Swiss Centre for Life Cycle Inventories

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Swiss Federal Offices

Code of Practice

Data v2.0 (2007)

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Code of Practice

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Responsibility

This report has been prepared on behalf of one or several Federal Offices (see "Commissioners"). The final responsibility for contents and conclusions remains with the authors of this report.

Acknowledgement ecoinvent Data v2.0

After the successful launch of ecoinvent data v1.0 and its fast and broad penetration in the LCA scene, the preparation of version 2.0 was due. We thank all institutions which continued to support the further development of the ecoinvent database and the investigation of the ecoinvent data.

We wish to thank the main commissioners, the Swiss Federal Office for the Environment (FOEN-BAFU), the Swiss Federal Office for Energy (BFE), and the Swiss Federal Office for Agriculture (BLW), that funded individual projects of data compilation and data updates. We thank all other institutions that funded selected parts of the work. They are mentioned in the respective final reports.

Besides this, several institutions took care of the implementation of the knowledge gained into daily practice, in particular in the building sector. We wish to thank the Swiss Federal Office for Buildings and Logistics, the Amt für Hochbauten of the City of Zürich and the Association eco-bau for their engagement to bring life cycle thinking to engineers and architects.

Acknowledgement ecoinvent Data v1.01 to 1.3

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We thank the institutions which supported the development of the ecoinvent database and the investigation of the ecoinvent data.

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The database software development was funded by the Swiss Centre for Life Cycle Inventories and the salary for the project management by EMPA and the Swiss Centre for Life Cycle Inventories.

Table of Contents

1 Welcome

We welcome you as a member to the ecoinvent database. The LCA (life cycle assessment) database ecoinvent contains about 4'000 datasets of products and services covering energy (including oil, natural gas, hard coal, lignite, nuclear energy, hydro power, photovoltaics, solar heat, wind power, electricity mixes, bioenergy), transport, building materials, wood (European and tropical wood), renewable fibres, metals (including precious metals), chemicals (including detergents and petrochemical solvents), electronics, mechanical engineering (metals treatment and compressed air), paper and pulp, plastics, waste treatment and agricultural products. In this booklet we highlight aspects which we consider important to know while working with the ecoinvent data.

The objective is to support the selection of appropriate datasets for a given LCA problem and the accurate use of ecoinvent datasets in LCA case studies. Experiences gained in the past and during the compilation of the datasets and limitations in applicability of the data on the one hand, the prevention of unintentional misuse and errors due to misunderstandings on the other were the main motivations to write this code of practice. It is strongly advised to read this document before starting to work with the ecoinvent data.

We start with an overview of the database contents. Recommendations are given which data to use for different purposes. Procedures are described how to work with ecoinvent data and warnings are stated which refer to limitations of data use in LCA case studies. Finally, administrative issues are mentioned which mainly cover the quoting of the source and the reproduction of ecoinvent data in LCA case studies.

We strongly recommend to read this booklet before starting to work with ecoinvent data.

2 Objective and Overview

2.1 Contents of this booklet

You find the following information in this booklet:

This Chapter contains a description of the contents of the CD-ROM and of the objective of the ecoinvent project. Chapter 3 contains an overview of the processes, elementary flows and impact assessment methods available in the ecoinvent database. The various ways to access the ecoinvent data are described in Chapter 4. Recommendations are given how to use the ecoinvent data in Chapter 5. A special focus is put on the selection of appropriate datasets (Section 5.1). The chapter also includes recommendations on how to cite ecoinvent data appropriately and in compliance with the ecoinvent Terms of Use (Section 5.7). Hints are given in Chapter 6 how to proceed if one wants to change ecoinvent life cycle inventory data. The last Chapter 7 informs about the announcement and the correction of errors in the database.

2.2 Contents of the ecoinvent CD-ROM

You are a member of the ecoinvent database and therefore got the CD-ROM comprising all final reports and this booklet.

The booklet contains a lot of information relevant for the work with the ecoinvent data. The contents of the CD-ROM are:

- **Final reports (/ecoinventReports)**
  PDF-files with the final reports of the ecoinvent projects. These reports with several 1000 pages of information describe every detail of the data analysed and compiled for the database.
- **Data in EXCEL-files (/ecoinventData)**
  The folder ecoinventData contains nine EXCEL files with the LCI results of all datasets investigated. Another file contains the LCIA results. These files can be used for own calculations and analyses. The EXCEL-file "ecoinventnames.xls" contains the names of processes, elementary flows, and location codes.
- **Working tools (/ecoinventTools)**
  The Excel workbooks serve to assign the impact assessment factors of the LCIA methods to the elementary flows of the ecoinvent database. The waste management tools will be provided together with ecoinvent data v2.1.
- **Software (/ecoinventSoftware)**
  This folder contains installation files for the EcoSpold software. The EcoSpold software adds certain tools as Macros to the EXCEL installation and it contains all XML schemes which help to program interfaces to the EcoSpold data format. The conversion of XML-files to Excel and

vice versa is done with this EcoSpold software (EcoSpoldSetup_v1.9.10.exe).

2.3 Objective of the ecoinvent projects

The Swiss Centre for Life Cycle Inventories is a professional provider of life cycle inventory data.

Consistent, transparent and quality controlled LCA datasets for basic processes make it easier and more efficient to perform life cycle assessment studies, and increase the credibility and acceptance of the life cycle assessment results. The assured quality of the life cycle data and the user-friendly access to the database are prerequisites for establishing LCA as a reliable tool for environmental assessment that supports an Integrated Product Policy (IPP), design for environment or eco-efficiency considerations.

3 Content of the ecoinvent data

3.1 Process data

The ecoinvent data comprise LCI data covering energy (including oil, natural gas, hard coal, lignite, nuclear energy, hydro power, photovoltaics, solar heat, wind power, electricity mixes, bioenergy), transport, building materials, wood (European and tropical wood), renewable fibres, metals (including precious metals), chemicals (including detergents and petrochemical solvents), electronics, mechanical engineering (metals treatment and compressed air), paper and pulp, plastics, waste treatment and agricultural products. The entire system consists of about 4’000 interlinked datasets. Each dataset describes a life cycle inventory on a unit process level. The complete list of all dataset names, of all elementary flow names and of all regional codes is available via the internet and on this CD-ROM (folder "ecoinventData/ecoinventnames .xls"). The functional unit of all these unit processes is either a product or a service (whereby the product may be as large as one complete power plant manufactured for producing electricity).

All products and services are assigned to one particular category and subcategory. Tab. 3.1 shows the complete list of categories and subcategories available. The category and subcategory of processes have informative purpose only. They can be used to search for certain processes, but they are not required to identify an individual process dataset. Process datasets are identified unequivocally by the name, the location, the unit and a marker for infrastructure processes.

Tab. 3.1 Categories and subcategories used to structure the product and service datasets in ecoinvent data v 2.0

Category	SubCategories
agricultural means of production	work processes; equipments; feed; buildings; machinery; mineral fertiliser; organic fertiliser; pesticides; seed; other auxiliary materials
agricultural production	plant production; animal production
building components	cladding, doors, windows
biomass	production; fuels; heating systems; power plants; cogeneration; others
chemicals	inorganics; organics
construction materials	coverings; concrete; binder; bricks; additives; production; others
construction processes	buildings; building construction; machinery; civil engineering
cooling	plant
district heating	systems; production of components
electricity	production mix; supply mix; distribution; final consumption
electronics	component, module, devices, services
food industry	processing; distribution
glass	construction; packaging
hard coal	production; fuels; heating systems; power plants
heat pumps	heating systems; production of components
hydro power	production of components; power plants
insulation materials	production
lignite	production; fuels; heating systems; power plants
mechanical engineering	compressed air equipment, compressed air generation, compressed air supply, equipment and buildings
metals	extraction; processing; refinement
natural gas	production; fuels; heating systems; power plants; cogeneration
nuclear power	production; power plants; waste treatment
oil	production; fuels; heating systems; power plants; cogeneration
others	unspecified
paintings	production
paper & cardboard	pulps; packaging papers; graphic paper; cardboard & corrugated board
photovoltaic	production of components; power plants
plastics	monomers; polymers; processing; others
private consumption	nutrition
solar collector systems	production of components; systems
textiles	production, processing
transport systems	airplane; road; ship; train
ventilation	production of components, ventilation systems
washing agents	bleaches; builders; tensides; auxiliary agents

Tab. 3.1 continued

waste management	recycling; municipal incineration; hazardous waste incineration; inert material landfill; residual material landfill; sanitary landfill; underground deposit; landfarming; building demolition; wastewater treatment; others
water supply	production
wind power	production of components; power plants
wood energy	fuels; heating systems; cogeneration
wooden materials	extraction; processing; refinement

3.2 Elementary flows

Categories and subcategories are also used to describe the elementary flows. Elementary flows are identified by the flow name (e.g. "Carbon dioxide, fossil"), the category and the subcategory and the unit. Tab. 3.2 shows the categories and subcategories which are used in the ecoinvent database. Categories describe the different environmental compartments air, water, soil and resource uses. Subcategories further distinguish subcompartments within these compartments which may be relevant for the subsequent impact assessment step.
The categories "air", "water" and "soil" describe the receiving compartment and are used for (direct) pollutant emissions whereas the category "resource" is used for all kinds of resource consumption. For instance, water consumption is recorded as an input in the category/subcategory "resource/in water". Land transformation and occupation is recorded as an input in the category/subcategory "resource/land". Further explanations about the definition and application of categories and subcategories used for elementary flows and about the way elementary flows are recorded are given in the methodology report No.1.[1]

3.3 Life cycle impact assessment (LCIA) methods

The ecoinvent database also contains the characterisation, damage or weighting factors of various impact assessment methods. Each topic of an impact assessment method is described with a category, subcategory, the name and its unit. The category defines the impact assess-

[1] Frischknecht R., Jungbluth N., Althaus H.-J., Doka G., Dones R., Heck T., Hellweg S., Hischier R., Nemecek T., Rebitzer G. and Spielmann M. (2007a) Overview and Methodology. ecoinvent report No. 1, v2.0. Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

Tab. 3.2 Categories and subcategories for elementary flows in ecoinvent data v2.0

Category	SubCategory	Category	SubCategory
air	low population density	soil	agricultural
	low population density, long-term		forestry
	lower stratosphere + upper troposphere		industrial
	high population density		unspecified
	unspecified	water	ground-
resource	in air		ground-, long-term
	biotic		lake
	in ground		ocean
	land		river
	in water		river, long-term
			fossil-
			unspecified

ment method (such as eco-indicator 99), the subcategory either a safeguard subject or an environmental theme (e.g., "human health" in case of eco-indicator 99). The dataset name is used for a further grouping if necessary or possible (e.g., "climate change", or "carcinogenics" within the "human health" subcategory of the "eco-indicator 99" category). Tab. 3.3 shows an overview of impact assessment methods currently implemented. The implementation of the methods in ecoinvent (matching of ecoinvent elementary flows to the elementary flows assessed in the impact assessment methods) is described in detail in the implementation report No. 3.[2]

[2] Frischknecht R., Jungbluth N., Althaus H.-J., Bauer C., Doka G., Dones R., Hellweg S., Hischier R., Humbert S., Margni M. and Nemecek T. (2007b) Implementation of Life Cycle Impact Assessment Methods. ecoinvent report No. 3, v2.0. Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

Tab. 3.3 Categories and subcategories for impact assessment methods in ecoinvent data v2.0

Category	SubCategory
CML 2001	acidification potential; climate change; eutrophication potential; freshwater aquatic ecotoxicity; freshwater sediment ecotoxicity; human toxicity; ionising radiation; land use; malodours air; marine aquatic ecotoxicity; marine sediment ecotoxicity; photochemical oxidation (summer smog); resources; stratospheric ozone depletion; terrestrial ecotoxicity
cumulative energy demand	fossil; nuclear; primary forest; biomass; water; wind; solar; geothermal
cumulative exergy demand	fossil; nuclear; primary forest; biomass; water; wind; solar; geothermal; metals; minerals
eco-indicator 99, (E,E)	ecosystem quality; human health; resources; total
eco-indicator 99, (H,A)	ecosystem quality; human health; resources; total
eco-indicator 99, (I,I)	ecosystem quality; human health; resources; total
ecological damage potential	total
ecological footprint	total
ecological scarcity 1997	total
ecological scarcity 2006	*total*
EDIP	environmental impact; impact on the working environment; resource consumption
EDIP 2003	acidification; ecotoxicity; eutrophication; global warming; human toxicity; land filling; non-renewable resources; nutrient enrichment; photochemical ozone formation; renewable resources; stratospheric ozone depletion
EPS 2000	*total*
IMPACT 2002+	climate change; ecosystem quality; human health; resources
IPCC 2001	climate change
TRACI	environmental impact; human health

italic: The methods will be (re)implemented in ecoinvent data v2.1

4 How to access ecoinvent data

There are several possibilities how to access the ecoinvent data. They are available via the Internet (Section 4.1). They are implemented or importable in all leading LCA software tools (Section 4.2) and they are also available on this CD-ROM (Section 4.3). Selected results are displayed in the result chapter of some of the final reports (Section 4.4). They however should not be used for further work.

4.1 Download from the internet

The ecoinvent database offers the possibility to download LCA datasets via the internet on www.ecoinvent.org. The following data are available and displayed online:

- unit process raw data (direct inputs and outputs of a unit process),
- life cycle inventory result (cumulative data, cradle to gate or gate to grave),
- life cycle impact assessment result (cumulative weighted data, cradle to gate or gate to grave)
- impact assessment weighting factors (derived from the original impact assessment methods and applied on the elementary flows reported in the ecoinvent database).

Datasets can be downloaded in XML-format. The files can be converted to Excel using the EcoSpold software. The software is available on this CD-ROM (/ecoinvent Software/) or can be downloaded via the Internet (www.ecoinvent.org, Software). The conversion of results files from EcoSpold to Excel may take some time (up to 20 minutes for ten datasets, depending on the Excel version and its settings). For display only, just use the button "View EcoSpold document ..." of the EcoSpold Access dialogue and select a dataset (an xml file).

4.2 LCA software tools

All leading LCA software suppliers implement the ecoinvent data into their LCA software tools or offer interfaces for an easy import. Selected LCA software providers sell ecoinvent licences that allow the access to the ecoinvent data. The utilization of LCA tools facilitates the use of the ecoinvent data in daily LCA work. An overview of software producers which offer the ecoinvent data is given in the "Resellers" section of the ecoinvent website.

4.3 Excel-Files on CD-ROM

For ecoinvent members not using a commercial LCA software tool but working with the complete content of ecoinvent

data, the cumulative LCI and LCIA results of all ecoinvent datasets are available on Excel-Files (named EI_DATA_LCI_1.xls, …, EI_DATA_LCIA.xls). The LCIA file contains a selection of life cycle inventory results in addition to the impact assessment results. All Excel-Files are available on this CD-ROM in the folder "/ecoinventData/".

4.4 Selected results in the final reports

The results chapter available in some of the final reports contains an excerpt of the LCI and LCIA results. The selection is not intended to represent the complete result of a life cycle assessment of the analysed processes and products. Therefore the use of the data presented in these result tables is strongly discouraged. For further calculations and the use of ecoinvent data in LCA studies, the data directly downloaded from the database (or available in commercial LCA software) shall be used. Besides their completeness, the data presented in the results tables of the final reports may possibly deviate from the ones in the database due to corrections and changes in background data after the publication of the final reports. In some reports, results calculated with a previous version of ecoinvent data are shown.

5 How to use ecoinvent data

5.1 Selection of the appropriate datasets

5.1.1 Introduction

General remarks and modelling assumptions for technology, location, etc. are described in the meta information data fields of each dataset. This information is delivered in the XML-format together with the flow data. Although care was taken to specify the exact content of each individual dataset (with the meta information and in the reports) it is not always straightforward to choose the appropriate dataset within the vast number of available LCI datasets. In the next sections, explanations are given for some of the (in our opinion) more frequently used datasets. It helps the user to select appropriate datasets and to avoid unnecessary errors.
Modelling principles, system boundaries, naming rules, uncertainty considerations

[3] Frischknecht R., Jungbluth N., Althaus H.-J., Doka G., Dones R., Heck T., Hellweg S., Hischier R., Nemecek T., Rebitzer G. and Spielmann M. (2007a) Overview and Methodology. ecoinvent report No. 1, v2.0. Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

etc. applied on the LCIs of the unit processes are described in the ecoinvent report No. 1 "Overview and Methodology".[3]

5.1.2 Electricity demand

Electricity is one major product necessary in most LCA studies. The database contains electricity mixes of the EU 27 countries and of EU27, of European electricity networks, of the United States, Brazil, China and Japan both for the domestic production as well as for the supply. The supply mix is a mix of domestic production and electricity imports. All country specific mixes are based on the average production situation in 2004/5. For each production and supply mix, four different datasets exist: at the busbar, at high voltage (>24kV), at medium voltage and at low voltage (<1kV). The transport, transformation and distribution infrastructure is included accordingly.
For LCA case studies we recommend to use the supply mixes at the appropriate voltage level (medium voltage for most industries, low voltage for households, commercials and agriculture) and the appropriate location. The corresponding datasets can be found in category / subcategory "electricity"/"supply mix". They are named like (name/location/unit/infrastructure process):

- "electricity, high voltage, at grid/RO/kWh/0";
- "electricity, medium voltage, at grid/RO/kWh/0";
- "electricity, low voltage, at grid/RO/kWh/0".

The name of the production mixes contains "production country" in its name (e.g., "electricity, medium voltage, production RO, at grid/RO/kWh/0") and should normally not be used in LCA studies. The only exception are production mixes for European power associations (e.g. UCTE, CENTREL, NORDEL), where no electricity imports are taken into account. Company-specific electricity mixes may be compiled using the datasets of individual power plant technologies plus the datasets for transmission and distribution infrastructure. Grid losses and other operational emissions that occur during transmission and distribution need to be added. Information is available in report No. 6-XVI.[4]

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[4] Frischknecht R., Tuchschmid M., Faist Emmenegger M., Bauer C. and Dones R. (2007c) Strommix und Stromnetz. In: Sachbilanzen von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen, ecoinvent report No. 6-XVI, v2.0 (ed. Dones R.). Paul Scher-rer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

5.1.3 Demand for energy carriers

Energy carriers like petrol, natural gas or wood is often used in product systems. The energy carrier's fuel chain includes its transportation and distribution to the consumers (industrial, commercial, and agricultural consumers as well as households), but not the combustion of the fuel. The following datasets should be chosen in LCA studies:

oil products: the dataset names end with "…, at regional storage". These datasets include storage and distribution (to the consumer) after refining crude oil. Fuels' datasets also include operation of filling stations. Hence, no additional transport services need to be added. Datasets are offered for a Swiss (CH) and a European (RER) supply situation.[5]

natural gas: Natural gas is supplied via low and high pressure networks. While low pressure natural gas is mainly consumed by households, commercials and farms, high pressure natural gas is purchased by industrial clients. One dataset for low pressure natural gas (CH) and several high pressure natural gas datasets (for Ireland, Great Britain, Japan and those UCTE, CENTREL, and NORDEL countries operating natural gas power plants) are available. The dataset name is "natural gas, high (low) pressure, at consumer".[6]

hard coal and lignite: While lignite is primarily used in mine-mouth power plants and hardly treated nor transported, hard coal may undergo refinement and long-distance transportation. Datasets are available for hard coal extracted in different regions of the world, both at mine and at regional storage. Additionally, average supply mixes for USA, China and all UCTE countries operating hard coal power plants are provided, including transport of coal from the regions of extraction to the single countries and representing country-specific import shares.[7]

wood fuels: Two wood qualities and three wood products are distinguished, namely hardwood and softwood on the one hand

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[5] Jungbluth N. (2007) Erdöl. In: Sachbilanzen von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen, ecoinvent report No. 6-IV, v2.0 (ed. Dones R.). Paul Scherrer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

[6] Faist Emmenegger M., Heck T. and Jungbluth N. (2007) Erdgas. In: Sachbilanzen von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen, ecoinvent report No. 6-V, v2.0 (ed. Dones R.). Paul Scherrer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

and pellets, logs and wood chips on the other. An additional distinction is made within wood chips, according to their provenance, i.e., directly from the forest and from industry. Furthermore, datasets for a mix of hard- and softwood (each for logs and wood chips, representing commercial conditions of the Swiss market) and for charcoal are available. All datasets are grouped in the subcategory "fuels".[8]

5.1.4 Fuel combustion and heat supply

Datasets are offered both for final and useful energy supply. If the amount of, e.g., light fuel oil burned in a boiler is known and no emission data are available, the final energy datasets are appropriate. They are all named similarly, starting with the name of the energy carrier (e.g.,"light fuel oil, burned in furnace…", "natural gas, burned in boiler…", or "logs, mixed, burned in furnace …"). They include the emissions of burning the fuel as well as a share of the capital equipment needed (boiler, chimney, oil tank, etc.).
If the amount of useful heat required is known, the datasets describing useful heat supply are appropriate. Their name starts with "heat,…" followed by the energy carrier's name (e.g., "heat, hard coal coke, at …", "heat, natural gas, at boiler…", or "heat, heavy fuel oil, at…"). Information support for the choice of an appropriate dataset of useful heat supply is given in the respective reports mentioned in 5.1.3.
If the amount of energy carrier is known and the emissions due to energy supply are reported as well (in a company's environmental report, for instance), it is advised to use the energy carrier's datasets (see section 5.1.3) and the measured emissions. Additional pollutants, usually emitted by boilers but not measured and / or not reported in the respective reference may be added based on information available from the ecoinvent database and the respective reports.
For combined heat and power systems five distinct datasets are offered in some cases that are based on different allocation parameters (energy, exergy, price, motivation heat and motivation electricity). Within the ecoinvent database the

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[7] Röder A., Bauer C. and Dones R. (2007) Kohle. In: Sachbilanzen von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen, ecoinvent report No. 6-VI, v2.0 (ed. Dones R.). Paul Scherrer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

[8] Bauer C. (2007) Holzenergie. In: Sachbilanzen von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen, ecoinvent report No. 6-IX, v2.0 (ed. Dones R.). Paul Scherrer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

heat and electricity datasets based on exergy allocation are used as a default. Depending on the goal of an LCA, it may be appropriate to choose another allocation parameter or another allocation approach.[9]

5.1.5 Bioenergy

The life cycle inventories of biofuels represent a possible supply situation in Switzerland. The environmental impacts of biofuels are dependent on the type of biomass used and the conversion processes, but less on the type of fuel produced. That is why data are only valid for the production of a biofuel from a specific biomass and with a specific conversion process. Adaptations are recommended if data are used to investigate biofuel supply options in other countries, with other conversion processes or for other types of biomass resources. The production of biomass resources should be investigated with country specific data. It may be necessary to adapt the allocation factors and/or energy inputs of the conversion processes due to the area specific differences. In case of imported biofuels, transportation modes and distances may require adjustments.
Please note that the modelling of biogenic carbon balances is influenced to a certain extend by rounding errors. It is recommended to make the LCIA under exclusion of biogenic CO_2. Some biofuels combustion datasets include a certain amount of fossil CO_2 emissions because fossil chemicals are used in the production process.[10]

5.1.6 Photovoltaics

Life cycle inventories of electricity produced with cristalline (single and multi) and with thin film technologies including amorphous silicon are provided. Average data of electricity production are provided for more than 20 European, Asian and American countries. The actual performance of PV plants is dependent on the solar irradiation at the place of installation. Thus, it is recommended to adapt the performance data to reflect the situation in other countries. The demand on "3kWp… installations"

[9] Heck T. (2007) Wärme-Kraft-Kopplung. In: Sachbilanzen von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen, ecoinvent report No. 6-XIV, v2.0 (ed. Dones R.). Paul Scherrer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

[10] Jungbluth N., Chudacoff M., Dauriat A., Dinkel F., Doka G., Faist Emmenegger M., Gnansounou E., Kljun N., Schleiss K., Spielmann M., Stettler C. and Sutter J. (2007) Life Cycle Inventories of Bioenergy. ecoinvent report No. 17, v2.0. ESU-services, Uster, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

in the datasets "electricity, production mix photovoltaic,…" needs to be recalculated. The data may also be used to calculate the environmental impacts of larger systems. Data on mounting systems must then be changed according to the specific installation.[11]

5.1.7 Emerging small scale combined **heat and power systems**

LCI data of new systems for combined heat and power generation (CHP) for stationary applications are provided. The inventories include micro turbines, fuel cells (PEM and SOFC) and Stirling engines. Further a small diffusion absorption heat pump and an absorption chiller are included.
The heat (MJ) and electricity (kWh) datasets, offered for the combined heat and power systems are based on exergy allocation. Datasets for operation with natural gas as well as biogas distributed in the regular natural gas network are included. For the Stirling engine wood pellets as fuel is included.
The operation of the diffusion absorption heat pump includes a heat dataset for operation with natural gas as well as biogas.

For the absorption chiller the dataset "cooling energy, natural gas, at cogen unit with absorption chiller 100 kW" uses heat from a 160kWel cogeneration unit.
Datasets with the suffix "future" include performance data which are currently not reached but are expected to be reached in a few years.

5.1.8 Transport services

Transports of goods and persons are necessary to link different stages of a product life cycle. Datasets for transport services are developed to the extent to which they are required within ecoinvent data and in company LCAs. It includes average life cycle inventory data of lorry, railway, ship and airplane transport services (based on average load factors). A differentiation is made with regard to the fuel used (private cars running on diesel and petrol, both for the average fleet in 2005 and 2010) and the emission standards of private cars and lorries (EURO 3 to 5). Data provided are not suited to be directly used for the comparison of different transport systems or for the optimisation of a company's logistic.

[11] Jungbluth N. and Tuchschmid M. (2007) Photovoltaics. In: Sachbilanzen von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen, ecoinvent report No. 6-XII, v2.0 (ed. Dones R.). pp. 180. Paul Scherrer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

The name of the datasets relevant for use in LCA studies describes the transport service in ton kilometres and starts with "transport,…". If the load factors of lorry transport differs substantially from the values used in the ecoinvent datasets, data of the operation of a lorry at full load and empty are available. In this case, datasets on vehicle and traffic infrastructure, etc. need to be added to complete the model.

Information support is given in the final report No. 14.[12]
If the amount of fuel used for transportation is given but not the total distance or the total transport services required (in the environmental report of a company, for instance), the values presented in Tab. 5.1 can be used to recalculate the transport distance.

Tab. 5.1 Fuel uses for passenger cars, delivery vans and lorries

Vehicle	Fuel		CH			RER		
			MJ	g	l	MJ	g	l
Car	gasoline, avg. 2005	vkm	2.89	67.9	0.091	2.55	60	0.081
	diesel, avg. 2005	vkm	2.62	61.3	0.073	2.61	61	0.073
	gasoline, avg. 2010	vkm	2.77	65.0	0.087	2.21	52	0.071
	diesel, avg. 2010	vkm	2.48	58.1	0.069	2.39	56	0.0665
Delivery van	diesel / gasoline	vkm	3.7	87.5	0.1	3.1	74	0.085
Lorry 3.5-20t	diesel, avg. 2005	vkm	7.68	180	0.214			
Lorry 20-28t	diesel, avg. 2005	vkm	10.67	250	0.297			
Lorry >28t	diesel, avg. 2005	vkm	11.95	280	0.333			
Lorry 3.5-7.5t	diesel, avg. 2005	vkm				6.16	144.4	0.172
Lorry 7.5-16t	diesel, avg. 2005	vkm				9.46	221.7	0.264
Lorry 16-32t	diesel, avg. 2005	vkm				9.07	212.5	0.253
Lorry >32t	diesel, avg. 2005	vkm				12.48	292.4	0.348

Care has to be taken not to count lorry emissions twice. It has to be checked whether or not emissions reported in a company's environmental report include transportrelated emissions.

[12] Spielmann M., Dones R., Bauer C. and Tuchschmid M. (2007) Life Cycle Inventories of Transport Services. ecoinvent report No. 14, v2.0. Paul Scherrer Institut, Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

5.1.9 Agricultural products and processes

The investigation of agricultural products and processes in report No. 15[13] and partly in report No. 17 and 21[14] gives a basis for LCA studies in the food sector, but partly also for other applications such as renewable energy systems or renewable materials. The datasets are divided into two categories:

agricultural means of production:
this category contains datasets that are required for modelling agricultural systems, like buildings, machinery, work processes, fertilisers, pesticides, seed and feedstuffs. They are intended for users who want to calculate such LCAs. Fertilisers are based on a European production situation, pesticides on European and Swiss situations, respectively and the other means of production are focused on Switzerland. Fertilisers are calculated with the respective nutrient (kg N, kg P_2O_5 and kg K_2O) as the reference flow, pesticides refer to the active substance. Various work processes are defined. In order to allow flexible use, these processes contain the use of infrastructure and fuel, as well as the related emissions, but not the other inputs like seed, fertilisers or pesticides. The latter have to be added according to the particular situation.

agricultural production:
this category contains the products from agriculture. These datasets are intended for users needing datasets on agricultural products in their LCAs. The agricultural products in the ecoinvent database are representative for Switzerland (arable crop products and hay), several European countries (arable crop product) as well as various products from Asia, USA and Brazil. For Swiss agricultural products, datasets for integrated, extensive and organic production are defined, for the other countries, the datasets refer to the average production (conventional). They can be used for LCA studies and for comparisons on the product level, but not for the evaluation and comparison of different farming systems. For the latter purpose, many other aspects must be considered (analysis at farm level considering distribution of farmyard manure, etc.). Environmental impacts of agricultural pro-

[13] Nemecek T., Heil A., Huguenin O., Meier S., Erzinger S., Blaser S., Dux. D. and Zimmermann A. (2007) Life Cycle Inventories of Agricultural Production Systems. ecoinvent report No. 15, v2.0. Agroscope Reckenholz Taenikon, Research Station, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

[14] Althaus H.-J., Dinkel F., Stettler C. and Werner F. (2007a) Life Cycle Inventories of Renewable Materials. ecoinvent report No. 21, v2.0. EMPA Dübendorf, Swiss Centre for Life Cycle Inventories, Dübendorf, from www.ecoinvent.org.

duction depend on natural conditions (soil, climate), agricultural techniques and yields, and strongly vary between and within the countries. Thus, it is recommended to investigate situation specific data in case the agricultural product forms an important part of the product system.

5.1.10 Building materials

Most of the mineral building materials such as cement, limestone, etc. are described based on the Swiss conditions. Care must be taken if these data are intended to model the European production situation. The emission standards as well as the kind and amount of fuels used may differ substantially. Depending on the uses in the database, some materials like milled lime are available as packed and unpacked products while others (e.g. cement) are available only unpacked. To these products a packaging dataset can be added if required. Some building materials are modelled per m^3 of product. Their densities have to be considered while accounting for transport services or for modelling their waste treatment. The ecoinvent data v2.0 also includes some building components like doors and windows. The data are intended to be used as background data for LCA. If a direct comparison of different building products is aimed at, more specific data of these products have to be used. Additional information support is given in report No. 7.[15]

5.1.11 Chemicals and solvents

Datasets on chemicals and solvents are either reported "…, at plant" or "…, at regional storage". Transport to the site where the chemical is used as a feedstock or working material need to be added, when only the dataset "…, at plant" is available. The ending " …, at regional storage" indicates that these transport services are already included.
When different production technologies are distinguished within the database, an average production mix (usually named as " …. production mix, at plant"[16]) is available for the user that has no information about the production technology used in his or her specific case. Transport to the site where the chemical is used as a feed-

[15] Kellenberger D., Althaus H.-J., Jungbluth N., Künniger T., Lehmann M. and Thalmann P. (2007) Life Cycle Inventories of Building Products. ecoinvent report No. 7, v2.0. EMPA Dübendorf, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

[16] In some cases, the mix module does not contain the term „production mix". In such cases, the most general dataset (e.g. GLO or RER as geographical area code) is the one that shall be used instead of more specific ones (e.g. from a country like MA–Maroc).

stock or working material need to be added in case, the dataset name does not end with "… at regional storage". Dissolved chemicals and solvents are reported as kg of the active substance. For instance, if a process requires 0.2 kg of pure hydrochloric acid (supplied in water solution), 0.2 kg of "hydrochloric acid, 30% in H^2O, at plant/kg/RER/0" is required. However, to correctly consider the amount of transport service required, the distance need to be multiplied with 0.67kg (= 1/0.3*0.2). The amount of the solvent required in addition to the active substance (2.33 kg of H_2O per kg HCl in the example) is already included in the inventory of the dissolved chemicals. Additional information support for chemicals is given in report No. 8[17]. Life cycle inventories of detergents are described in report No. 12[18], life cycle inventories of petrochemical solvents in report No. 22.[19], and life cycle inventories of highly pure chemicals in report No. 19.[20]

5.1.12 Metals

Datasets on metals are either reported "…, at plant" or "…, at regional storage". The latter represents the supply mix of a metal produced with different production technologies and or in different regions modelled within ecoinvent. Transport to the site where the metal is used or processed need to be added.
For various metals, separate datasets for primary and secondary metal (partially distinguishing between old and new scrap) are available as well as the actual average mixes (partially distinguishing between different types of alloys) of primary and secondary material on the market. Depending on the goal of the LCA primary material, secondary material or the mixes of the two are appropriate. Since a cutoff approach for scrap to recycling is applied, the datasets of secondary metals cover the whole recycling process, not including scrap input. Thus these datasets can be

[17] Althaus H.-J., Chudacoff M., Hischier R., Jungbluth N., Osses M. and Primas A. (2007b) Life Cycle Inventories of Chemicals. ecoinvent report No. 8, v2.0. EMPA Dübendorf, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

[18] Zah R. and Hischier R. (2007) Life Cycle Inventories of Detergents. ecoinvent report No. 12, v2.0. EMPA St.Gallen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

[19] Sutter J. (2007a) Life Cycle Inventories of Petrochemical Solvents. ecoinvent report No. 22, v2.0. ETH Zürich, Swiss Centre for Life Cycle Inventories, Dübendorf, from www.ecoinvent.org.

[20] Sutter J. (2007b) Life Cycle Inventories of Highly Pure Chemicals. ecoinvent report No. 19, v2.0. ETH Zürich, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

used when applying a system expansion approach.
Metal processing is modelled in separate unit processes. The datasets only contain the inputs and outputs needed to process the metal but not the metal input itself. The dataset names start with the name of the treatment activity (e.g., "enamelling, …", "zinc coating",…", or "anodising, …"). A dataset that describes a product made out of anodised aluminium for instance has to be linked to an aluminium dataset on one hand and to the anodising processing dataset on the other. Additional information support is given in report No. 10.[21]

5.*1.13 Packaging & graphical paper*

The final report No. 11 describes the inventories for many packaging materials made from paper, carton, plastics and glass.[22] The different types of market pulp – i.e. pulp that is sold on the free market – are only reported as "…. at plant". Thus, transport to the site where the pulp is used as a feedstock or working material need to be added. As these pulp datasets represent only market pulp, they shall not be used for the pulp part of an integrated production plant. Otherwise, the environmental load attributed to the pulp will be too high due to the additional steps included for conditioning pulp for selling as such.
Datasets on graphical paper are reported as "…. at plant" and as "…. at regional storage". The appropriate datasets to use are the latter ones, including the trade situation of paper between the European countries according to information from their industrial association (CEPI).
Corrugated board: Besides the datasets of four types of base paper as well as of various corrugated board types, examples for a corrugated box for Swiss and for European conditions are included. Thus, for a user-defined corrugated box only the link with the corrugated board has to be replaced with the case-specific corrugated board.
Cartonboard: Besides datasets for the different board types, datasets for the production of boxes are included. These latter datasets only contain the inputs and outputs needed to produce the respective box, but not the board input itself. The

[21] Classen M., Althaus H.-J., Blaser S., Doka G., Jungbluth N. and Tuchschmid M. (2007) Life Cycle Inventories of Metals. ecoinvent report No. 10, v2.0. EMPA Dübendorf, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

[22] Hischier R. (2007) Life Cycle Inventories of Packaging and Graphical Paper. ecoinvent report No.11, v2.0. EMPA St.Gallen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

dataset that describes a cartonboard box for rice for instance is linked to the "folding boxboard" dataset on one hand and to the "packaging, corrugated board" dataset on the other.
If no specific information about the paper /board used is available, it is recommended to use the following datasets as a first approximation: LWC paper (at regional storage, RER) and solid bleached board (SBB, at plant, RER).
Inventories for plastics are mainly based on the European average datasets from PlasticsEurope – data that are highly aggregated and thus not in accordance with the ecoinvent data quality guidelines. Nevertheless, these datasets are used in ecoinvent for most of the granulates due to a lack of other sources. All these datasets are "… at plant". Like for cartonboard, the datasets of the different processing steps contain only the inputs and outputs needed for this respective step, but not the raw material (i.e. plastics) input itself. Thus, a dataset that describes a plastic bottle for milk for instance is linked to the adequate polyethylene dataset on one hand side and to the dataset blow moulding on the other.

5.1.14 Wood

Life cycle inventory datasets of wooden materials (including tropical wood from sustainable forest management and wood fuels) described in reports No. 9[23] and No. 21[24] are modelled per m^3. Since the density and the heating value of wood strongly depend on its moisture content, the u-value (i.e. the water mass relative to the mass of dry material) is given in the names of the processes or products. The whole wood chain is consequently modelled with multioutput processes even if only one of the outputs has an economic value. Thus it was possible to allocate the biomass, carbon content and the embodied energy by mass to the main product and to the coproduct that usually is used as fuel while allocating all of the other flows (inputs and outputs) by economic revenue (i.e. in some cases 100 % to the main product).

5.1.15 Renewable Materials

Datasets of tropical timber from sustainable forest management, natural fibres, yarns and textiles and biopolymers are

[23] Werner F., Althaus H.-J., Künniger T., Richter K. and Jungbluth N. (2007) Life Cycle Inventories of Wood as Fuel and Construction Material. ecoinvent report No. 9, v2.0. EMPA Dübendorf, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

[24] Althaus H.-J., Dinkel F., Stettler C. and Werner F. (2007a) Life Cycle Inventories of Renewable Materials. ecoinvent report No.21, v2.0. EMPA Dübendorf, Swiss Centre for Life Cycle Inventories, Dübendorf, from www.ecoinvent.org.

available and document in ecoinvent report No. 21[25]. Tropical timber is modelled consistent with the modelling of European wood. Data refer to specific regions, wood species and forest management regimes and are not representative for average production. It also has to be borne in mind that these LCI data are neither suited to cover local environmental aspects properly nor social aspects at all. Also, the modelling uses a natural state as baseline scenario, thus neglecting that in tropical regions sustainable forest management is an alternative for unsustainable forest management rather than for not using tropical forests at all. If data is compared to tropical wood from clearcut (which is modelled as co-product of land transformation from forest to agricultural land), allocations need to be looked at carefully and might have to be altered to render data compliant to the scope of the study. For comments on natural fibre and biopolymer productions refer to Section 5.1.9.

5.1.16 Waste treatment

For modelling a life cycle from cradle to grave considering production or post consumer waste is an essential part. Waste treatment processes are modelled like any other technical processes. Waste characteristics like elementary composition, heating value, waste burnability and waste deg-radation rates are used to calculate waste-specific outputs and expenditures of waste treatment processes. The model components developed and used in the ecoinvent project are described in report No. 13[26].
In contrast to former ETH waste data, the transport of the waste from the waste producer to the disposal facility is not included in the current database. Exceptions are the 'disposal, building,…' modules, where everything downstream of demolition is included, and wastewater which is transported in sewers. For all other wastes a transport to the disposal facility must be inventoried additionally by the user. See chapter 'standard transportation distances in the methodology report [27].

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[25] Althaus H.-J., Dinkel F., Stettler C. and Werner F. (2007a) Life Cycle Inventories of Renewable Materials. ecoinvent report No. 21, v2.0. EMPA Dübendorf, Swiss Centre for Life Cycle Inventories, Dübendorf, from www.ecoinvent.org.

[26] Doka G. (2007) Life Cycle Inventories of Waste Treatment Services. ecoinvent report No. 13, v2.0. EMPA St. Gallen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

[27] Frischknecht R., Jungbluth N., Althaus H.-J., Doka G., Dones R., Heck T., Hellweg S., Hischier R., Nemecek T., Rebitzer G. and Spielmann M. (2007a) Overview and Methodology. ecoinvent report No. 1, v2.0. Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

The name of the waste treatment datasets starts with "disposal, …", for incineration, landfills, building demolition, underground deposition and landfarming, and with "treatment,…" for waste water treatment. The datasets describe the current state of technology in operation in Switzerland. The state of technology (e.g., share of DeNOx-equipment in municipal waste incineration plants) can however be changed according to a particular situation.
The waste management Excel-tools introduced with ecoinvent data v1.0 will be adapted to ecoinvent data v2.0 in 2008 and provided together with the update ecoinvent data v2.1.

5.1.17 Electronics

The final report No.18 describes datasets in the electronics sector, from individual components to IT services including dismantling and disposal/recycling of electronic devices[28].

IT-Services: the printing activity is modelled in two ways – per hour of printing and per kg of printed paper. The use of desktop and laptop computer is modelled on a per hour basis. It is distinguished between home and office and between active, standby and off mode. It is highly recommended to use the modules "… office use" resp. "… home use" in order to take into account the production of the devices.

Devices: the devices are modelled per unit – i.e.one laptop computer. Each of these datasets contains its individual, state-of-the-art disposal process – allowing to the user the inclusion of the complete life cycle (with-out the use phase) by adding just one single process.

Modules: most important modules are printed wiring boards (PWB) – either as bare board (modelled per m^2) or as various types of mounted PWB (modelled per kg). Datasets of Lead-free, Lead-containing and unspecified soldering are available for each individual PWB. All datasets in the subcategory "module" do not include the final disposal, as the modules get disposed of as part of a complete device.

Components: nearly all components are modelled on a per kg basis. The weight per piece is reported and allows to convert these data in case the number of components is known. Cables are modelled per

[28] Hischier R., Classen M., Lehmann M. and Scharnhorst W. (2007) Life Cycle Inventories of Electric and Electronic Equipment-Production, Use & Disposal. ecoinvent report No. 18, v2.0. EMPA St.Gallen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

meter and units of plugs. The weight per meter is reported and allows to convert the data in case the cable weight is known. Similar to the modules, no final disposal is included, as they get disposed of as part of a complete device.

Disposal: Disposal processes reflect the dismantling, recycling and disposal activities of the two Swiss WEEE recycling systems. It is recommended to apply the datasets "disposal, …, to WEEE treatment", which represent the complete downstream chain of activities. All recycling processes are established as multi-output processes with a 100% allocation to the "disposal service" offered.

5.1.18 Mechanical engineering

Three aspects of mechanical engineering are covered with ecoinvent data v2.0, namely machining processes, ancillary machining processes, and compressed air supply.[29] There are basically two types of machining: chipping: where material is removed from the raw part (turning, milling, drilling) and chipless machining: where the raw part is only reshaped and (practically) no material is lost (impact extrusion, deep drawing, laser machining). Average machining datasets are provided to be used when the type of machining is unknown. This encompasses on the one hand average machines and machine operation but on the other hand also average factory infrastructure and factory operation. In addition to that, an LCI dataset "degreasing" is provided which is commonly used together with a machining process and can be added as necessary.
The data of chipping datasets refers to the amount of material removed, the others refer to the weight of the processed material (impact extrusion and deep drawing) and to the operation time (laser machining).

The production and supply of compressed air in networks of different pressure levels, installed power and energy efficiencies are provided.

[29] Steiner R. and Frischknecht R. (2007) Life Cycle Inventories of Metal Processing and Compressed Air Supply. ecoinvent report No. 23, v2.0. ESU-services Ltd., Swiss Centre for Life Cycle Inventories, Dübendorf, from www.ecoinvent.org.

5.2 Product systems including or excluding infrastructure

In earlier LCA studies infrastructure has sometimes been neglected due to its assumed minor importance. In ecoinvent, each process for which LCI data have been collected includes information about the amount of infrastructure needed per functional unit (e.g., 4*10-10 units of a chemical plant per kg chemicals output). Then, LCI and LCIA results are calculated including or excluding the infrastructure requirements. Because infrastructure may lead to important environmental impacts (in particular land occupation and transformation, see also Section 5.7), the use of data excluding infrastructure is strongly discouraged. For the time being data excluding infrastructure is not offered in the ecoinvent database.

5.3 Comparative LCA with ecoinvent data

The data collected and compiled in the ecoinvent database are not primarily suited for direct comparisons. Waste management datasets for instance shall not directly be used for waste management policy assessments (landfilling versus incineration), transport service datasets shall not directly be used for transport systems comparison and farming systems (integrated, extensive or organic production) shall not directly and solely be compared based on ecoinvent data. In all cases the systems for comparison have to be thoroughly defined beforehand. Then it has to be checked which adaptation to the average data investigated would be necessary to appropriately describe these systems according to the goals of the study.

5.4 Uncertainty information

The ecoinvent inventory result files contain quantitative and qualitative information about the minimum and maximum value of each individual elementary flow. In many cases a simplified pedigree approach has been used. The methodology report[30] provides information how to understand the meaning of the pedigree scores which look like "(2,4,3,na,5,na)".

Uncertainty information is valuable to judge the overall variability of LCI results. Care must be taken when using the minimum and maximum figures in comparative assertions on the basis of LCI results

[30] Frischknecht R., Jungbluth N., Althaus H.-J., Doka G., Dones R., Heck T., Hellweg S., Hischier R., Nemecek T., Rebitzer G. and Spielmann M. (2007a) Overview and Methodology. ecoinvent report No. 1, v2.0. Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

because all uncertainty values are assumed to be independent (which is not the case in reality).

The uncertainty figures presented in the cumulative LCI results may however not directly be used for the assessment of the uncertainties of LCA case studies. Please note also that the minimum and maximum values of individual exchanges must not be added (see chapter 5.6).

For a correct uncertainty assessment for the modelled LCA case study, the uncertainty information on a unit process level is required. A Monte Carlo simulation based on the case study's LCI raw data is required to correctly assess the uncertainty in the LCI results. Some of the commercially available LCA software are able to perform such project-specific Monte Carlo simulation.

5.5 Multioutput processes

Multi-output processes, i.e., processes that deliver two or more products or services, are available as datasets before allocation. Besides the inputs (resources, energy, working materials, services, etc.) and outputs (emissions and all co-products) of the process, allocation factors are reported in the unallocated dataset. Tab. 5.2 shows an excerpt of the inputs and outputs of the (unallocated) MG silicon purification process[31] and its allocation factors, information that is available in the multi-output process dataset.

The first three lines show the outgoing coproducts EG-silicon (0.68 kg), off-grade electronic grade silicon (0.084 kg) and silicon tetrachloride (1.2 kg). The next six lines show examples for the inputs required for the purification of 1 kg of MG-silicon. The three columns to the right show the allocation factors: For instance, 71.1% of the MG-silicon, at plant are allocated to the 0.68 kg of EG silicon, 8.9% to 0.084 kg off-grade silicon and 20% to 1.2 kg $SiCl_4$. Hence, the allocation factors indicate the share of total inputs and outputs that are allocated to the actual amount of co-product output.

Given an adequate LCA software, allocation factors may be changed according to own needs. Care must be taken that the sum of the allocation factors equals 100% and – as said above – that the allocation

[31] Jungbluth N. (2003) Photovoltaik. In: Sachbilanzen von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz (ed. Dones R.). Paul Scherrer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

Tab. 5.2 Excerpt of the multi-output process raw data of the purification of 1 kg of MG silicon and allocation factors used for the three co-products

	Name	Location	Unit	MG-silicon, to purification	silicon, electronic grade, at plant	silicon, electronic grade, off-grade, at plant	silicon tetrachloride, at plant	Allocation criteria
	Location			DE	DE	DE	DE	
	Unit			kg	kg	kg	kg	
allocated products	silicon, electronic grade, at plant	DE	kg	6.76E-1	100	0	0	
	silcon, electronic grade, off-grade, at plant	DE	kg	8.44E-2	0	100	0	
	silicon tetrachloride, at plant	DE	kg	1.20E+0	0	0	100	
techno-sphere	MG-silicon, at plant	NO	kg	1.00E+0	71.1	8.9	20.0	Material balance
	polyethylene, HDPE, granulate, at plant	RER	kg	6.37E-4	72.0	2.4	25.6	Revenue all products
	hydrochloric acid, 30% in H_2O, at plant	RER	kg	2.00E+0	48.4	1.6	50.0	Stoechometric calculation
	natural gas, burned in boiler condensing modulating >100kW	RER	MJ	1.22E+2	96.8	3.2	-	Revenue purified silicon
	electricity, natural gas, at combined cycle plant, best	RER	kWh	8.66E+1	96.8	3.2	-	Revenue purified silicon
	electricity, hydropower, at run-of-river power plant	RER	kWh	2.74E+1	96.8	3.2	-	Revenue purified silicon
	price	GLO	€	70.36	75.00	20.00	15.00	
	revenue	GLO	€	70.36	50.67	1.69	18.00	

factors are applied on the total (unallocated) inputs and outputs and referred to the amount of co-product output of the multi-output process.

5.6 Aggregate elementary flow data

Elementary flows (emissions and resource uses) are classified with the help of categories and sub-categories. Categories describe the compartments to which elementary flows are emitted (air, water, soil) and the resources. Subcategories further distinguish subcompartments within these compartments which may be relevant for the subsequent impact assessment step.
Each elementary flow is recorded only once. Hence, if appropriate, one may add up the elementary flows of all subcompartments to get the total flow of an elementary flow of the compartment. For example, one might add up the mean values of all "Carbon monoxide, fossil" emitted to "air/high population density", "air/low population density", air/lower stratosphere + upper troposphere", and air/unspecified" to get the total amount of fossil CO emitted to air.

The particulate emissions are reported in classes of <2.5 mm, between 2.5 mm and 10 mm, and >10 mm. In order to get the amount of PM10 emitted, the results of particulates emissions of <2.5 mm, and between 2.5 mm and 10 mm (named "Particulates, < 2.5 um" and "Particulates, > 2.5 um, and < 10um") need to be added.

The minimum and maximum values of elementary flows reported in the LCI results of the ecoinvent database shall not be added to total emissions into a compartment because the sum of all minimum and maximum values, respectively does not correspond to the minimum and maximum values determined with a Monte Carlo simulation.

Warning: Adding up elementary flows emitted to different subcompartments may be a substantial loss of environmentally relevant information.

5.7 Use of impact assessment results

The use of life cycle impact assessment (LCIA) methods facilitates the interpretation of LCA results. The ecoinvent database also contains life cycle impact assessment results. Assumptions and inter-pretations were necessary to match current LCIA methods with the ecoinvent inventory re-sults. It is strongly advised to read the respective chapters of the implementation report[32] and the original reports describing the LCIA methods before applying LCIA results.

Impact assessment results are reported on the basis of a final indicator (eco-indicator 99, hierarchist/average, total) as well as on the basis of safeguard subjects (e.g., human health) and environ-mental topics (e.g., ionising radiation).

The use of impact assessment results excluding infrastructure should be avoided due to missing substantial parts of the LCA score. Because most landuse consuming datasets represent infrastructure processes, land use would substantially be underestimated (e.g., assessed with eco-indicator 99, hierarchist, average, or with ecological damage potential).

[32] Frischknecht R., Jungbluth N., Althaus H.-J., Bauer C., Doka G., Dones R., Hellweg S., Hischier R., Humbert S., Margni M. and Nemecek T. (2007b) Implementation of Life Cycle Impact Assessment Methods. ecoinvent report No. 3, v2.0. Swiss Centre for Life Cycle Inventories, Dübendorf, CH, from www.ecoinvent.org.

5.8 How to reproduce and quote ecoinvent data in case studies

How shall the use of the ecoinvent database be quoted?

The ecoinvent terms of use state that *"the use of the ecoinvent data by preparing extracts, or for further use for commercial purposes is prohibited. The licensee shall not reproduce, disseminate or publicly display the ecoinvent data as a whole or any substantial part thereof, as determined by their nature and quantity. Reproduction, dissemination or public display with regard to nature and quantity of insignificant portions of the ecoinvent data is prohibited, to the extent this would unreasonably affect the legitimate interests of the Licensor."*

It means that ecoinvent LCI raw data and results and LCIA results (either directly downloaded from the ecoinvent database or calculated with ecoinvent LCI results and the factors downloaded from the ecoinvent database) shall not be reproduced in other LCA case studies. Contribution analyses may include graphical representation of the share of ecoinvent processes on the total LCA results (e.g., the contribution of energy supply to the total burdens of manufacturing a mobile phone). Hereby the possibilities to recalculate the exact LCI and LCIA results of an ecoinvent dataset shall be prevented as much as possible.

The ecoinvent data shall generally be quoted by including the exact version number of the data, and whether data including or excluding infrastructure are used. Additional reference may be made to the respective final report(s) if data of selected processes have been used (see Section 6.4 for quoting adapted versions of ecoinvent data). If the database ecoinvent and its contents are cited as a whole the following format is recommended:

ecoinvent Centre 2007
ecoinvent Centre (2007), ecoinvent data v2.0. ecoinvent reports No. 1-25, Swiss Centre for Life Cycle Inventories, Dübendorf, 2007, retrieved from: www.ecoinvent.org.

6 How to change ecoinvent data

6.1 General remarks

The ecoinvent database is not just an LCI data library but an LCI data network. The datasets of ecoinvent unit processes are interlinked. All inputs from technosphere to a unit process, be it the consumption of electricity, the demand for working materials, the use of the road infrastructure, refer to other unit processes available in ecoinvent data. This means, that any change in the flow data of a unit process influences the LCI results of almost all unit processes. Depending on the magnitude of the change, this influence may be negligible for the majority of the datasets but it may also be significant to many or a few datasets.

Hence, changes in the original data made by the user need to be done carefully. The responsibility for any modification applied to ecoinvent data and any results and conclusion obtained with such data remain fully with the authors of these modifications and the respective studies. The ecoinvent software system and the Excel-Files on this CD-ROM do not provide calculation software that enables recursive recalculations. Commercial LCA software tools capable to solve recursive loops are required for that purpose.

6.2 Change of inputs or outputs, change of amounts

The unit process raw data allow for a change of inputs or outputs of unit processes (e.g., have an input of "electricity, high voltage, at grid/kWh/DE/0" instead of "electricity, high voltage, SBB, at grid/kWh/CH/0") or for a change of the amount of an input or an output (e.g., change the amount from 3 kWh to 1.8 kWh per functional unit). However, the LCI results need to be recalculated. Commercial LCA software are required for that purpose as ecoinvent only provides the LCI data but no LCI calculation tool.

6.3 Change of allocation approaches and allocation factors

Allocation approaches and allocation factors applied in multi-output processes may be changed as well. One might want to perform allocation based on mass instead of economic parameters which leads to changes in the allocation factors. How to change the allocation factors is described in section 5.5. Again it must be emphasised that the LCI results need to be recalculated after changes in the allocation factors.

6.4 How to quote adapted versions of ecoinvent data

If the ecoinvent data is used in an adapted version (by introducing changes as described in the sections above) to perform LCA studies, the source of information shall be quoted accordingly and the changes made shall be documented. The quotation should include the exact version number of the ecoinvent data, whether or not infrastructure is included in the results and a comment that it is a version derived from the original one (see also Section 5.8). Such derived versions of the ecoinvent database must not be sold.

7 Correction of errors

7.1 Announcement of known errors

Discovered errors are described on www.ecoinvent.org/ under the "Database News" ("Datenbank Neuigkeiten") section. In case of serious errors an announcement will be sent out via the ecoinvent Newsletter. You can opt for receiving this Newsletter during the registration procedure. Nevertheless, there will be no frequent update of the ecoinvent data in order to keep a clear versions management of ecoinvent data. Changes and/or corrections will only be made together with a new ecoinvent data version (i.e., ecoinvent data v2.X).

7.2 Questions and reporting of errors

Special emphasis was put on a very detailed documentation of the ecoinvent data in final reports and in the datasets' meta information. If - even after reading these documents - questions remain, the authors responsible for the respective datasets should first be contacted via the email address provided in the dataset meta information (of the person listed under "DataGenerator" and "DataEntryBy").
If you think you have discovered an error in a dataset which has not been announced so far via the ecoinvent website, please get in contact with the analyst responsible for the dataset. Please describe the error as detailed as possible in order to help us correcting it efficiently and in short time.

Abbreviations

a	annum = year
avg	average
ART	Agroscope Reckenholz-Tänikon Research Station
CML	Centre for Environmental Science, Leiden, the Netherlands
EDIP	Environmental Design of Industrial Products, Danish LCA programm
EG-Si	electronical-grade silicon
EMPA	Swiss Federal Laboratories for Materials Science & Technology
EPFL	Swiss Federal Institute of Technology Lausanne
ESU	Energie – Stoffe – Umwelt (energy – materials – environment)
ETHZ	Swiss Federal Institute of Technology Zürich
HWI	Hazardous waste incineration
IPCC	Intergovernmental Panel on Climate Change
kg	kilogram
kWh	kilo watt hours
LCA	Life cycle assessment
LCI	Life cycle inventory
LCIA	Life cycle impact assessment
m^3	cubic metre
MG-Si	metallurgical-grade silicon
MJ	Mega joule
MSWI	Municipal solid waste incineration
MSWLF	Municipal solid waste landfill
na	not available
PM10	particulate matter with a diameter of less than 10 µm
PSI	Paul Scherrer Institute
tkm	ton kilometre (Tonnenkilometer)
vkm	vehicle kilometre (Fahrzeugkilometer, Fzkm)
WWT	Waste water treatment
XML	extended markup language

Rolf Frischknecht, Niels Jungbluth, Hans-Jörg Althaus, Christian Bauer, Gabor Doka, Roberto Dones, Roland Hischier, Thomas Nemecek, Alex Primas, Gregor Wernet (2007), Code of Practice, ecoinvent report No. 2. Swiss Centre for Life Cycle Inventories, Dübendorf, 2007