACE code), system boundaries (included and excluded activities), this will be an overall reference for the process.

Field	Description	Required/ Optional
Name	General and descriptive name of the process, product and/or service, following the nomenclature showed in the examples: "product + action (+specifications), XX (FU)" Tomato production in multitunnel greenhouse, ES (1 ha) The functional unit must be included if different types of functional units can be used. Moreover, the geographical scope should be included in the activity name with 2 or 3 letters (For example, ES for Spain, or FR for France). Further examples: *Tomato production in multitunnel greenhouse, ES (1 kg)* *Tomato distribution and retail, ES (1 kg)* *Single house construction, ES (1 u)*	*Required
Type	Select the activity typology from the list.	*Required
ID	Code of the activity of 7 digits: XX.YYYY.ZZZ [Fields for XX and ZZZ are automatically generated] (*Appendix A*) A full document with the Detailed Structure of NACE codes will open by clicking "*Codes*".	*Required
Synonym	Indicate synonymous of the activity.	Optional
Local name	Indicate local names attributed to the activity.	Optional
Life cycle stages included	Multiselection cell to indicate the different life cycle stages included on the data sheet.	*Required
System boundaries	Select from the list the classification data sheet according to the system boundaries considered.	*Required
System boundaries description	Detailed description of the system boundaries considered. This description is divided in three sections: (*Appendix B*, for examples and writing formulas) Starting and ending activities: *-The activity starts... (first activity)... and ends...(last activity)* Included activities: *- The system includes (list of the activities and/or production stages considered)* Excluded activities: *- The system does not include (list of the exclusions of the system)*	*Required

Functional unit

It specifies the functional unit the information relates to specifying: quantity, unit and product according to the formula (**quantity**) (**unit**) of (**product**). For example, *1 kg of paper.*

Each field may be filled out according to the following description:

Field	Description	Required/ Optional
Functional unit	Functional unit must be referred to 1, avoid other reference units (like 50 products or 10 kg). Moreover, units must be given in the international system (SI), such as kg for mass or dm^3 for volume.	*Required
Comment	Basic description of the functional unit and relationship to other properties: This field must indicate estimates or extrapolations made to obtain the functional unit from product or material properties (density, calorific value, mass, energy, ...)	Optional

Time period

It indicates the length of the period the data of this project is valid.

Each field may be filled out according to the following description:

Field	Description	Required/ Optional
Start of period	For the two date fields it is indicated the beginning and the end of the period for which data are valid. This time period can be different from data collection if they are extrapolated or interpolated.	*Required
End of period		*Required
Comment	Other comments about the temporal period as their extrapolation or interpolation.	Optional

Geographical Information

It indicates the location of the project.

Each field may be filled out according to the following description:

Field	Description	Required/ Optional
Country	Indicate the code for the country. For example, ES for Spain.	*Required
Region	Indicate the region, province or county, in the case of specific information.	Optional
City	Indicate the city in the case of specific information.	Optional
Comment	Other comments about the geographical context of the information.	Optional

Technology

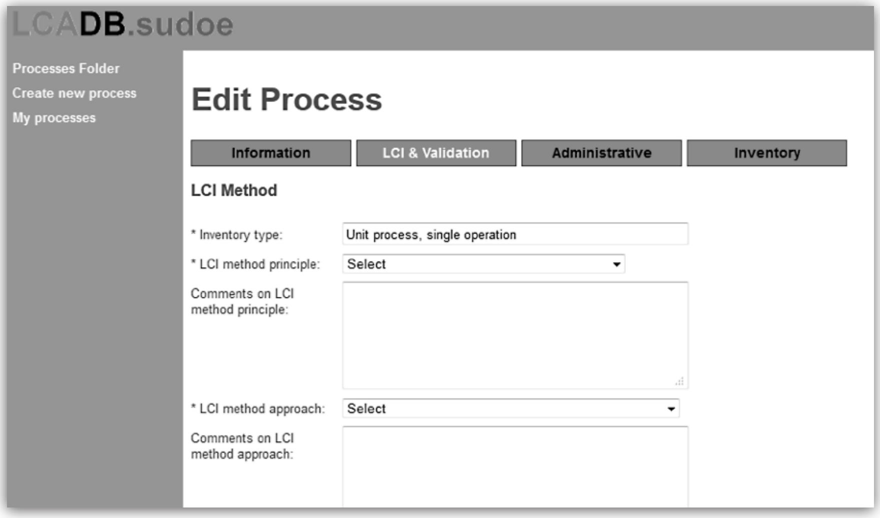
This section describes the type of technology used throughout the process. In this section a flow diagram should be included too.
The flow diagram should ideally show: included life cycle stages, systematically excluded activity types and elementary flows, specifically excluded processes and elementary flows, and quantified but not completely modeled product and waste flows.[2]

Field	Description	Required/ Optional
Classification	Select the activity typology from the list (*Appendix* C).	*Required
Technology description	Detailed description of the process and the infrastructure related with the technology considered.	*Required
Flow diagram	The technological description may be accompanied with a flow diagram with the process and products considered. The format of the picture must be JPEG, NPG or GIF NOTE: Word format is not allowed due to its quality.	*Required
Comment	Description of processes and technology systems that are not considered in the data sheet. For example, exclusion of production stages	Optional

Step 02 - LCI & Validation

In this step further information about the methodology and approach used in the database are asked. There are two main LCI method principles that are commonly used: attributional or consequential. For more complete information about these terms please read the *GLOSSARY* section.

LCI Method

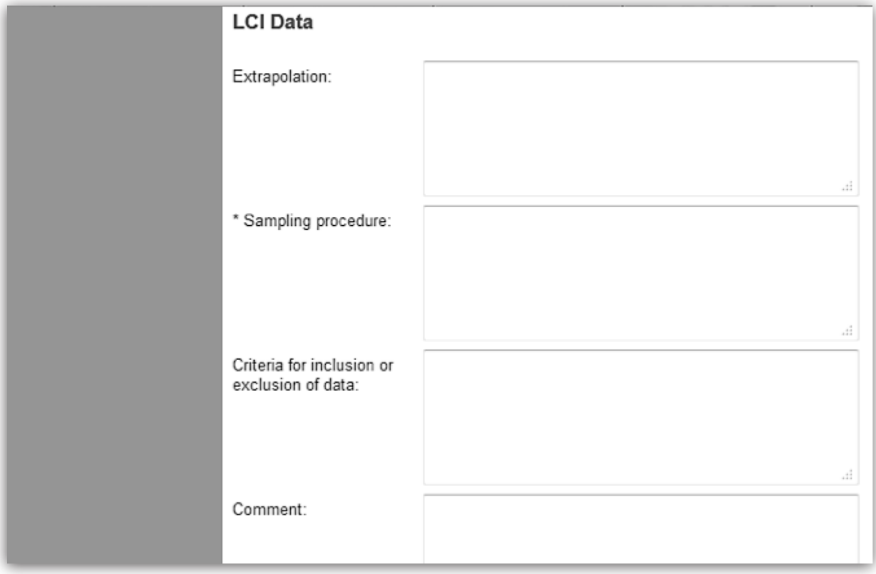


This section describes the Life Cycle Inventory method such as the inventory type, principle and approach.

Each field may be filled out according to the following description:

Field	Description	Required/ Optional
Type of dataset	Select the type of dataset. In a first phase the datasets must be "*Unit process, single operation*".	*Required
LCI method principle	Select the method chosen for the inventory.	*Required
Comment on the LCI method	Detailed description of possible deviations of the LCI method selected, with additional explanations.	Optional
LCI method approach	Select the method approach chosen for the inventory.	*Required
Comment on the LCI approach	Detailed description of possible deviations of the LCI approach selected, with additional explanations.	Optional

LCI Data

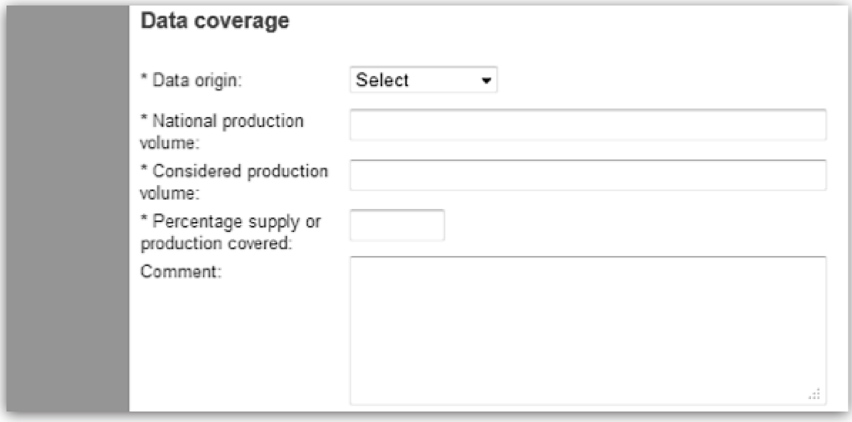


The Life Cycle Inventory Data gives information about the data if it has been extrapolated, which criteria was used for including or excluding information, etc.

Each field may be filled out according to the following description:

Field	Description	Required/ Optional
Extrapolation	Description of general extrapolation methods for the data of the data sheet. For example, if data from paper production have been extrapolated to the production of recycled paper with a factor 1.2	Optional
Sampling procedure	Detailed description of the sampling method for obtaining the inventory. For example, data were obtained from 3 companies in the same geographic area (Cuenca).	*Required
Criteria for inclusion or exclusion of data	Indication of criteria or methodologies that have been considered for inclusion or exclusion of life cycle stages, products or inputs. For example, exclusion of the infrastructure to follow the methodology of the PAS2050	Optional
Comment	Select the method chosen for the inventory	Optional

Data coverage

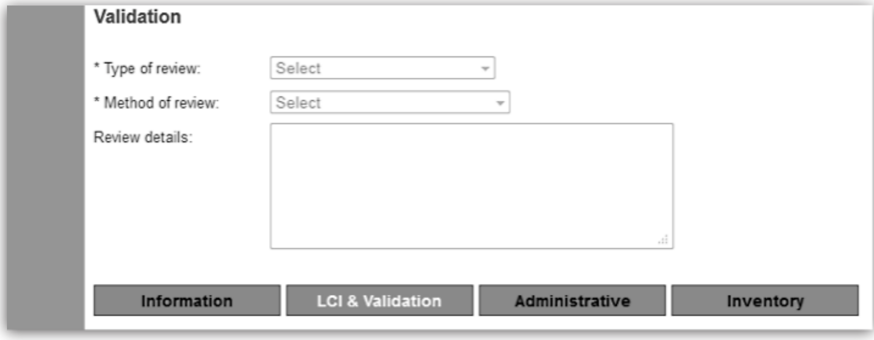


This section refers to the production volume for this process, a comparison with the national production volume and the percentage covered by this process.

Each field may be filled out according to the following description:

Field	Description	Required/ Optional
Data origin	Indicate the origin type of the data: ▪ Real data: real data for an enterprise. You must complete the following fields. ▪ Average data: if you are working with national average data, you don't need to complete the other fields regarding this section. ▪ Prototype: when data comes from a prototype and a market for it has not been developed yet, the other fields doesn't need to be completed.	*Required
National production volume	This cell contains the Spanish annual production of the activity considered in the data sheet. You must indicate quantity, unit and the product concerned. For example, 1,200,000 tons of paper	*Required
Considered production volume	This cell contains the total production that has been considered in the inventory; real data from companies or estimated. If company data, indicate the year of the data considered. For example, *300,000 tons of paper (production for 2010)*	*Required
Percentage supply or production covered	Percentage covers the production considered for the inventory of total Spanish production. For example, 25%.	*Required
Comment	Other details about the coverage of the data considered.	Optional

Validation



This section is only valid for editors and thus it cannot be modified by users. It gives information about the type, method and details regarding the review of the process.

Step 03 - Administrative information

The information provided in this section will be useful to be contacted by the reviser for feedback, asking for supporting documentation or complementary information.

Author, data entry and data reviewer

In this section all the information about the authors of the project, data review and entry. The data fields concerning the reviewer must be completed by him/her, being left blank by the authors of the data sheet:

Field	Description	Required/ Optional
Name	The different fields indicate the name, workplace and contact details of the author, who has entered the dataset and the reviewer. It also indicates the date of conduction of various tasks.	*Required
Centre		*Required
Contact details		*Required
Date		*Required

Data sheet status

In this section the status of the data sheet should be indicated. Each field may be filled out according to the following description:

Field	Description	Required/ Optional
Data sheet status	Select the data sheet status from the list. You must indicate the data sheet status in relation to the publication in the database. For instance, the data sheet can be still unfinished (Draft version), or can be done but without revision (Final draft for review) or already reviewed and published (Reviewed dataset, published in the database) This is a field to have a control of the data sheet status.	*Required
Access	Indicate the type of access of the dataset	*Required
Copyright	Indicate whether the dataset as data protection	*Required

Inventory publication

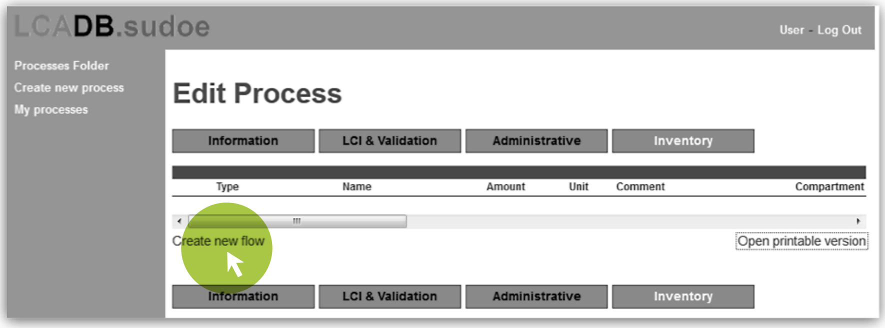
In this section it may be indicated if the inventory has already been published or not in a scientific journal or in another type of publication:

Field	Description	Required/ Optional
Inventory	Indicate if the inventory has already been published or not in a scientific journal or in another type of publication. NOTE: *The publication must show the inventory not results based on it.*	*Required
Published source	Indicate the reference to the inventory publication.	Optional

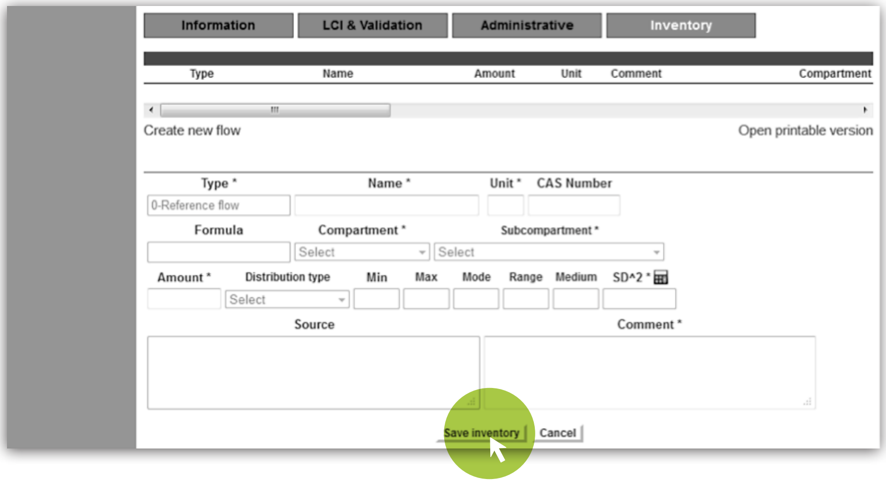
Step 04 - Data sheet

This represents the most crucial step in the process of the LCADB.sudoe® consolidation, the user should include the data compiled for the process studied, it is important to use the correct nomenclature.

In this step each flow of the process and its proper information should be included.



To create a new flow click on the section "*Create a New Flow*".



A new format will appear with the information required for each flow; the two sections per flow are the following.

NOTE:
By default the first flow to be included in the format is the reference flow. The reference flow is the flow (or flows in case of multifunctional processes) to which all other input and output flows quantitatively relate. The reference flow can be expressed in direct relation to the functional unit.
In this format the reference flow (*Type: 0 - Reference flow*) must indicate in the section "Inventory" the amount which normally will be 1 and must fill out the comment with and explanation (referenced or not) on it. The other fields shouldn't be completed.

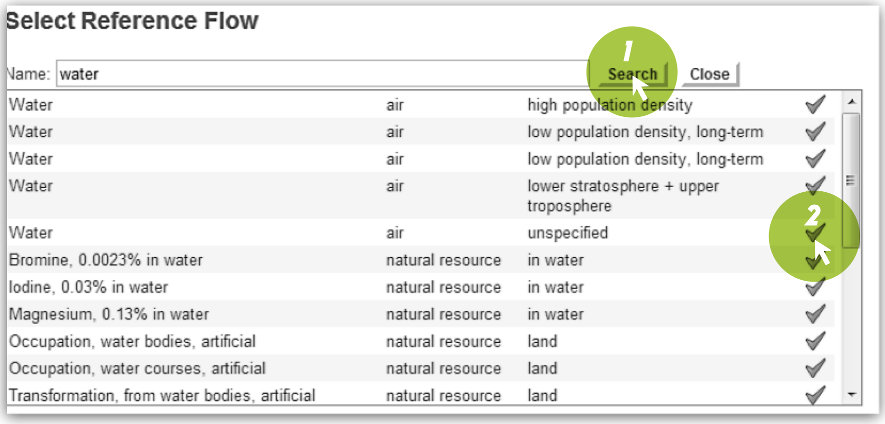
Exchanges

This refers to all relevant unit processes within the system boundaries that compose the analyzed system. Examples of inputs and outputs quantities include inputs of materials, energy, chemicals and 'other' - and outputs of air emissions, water emissions or solid waste. Other types of interventions such as radiation or land use should also be included.

Each field may be filled out according to the following description:

Field	Description	Required/ Optional
Type	Select the type of flow from the list: • Reference flow • Byproduct • From environment • From technosphere • To environment • To technosphere For more complete information about these terms please read the *GLOSSARY* section.	*Required
Name	Indicate the name of the inventory flow (only for types 1, 3 and 5), following the nomenclature of the ILCD Handbook and Ecoinvent.	*Required
Unit	Give the unit of measure of flow according to the International System of Units.	*Required
Compartment	Select the compartment and subcompartment of flows (Appendix D).	Optional
Subcompartment		Optional
Formula	Indicate the formula, for chemical compounds.	Optional
CAS number	Indicate the CAS number of elementary flows.	Optional

For the types 2- *From environment* and 4-*To enviroment* a new window will pop up. Type the name of the flow in the "*Name:*" field and click on search, then a list of all the elements with or containing this name will appear. Identify the required flow and choose it by click on the tick button. The fields of *Name, Unit, Compartment, Subcompartment, Formula and CAS number* will be filled out with the information of this flow.

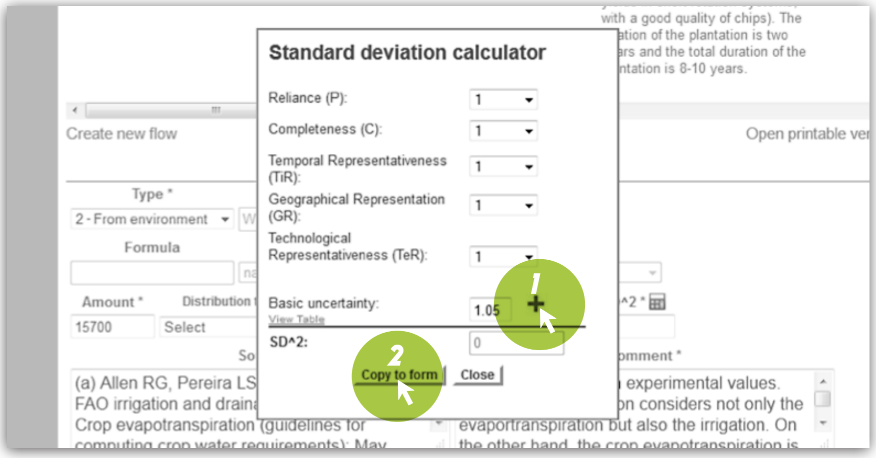


Inventory

This step is the core of the LCI since it involves all the data collection meaningful to the system process. The data must be related to the reference flow(s) and/or functional unit(s) defined in the scope of the project to be studied. Each field may be filled out according to the following description:

Field	Description	Required/ Optional
Activity name	Indicate the activity in the inventory referred	*Required
Amount	Indicate the amount of the corresponding flow	*Required
Comment	Each flow must include a characterization of the type of data and a description of methods and assumptions made for their quantification (see *Appendix E*). **IMPORTANT**: For flows with more than one input (for example, diesel consumption by different machines), a breakdown of these inputs in different lines is required with the aim of not losing information by aggregating data. In the comment fields you can include the percentage that represents from the total.	*Required
Source(s)	The references considered for obtaining inventory values should be included in this field, including author, publication name, year and place of publication and journal name if necessary	Optional
Distribution	For own statistical values, select the type of distribution. By default, this field is "*Lognormal*".	Optional
Min	For own statistical values, complete the statistical parameters that you have already calculated or are necessary for the distribution type chosen	Optional
Max		
Mode		
Range		
Medium		
SDˆ2	For own statistical values, indicate the standard deviation value. By default, this field is automatically filled with the formula written (*Appendix F*) Click on the calculator button and include the correct values in order to calculate the standard deviation.	*Required

When filling out the the SDˆ2 field, after clicking on the calculator button a window called "*standard deviation calculator*" will appear. The proper numbers should be added for each field including the Basic Uncertainty number, click on the plus button and then on the "*copy to form*" button to automatically input the correct value to the flow form.



Once all the information for this flow is filled out, click on "*Save Inventory*" to save this flow into the process.

Introduce as much flows as required to complete the process.

PAY ATTENTION USER:

In each flow, inside the comment area, user has to fill in the number selected for each of the variables completed in the Standard Deviation Calculator.

Quality analysis *(For a Default Standard Deviation calculation)*

Refers to the quantitative and qualitative aspects of input data and the methods by which they are measured or calculated, collected, and integrated into the LCA model.

In this case the numbers are required to calculate a standard deviation which will be helpful to understand the precision of the data provided:

Field	Description	Required/ Optional
TeR	Values to select from the list according with the punctuation table (*Appendix F*).	Optional
GR		
TiR		
C		
P		
M		
Xw		
i		

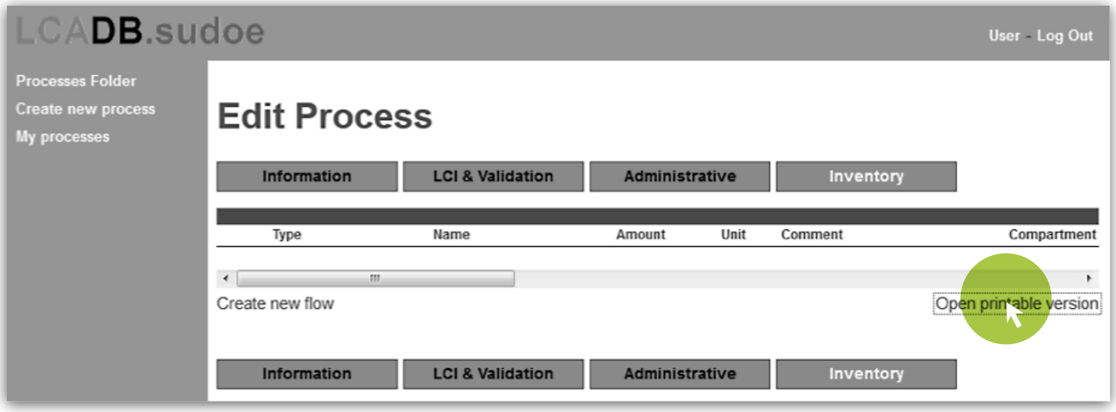
Uncertainty analysis

In this step uncertainty refers the quantitative degree of lack of precision in the data. The required uncertainties to be reported are:

σ_b	The basic uncertainty must be provided manually for the calculation of the default Standard Deviation when the inventory doesn't provide own statistical data (*Appendix F* for the values).
σ_1	These are automatic values for the calculation of the default Standard Deviation when the inventory doesn't provide own statistical data. These values are generated according to the indicated scores of the Pedigree matrix (*Appendix F* for more information).
σ_2	
σ_3	
σ_4	
σ_5	
σ_6	

Printable version

There is an option at the bottom of the list of flows called "*Open Printable Version*" which launches in a new window a version of the uploaded data for a better visualization and suitable to be printed.



Step 05 - Save process & Review

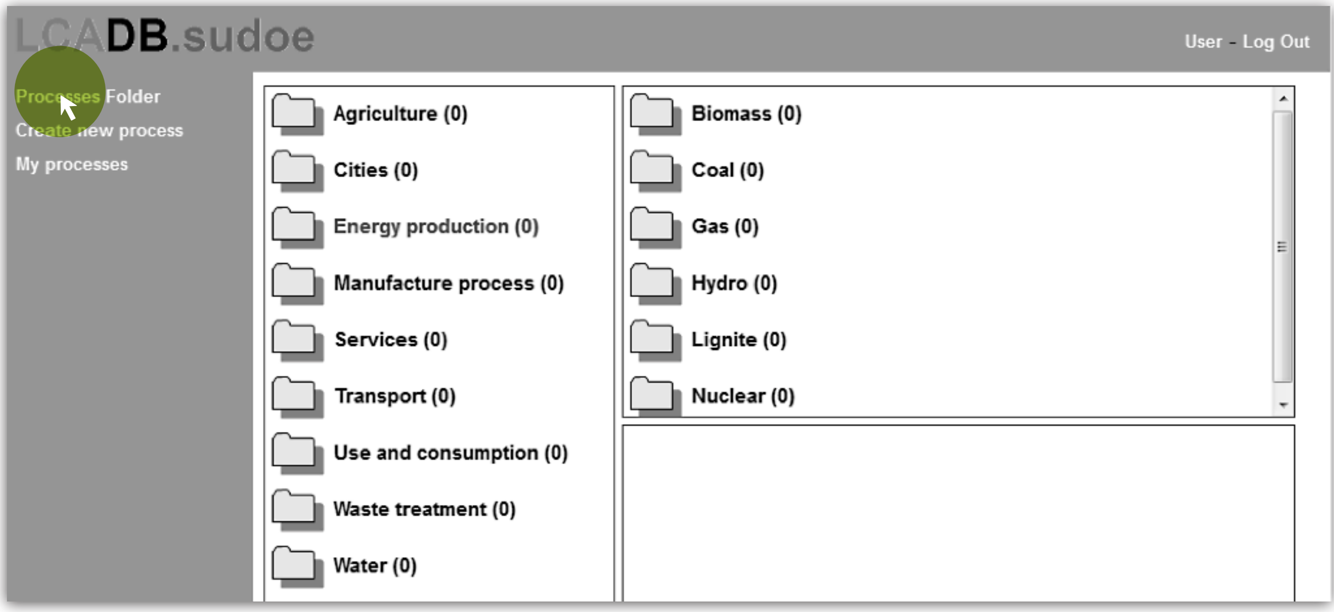
After completing each step, the data should be saved using the “Save Process” button. The format can be filled out in parts and in different sessions before it is submitted for review.

As mentioned, the data could be saved and completed in a later stage, for this is recommendable to click on “*save process & exit*”.

Once the database is uploaded into the system it will be reviewed by any of the nine editors/revisers specialized in the area. The reviewer will contact the database author (user) in the case further documentation or complementary information is required

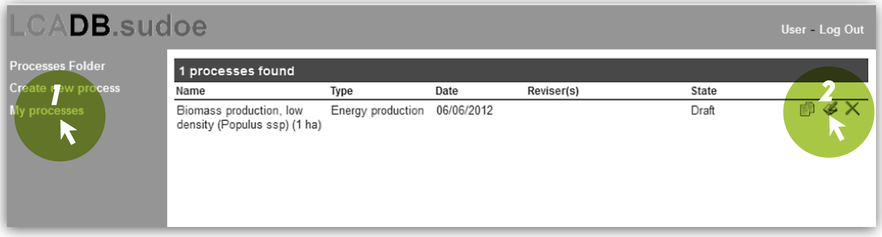
3) Processes Folder

In this tab the processess are classified according to its type: *Agriculture, Cities, Energy Production, etc.* and then subcategorized in different types.



4) My Processes

The user can save different processes and they can be found under the "*My Processes*" tab. In this section is listed the name of the processes, its type, the date and the state. There are three options:



1. **Copy the process** as a new one
2. **Edit the Process** – to continue updating the information and completing the form before it is submitted for review
3. **Delete the Process**

5) Glossary

LCA	Life Cycle Assessment (LCA) is a structured, comprehensive and internationally standardised method. It quantifies all relevant emissions and resources consumed and the related environmental and health impacts and resource depletion issues that are associated with any goods or services ("products"). Life Cycle Assessment takes into account a product"s full life cycle: from the extraction of resources, through production, use, and recycling, up to the disposal of remaining waste. Critically, LCA studies thereby help to avoid resolving one environmental problem while creating others: This unwanted "shifting of burdens" is where you reduce the environmental impact at one point in the life cycle, only to increase it at another point. Therefore, LCA helps to avoid, for example, causing waste-related issues while improving production technologies, increasing land use or acid rain while reducing greenhouse gases, or increasing emissions in one country while reducing them in another. Life Cycle Assessment is therefore a vital and powerful decision support tool, complementing other methods, which are equally necessary to help effectively and efficiently make consumption and production more sustainable.
ELCD	ELCD core database comprises Life Cycle Inventory (LCI) data from front-running EU-level business associations and other sources for key materials, energy carriers, transport, and waste management. Focus is laid on data quality, consistency, and applicability. The respective data sets are officially provided and approved by the named industry associationhe target users of these data sets are experts/practitioners in Life Cycle Assessment (LCA). The data sets are accessible free of charge and without access or use restrictions for all LCA practitioners. For more information: http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm

ECOINVENT	Is the world's leading database with consistent and transparent, up-to-date Life Cycle Inventory (LCI) data. With more than 4'000 LCI datasets in the areas of agriculture, energy supply, transport, biofuels and biomaterials, bulk and speciality chemicals, construction materials, packaging materials, basic and precious metals, metals processing, ICT and electronics as well as waste treatment, we offer one of the most comprehensive international LCI databases. Our high-quality generic LCI datasets are based on industrial data and have been compiled by internationally renowned research institutes and LCA consultants. The data are available in the EcoSpold data format, and they are compatible with all major LCA and eco-design software tools. For more information: http://www.ecoinvent.org
SYSTEM BOUNDARY	The system boundary determines which life cycle stages and process steps are included in the LCA and which have been left out. It also indicates the elementary streams that flow in and out to the system.
(FLOW TYPE) REFERENCE FLOW	An elementary flow is defined as material or energy entering the system being studied that has been drawn from the environment without previous human transformation, or material or energy leaving the system being studied that is released into the environment without subsequent human transformation.
(FLOW TYPE) BYPRODUCT	Flow produced along the process in addition to the principal product.
(FLOW TYPE) ENVIRONMENT	Refers to the ecosphere or natural environment.
(FLOW TYPE) TECHNOSPHERE	By definition is the part of the physical environment affected through building or modification by humans, examples of this are artificial materials, production processes, transport, etc.
FUNCTION AND FUNCTIONAL UNIT	A function means to quantitatively and qualitatively specify the analysed object. In a LCA this is generally done by using the functional unit that names and quantifies the qualitative and quantitative aspects of these function(s) along the questions "what", "how much", "how well", and "for how long". In other words the functional unit measures the performance of the functional output of the product or services system. The first step of defining the functional unit is to identify and quantify the relevant quantifiable properties and the technical / functional performance of the system.
ATTRIBUTIONAL LCI	The attributional life cycle model depicts its actual or forecasted specific or average supply-chain plus its use and end-of-life value chain. The existing or forecasted system is embedded into a static technosphere. The attributional LCI depicts the potential environmental impacts that can be attributed to a system (e.g. a product) over its life cycle, i.e. upstream along the supply-chain and downstream following the system's use and end-of-life value chain. Attributional modelling makes use of historical, fact-based, measureable data of known (or at least know-able) uncertainty, and includes all the processes that are identified to relevantly contribute to the system being studied. [2]

CONSEQUENTIAL LCI	The consequential life cycle model depicts the generic supply-chain as it is theoretically expected in consequence of the analysed decision. The system interacts with the markets and those changes are depicted that an additional demand for the analysed system is expected to have in a dynamic technosphere that is reacting to this additional demand. Therefore the consequential LCI aims at identifying the consequences that a decision in the foreground system has for other processes and systems of the economy, both in the analysed system's background system and on other systems. It models the analysed system around these consequences. The consequential life cycle model is hence not reflecting the actual (or forecasted) specific or average supply-chain, but a hypothetic generic supply-chain is modelled that is prognostizised along market-mechanisms, and potentially including political interactions and consumer behaviour changes. [2]
ALLOCATION	Partitioning the input or output flows of a process or a product System between the product system under study and one or more other product Systems. In other words it solves the multifunctionality by splitting up the amounts of the individual inputs and outputs between the co-functions according to some allocation criterion, being a property of the co-functions. Allocation should be performed in accordance with the underlying causal physical - and implicitly also covered: chemical and biological - relationship between the different products or functions.
SUBSTITUTION	Is a variant of the system expansion. Substitution means to subtract the inventory of another system from the analysed system. This often leads to negative inventory flows. It can even result in negative overall environmental impacts for the analysed system. This means that there is a net benefit of producing the analysed system as the overall impact is more than compensated by the avoided impact the co-functions have elsewhere. This is the correct interpretation, if made within the assumptions of the study, including on the amount of co-functions produced. In practice two different situations can be encountered in the usage of substitution: The first one is to solve the multifunctionality by expanding the system boundaries substituting the not required function with an alternative way of providing it. The second one is when several multifunctional systems (e.g. *different brands of a complex consumer product*) are to be made comparable in a comparison study. Substitution is also applicable for attributional modelling that is interested to include existing interactions with other systems

6) References

1- G. Rebitzer, T. Ekvall, R. Frischknecht, D. Hunkeler, G. Norris, T. Rydberg, W.-P. Schmidt, S. Suh, B.P. Weidema, D.W. Pennington, Life cycle assessment: Part 1: Framework, goal and scope definition, inventory analysis, and applications, Environment International, Volume 30, Issue 5, July 2004, Pages 701-720.

2- European Commission - Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. First edition March 2010. EUR 24708 EN. Luxembourg. Publications Office of the European Union; 2010.

7) Appendix A: Formulation for the Identifier Code Process

The ID of each process consists of 7 digits: XX.YYYY.ZZZ

The first component of ID (XX) corresponds to the type of process being documented, and specified in the same data sheet (Type):

Type	Code
Agriculture	01
Manufacturing process (materials and products)	02
Energy production	03
Transport	04
Use and consumption	05
Services	06
Waste treatment	07
Water treatment	08
Construction	09
Forest & Forestry	10

The second component of ID (YYYY) corresponds to the NACE Rev. 2 code, the Statistical classification of economic activities in the European Community. This is a 4-digit code that corresponds to the classes of activities [see the file: Nace_code.pdf or visit http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-RA-07-015/EN/KS-RA-07-015-EN.PDF]

The third component (ZZZ) corresponds to the numbering of the processes recorded for each class of activity, which is assigned in order of their creation. This registration number is assigned by the reviewer of the data sheet.

8) Appendix B: System Boundaries

A detailed description of the system boundaries must have the following structure:

- The activity starts ... *(first activity)* and ends ... *(last activity)*
- The system includes *(list of activities and / or production stages considered)*
- The system does not include *(list of exclusions from the system)*

Examples and writing formulas for the initial activity of the process:

- **General activity:** From reception of *(input materials)* at the factory gate.
  Example: *From reception of ethanol and acetic acid at the factory gate.*

- **Service** (e.g. injection moulding, packing, sheet rolling, etc.): *(Service activity)* process from *(material or product concerned)*, ex. *(initial state)*
  Example: *Packing process starting from clay, unpacked.*

- **Infrastructure:** From (initial state of the area) foreseen for (type of infrastructure)
  Example: *From unoccupied land foreseen for a clay pit.*

- **Renewable energy:** From *(initial form of energy)*, entering the power plant
  Example: *From water in a lake, entering the power plant.*

- **Agricultural processes:** From (initial point of the plant/animal), (starting activity) on the farm/field
  Example: *From wheat seeds, sown on the farm.*

Complete example of detailed description of the system boundaries:

Activity: Paper production, ES, 2002 - 2005

System boundaries description, in the 3 sections:

- "From reception of wood at the factory gate, to packed paper at consumer."
- "The dataset includes the production steps, packing processes, solid waste treatment and the transport of the packed product to the retail."
- "The dataset doesn't include the wastewater treatment."

9) Appendix C: Quality Guidelines

The technological level classification is governed by the "Quality Guidelines" of 3rd version of Ecoinvent, which define the following:

- **"New"** for a technology assumed to be on some aspects technically superior to modern technology, but not yet the most commonly installed when investment is based on purely economic considerations.
- **"Modern"** for a technology currently used when installing new capacity, when investment is based on purely economic considerations (most competitive technology).
- **"Current"** for a technology in between modern and old.
- **"Old"** for a technology that is currently taken out of use, when decommissioning is based on purely economic considerations (least competitive technology).
- **"Outdated"** for a technology no longer in use.

10) Appendix D: Compartments and Subcompartments

Compartments and subcompartments follows the database of Ecoinvent classification of the and are defined below:

Compartment	Subcompartment	Definition	Assigned in general to
Air (output to)	non-urban air or from high stacks	Emission in areas with a population density be-low 400 persons per km2 or from stacks higher than 100 m	Resource extraction, forestry, agriculture, hydro energy, wind power, coal and nuclear power plants, municipal landfills, wastewater treatment, long-distance transports, shipping
	low population den-sity, long-term	Emission which take place in the future, >100 years after the start of the activity	Emissions from uranium mill tailings
	lower stratosphere + upper tropo-sphere	Emission from airplanes	Air transport, cruising
	urban air close to ground	Emission below 100 metres in areas with a population density above 400 persons per km2	Industry, oil and gas power plants, manufacturing, households, municipal waste incineration, local traffic, construction activities
	indoor	Emission inside closed buildings and outside of dedicated fume hoods with intake speed >0,5 m/s	Use stage of products for indoor use
	unspecified	Only used if no specific information available	
natural resource (input of)	in air	Natural resource in air, e.g. argon, carbon dioxide	Used for carbon uptake in biomass and gas-es produced by air separation
	biotic	Biogenic resource, e.g. wood	
	in ground	Natural resource in soil e.g. ores; landfill volume	
	land	Land occupation and land transformation	
	in water	Natural resource in water, e.g. magnesium, water	
soil (output to)	agricultural	Emission to soil that is used for or is suitable for the production of agricultural products that enter the human food chain.	Agriculture, agricultural biomass production
	forestry	Emission to soil that is used for plant production (wood, renewable raw materials), but which is not used or suitable for production of agricultural products that enter the human food chain (permanent forest land, marginal lands)	Forestry
	industrial	Emission to soil used for industry, manufacturing, waste management and infrastructure	
	unspecified	Only used if no specific information available	

water (output to)	ground-	Groundwater which will get in contact with the biosphere after some time	
	ground-, long-term	Emission which take place in the future, >100 years after the start of the activity	Long-term emissions from landfills
	ocean	Ocean, sea and salty lake	Offshore works, overseas ship transports
	surface water	River and lake	Discharge of effluents from wastewater treatment facilities
	unspecified	Only used if no specific information available	
direct hu-man up-take (out-put to)	unspecified	Contamination in products used for oral intake or with skin contact	Food products and medicine at the point of human intake, hygiene products and clothing at the use stage
economic (input of)	primary production factor	Labour cost, net tax, net operating surplus, rent	All net expenditures except those paid for goods and services purchased
social (input of)	unspecified	Change in social pressure	All externalities affecting human welfare and/or productivity, not elsewhere covered

11) Appendix E: Inputs & Outputs

Each input and output must include information on how it has obtained. The field "Comment" must begin with the following formulations to indicate the type of data:

- **Measured value:** for own data obtained from field work
- **Stoichiometric value:** for data calculated based on stoichiometric relationships
- **Calculated value:** for fata calculated based on non-stoichiometrics relationships (for example, emissions calculated from inputs)
- **Literature value:** for values extracted in a 1:1 ratio
- **Estimation:** for estimated values (for example, values based on references or personal communications)
- **Proxy:** for input or output considered which are different from our system and it has selected a similar one that is already in the database

Example:

Name	Unit	Amount	Comment	Source(s)
Carbon dioxide	Kg	0.006	Estimation, based on a literature value. The emission factor was taken from Gracia et al. (2010)	Gracia C, Sabaté S, Vayreda J, Sebastiá T, Savé R, Alonso M and Vidal M. Sinks. In: II Report on climate change in Catalonia. Institut d'estudis Catalans i Generalitat de Catalunya. Llebot JE. (eds) (2010).

12) Appendix F: Methodology for uncertainty calculation

(Ecoinvent methodology chapter 10, Ecoinvent report nº1: Quality Guidelines)

Uncertainty

Uncertainty expresses the general problem that an observed value can never be exactly reproduced, but when an adequate number of observations have been made, certain characteristic features of their distribution can be described, such as mean and standard deviation. A *probability distribution* is the mathematical and/or graphical function giving the probability that an observation will take a given value.

Many different concepts are used to describe uncertainty. When applicable, we use statistical terms as defined in ISO 3534. *Uncertainty* is the general term we use to cover any distribution of data within a population, caused by either random variation or bias.

Variation is the general term used for the random element of uncertainty. This is what is typically described in statistical terms as variance, spread, standard deviation etc., see definitions below. It is the randomness of the observations, which allows a statistical treatment, since this describes the probability distribution of the observations.

Bias is the skewness introduced into a distribution as a result of systematic (as opposed to random) errors in the observations, e.g. when the observations are made on a specific sub-set of a non-homogenous population.

The *population* is the total number of items under consideration, from which only a sample is typically observed. The *arithmetic mean* or average value is the sum of the observed values divided by the number of observations. The *error* of an observation is the deviation of the observed value from the mean value, i.e the value of the observation minus the mean value. *Variance* is a description of variation defined as the sum of the squares of the errors divided by the number of observations less 1. The *standard deviation* (σ) is the positive square root of the variance. The *median* is the value for which 50% of the distribution is smaller and 50% of the distribution is larger, also known as the 50% fractile. The *mode or most likely value* is the value that has the largest probability within the distribution. A *two-sided confidence interval* is the central part of a distribution that lies between two values chosen so that the interval includes a required percentage of the total population. For example, a 95% confidence interval includes 95% of the population, i.e. it excludes 2.5% of the population on both extremes.

Table 1 shows how uncertainty information is reported in the ecoSpold 2 format, illustrated with some examples. In some cases, the values used for calculations which don't consider uncertainty are not the average value of the distribution, like the mode for the triangular distribution. This effect is es-pecially pronounced for the lognormal distribution, where static calculations use the median value. In these cases, it is the judgment of the ecoinvent Centre that the data available should be used to derive the most representative value of the distribution, even if this is not the mathematical average value of the distribution. As the average value of a lognormal distribution is always higher than the median value, the average value of a Monte Carlo LCA calculation where a large number of lognormal distributions are present will be biased higher than the static calculation result. Table 2 shows the values used in static calculations for the distributions in the Table 1.

The choice of distribution has limited influence on the overall uncertainty of a product system, since the aggregation of a large number of independent variables each with their distribution will always approach a result with normal distribution. This is called the “central limit theorem”. Many real life phenomena are caused by a large number of independent random effects, and the central limit theorem explains why we so often find real life data to be approximately normally distributed.

The *normal* distribution is a symmetrical distribution (as opposed to a skewed distribution, see the lognormal and triangular distributions below), which implies that the arithmetic mean, the median, and the mode all appear at the same place. An interesting feature of the normal distribution is that 68% of the data lies within one standard deviation either side of the mean, 95% of the data lies with two standard deviations of the mean, and 99.7% of the data lies within three standard deviations of the mean. Thus, it is easy to compare confidence intervals and standard deviations.

Table 1. Description of uncertainties in the ecoinvent database, with examples.

EcoSpold data field		Probability function / parameter	Formula / symbol	Example	Unit	Database input
2100	*Uncertainty type*	*Lognormal*				1
2101	geometricMean	Median (geometric mean)	μ_g	1540	kg	1540
2102	AritmeticMeanOfLogtransformedData	Arithmetic mean of underlying normal distribution	μ	7.3	-	7.3
2103	varianceOfLogtransformed Data	Unbiased variance of the underlying normal distribution	σ_b^2	0.25	-	0.25
2104	varianceWithPedigreeUncertainty	Unbiased variance of the underlying normal distribution, basic uncertainty with pedigree uncertainty	σ^2	0.46		0.46
2110	*Uncertainty type*	*Normal*				2
2111	meanValue	Arithmetic mean	μ	1540	kg	1540
2112	variance	Unbiased variance	σ_b^2	44100	-	44100
2120	*Uncertainty type*	*Triangular*				3
2121	minValue	Minimum value	B	930	kg	930
2122	mostLikelyValue	Mode	A	1780	kg	1780
2123	maxValue	Maximum value	C	1910	kg	1910
2130	*Uncertainty type*	*Uniform*				4
2131	minValue	Minimum value	A	1210	kg	1210
2132	maxValue	Maximum value	B	1870	kg	1870
2140	*Uncertainty type*	*BetaPERT*				5
2141	minValue	Minimum value	a	1210	kg	1210
2142	mostFrequentValue	Most frequent value	m	1600	kg	1600
2143	maxValue	Maximum value	b	1870	kg	1870
2150	*Uncertainty type*	*Gamma*				6
2151	shape	Shape parameter	K	3	-	3
2152	scale	Scale parameter	Θ	1.5	-	1.5
2153	minValue	Minimum value (location parameter)	M	2.5	kg	2.5
2160	*Uncertainty type*	*Binomial*				7
2161	n	Number of independent yes/no experiments	N	10	-	10
2162	p	Probability of success	P	0.6	-	0.6
2170	*Uncertainty type*	*Undefined (range)*				8
2171	minValue	Minimum value		1	kg	1
2172	maxValue	Maximum value		7	kg	7
2173	standardDeviation95	The value, extended from both sides of the mean, that would be necessary to cover 95% of the population		2.5	kg	2.5

Table 2. Values used in static calculations, with examples.

Uncertainty type	Statistical parameter	Value used (formula)	Example value (relating to Table 10.1)
Lognormal	Median	μ_g	1540
Normal	Mean	μ	1540
Triangular	Mode	A	1780
Uniform	Mean	(B+A)/2	1540
BetaPERT	Mode	(a+4m+b)/6	1580
Gamma	Mean	KΘ + M	7
Binomial	Mean	NP	6
Undefined (range)		(Minimum + maximum)/2	4

The lognormal distribution is a probability distribution where the natural logarithm of the observed values is normally distributed. The lognormal distribution is the predominant distribution used to model uncertainties in the Ecoinvent database for a number of reasons:

- The lognormal distribution is frequently observed in real life populations (Koch 1966). One reason for this is that many real life effects are multiplicative rather than additive, and in parallel to the central limit theorem for additive effects, it can be shown that multiplicative effects will result in a lognormal distribution.
- Most parameters for real life populations are always positive, and this constraint will result in a skewed distribution with a longer tail towards the higher values.
- The standard deviation of the underlying normal distribution is scale independent. This means that for a lognormally distributed vector of random values X, multiplying by a constant a does not change the standard deviation, also not the standard deviation of the underlying

$$\sigma = stdev(\ln X)$$
$$stdev(\ln[aX]) = stdev(\ln a + \ln X) = stdev(\ln X)$$

normal distribution:

As for the normal distribution, confidence intervals are related to the geometric standard deviation, but for the lognormal distribution, this relation is multiplicative: 68% of the data lies in the interval ε/σ_g to $\varepsilon\sigma_g$, 95% of the data lies in the interval $\varepsilon/\sigma_g{}_2$ to $\varepsilon\sigma_{g\,2}$, and 99.7% of the data lies in the interval $\varepsilon/\sigma_{g\,3}$ to $\varepsilon\sigma_{g\,3}$, where the median (ε) is equal to the geometric mean μ_g. The geometric mean is the nth root of the product of n observed values.

For backwards compatibility reasons, an "undefined" range distribution is also provided, with fields minimum, maximum, and standard deviation 95. Many distributions can be transformed to be represented by each other.

The probability distribution functions for all defined distributions in Table 1 are:

Lognormal:
$$f(x) = \frac{1}{x\sigma\sqrt{2\pi}} e^{-\frac{(\ln x-\mu)^2}{2\sigma^2}}$$

Normal:
$$f(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

Triangular:
$$f(x) = \begin{cases} \frac{2(x-A)}{(B-A)(C-A)} & \text{for } A \le x \le C \\ \frac{2(B-x)}{(B-A)(B-C)} & \text{for } C \le x \le B \\ 0 & \text{otherwise} \end{cases}$$

Uniform:
$$f(x) = \frac{1}{B-A}$$

betaPERT:
$$\alpha = 1 + 4\frac{m-a}{b-a}$$
$$\beta = 6 - \alpha$$
$$f(x) = \frac{\Gamma(\alpha+\beta)}{\Gamma(\alpha)\Gamma(\beta)} x^{\alpha-1}(1-x)^{\beta-1}$$

Gamma:
$$f(x) = (x-M)^{K-1}\frac{e^{-(x-M)/\theta}}{\theta^K\Gamma(K)}$$

Binomial:
$$f(x) = \frac{n!}{x!(n-x)!} p^x (1-p)^{n-x}$$

The ecoSpold 2 format allows the entry of uncertainty information, not only for the amounts of exchanges, but also for exchange properties, parameters, and transfer coefficients. This allows the reporting of the uncertainty on the primary data, which is of particular interest when the exchange amount is calculated by a mathematical relation involving these properties, parameters or coefficients. The uncertainty of the exchange can then be calculated from the uncertainty on its components. Currently, this calculation is done manually by the data provider, but software support for this is planned.

In the ecoinvent database, two kinds of uncertainty are quantified for the amounts of the exchanges:

- Variation and stochastic error of the values which describe the exchanges, due to e.g. measurement uncertainties, activity specific variations, temporal variations, etc. This is expressed in the basic uncertainty. When relevant information to completely describe an activity in detail is unavailable, so that the exchanges are only reported in an unspecific way or at a high aggregation level of activities, the average data applied, with inadequate specification of important exchanges, will have a basic uncertainty that reflects the lack of knowledge on their precise nature.

- Uncertainty due to use of estimates, lacking verification, incompleteness in the sample, or extrapolation from temporally, spatially and/or technologically different conditions. For instance, if the electricity consumption of an activity that takes place in Nigeria is approximated with the dataset of the Rest-Of-World (ROW) electricity supply mix. These aspects of uncertainty are reflected in the additional uncertainty estimated via data quality indicators; see Chapter 10.2.

Default values for basic uncertainty

If the sample data are available, the probability distribution and standard deviation of the sample can be calculated directly. If the sample is small, an approximate standard deviation can be calculated from the range (the difference between the largest and the smallest observed value). For the normal distribution, the range is approximately 3, 4, and 5 times the standard deviation when the sample size is 10, 30, and 100, respectively. Life cycle data often result from a small number of observations, so it is reasonable to use the factor 3 when the number of observations is unknown.

Quite often the uncertainty of a specific value cannot be derived from the available information, when there is only one source of information and this only provides only a single value without any information about the uncertainty of this value. A simplified standard procedure was developed to quantify the uncertainty for these (quite numerous) cases.

The lognormal distribution is always assumed when applying the simplified standard procedure. Table 3 gives basic uncertainty factors (variances of the underlying normal distribution to the lognormal distribution) are given for various types of exchanges. It is assumed that different types of exchanges differ in their uncertainty. For instance, CO_2 emissions show in general a much lower un-certainty than CO emissions. While the former can be calculated from fuel input, the latter is much more dependent on boiler characteristics, engine maintenance, load factors etc. The basic uncertainty factors are based on expert judgments.

Outlook: The ecoinvent Centre has commissioned an empirical study to validate and revise the basic uncertainty factors in Table 10.3, which are simple estimates by a group of ecoinvent analysts. The experiences with variations found in the literature make it probable that these basic uncertainties tend to underestimate the "real" uncertainty. Especially for pollutants which are only seldom measured and which depend on impurities rather than on product properties the range found in the literature might be considerably higher. Furthermore sometimes uncertainties add up. This was observed for example for the emissions of heavy metals during fuel combustion or for the elements emitted with the wastewater streams from crude oil extraction.

For some ecoinvent datasets, different approaches have been used. These approaches are described in the respective datasets.

[**Changes relative to ecoinvent version 2**: *In version 2, the confidence factor (the square of the geo-metric standard deviation of the lognormal distribution) was used in default uncertainty calculations. In version 3, the variance of the underlying normal distribution is used, which is mathematically identical, but closer to the format used with original data. This change was made to reduce the complexity of the formula for calculating the standard deviation, and to keep the parameters describing uncertainty in the same framework as the parameters that describe the distribution itself, i.e. all are directly related to the underlying normal distribution.*]

input / output group	C	P	A
demand of:			
thermal energy, electricity, semi-finished products, working material, waste treatment services	0.0006	0.0006	0.0006
transport services (tkm)	0.12	0.12	0.12
Infrastructure	0.3	0.3	0.3
resources:			
primary energy carriers, metals, salts	0.0006	0.0006	0.0006
land use, occupation	0.04	0.04	0.002
land use, transformation	0.12	0.12	0.008
pollutants emitted to water:			
BOD, COD, DOC, TOC, inorganic compounds (NH_4, PO_4, NO_3, Cl, Na etc.)		0.04	
individual hydrocarbons, PAH		0.3	
heavy metals		0.65	0.09
Pesticides			0.04
NO_3, PO_4			0.04
pollutants emitted to soil:			
oil, hydrocarbon total		0.04	
heavy metals		0.04	0.04
Pesticides			0.033

input / output group	c	p	a
pollutants emitted to air:			
CO_2	0.0006	0.0006	
SO_2	0.0006		
NMVOC total	0.04		
NO_X, N_2O	0.04		0.03
CH_4, NH_3	0.04		0.008
Individual hydrocarbons	0.04	0.12	
PM>10	0.04	0.04	
PM10	0.12	0.12	
PM2.5	0.3	0.3	
Polycyclic aromatic hydrocarbons (PAH)	0.3		
CO, heavy metals	0.65		
inorganic emissions, others		0.04	
Radionuclides (e.g., Radon-222)		0.3	

Table 3. Basic uncertainty factors (σ_2 of the underlying normal distribution) applied by default to intermediate and elementary exchanges: c: combustions, p: process emissions: a: agricultural emissions.

Additional uncertainty via data quality indicators

In addition to the basic uncertainty, either measured or estimated from Table 10.3, an additional uncertainty from data quality indicators is added to the lognormal distribution. These additional uncertain-ties are based on a pedigree matrix approach, taking pattern from work published by Weidema & Wesnaes (1996) and Weidema (1998).

Data sources are assessed according to the five characteristics "reliability", "completeness", "temporal correlation", "geographic correlation", and "further technological correlation" (see Table 10.4). Each characteristic is divided into five quality levels with a score between 1 and 5. Accordingly, a set of five indicator scores is attributed to each individual input and output exchange (except the reference products) reported in a data source.

Table 4 is called a pedigree matrix (after Funtowicz & Ravetz 1990) since the data quality indicators refer to the history or origin of the data, like a genealogical table reports the pedigree of an individual.

Overall uncertainty is increased by the addition of normal distributions to the underlying normal distribution derived from the basic uncertainty.

A normal uncertainty distribution is attributed to each score of the five characteristics. Each of these distributions has a mean value of zero, and a variance based on expert judgement, and shown in Table 5.

Each normal distribution is assumed to be independent, i.e. their covariance is zero. The variance of the summed final distribution is then:

$$\sigma^2(X+Y)=\sigma^2(X)+\sigma^2(Y)+2\operatorname{cov}(X,Y)$$

$$\sigma^2=\sum_{n=1}^{6}\sigma_n^2$$

with:

σ^2_1: basic uncertainty (variance measured or estimated according to Table 10.2)
σ^2_2: uncertainty factor (variance) of reliability distribution
σ^2_3: uncertainty factor (variance) of completeness distribution
σ^2_4: uncertainty factor (variance) of temporal correlation distribution
σ^2_5: uncertainty factor (variance) of geographical correlation distribution
σ^2_6: uncertainty factor (variance) of other technological correlation distribution

Outlook: A separate ecoinvent project is ongoing to provide a better empirical basis for the uncertainty factors in Table 10.5, and this may lead to a revision of the pedigree matrix as well.

*[***Changes relative to ecoinvent version 2:*** *The pedigree matrix has been slightly revised compared to version 2, and entries added for score 4 of geographical correlation and score 2 of technological correlation. In the ecoinvent 2 datasets, it was not possible to store the basic uncertainty separately. There-fore, the basic uncertainties have been back-calculated from the calculated additional uncertainty and the data quality uncertainty factors.]*

Indicator score	**1**	**2**	**3**	**4**	**5 (default)**
Reliability	Verified[5] data based on measurements[6]	Verified data partly based on assumptions *or* non-verified data based on measurements	Non-verified data partly based on qualified estimates	Qualified estimate (e.g. by industrial expert)	Non-qualified estimate
Completeness	Representative data from all sites relevant for the market considered, over an adequate period to even out normal fluctuations	Representative data from >50% of the sites relevant for the market considered, over an adequate period to even out normal fluctuations	Representative data from only some sites (<<50%) relevant for the market considered *or* >50% of sites but from shorter periods	Representative data from only one site relevant for the market considered *or* some sites but from shorter periods	Representativeness unknown or data from a small number of sites *and* from shorter periods
Temporal correlation	Less than 3 years of difference to the time period of the dataset	Less than 6 years of difference to the time period of the dataset	Less than 10 years of difference to the time period of the dataset	Less than 15 years of difference to the time period of the dataset	Age of data unknown or more than 15 years of difference to the time period of the dataset
Geographical correlation	Data from area under study	Average data from larger area in which the area under study is included	Data from area with similar production conditions	Data from area with slightly similar production conditions	Data from unknown *or* distinctly different area (North America instead of Middle East, OECD-Europe instead of Russia)
Further technological correlation	Data from enterprises, processes and materials under study	Data from processes and materials under study (i.e. identical technology) but from different enterprises	Data from processes and materials under study but from different technology	Data on related processes or materials	Data on related processes on laboratory scale *or* from different technology

Table 4. Pedigree matrix used to assess the quality of data sources, modified from Weldema 1998.

[5] Verification may take place in several ways, e.g. by on-site checking, by recalculation, through mass balances or cross-checks with other sources.

[6] Includes calculated data (e.g. emissions calculated from inputs to an activity), when the basis for calculation is measurements (e.g. measured inputs). If the calculation is based partly on assumptions, the score would be 2 or 3.

Indicator score	1	2	3	4	5
Reliability	0.000	0.0006	0.002	0.008	0.04
Completeness	0.000	0.0001	0.0006	0.002	0.008
Temporal correlation	0.000	0.0002	0.002	0.008	0.04
Geographical correlation	0.000	2.5e-5	0.0001	0.0006	0.002
Further technological correlation	0.000	0.0006	0.008	0.04	0.12

Table 5. Uncertainty factors (variances for the underlying normal distributions) used to convert the data quality indicators of the pedigree matrix in Table 10.4 into additional uncertainty

To get an overall indicator of quality it has designed a composite indicator that assesses different data vectors. This is a hybrid methodology of applied in the Ecoinvent and ILCD databases.

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