

Life Cycle Inventories of Electricity Mixes and Grid

Version 1.3

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Summary

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This report describes the life cycle inventories of electricity production in selected African, American, Asian, Australian and European countries, in different networks and of a global electricity mix. The different production technologies and the electricity trade with the neighbouring countries are considered for each country. Two different approaches are used, a domestic production mix for each country named “electricity, production country, at grid/kWh/country/0”, which describes the domestic electricity production, and a supply mix named “electricity/kWh/country/0”, which describes the domestic electricity production including electricity imports.

In this study the electricity mixes of the following countries are described:

Africa: South Africa (ZA), Tanzania (TZ), Tunisia (TN)

Americas: Brazil (BR), Canada (CA), Mexico (MX), Peru (PE) and United States of America (US)

Asia and Australia: Australia (AU), India (IN), Indonesia (ID), Iran (IR), Japan (JP), Malaysia (MY), People’s Republic of China (CN), Saudi Arabia (SA), South Korea (KR), Chinese Taipei (TW) and Thailand (TH)

Europe: Austria (AT), Belgium (BE), Bosnia and Herzegovina (BA), Bulgaria (BG), Croatia (HR), Czech Republic (CZ), Denmark (DK), Estonia (EE), Finland (FI), France (FR), Germany (DE), Greece (GR), Hungary (HU), Iceland (IS), Ireland (IE), Italy (IT), Latvia (LV), Lithuania (LT), Macedonia (MK), Netherlands (NL), Norway (NO) Poland (PL), Portugal (PT), Romania (RO), Serbia (CS), Slovakia (SK), Slovenia (SI), Spain (ES), Sweden (SE), Switzerland (CH), United Kingdom (GB), Russia (RU), Turkey (TR) and Ukraine (UA)

The average electricity production in the year 2008 is described for all countries. Hence, daily or seasonal variations of power production are not covered. The electricity production is divided in seven major categories (fossil fuels, hydro power, nuclear power, new renewables, wastes, imports and other). Within the category of the fossil fuels electricity generation using hard coal, lignite, peat, industrial gases, fuel oil, diesel, natural gas and other fossil fuels are distinguished. The category hydro power is divided in run-of-river, storage type and pumped storage hydro power. In the category nuclear power electricity generation from boiling- and pressurised-water reactors is distinguished. The category new renewables is divided into geothermal, photovoltaic, solar thermal, wave and tidal, wind, wood and biogas electricity production. Electricity from municipal or industrial waste and sewage sludge or landfill gases is distinguished within the category waste. The electricity production in municipal incineration is considered as by-product of the waste disposal and has no environmental impacts during generation. For the Swiss electricity mix (reference year 2009) the separately sold certified electricity is modelled separately and the Swiss supply mix excludes certified electricity.

Three different voltage levels (high, medium and low voltage) are modelled. The cumulated losses from transmission and distribution on the high, medium and low voltage level range from 2.2 % to 32.3 % (Luxembourg and Bosnia and Herzegovina, respectively). The global average corresponds to 11.5 % cumulated losses on the low voltage level.

There is a large variation of the environmental impacts of 1 kWh of electricity depending on the technology used for electricity production. The cumulative energy demand ranges from 3.9 to 14.8 MJ-oil-eq/kWh (Iceland and Greece respectively), whereas the greenhouse gas emissions range from 6 to 1110 g CO₂-eq/kWh (Iceland and China, respectively). The environmental impacts according to the ecological scarcity method 2006 range from 16 to 2470 eco-points/kWh (Iceland and India, respectively).

The European electricity mix (ENTSO-E network) causes greenhouse gas emissions equal to 462 g CO₂-eq/kWh, a cumulative energy demand of 10.3 MJ-oil-eq/kWh and a total environmental impact of 439 eco-points/kWh. The global electricity mix, represented by 84 % of the world’s elec-

tricity production causes a cumulative energy demand of 11.1 MJ-oil-eq/kWh, greenhouse gas emissions of 721 gCO₂-eq/kWh and a total environmental impact of 680 eco-points/kWh according to the ecological scarcity method 2006.

SF₆ emissions of switchgear, N₂O and ozone emissions due to electricity transmission and heavy metal emissions from wooden poles during operation are taken into account in transmission and distribution. There are significant differences in the SF₆ emissions and the transmission and distribution losses of the different countries.

Unknown electricity demand, which cannot be allocated to a specific country or region, is modelled with the ENTSO-E mix. This is a simplification and causes small deviations from the real electricity production and consumption. If more accurate data are available a local or industry specific electricity mix should be used.

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Abbreviations

Abbreviation	English	German
CENTREL	Central European power association (CZ, HU, PL, SK)	
CH	Switzerland	
EWZ		Elektrizitätswerk der Stadt Zürich
GJ	Gigajoule (10 ⁹ Joule)	
HV	High voltage	
kV	Kilovolt (1'000 Volt)	
MSWI	Municipal solid waste incineration	
MJ	Megajoule (10 ⁶ Joule)	
MV	Medium voltage	
MVA	Mega Volt Ampère (10 ⁶ Volt Ampère)	
NM VOC	Non methane volatile organic carbon	
NORDEL	Nordic countries power association (DK, FI, NO, SE, IS)	
LV	Low voltage	
PCB		Polychlorierte Biphenyle
RER	Europe (EU-27)	
SF ₆	Sulphur hexafluoride	
SBB	Swiss Railways	Schweizerische Bundesbahnen
Tkm	Tonkilometre	
UBP	Eco-point	Umweltbelastungspunkt
UCTE	Union for the Co-ordination of Trans- mission of Electricity	
VSE		Verband Schweizerischer Elektrizitätsunternehmen

A list of all country codes can be found in Frischknecht et al. (2007b).

1 Introduction

European electricity mixes are modelled since the 1990's <BUWAL 1991>¹. In the beginning only the electricity mixes of a few European countries have been modelled (DF, FR, BE, IT, NL, LU, GR, ES, PT, CH and AT). Since then, the electricity markets all over the world have changed. The continuing deregulation lessens the influence of political boundaries. In 2008 the Union for the Co-ordination of the Transmission of Electricity (UCTE) including most of the countries in continental Europe was replaced with its successor, the European network of transmission system operators for electricity (ENTSO-E) including most of the European countries.

The ENTSO-E network includes the former UCTE members (already including the former members of the CENTREL network) and the former NORDEL members. In 2012 all the European countries except Russia, Belarus, Moldavia, Albania and the Ukraine are members of the ENTSO-E network. Nevertheless the electricity mixes of former networks (UCTE, CENTREL, NORDEL) are updated with the actual production volumes.

The existing European electricity mix (EU-27 without Baltic States, including Norway, Switzerland, Croatia, Bosnia-Herzegovina, Serbia and Macedonia) is updated as well.

Besides the European electricity supply, life cycle inventories of countries of all other continents are established. Life cycle inventories of the electricity supply in three African, six American, and eleven Asian and Australasian countries are described in this report. In total this covers 84 % of the world's electricity production.

In addition to the aforementioned networks, two company specific electricity mixes, namely the mix of the Swiss Federal Railways (SBB) and the European Aluminium Association (EAA) are modelled.

Unknown electricity demand, which cannot be allocated to a specific country or region, is modelled with the ENTSO-E mix. This causes small deviations from the real electricity production and consumption. If more accurate data is available a local or industry specific electricity mix should be used.

¹ Angle brackets '<>' denote references from 1996, parentheses '()' are references of the updates 2000, 2004 or 2012

2 System description

In this chapter the calculation of the electricity production volumes of the different types of power plants is described for the countries analysed in this study. The existing electricity mixes of the European, Asian and North American countries are updated and several new African, Asian, Central and South American countries are added. The UCTE, NORDEL and CENTREL networks are merged in the ENTSO-E network (European Network of Transmission System Operators for Electricity), but the former UCTE, NORDEL and CENTREL networks are still modelled separately in addition to the new ENTSO-E electricity production mix. A global electricity mix, covering more than 84 % of the world's electricity production, is established too.

2.1 Electricity production data

The calculation of the electricity production mixes of all countries is based on statistics of the International Energy Agency (IEA). The data on the national electricity production is available from online databases (IEA 2010, 2011). The gross electricity production of the conventional fossil and nuclear power plants, as well as the overall net electricity production is given. For the conventional fossil power plants the own electricity demand was considered as equal for all fossil fuels due to the lack of more detailed information. This simplification neglects the energy demand for the processing of the different fuels (fuel oil compared to hard coal). Due to this assumption the net electricity production using fuels with a high processing intensity are overestimated, but the error is very small when looking at the absolute numbers.²

The own electricity consumption of hydro power plants is 1 % according to the IEA statistics, for geothermal and solar power plants the own electricity consumption is 4 %. These shares are based on statistical estimations and have no well ground scientific background. Nevertheless the shares indicated are used because of lacking data.³

The electricity production using hydro power can fluctuate between years with more and less precipitation. This causes a yearly varying share of hydro power in relation to the total electricity production. Yearly averaged electricity production data covering multiple years would be needed in order to cover the yearly change. The averaging of multiple years is not followed because the yearly change in the production technologies is expected to outweigh the fluctuation in hydropower production. In addition, yearly averages offer the advantage of a simplified data basis.

2.2 Electricity trade

2.2.1 Introduction

Switzerland, like a few other countries, is trading a considerable amount of electricity with the neighbouring countries. In the year 2009 52'002 GWh of electricity was imported to Switzerland and 54'149 GWh were exported. This corresponds to a traded electricity volume of about 85 % of the actual domestic demand of electricity. The electricity is mainly imported from France and Germany and (re)exported to Italy, Germany and France.

In TECOVA (1992) the CO₂ emissions caused by the electricity production including the traded electricity have been quantified for the first time. Several models have been used to model the Swiss electricity mix. Ménard et al. (1998) and Frischknecht & Jungbluth (2000) give an overview of the different models, which are described in the following subchapter.

² The own electricity consumption of conventional fossil power plants varies between 2 % and 11 %.

³ This approach is chosen solely to be consistent with the statistics on electricity production

2.2.2 Models including traded electricity

Ménard et al. (1998) describe different approaches for the modelling of the electricity trade (see Tab. 2.1 and Fig. 2.1).

The electricity mix according to **Model M1** corresponds to the domestic electricity production mix. **Model M1** includes the electricity production of different power plants within a geographic boundary. Electricity trade is not considered in this model. The electricity mix of countries with a low share of imported or exported electricity can be modelled with such a simplified approach.

The electricity mix according to **Model M2** includes the electricity imports in addition to domestic electricity production. There is no difference between electricity exported and electricity supplied to the domestic market. If no detailed information on the traded volumes of electricity is available, this model offers a balanced and reliable approximation.

The electricity mix according to **Model M3** assumes that the exported electricity is produced by the domestic power plants and that the imported electricity is used exclusively for electricity supply within the importing country. This approach does not consider that imported electricity can be exported to other countries. This may have a strong influence on the electricity mix of countries with a high volume of traded electricity.

The electricity mix according to **Model M4** is based on the assumption that simultaneous, physically measured imports and exports are due to transit trade. This approach was developed in order to model the electricity flows in countries like Switzerland. The electricity imports and exports are measured with eight hourly samples in one year and extrapolated to the entire year. The net electricity imports are modelled with the electricity mix of the exporting countries and net electricity exports are modelled with the electricity mix of the importing countries (**Model M1**). This approach is based on physical electricity flows, which may deviate from the economic realities. It is difficult to apply because of the detailed data, which are needed to describe the electricity trade. The uncertainties introduced with the extrapolations are very high.

A fifth model, **Model M5**, was introduced with the ecoinvent data v2.2: The electricity mix of the domestic supply is modelled according to the integration of the electricity declarations of all electric utilities in a country. The declaration includes a differentiation according to technology and whether or not the electricity is produced domestically or is imported. It usually includes a share of “unknown” electricity, which in this study is represented by the ENTSO-E electricity mix.

Tab. 2.1: Model approaches for electricity mixes in LCA (Ménard et al. 1998)

Model	Described in
M1 Domestic production = supply mix	Frischknecht et al. (1996)
M2 Domestic production + imports = supply mix	This study (all countries except Switzerland), ecoinvent v2.2, (Frischknecht & Jungbluth 2000) (Tecova 1992)
M3 Domestic production - exports + imports = supply mix	Frischknecht et al. (1996), Habersatter (1996), Tecova 1992)
M4 Domestic production + net imports/exports = supply mix	Ménard et al. (1998) (Kaufmann et al. 1999:45)
M5 Consumer mix	This study, applied on Swiss electricity mix only

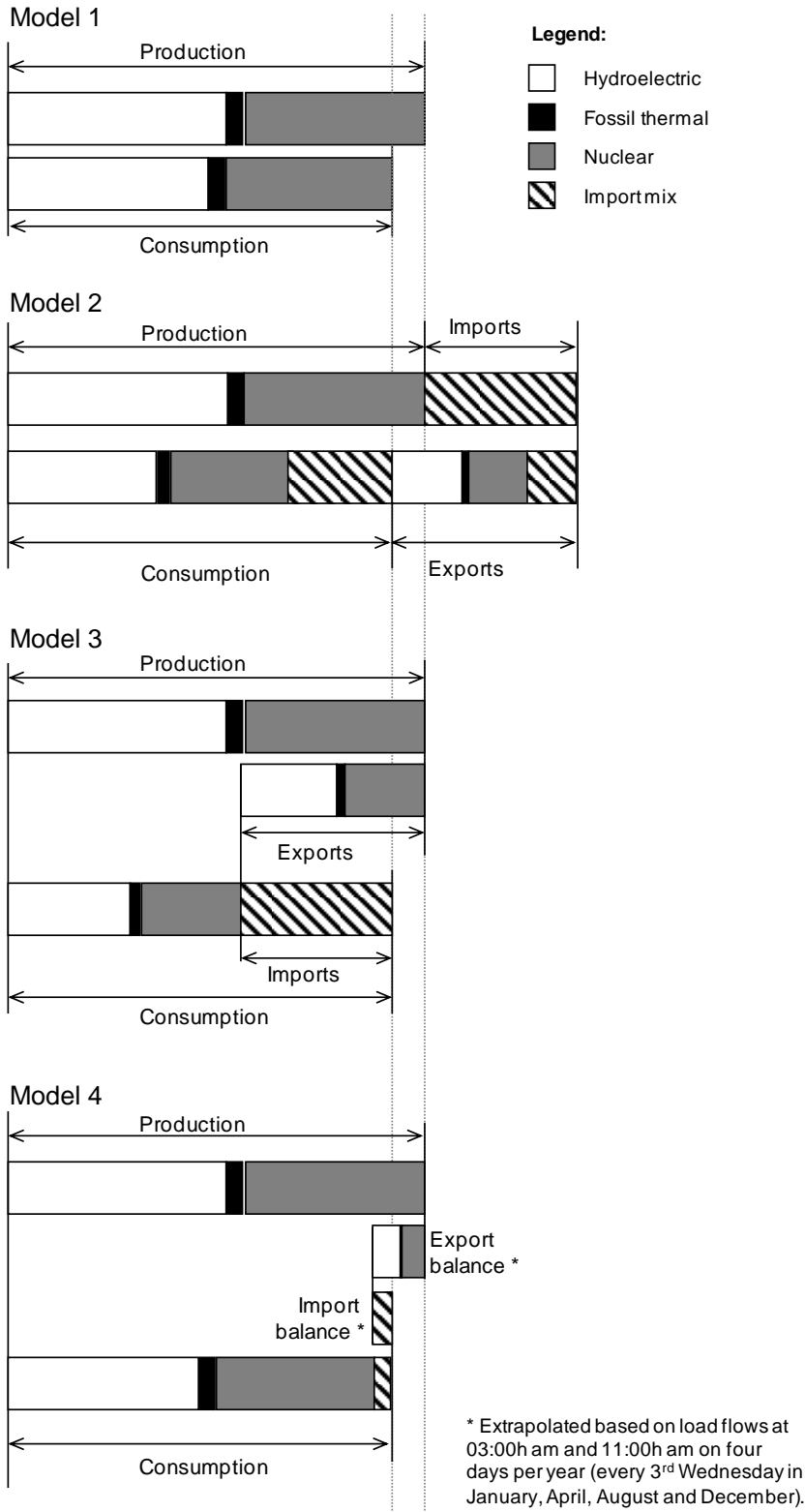


Fig. 2.1: Model approaches for electricity mixes in LCA; graphs represent annual averages (Ménard et al. 1998, S. 10-11)

A survey of the leading Swiss electricity suppliers (Alpiq, BKW, EGL, EOS, EWZ and Aepo) showed, that the origin of the supplied electricity is undocumented in the contracts with their costumers. Four suppliers report a fluctuating share of transit trade varying between zero and a few percent.

Alpiq and EGL report transit trade for other electricity suppliers in their annual report⁴. The reported transit trade can be within Switzerland or with neighbouring countries.

2.2.3 Model used in this study

The electricity mixes can be modelled according to physical flow or contractually accorded production. The power plants are operated to sell the produced electricity. The customers of the power plants are the reason why the power plants are operated. Therefore, the modelling of the electricity mixes according to the contractually accorded production volumes is favoured.

The physical electricity flows are not able to show the relation between electricity producers and consumers. The deviation between physical and contractually accorded electricity flows may be very high in deregulated electricity markets. For instance, no physical electricity flow occurs when there is a simultaneous electricity flow from southern to northern Switzerland and vice versa on the same transmission line.

In order to allocate the emissions to the actual consumer, the electricity mixes in this study (except for the Swiss supply mixes) are modelled according to *Model M2*. *Model M2* is the best approximation because electricity sales and production are independent of each other⁵. A (foreign) customer can purchase electricity from Swiss suppliers without knowledge on the electricity production (in Switzerland and other countries). Therefore, it is assumed that the electricity mix on a national level corresponds to the domestic production including the electricity imports.

The Swiss supply mix is modelled according to *Model M5* using information from the most recent survey of the Swiss Federal Office of Energy (BFE 2012). Although this mix contains a 20 % share of unknown electricity it is considered to be more appropriate as compared to a Swiss electricity mix based on *Model M2*.

The *Model M2* can be applied to a deregulated electricity market, because this approach is based on the contractually accorded production volumes. With this approach the actual emissions are determined by the customer.

In this study the economic and contractually accorded electricity flows are modelled with the available information. For all countries except Switzerland the physical electricity flows are used (IEA 2010, 2011).

The electricity imports are modelled with the domestic production mix instead of the electricity supply mix of the corresponding countries. With this simplifying approach a virtual feedback loop between the electricity supply mixes of different countries is avoided.

2.2.4 Certified electricity in Switzerland

The Swiss electricity suppliers are committed to provide information on the origin of the sold electricity due to the deregulation of the electricity market. Labelled products consisting of electricity from specific production technologies are offered and sold. The environmental impacts of these electricity products are reported in the environmental reports of the companies.

The volumes of the certified electricity products, which are sold separately, are subtracted from the supply mix of the respective country in order to assess the environmental impacts of the consumption

⁴ For the year 1996 Alpiq reported 7'394GWh of transit trade and 22'753GWh of supplied electricity (Ménard et al. 1998, ATEL 1999)

⁵ The electricity production has to be in balance with the electricity demand but only on the grid level and not on the level of a single power plant or individual customers.

of electricity of non-specified quality (“whatever” electricity). With this approach the double counting of the environmental impacts of certified electricity products is avoided.

The actual supply mix in a specific country represents the electricity mix of non-specified quality delivered to the average customer. The amount of certified electricity is subtracted from the net production volumes of the different production technologies. This supply mix consists of the not certified (and not separately sold) electricity and the electricity imports.

The amount of electricity which is sold in certified Swiss electricity products is known. Therefore, four Swiss electricity mixes are established:

- Domestic production mix: electricity produced in Switzerland (certified electricity included)
- Consumer mix: electricity consumed in Switzerland (imports and domestic production, based on *Model 5*)
- Certified electricity: certified electricity sold in Switzerland (based on *Model 5*)
- Supply mix: Consumer mix excluding separately sold, certified electricity

There is not enough information available about the consumer mix and about certified electricity in the countries covered in this study. Therefore, Model M5 and the subtraction of the sales volumes of separately sold certified electricity is only applied for Switzerland.

2.2.5 Renewable Energy and Electric Energy Certificates System (RECS and EECS)

The trade with electricity certificates in Europe developed dynamically during the recent past. Tab. 2.2 shows the trade and cancellation (use) of RECS certificates during the years 2004 to 2010 (AIB 2011). It shows that Norwegian electricity suppliers are most active in issuing RECS certificates, while other countries like Poland or United Kingdom have no activities. Norway exported about 50.5 TWh RECS certificates while Belgium (28.1 TWh), the Netherlands (18.9 TWh) and Germany (14.6 TWh) are the most important countries with respect to RECS imports. RECS certificates need not to be cancelled in the same year. Belgium, the Netherlands and Germany cancelled 14 TWh, 21 TWh, and 8 TWh RECS certificates in 2008.

Tab. 2.2: Issued and cancelled volumes of RECS certificates during the year 2004 to 2010 (AIB 2011)

Countries issuing	2010	2009	2008	2007	2006	2005	2004
Unit	GWh	GWh	GWh	GWh	GWh	GWh	GWh
Norway	103'925'208	109'972'124	111'080'954	83'289'057	19'762'654	14'506'286	5'625'516
Sweden	67'270'258	68'039'502	67'433'903	34'358'895	25'293'491	16'589'875	5'832'690
Belgium	3'777'459	3'148'822	1'761'062	1'389'626	1'236'592	0	0
Germany	0	0	20'901	0	0	0	5'963
Italy	11'693'754	8'924'377	7'047'084	1'288'221	1'185'323	418'397	73'970
France	9'194'442	4'441'234	2'667'701	2'241'296	960'349	719'430	443'662
Rest of Europe	35'876'974	24'320'552	23'043'776	23'043'863	18'037'109	16'023'937	19'443'084
Total	231'738'095	218'846'611	213'055'381	145'610'958	66'475'518	48'257'925	31'424'885

Technologies	2010	2009	2008	2007	2006	2005	2004
Unit	GWh	GWh	GWh	GWh	GWh	GWh	GWh
Hydropower	181'520'628	171'503'962	168'339'409	134'064'076	54'133'365	38'080'648	19'947'178
Wind power	12'701'701	10'343'571	8'652'480	5'870'060	4'224'211	3'266'322	2'151'274
Biomass	5'738'159	4'723'245	4'372'315	2'647'034	4'010'122	3'504'878	7'826'163
Other renewables	5'734'272	4'743'671	4'033'705	3'029'788	4'107'820	3'406'077	1'500'270
Nuclear	26'043'335	27'532'162	27'657'472	0	0	0	0
Total	231'738'095	218'846'611	213'055'381	145'610'958	66'475'518	48'257'925	31'424'885

Countries cancelling	2010	2009	2008	2007	2006	2005	2004
Unit	GWh	GWh	GWh	GWh	GWh	GWh	GWh
Norway	28'514'371	28'763'116	28'062'028	12'636'718	2'711'968	1'101'274	827'342
Sweden	55'512'661	53'144'161	28'749'478	19'732'466	9'749'209	88'602	59'596
Belgium	48'735'704	7'644'139	14'360'402	4'064'499	647'349	450'730	50'000
Germany	21'420'979	17'078'933	8'150'988	5'289'723	616'653	25'036	48'647
Italy	7'670'751	5'678'056	3'759'063	928'675	573'660	241'048	76'873
France	6'225'743	5'421'017	3'630'351	10'356'326	610'996	461'004	214'878
Rest of Europe	43'899'918	33'845'910	24'295'137	22'265'906	20'835'990	22'387'331	15'290'442
Total	211'980'127	151'575'332	111'007'447	75'274'313	35'745'825	24'755'025	16'567'778

Norway exports about one third of its domestic hydroelectric power quality, whereas the share of RECS imports to Belgium, the Netherlands and Germany represents about 30 %, 20 %, and 2.5 %, respectively of domestic electricity production. The RECS trade volumes exceed by far the physical trade volumes.

The question is how to deal with RECS certificates in life cycle assessment and carbon footprint studies. This question calls for a closer look. We may distinguish two situations: Either the RECS certificates are sold together with the respective physical delivery of renewable electricity or the RECS certificates are sold separately.

The international standard on life cycle assessment advises to use the “actual electricity production mix in order to reflect the various sources of resources consumed” (International Organization for Standardization (ISO) 2006). The current draft standard on the carbon footprint of products requires that “specific electricity products, including a guarantee that the product sale and associated emission are not double counted” are used if the electricity supplier delivers such an electricity product (International Organization for Standardization (ISO) 2011). The draft standard also notes that “some “green certificates” are sold without coupling to the electricity, which might lead to double counting”.

The RECS trading scheme would substantially affect the national electricity mixes, if the purchase of independently traded RECS certificates would be considered for the national electricity mixes. The life cycle inventories of national electricity mixes documented in this study are based on international statistics, which do not consider RECS trade but only trade connected to physical deliveries of electricity. If it were allowed to adjust the electricity mix purchased by buying independently traded RECS certificates, substantial double counting of renewable electricity production would occur.

We therefore recommend disregarding independently traded RECS certificates in product and service LCA as long as the LCI of national electricity mixes is based on international statistics disregarding RECS trade. If RECS certificates are linked to the production and delivery of renewable electricity, we recommend including the respective share of renewables in the electricity mix.

2.2.6 Recommended data sets for the use in LCA

The recommended data sets for the general use in LCA are the country specific *supply* mixes on the corresponding voltage level (medium voltage for industrial use, low voltage for agricultural, commercial and domestic use). These data sets can be found in the category / subcategory “electricity” / “supply mix” and are named (name/location/unit/infrastructure process):

“electricity, high voltage, at grid/FR/kWh/0”,

“electricity, medium voltage, at grid/FR/kWh/0”,

“electricity, low voltage, at grid/FR/kWh/0”.

The name of the domestic production mix includes the addition “Production country” (e.g. “electricity, medium, voltage, production FR, at grid/FR/kWh/0”). These data sets should not be used. Exceptions are data sets of networks like ENTSO-E, UCTE, NORDEL, CENTREL or RER, which can be found in the subcategory “production mix”.

Specific company electricity mixes can be established with the corresponding production technologies. The electricity distribution has to be taken into account. Information on the electricity losses and other emissions during operation can be found in Chapter 4.

3 Life cycle inventories of electricity mixes

3.1 Introduction

In the following sections the electricity mixes of different countries are documented. The domestic production mix (country specific production) and the supply mix (country specific production including imports) are distinguished. For the modelling of the electricity imports the domestic production mix and not the supply mix of the exporting country is used. If the supply mix would be used for the modelling of the electricity imports there would be recursive links between the different country mixes. This would lead to significant virtual electricity production in some countries.

Three tables are shown per country. The first table shows the shares of the different technologies used for electricity production according to the available information. The subtotals for different production technologies (e.g. conventional thermal = fossil) are marked with grey colour. The second and the third table show the domestic production mix and the supply mix modelled in the life cycle inventories. Simplifications cannot be avoided. For instance, blast furnace gases and coke gases are merged to the category industrial gases. The electricity production using peat as fuel is modelled with a dataset derived from the electricity production using lignite as fuel. Electricity from biogas is modelled using the data set “electricity, at cogen with biogas engine, allocation exergy, CH” and electricity production using wood is modelled with the dataset “electricity, at cogen 6400kWth, wood, allocation exergy, CH”.

Electricity from hydro power is divided in run-of-river power plant and storage-type power plants. The shares of run-of-river power and storage type power generation for the European countries are shown in Tab. 3.1. Nuclear electricity is generated using boiling water reactors (BWR) and pressurised water reactors (PWR). The shares of the different technologies are derived from the reactor types in the different countries given in the PRIS database (PRIS 2011). The electricity production from photovoltaic is modelled with country specific datasets according to Jungbluth et al (2009). Geothermal and tidal electricity production is modelled using the data set for wind power.

The uncertainties of the electricity production and the shares are quantified using the pedigree approach (Frischknecht et al. 2007b). The data originate from international statistics and have only low uncertainties. If data sets are used which do not correspond to the used technology or the country the uncertainties are increased. Uncertainties caused by the modelling approach are not quantified. Differences in national and international statistics are caused by incomplete reporting and have no influence on the uncertainties.

3.1.1 Hydro power

Europe

The shares of hydro power production from run-of-river and storage type power plants for the European countries are shown in Tab. 3.1. For several countries the shares had to be estimated. Estimated shares are marked with stars. The share of pumped storage is the fraction of the amount of electricity produced with pumped storage and the total hydro power, whereas the shares for run-of-river and storage type hydropower are calculated as fraction of run-of-river hydropower respectively storage type hydropower and the sum of run-of-river and storage type hydropower. Therefore, the three shares (pumped storage, run-of-river and storage type) do not add up to 100 %.

Tab. 3.1: Yearly electricity production from run-of-river and storage type hydro power in GWh and percent for the European countries. Total production for the year 2008 (IEA 2011, IEA 2010) and shares for the year 2000 according to Frischknecht & Emmenegger (2003) and own estimations

Country	Code	Production / GWh				Share / %		
		Hydro Power	Pumped Storage	Run-of-river	Storage type	Pumped Storage	Run-of-river	Storage type
Austria	AT	40678	2732	28460	9487	7	75	25
Belgium	BE	1757	1347	410	0	77	100	0
Bosnia and Herzegovina	BA	4552	0	2959	1593	0	65*	35*
Bulgaria	BG	3277	0	3277	0	0	100***	0***
Croatia	HR	5326	426	98	4802	8	2	98
Czech Republic	CZ	2376	352	1518	506	15	75**	25**
Denmark	DK	26	0	26	0	0	100	0
Estonia	EE	28	0	28	0	0	100***	0***
Finland	FI	17112	0	12834	4278	0	25	75
France	FR	68325	4599	53530	10196	7	84	16
Germany	DE	26963	6021	17591	3351	22	84	16
Greece	GR	4149	837	3312	0	20	100	0
Hungary	HU	213	0	213	0	0	100	0
Iceland	IS	12427	0	0	12427	0	0***	100***
Ireland	IE	1300	331	969	0	25	100	0
Italy	IT	47227	5604	14984	26639	12	36	64
Latvia	LV	3109	0	3109	0	0	100***	0***
Lithuania	LT	988	0	988	0	0	100***	0***
Luxembourg	LU	965	833	132	0	86	100	0
Macedonia	MK	840	0	151	689	0	18	82
Netherlands	NL	102	0	102	0	0	100	0
Norway	NO	140522	968	0	139554	1	0***	100***
Poland	PL	2747	595	2152	0	22	100	0
Portugal	PT	7296	498	4487	2311	7	66	34
Romania	RO	17195	0	17195	0	0	100***	0***
Russia	RU	166711	0	125033	41678	0	75***	25***
Serbia	CS	10109	505	8067	1537	5	84	16
Slovakia	SK	4241	202	3029	1010	5	75**	25**
Slovenia	SI	4018	0	4018	0	0	100	0
Spain	ES	26112	2612	15510	7990	10	66	34
Sweden	SE	69211	142	55255	13814	0.2	80	20
Switzerland ¹	CH	37136	1325	12710	19701	5	46	54
Turkey	TR	33270		16635	16635	0	50***	50***
Ukraine	UA	11512	0	11512	0	0	100***	0***
United Kingdom	GB	9257	4089	5168	0	44	100	0

* Shares estimated equal to Former Yugoslavian Republic

** Shares estimated equal to Austria

*** Own assumption

1) The values for Switzerland are for the year 2009 and the electricity production for small hydropower plants (3400 GWh) are not shown in this table

Rest of the world

The shares of hydro power production from run-of-river and storage type power plants for the non-European countries are shown in Tab. 3.2. For several countries the shares had to be estimated. Estimated shares are marked with stars. The share of pumped storage is the fraction of the amount of electricity produced with pumped storage and the total hydro power, whereas the shares for run-of-river and storage type hydropower are calculated as fraction of run-of-river hydropower respectively storage type hydropower and the sum of run-of-river and storage type hydropower. Therefore, the three shares (pumped storage, run-of-river and storage type) do not add up to 100 %.

Tab. 3.2: Yearly electricity production from run-of-river and storage type hydro power in GWh and percent for the non European countries. Total production for the year 2008 (IEA 2011, IEA 2010) and shares for the year 2000 according to Frischknecht & Emmenegger (2003) and own estimations

Country	Code	Production / GWh				Share / %		
		Hydro Power	Pumped Storage	Run-of-river	Storage type	Pumped Storage	Run-of-river	Storage type
Australia	AU	12057	148	11909	0	1	100*	0*
Brazil	BR	369556	0	0	369556	0	0	100
Canada	CA	382580	111	305975	76494	0	80**	20**
Chile	CL	24193	0	24193	0	0	100*	0*
China	CN	585187	0	146297	438890	0	25***	75***
India	IN	114295	14058	12129	88108	12	12	88
Indonesia	ID	11528	0	0	11528	0	0****	100****
Iran	IR	5003	0	5003	0	0	100*	0*
Japan	JP	83295	7056	60991	15248	8	80**	20**
Malaysia	MY	7459	0	0	7459	0	100*	0*
Mexico	MX	39178	0	39178	0	0	100*	0*
Peru	PE	19040	0	0	19040	0	0****	100****
Saudi Arabia	SA	0	0	0	0	0	0	0
South Africa	ZA	4032	2742	0	1290	68	0	100
South Korea	KR	5563	2493	2456	614	45	80**	20**
Taiwan	TW	7772	0	7772	0	0	100*	0*
Tanzania	TZ	2655	0	0	2655	0	0****	100****
Thailand	TH	7113	0	0	7113	0	0****	100****
Tunisia	TN	38	0	38	0	0	100*	0*
United States	US	281995	25281	205371	51343	9	80**	20**

* Own assumption

** Own assumption, same as Sweden

*** Own assumption, same as Finland

**** Own assumption, same as Brazil

3.1.2 Nuclear Power

Europe

The shares of nuclear power production from pressure water reactors (PWR) and boiling water reactors (BWR) in the European countries are shown in Tab. 3.3. The shares are calculated according to the net capacity and the type of the nuclear power plant according to the power reactor information system (PRIS 2011).

Tab. 3.3: Yearly electricity production from PWR and BWR power plants in GWh and percent in the European countries for the year 2008 according to the power reactor information system (PRIS 2011).

Country	Code	Production / GWh		Share / %	
		PWR	BWR	PWR	BWR
Austria	AT	0	0	0	0
Belgium	BE	45586	0	100	0
Bosnia and Herzegovina	BA	0	0	0	0
Bulgaria	BG	15765	0	100	0
Croatia	HR	0	0	0	0
Cyprus	CY	-	-	-	-
Czech Republic	CZ	26551	0	100	0
Denmark	DK	0	0	0	0
Estonia	EE	0	0	0	0
Finland	FI	8250	14708	36	64
France	FR	439468	0	100	0
Germany	DE	116847	31648	79	21
Greece	GR	0	0	0	0
Hungary	HU	14818	0	100	0
Iceland	IS	0	0	0	0
Ireland	IE	0	0	0	0
Italy	IT	0	0	0	0
Latvia	LV	0	0	0	0
Lithuania	LT	9894	0	100	0
Luxembourg	LU	0	0	0	0
Macedonia	MK	0	0	0	0
Netherlands	NL	4169	0	100	0
Norway	NO	0	0	0	0
Poland	PL	0	0	0	0
Portugal	PT	0	0	0	0
Romania	RO	11226	0	100	0
Russia	RU	89645	73440	55	45
Serbia	CS	0	0	0	0
Slovakia	SK	16703	0	100	0
Slovenia	SI	6273	0	100	0
Spain	ES	45390	13583	77	23
Sweden	SE	14215	49674	22	78
Switzerland	CH	14432	13268	52	48
Turkey	TR	0	0	0	0
Ukraine	UA	89841	0	100	0
United Kingdom	GB	52486	0	100	0

Rest of the world

The shares of nuclear power production from pressure water reactors (PWR) and boiling water reactors (BWR) in countries outside of Europe are shown in Tab. 3.4. The shares are calculated according to net capacity and the type of the nuclear power plant according to the power reactor information system (PRIS 2011).

Tab. 3.4: Yearly electricity production from PWR and BWR power plants in GWh and percent for the non-European countries for the year 2008 according to the power reactor information system (PRIS 2011).

Country	Code	Production / GWh		Share / %	
		PWR	BWR	PWR	BWR
Australia	AU	0	0	0	0
Brazil	BR	13969	0	100	0
Canada	CA	93951	0	100	0
Mexico	MX	0	9804	0	100
United States	US	556150	281654	66	34
Japan	JP	112580	145548	44	56
South Korea	KR	150958	0	100	0
Chile	CL	0	0	0	0
Peru	PE	0	0	0	0
China	CN	68394	0	100	0
India	IN	13708	1005	93	7
Indonesia	ID	0	0	0	0
Iran	IR	0	0	0	0
Saudi Arabia	SA	0	0	0	0
Taiwan	TW	15087	25740	37	63
Thailand	TH	0	0	0	0
South Africa	ZA	13004	0	100	0
Tanzania	TZ	0	0	0	0
Tunisia	TN	0	0	0	0
Malaysia	MY	0	0	0	0

3.2 Africa

3.2.1 South Africa (ZA)

Tab. 3.5 shows an overview over the South African electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The South African power production relies on fossil fuels, mainly hard coal (93 %), as main energy source. Further electricity is produced from nuclear (5 %) and hydro power (2 %). A share of about 4.4 % of the electricity is imported. The electricity is imported mainly from Mozambique, Lesotho and Zimbabwe⁶. The imports are modelled with Brazilian storage type hydropower because this data set is the best approximation for electricity production from hydropower in the neighbouring countries of South Africa.

The electricity production from hydro power is approximated using the Brazilian dataset for storage type hydropower production. The share of storage type hydropower plants in South Africa is 100 %. The storage type hydropower production is approximated using the dataset for Brazil. The share of pumped storage in South Africa is 68% (Eskom 2010).

Power production from nuclear power plants is approximated using the UCTE dataset for pressurised water reactors. These dataset reflects the conditions of nuclear power production using a mix PWR power plants (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

⁶ Personal communication: Philippa Notten, The Green House, ZA (14.02.2012)

The unit process raw data of the electricity production and supply mix of South Africa are shown Tab. 3.6 and Tab. 3.7.

Tab. 3.5: Composition of the South African electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	240'942	212'381	92.79	88.70
Hard coal	240'799	212'255	92.74	88.64
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	0	0	0.00	0.00
<i>Coke gases</i>	0	0	0.00	0.00
<i>Blast furnace gases</i>	0	0	0.00	0.00
Petroleum products	143	126	0.06	0.05
<i>Fuel oil</i>	0	0	0.00	0.00
<i>Diesel</i>	0	0	0.00	0.00
<i>other petroleum products</i>	0	0	0.00	0.00
Natural Gas	0	0	0.00	0.00
Other fossil	0	0	0.00	0.00
Hydro	4'032	3'992	1.74	1.67
Reservoir power plants	1'290	1'277	0.56	0.53
Run-of-river power plants	0	0	0.00	0.00
Pumped storage power plants	2'742	2'714	1.19	1.13
Nuclear	13'004	12'224	5.34	5.10
Pressurised-water reactor (PWR)	13'004	12'224	5.34	5.10
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	313	281	0.12	0.12
Geothermal	0	0	0.00	0.00
Solar	22	21	0.00	0.00
<i>Photovoltaic</i>	22	21	0.01	0.01
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	32	32	0.01	0.01
Wood	259	228	0.10	0.10
Biogas	0	0	0.00	0.00
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	258'291	228'878	100.00	95.58
Imports	0	10'572	0.00	4.42
Mozambique	0	10'572	0.00	4.42
Total	258'291	239'450	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.6: Unit process raw data of the electricity production mix in South Africa 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviation95%	GeneralComment
	Location			ZA			
	InfrastructureProcess			0			
	Unit			kWh			
product	electricity mix, domestic production	ZA	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	UCTE	kWh	9.27E-1	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in South Africa, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	kWh	5.51E-4	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in South Africa, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant	BR	kWh	5.58E-3	1	1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in South Africa: 100%
	electricity, hydropower, at pumped storage power plant	ZA	kWh	1.19E-2	1	1.05	(1,1,1,3,1,1); estimated share of pumped storage production in South Africa: 68%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	5.34E-2	1	1.05	(1,1,1,3,1,1); assumption for nuclear power production in South Africa using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	1.40E-4	1	1.05	(1,1,1,3,1,1); assumption for geothermal power production in South Africa, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	NZ	kWh	9.04E-5	1	1.05	(1,1,1,3,1,1); assumption for solar power production in South Africa, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	9.97E-4	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in South Africa, value: IEA statistics 2008

Tab. 3.7: Unit process raw data of the electricity supply mix in South Africa 2008, at busbar

	Name	Location	Category	SubCategory	Infrastructure	Unit	electricity mix	UncertaintyType	StandardDeviation95%	GeneralComment
	Location						ZA			
	InfrastructureProcess						0			
	Unit						kWh			
product	electricity mix	ZA	-	-		0 kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	UCTE	-	-		0 kWh	8.86E-1	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in South Africa, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	-	-		0 kWh	5.26E-4	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in South Africa, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant	BR	-	-		0 kWh	4.95E-2	1	1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in South Africa: 100%
	electricity, hydropower, at pumped storage power plant	ZA	-	-		0 kWh	1.13E-2	1	1.05	(1,1,1,3,1,1); estimated share of pumped storage production in South Africa: 68%
	electricity, nuclear, at power plant pressure water reactor	UCTE	-	-		0 kWh	5.10E-2	1	1.05	(1,1,1,3,1,1); assumption for nuclear power production in South Africa using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	-	-		0 kWh	1.34E-4	1	1.05	(1,1,1,3,1,1); assumption for geothermal power production in South Africa, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	NZ	-	-		0 kWh	8.64E-5	1	1.05	(1,1,1,3,1,1); assumption for solar power production in South Africa, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	-	-		0 kWh	9.53E-4	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in South Africa, value: IEA statistics 2008

3.2.2 Tanzania (TZ)

Tab. 3.8 shows an overview over the Tanzanian electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Tanzanian power production relies on fossil fuels, mainly natural gas (36 %), hard coal (3 %) and petroleum products (1 %) as main energy source. Further electricity is produced from hydro power (61 %). No electricity is imported to Tanzania. Therefore, the production mix and the supply mix are identical.

There are no nuclear power plants in Tanzania (PRIS 2011). Therefore, the nuclear power production is zero.

The electricity production from hydro power is approximated using the Brazilian dataset for storage type hydropower production. It is assumed that 100 % of the electricity from hydropower comes from storage type hydropower plants. The share of pumped storage in Tanzania is 0%. The Brazilian dataset is used, because of the similar climatic conditions of Brazil and Tanzania.

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approxima-

tion. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Tanzania are shown in Tab. 3.9 and Tab. 3.10.

Tab. 3.8: Composition of the Tanzanian electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	1'759	1'712	39.44	39.44
Hard coal	119	116	2.67	2.67
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	0	0	0.00	0.00
Coke gases	0	0	0.00	0.00
Blast furnace gases	0	0	0.00	0.00
Petroleum products	40	39	0.90	0.90
Fuel oil	0	0	0.00	0.00
Diesel	0	0	0.00	0.00
other petroleum products	0	0	0.00	0.00
Natural Gas	1'600	1'557	35.87	35.87
Other fossil	0	0	0.00	0.00
Hydro	2'655	2'628	60.56	60.56
Reservoir power plants	2'655	2'628	60.56	60.56
Run-of-river power plants	0	0	0.00	0.00
Pumped storage power plants	0	0	0.00	0.00
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	0	0	0.00	0.00
Geothermal	0	0	0.00	0.00
Solar	0	0	0.00	0.00
Photovoltaic	0	0	0.00	0.00
Solar thermal	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	0	0	0.00	0.00
Wood	0	0	0.00	0.00
Biogas	0	0	0.00	0.00
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	4'414	4'340	100.00	100.00
Imports	0	0	0.00	0.00
Total	4'414	4'340	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.9: Unit process raw data of the electricity production mix in Tanzania 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviations%	GeneralComment
	Location			TZ			
	InfrastructureProcess			0			
product	Unit			kWh			
	electricity mix, domestic production	TZ		kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	UCTE		kWh	2.67E-2	1 1.05	(1,1,1,3,1,1); assumption for hard coal power production in Tanzania, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE		kWh	8.97E-3	1 1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Tanzania, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE		kWh	3.59E-1	1 1.05	(1,1,1,3,1,1); assumption for natural gas power production in Tanzania, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant	BR		kWh	6.06E-1	1 1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in Tanzania: 100%

Tab. 3.10: Unit process raw data of the electricity supply mix in Tanzania 2008, at busbar

	Name	Location	Unit	electricity mix	UncertaintyType	StandardDeviations%	GeneralComment
	Location			TZ			
	InfrastructureProcess			0			
product	Unit			kWh			
	electricity mix	TZ		kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	UCTE		kWh	2.67E-2	1 1.05	(1,1,1,3,1,1); assumption for hard coal power production in Tanzania, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE		kWh	8.97E-3	1 1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Tanzania, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE		kWh	3.59E-1	1 1.05	(1,1,1,3,1,1); assumption for natural gas power production in Tanzania, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant	BR		kWh	6.06E-1	1 1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in Tanzania: 100%

3.2.3 Tunisia (TN)

Tab. 3.11 shows an overview over the Tunisian electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Tunisian power production relies on fossil fuels, mainly natural gas (87 %) and petroleum products (11 %) as main energy source. Further electricity is produced from hydro power. No electricity is imported to Tunisia. Therefore, the production mix and the supply mix are identical.

There are no nuclear power plants in Tunisia (PRIS 2011). Therefore, the nuclear power production is zero.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydro-power generation according to Tab. 3.2 is taken into account. The share of run-of-river hydropower plants in Tunisia is 100 %.

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Tunisia are shown in Tab. 3.12 and Tab. 3.13.

Tab. 3.11: Composition of the Tunisian electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	15'234	14'508	99.47	99.47
Hard coal	0	0	0.00	0.00
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	0	0	0.00	0.00
<i>Coke gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Blast furnace gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Petroleum products	1'657	1'578	10.82	10.82
<i>Fuel oil</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Diesel</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>other petroleum products</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Natural Gas	13'577	12'930	88.65	88.65
Other fossil	0	0	0.00	0.00
Hydro	38	38	0.26	0.26
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	38	38	0.26	0.26
Pumped storage power plants	0	0	0.00	0.00
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	39	39	0.27	0.27
Geothermal	0	0	0.00	0.00
Solar	0	0	0.00	0.00
<i>Photovoltaic</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Solar thermal</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Wave and tidal energy	0	0	0.00	0.00
Wind	39	39	0.27	0.27
Wood	0	0	0.00	0.00
Biogas	0	0	0.00	0.00
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	15'311	14'584	100.00	100.00
Imports	0	0	0.00	0.00
Total	15'311	14'584	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.12: Unit process raw data of the electricity production mix in Tunisia 2008, at busbar

product	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviations%	GeneralComment
	Location			TN			
	InfrastructureProcess			0			
	Unit			kWh			
	electricity mix, domestic production	TN	kWh	1.00E+0			
	electricity, oil, at power plant	UCTE	kWh	1.08E-1	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Tunisia, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE	kWh	8.87E-1	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Tunisia, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	2.58E-3	1	1.05	(1,1,1,3,1,1); estimated share of ROR hydropower production in Tunisia: 100%
	electricity, at wind power plant	RER	kWh	2.67E-3	1	1.05	(1,1,1,3,1,1); assumption for geothermal power production in Tunisia, value: IEA statistics 2008

Tab. 3.13: Unit process raw data of the electricity supply mix in Tunisia 2008, at busbar

product	Name	Location	Unit	electricity mix	UncertaintyType	StandardDeviations%	GeneralComment
	Location			TN			
	InfrastructureProcess			0			
	Unit			kWh			
	electricity mix	TN	kWh	1.00E+0			
	electricity, oil, at power plant	UCTE	kWh	1.08E-1	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Tunisia, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE	kWh	8.87E-1	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Tunisia, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	2.58E-3	1	1.05	(1,1,1,3,1,1); estimated share of ROR hydropower production in Tunisia: 100%
	electricity, at wind power plant	RER	kWh	2.67E-3	1	1.05	(1,1,1,3,1,1); assumption for geothermal power production in Tunisia, value: IEA statistics 2008

3.3 Americas

3.3.1 Brazil (BR)

Tab. 3.15 shows an overview over the Brazilian electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Brazilian power production relies on hydro power as main energy source (73 %). Further electricity is produced from renewables, mainly biomass (4 %) and nuclear power (3 %). A share of about 9 % of the electricity is imported from Paraguay (62 %), Argentina (28 %), Venezuela (6 %) and Uruguay (4 %) (OECD/IEA 2006).

Because no electricity datasets for Paraguay, Argentina Venezuela and Uruguay are available, the shares of these countries are directly considered in the supply mix. The electricity production in Paraguay, Venezuela and Uruguay is modelled with the Brazilian storage type hydro power dataset, because hydro power has the highest share in these countries. For the Electricity production in Argentina the UCTE data set for electricity generation using natural gas is used, because natural gas has the highest share in the Argentinian power production.

The electricity production from hydro power is approximated using the Brazilian dataset for storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.2 is taken into account. The share of run-of-river hydropower plants in Brazil is 0 %. The share of the storage type hydropower plants is 100 %. The share of pumped storage in Brazil is 0%.

Power production from nuclear power plants is approximated using the UCTE dataset for pressure water reactors. This dataset reflects the conditions of nuclear power production using PWR power plants only (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from wood the Brazilian datasets for electricity generation from bagasse are used.

The unit process raw data of the electricity production and supply mix of Brazil are shown Tab. 3.16 and Tab. 3.17.

Tab. 3.14: Brazilian Electricity Imports for the year 2005 (OECD/IEA 2006)

	Export to BR	Hydro power	Fossil-thermal	Nuclear	Renewables
	GWh	%	%	%	%
Paraguay	27'131	100.00%	0.00%	0.00%	0.00%
Argentina	10'773	30.00%	60.00%	8.00%	1.00%
Venezuela	948	71.00%	29.00%	0.00%	0.00%
Uruguay	349	81.00%	18.00%	0.00%	1.00%
Total	39'201	79.89%	17.35%	2.20%	0.28%

Tab. 3.15: Composition of the Brazilian electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	59'131	56'784	12.46	11.39
Hard coal	310	298	0.07	0.06
Lignite	6'538	6'278	1.38	1.26
Peat	0	0	0.00	0.00
Industrial Gases	5'708	5'482	1.20	1.10
<i>Coke gases</i>	0	0	0.00	0.00
<i>Blast furnace gases</i>	0	0	0.00	0.00
Petroleum products	17'554	16'857	3.70	3.38
<i>Fuel oil</i>	0	0	0.00	0.00
<i>Diesel</i>	0	0	0.00	0.00
<i>other petroleum products</i>	0	0	0.00	0.00
Natural Gas	29'021	27'869	6.12	5.59
Other fossil	0	0	0.00	0.00
Hydro	369'556	365'860	80.29	73.38
Reservoir power plants	369'556	365'860	80.29	73.38
Run-of-river power plants	0	0	0.00	0.00
Pumped storage power plants	0	0	0.00	0.00
Nuclear	13'969	13'131	2.88	2.63
Pressurised-water reactor (PWR)	13'969	13'131	2.88	2.63
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	20'464	19'677	4.32	3.95
Geothermal	0	0	0.00	0.00
Solar	0	0	0.00	0.00
<i>Photovoltaic</i>	0	0	0.00	0.00
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	637	637	0.14	0.13
Biomass	19'827	19'040	4.18	3.82
Biogas	0	0	0.00	0.00
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	249	239	0.05	0.05
Total domestic	463'369	455'691	100.00	91.40
Imports	0	42'901	0.00	8.60
Argentina	0	12'012	0.00	2.41
Paraguay	0	26'599	0.00	5.33
Venezuela	0	2'574	0.00	0.52
Uruguay	0	1'716	0.00	0.34
Total	463'369	498'592	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.16: Unit process raw data of the electricity production mix in Brazil 2008, at busbar

	Name	Location	Unit	electricity, production mix BR	UncertaintyType	StandardDeviation95%	GeneralComment
	Location			BR			
	InfrastructureProcess			0			
	Unit			kWh			
product	electricity, production mix BR	BR	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	UCTE	kWh	6.53E-4	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Brazil, value: IEA statistics 2008
	electricity, lignite, at power plant	UCTE	kWh	1.38E-2	1	1.05	(1,1,1,3,1,1); assumption for lignite power production in Brazil, value: IEA statistics 2008
	electricity, industrial gas, at power plant	UCTE	kWh	1.20E-2	1	1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Brazil, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	kWh	3.70E-2	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Brazil, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE	kWh	6.12E-2	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Brazil, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant	BR	kWh	8.03E-1	1	1.05	(1,1,1,1,1,1); estimated share of reservoir hydropower production in Brazil: 100%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	2.88E-2	1	1.05	(1,1,1,3,1,1); assumption for nuclear power production in Brazil using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	1.92E-3	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Brazil, value: IEA statistics 2008
	electricity, bagasse, sugarcane, at fermentation plant	BR	kWh	4.18E-2	1	1.05	(1,1,1,1,1,1); assumption for cogeneration power production in Brazil, value: IEA statistics 2008

Tab. 3.17: Unit process raw data of the electricity supply mix in Brazil 2008, at busbar

	Name	Location	Unit	electricity mix	UncertaintyType	StandardDeviation95%	GeneralComment
	Location			BR			
	InfrastructureProcess			0			
	Unit			kWh			
product	electricity mix	BR	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	UCTE	kWh	5.97E-4	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Brazil, value: IEA statistics 2008
	electricity, lignite, at power plant	UCTE	kWh	1.26E-2	1	1.05	(1,1,1,3,1,1); assumption for lignite power production in Brazil, value: IEA statistics 2008
	electricity, industrial gas, at power plant	UCTE	kWh	1.10E-2	1	1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Brazil, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	kWh	3.38E-2	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Brazil, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE	kWh	8.00E-2	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Brazil, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant	BR	kWh	7.96E-1	1	1.05	(1,1,1,1,1,1); estimated share of reservoir hydropower production in Brazil: 100%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	2.63E-2	1	1.05	(1,1,1,3,1,1); assumption for nuclear power production in Brazil using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	1.76E-3	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Brazil, value: IEA statistics 2008
	electricity, bagasse, sugarcane, at fermentation plant	BR	kWh	3.82E-2	1	1.05	(1,1,1,1,1,1); assumption for cogeneration power production in Brazil, value: IEA statistics 2008

3.3.2 Canada (CA)

Tab. 3.18 shows an overview over the Canadian electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Canadian power production relies on hydro power as main energy source (58 %). Further electricity is produced from fossil fuels, mainly hard coal (13 %), natural gas (6 %) and lignite (2 %), and from nuclear power (14 %). A share of about 4 % of the electricity is imported from the United States of America.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.2 is taken into account. The share of run-of-river hydropower plants in Canada is 80 %. The share of the storage type hydropower plants is 20 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Canada is 0.03 %.

Power production from nuclear power plants is approximated using the US dataset for pressurised water reactors. These datasets reflect the conditions of nuclear power production using PWR power plants only (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Canada are shown Tab. 3.19 and Tab. 3.20.

Tab. 3.18: Composition of the Canadian electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	162'453	149'867	23.84	22.92
Hard coal	95'501	88'102	14.02	13.48
Lignite	16'408	15'137	2.41	2.32
Peat	0	0	0.00	0.00
Industrial Gases	60	55	0.01	0.01
Coke gases	31	29	0.00	0.00
Blast furnace gases	29	27	0.00	0.00
Petroleum products	9'845	9'082	1.44	1.39
Fuel oil	4'259	3'929	0.63	0.60
Diesel	1'195	1'102	0.18	0.17
other petroleum products	4'391	4'051	0.64	0.62
Natural Gas	40'639	37'490	5.96	5.73
Other fossil	0	0	0.00	0.00
Hydro	382'580	378'754	60.25	57.93
Reservoir power plants	76'494	75'729	12.05	11.58
Run-of-river power plants	305'975	302'915	48.19	46.33
Pumped storage power plants	111	110	0.02	0.02
Nuclear	93'951	88'314	14.05	13.51
Pressurised-water reactor (PWR)	93'951	88'314	14.05	13.51
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	11'413	10'828	1.72	1.66
Geothermal	0	0	0.00	0.00
Solar	33	31	0.00	0.00
Photovoltaic	33	31	0.00	0.00
Solar thermal	0	0	0.00	0.00
Wave and tidal energy	33	33	0.01	0.01
Wind	3'819	3'819	0.61	0.58
Wood	7'528	6'945	1.10	1.06
Biogas	0	0	0.00	0.00
Waste	927	855	0.14	0.13
Municipal waste	157	145	0.02	0.02
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	770	710	0.11	0.11
Other	0	0	0.00	0.00
Total domestic	651'324	628'618	100.00	96.15
Imports	0	25'189	0.00	3.85
United States of America	0	25'189	0.00	3.85
Total	651'324	653'807	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.19: Unit process raw data of the electricity production mix in Canada 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviation95%	GeneralComment
product	Location						
	InfrastructureProcess						
	Unit						
	electricity mix, domestic production	CA	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	US	kWh	1.40E-1	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Canada, value: IEA statistics 2008
	electricity, lignite, at power plant	UCTE	kWh	2.41E-2	1	1.05	(1,1,1,3,1,1); assumption for lignite power production in Canada, value: IEA statistics 2008
	electricity, industrial gas, at power plant	UCTE	kWh	8.81E-5	1	1.05	(1,1,1,3,1,1); assumption for industrial, coke and blast furnace gas power production in Canada, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	kWh	1.27E-2	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Canada, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.75E-3	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Canada, value: IEA statistics 2008
	electricity, natural gas, at power plant	US	kWh	5.96E-2	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Canada, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	1.20E-1	1	1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in Canada: 20%
	electricity, hydropower, at run-of-river power plant	RER	kWh	4.82E-1	1	1.05	(1,1,1,3,1,1); estimated share of ROR hydropower production in Canada: 80%
	electricity, hydropower, at pumped storage power plant	GB	kWh	1.75E-4	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Canada: 0.03%
	electricity, nuclear, at power plant pressure water reactor	US	kWh	1.40E-1	1	1.05	(1,1,1,3,1,1); assumption for nuclear power production in Canada using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	6.13E-3	1	1.05	(1,1,1,3,1,1); assumption for geothermal power production in Canada, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	CA	kWh	4.93E-5	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Canada, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.10E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Canada, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.13E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Canada, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	2.30E-4	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Canada, value: IEA statistics 2008

Tab. 3.20: Unit process raw data of the electricity supply mix in Canada 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty Standard Deviation 95%	GeneralComment
	Location InfrastructureProcess			CA 0 kWh		
product	electricity mix	CA	kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	US	kWh	1.35E-1	1 1.05	(1,1,1,3,1,1); assumption for hard coal power production in Canada, value: IEA statistics 2008
	electricity, lignite, at power plant	UCTE	kWh	2.32E-2	1 1.05	(1,1,1,3,1,1); assumption for lignite power production in Canada, value: IEA statistics 2008
	electricity, industrial gas, at power plant	UCTE	kWh	8.47E-5	1 1.05	(1,1,1,3,1,1); assumption for industrial, coke and blast furnace gas power production in Canada, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	kWh	1.22E-2	1 1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Canada, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.69E-3	1 1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Canada, value: IEA statistics 2008
	electricity, natural gas, at power plant	US	kWh	5.73E-2	1 1.05	(1,1,1,3,1,1); assumption for natural gas power production in Canada, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	1.16E-1	1 1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in Canada: 20%
	electricity, hydropower, at run-of-river power plant	RER	kWh	4.63E-1	1 1.05	(1,1,1,3,1,1); estimated share of ROR hydropower production in Canada: 80%
	electricity, hydropower, at pumped storage power plant	GB	kWh	1.68E-4	1 1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Canada: 0.03%
	electricity, nuclear, at power plant pressure water reactor	US	kWh	1.35E-1	1 1.05	(1,1,1,3,1,1); assumption for nuclear power production in Canada using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	5.89E-3	1 1.05	(1,1,1,3,1,1); assumption for geothermal power production in Canada, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	CA	kWh	4.74E-5	1 1.05	(1,1,1,1,1,1); assumption for solar power production in Canada, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.06E-2	1 1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Canada, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.09E-3	1 1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Canada, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	2.22E-4	1 1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Canada, value: IEA statistics 2008
electricity mix, domestic production	US	kWh	3.85E-2	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Canada, value: IEA statistics 2008	

3.3.3 Chile (CL)

Tab. 3.21 shows an overview over the Chilean electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Chilean power production relies on fossil fuels, mainly petroleum products (26 %), hard coal (23 %) and natural gas (4 %) as main energy source. Further electricity is produced from hydro power (40 %) and renewables, mainly wood (5 %). A share of about 2.0 % of the electricity is imported. It is assumed that 100 % of the electricity is imported from Argentina.

Because no electricity dataset for Argentina is available, the share of the imports is directly considered in the supply mix. For the electricity production in Argentina the UCTE data set for electricity generation using natural gas is used, because natural gas has the highest share in the Argentinian power production.

The electricity production from hydro power is approximated using the European dataset for run-of-river hydropower. The share of the run-of-river and storage type hydropower generation according to Tab. 3.2 is taken into account. The share of run-of-river hydropower plants in Chile is 100 %. The share of the storage type hydropower plants is 0 %. The share of pumped storage in Chile is 0 %.

There are no nuclear power plants in Chile (PRIS 2011). Therefore, the nuclear power production is zero.

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Chile are shown Tab. 3.22 and Tab. 3.23.

Tab. 3.21: Composition of the Chilean electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	32'390	31'160	53.62	52.57
Hard coal	14'112	13'576	23.36	22.91
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	0	0	0.00	0.00
<i>Coke gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Blast furnace gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Petroleum products	16'090	15'479	26.63	26.12
<i>Fuel oil</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Diesel</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>other petroleum products</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Natural Gas	2'188	2'105	3.62	3.55
Other fossil	0	0	0.00	0.00
Hydro	24'193	23'951	41.21	40.41
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	24'193	23'951	41.21	40.41
Pumped storage power plants	0	0	0.00	0.00
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	3'121	3'004	5.17	5.07
Geothermal	0	0	0.00	0.00
Solar	0	0	0.00	0.00
<i>Photovoltaic</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Solar thermal</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Wave and tidal energy	0	0	0.00	0.00
Wind	38	38	0.07	0.06
Wood	3'083	2'966	5.10	5.00
Biogas	0	0	0.00	0.00
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	59'704	58'115	100.00	98.05
Imports	0	1'154	0.00	1.95
Argentina	0	1'154	0.00	1.95
Total	59'704	59'269	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.22: Unit process raw data of the electricity production mix in Chile 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviations%	GeneralComment
	Location			CL			
	InfrastructureProcess			0			
	Unit			kWh			
product	electricity mix, domestic production	CL	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	UCTE	kWh	2.34E-1	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Chile, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	kWh	2.66E-1	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Chile, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE	kWh	3.62E-2	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Chile, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	4.12E-1	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Chile: 100%
	electricity, at wind power plant	RER	kWh	6.54E-4	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Chile, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	5.10E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Chile, value: IEA statistics 2008

Tab. 3.23: Unit process raw data of the electricity supply mix in Chile 2008, at busbar

	Name	Location	Unit	electricity mix	UncertaintyType	StandardDeviations%	GeneralComment
	Location			CL			
	InfrastructureProcess			0			
	Unit			kWh			
product	electricity mix	CL	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	UCTE	kWh	2.29E-1	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Chile, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	kWh	2.61E-1	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Chile, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE	kWh	5.50E-2	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Chile, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	4.04E-1	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Chile: 100%
	electricity, at wind power plant	RER	kWh	6.41E-4	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Chile, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	5.00E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Chile, value: IEA statistics 2008

3.3.4 Mexico (MX)

Tab. 3.24 shows an overview over the Mexican electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Mexican power production relies on fossil fuels, mainly natural gas (50 %), petroleum products (19 %) and hard coal (8 %) as main energy source. Further electricity is produced from hydro power (16 %) and nuclear power (4 %). A share of about 0.1 % of the electricity is imported from the United States of America.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydro-power generation according to Tab. 3.2 is taken into account. The share of run-of-river hydropower plants in Mexico is 100 %. The share of the storage type hydropower plants is 0 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Mexico is 0 %.

Power production from nuclear power plants is approximated using the US dataset for boiling water reactors. This dataset reflects the conditions of nuclear power production using BWR power plants only (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Mexico are shown Tab. 3.25 and Tab. 3.26.

Tab. 3.24: Composition of the Mexican electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	201'797	190'367	77.33	77.22
Hard coal	20'908	19'724	8.01	8.00
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	502	474	0.19	0.19
Coke gases	67	63	0.03	0.03
Blast furnace gases	435	410	0.17	0.17
Petroleum products	49'311	46'518	18.90	18.87
Fuel oil	46'433	43'803	17.79	17.77
Diesel	856	808	0.33	0.33
other petroleum products	2'022	1'907	0.77	0.77
Natural Gas	131'076	123'652	50.23	50.16
Other fossil	0	0	0.00	0.00
Hydro	39'178	38'786	15.76	15.73
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	39'178	38'786	15.76	15.73
Pumped storage power plants	0	0	0.00	0.00
Nuclear	9'804	9'216	3.74	3.74
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	9'804	9'216	3.74	3.74
Renewables	8'067	7'743	3.15	3.14
Geothermal	7'056	6'774	2.75	2.75
Solar	9	8	0.00	0.00
Photovoltaic	9	8	0.00	0.00
Solar thermal	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	269	269	0.11	0.11
Wood	733	691	0.28	0.28
Biogas	0	0	0.00	0.00
Waste	67	63	0.03	0.03
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	67	63	0.03	0.03
Other	0	0	0.00	0.00
Total domestic	258'913	246'175	100.00	99.86
Imports	0	351	0.00	0.14
United States of America	0	351	0.00	0.14
Total	258'913	246'526	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.25: Unit process raw data of the electricity production mix in Mexico 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviation95%	GeneralComment			
								Location	Infrastructure	Process
								Unit		
product	electricity mix, domestic production									
				MX 0 kWh						
technosphere	electricity, hard coal, at power plant	US	kWh	1.00E+0						
	electricity, industrial gas, at power plant	UCTE	kWh	8.01E-2	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Mexico, value: IEA statistics 2008			
	electricity, oil, at power plant	UCTE	kWh	1.92E-3	1	1.05	(1,1,1,3,1,1); assumption for industrial, coke and blast furnace gas power production in Mexico, value: IEA statistics 2008			
	electricity, at cogen 200kWe diesel SCR, allocation exergy	UCTE	kWh	1.86E-1	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Mexico, value: IEA statistics 2008			
	electricity, natural gas, at power plant	CH	kWh	3.28E-3	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Mexico, value: IEA statistics 2008			
	electricity, hydropower, at run-of-river power plant	US	kWh	5.02E-1	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Mexico, value: IEA statistics 2008			
	electricity, nuclear, at power plant boiling water reactor	RER	kWh	1.58E-1	1	1.05	(1,1,1,3,1,1); estimated share of ROR hydropower production in Mexico: 100%			
	electricity, at wind power plant	US	kWh	3.74E-2	1	1.05	(1,1,1,3,1,1); assumption for nuclear power production in Mexico using BWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)			
	electricity, production mix photovoltaic, at plant	RER	kWh	2.86E-2	1	1.05	(1,1,1,3,1,1); assumption for geothermal power production in Mexico, value: IEA statistics 2008			
	electricity, at cogen 6400kWh, wood, allocation exergy	US	kWh	3.44E-5	1	1.05	(1,1,1,3,1,1); assumption for solar power production in Mexico, value: IEA statistics 2008			
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	2.81E-3	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Mexico, value: IEA statistics 2008			
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	2.57E-4	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Mexico, value: IEA statistics 2008			

Tab. 3.26: Unit process raw data of the electricity supply mix in Mexico 2008, at busbar

	Name	Location	Unit	electricity mix	UncertaintyType	StandardDeviation95%	GeneralComment			
								Location	Infrastructure	Process
								Unit		
product	electricity mix									
				MX 0 kWh						
technosphere	electricity, hard coal, at power plant	US	kWh	8.00E-2	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Mexico, value: IEA statistics 2008			
	electricity, industrial gas, at power plant	UCTE	kWh	1.92E-3	1	1.05	(1,1,1,3,1,1); assumption for industrial, coke and blast furnace gas power production in Mexico, value: IEA statistics 2008			
	electricity, oil, at power plant	UCTE	kWh	1.85E-1	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Mexico, value: IEA statistics 2008			
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	3.28E-3	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Mexico, value: IEA statistics 2008			
	electricity, natural gas, at power plant	US	kWh	5.02E-1	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Mexico, value: IEA statistics 2008			
	electricity, hydropower, at run-of-river power plant	RER	kWh	1.57E-1	1	1.05	(1,1,1,3,1,1); estimated share of ROR hydropower production in Mexico: 100%			
	electricity, nuclear, at power plant boiling water reactor	US	kWh	3.74E-2	1	1.05	(1,1,1,3,1,1); assumption for nuclear power production in Mexico using BWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)			
	electricity, at wind power plant	RER	kWh	2.86E-2	1	1.05	(1,1,1,3,1,1); assumption for geothermal power production in Mexico, value: IEA statistics 2008			
	electricity, production mix photovoltaic, at plant	US	kWh	3.43E-5	1	1.05	(1,1,1,3,1,1); assumption for solar power production in Mexico, value: IEA statistics 2008			
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	2.80E-3	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Mexico, value: IEA statistics 2008			
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	2.56E-4	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Mexico, value: IEA statistics 2008			
	electricity mix, domestic production	US	kWh	1.42E-3	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Mexico, value: IEA statistics 2008			

3.3.5 Peru (PE)

Tab. 3.27 shows an overview over the Peruvian electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Peruvian power production relies on hydro power as main energy source. Further electricity is produced from fossil fuels, mainly natural gas (28 %), petroleum products (9 %) and hard coal (3 %) and renewables, mainly wood (2 %). According to the IEA statistics (IEA 2010) no electricity is imported to Peru. Therefore, the electricity production mix and supply mix are identical.

The electricity production from hydro power is approximated using the Brazilian dataset for storage type hydropower production. It is assumed that 100 % of the electricity from hydropower comes from storage type hydropower plants. The share of pumped storage in Peru is 0 %. The Brazilian dataset is used, because of the similar climatic conditions of Brazil and Peru.

There are no nuclear power plants in Peru (PRIS 2011). Therefore, the nuclear power production is zero.

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Peru are shown Tab. 3.28 and Tab. 3.29.

Tab. 3.27: Composition of the Peruvian electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	12'892	12'679	39.60	39.60
Hard coal	877	863	2.69	2.69
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	0	0	0.00	0.00
<i>Coke gases</i>	0	0	0.00	0.00
<i>Blast furnace gases</i>	0	0	0.00	0.00
Petroleum products	2'921	2'873	8.97	8.97
<i>Fuel oil</i>	0	0	0.00	0.00
<i>Diesel</i>	0	0	0.00	0.00
<i>other petroleum products</i>	0	0	0.00	0.00
Natural Gas	9'094	8'944	27.93	27.93
Other fossil	0	0	0.00	0.00
Hydro	19'040	18'850	58.87	58.87
Reservoir power plants	19'040	18'850	58.87	58.87
Run-of-river power plants	0	0	0.00	0.00
Pumped storage power plants	0	0	0.00	0.00
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	498	490	1.53	1.53
Geothermal	0	0	0.00	0.00
Solar	0	0	0.00	0.00
<i>Photovoltaic</i>	0	0	0.00	0.00
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	1	1	0.00	0.00
Wood	497	489	1.53	1.53
Biogas	0	0	0.00	0.00
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	32'430	32'019	100.00	100.00
Imports	0	0	0.00	0.00
Total	32'430	32'019	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.28: Unit process raw data of the electricity production mix in Peru 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	Uncertainty Type	Standard Deviation 95 %	GeneralComment
	Location			PE			
	InfrastructureProcess			0			
	Unit			kWh			
product	electricity mix, domestic production	PE	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	UCTE	kWh	2.69E-2	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Peru, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	kWh	8.97E-2	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Peru, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE	kWh	2.79E-1	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Peru, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant	BR	kWh	5.89E-1	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Peru: 100%
	electricity, at wind power plant	RER	kWh	3.12E-5	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Peru, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.53E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Peru, value: IEA statistics 2008

Tab. 3.29: Unit process raw data of the electricity supply mix in Peru 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty Type	Standard Deviation 95 %	GeneralComment
	Location			PE			
	InfrastructureProcess			0			
	Unit			kWh			
product	electricity mix	PE	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	UCTE	kWh	2.69E-2	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Peru, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	kWh	8.97E-2	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Peru, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE	kWh	2.79E-1	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Peru, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant	BR	kWh	5.89E-1	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Peru: 100%
	electricity, at wind power plant	RER	kWh	3.12E-5	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Peru, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.53E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Peru, value: IEA statistics 2008

3.3.6 United States of America (US)

Tab. 3.30 shows an overview over the American electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The American power production relies on fossil fuels, mainly hard coal (46 %), natural gas (20 %) and lignite (2 %) as main energy source. Further electricity is produced from nuclear power (19 %) and hydro power (7 %). A share of about 1.4 % of the electricity is imported. The electricity is imported from Canada and Mexico.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.2 is taken into account. The share of run-of-river hydropower plants in the United States is 80 %. The share of the storage type hydropower plants is 20 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in the United States is 9 %.

Power production from nuclear power plants is approximated using the US datasets for boiling and pressure water reactors. These datasets reflect the conditions of nuclear power production using a mix of PWR (66.4 %) and BWR (33.6 %) power plants (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of the United States are shown Tab. 3.31 and Tab. 3.32.

Tab. 3.30: Composition of the US American electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	3'100'961	2'858'063	70.28	69.31
Hard coal	2'041'229	1'881'340	46.26	45.62
Lignite	87'106	80'283	1.97	1.95
Peat	0	0	0.00	0.00
Industrial Gases	3'857	3'555	0.09	0.09
Coke gases	595	548	0.01	0.01
Blast furnace gases	3'262	3'006	0.07	0.07
Petroleum products	58'180	53'623	1.32	1.30
Fuel oil	24'848	22'902	0.56	0.56
Diesel	8'602	7'928	0.19	0.19
other petroleum products	24'730	22'793	0.56	0.55
Natural Gas	910'589	839'263	20.64	20.35
Other fossil	0	0	0.00	0.00
Hydro	281'995	279'175	6.87	6.77
Reservoir power plants	51'343	50'829	1.25	1.23
Run-of-river power plants	205'371	203'317	5.00	4.93
Pumped storage power plants	25'281	25'028	0.62	0.61
Nuclear	837'804	787'536	19.37	19.10
Pressurised-water reactor (PWR)	556'150	522'781	12.86	12.68
Boiling-water reactor (BWR)	281'654	264'755	6.51	6.42
Renewables	117'538	113'391	2.79	2.75
Geothermal	17'014	16'333	0.40	0.40
Solar	2'450	2'303	0.06	0.06
Photovoltaic	1'572	1'478	0.04	0.04
Solar thermal	878	825	0.02	0.02
Wave and tidal energy	0	0	0.00	0.00
Wind	55'696	55'696	1.37	1.35
Wood	41'619	38'359	0.94	0.93
Biogas	759	700	0.02	0.02
Waste	30'013	27'662	0.68	0.67
Municipal waste	16'987	15'656	0.39	0.38
Industrial waste	5'203	4'795	0.12	0.12
Sewage sludge and landfill gases	7'823	7'210	0.18	0.17
Other	788	726	0.02	0.02
Total domestic	4'369'099	4'066'553	100.00	98.62
Imports	0	57'020	0.00	1.38
Canada	0	55'732	0.00	1.35
Mexico	0	1'288	0.00	0.03
Total	4'369'099	4'123'573	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.31: Unit process raw data of the electricity production mix in the United States 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviation95%	GeneralComment
product	electricity mix, domestic production	US	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	US	kWh	4.63E-1	1	1.05	(1,1,1,1,1,1); assumption for hard coal power production in United States, value: IEA statistics 2008
	electricity, lignite, at power plant	UCTE	kWh	1.97E-2	1	1.05	(1,1,1,3,1,1); assumption for lignite power production in United States, value: IEA statistics 2008
	electricity, industrial gas, at power plant	UCTE	kWh	8.74E-4	1	1.05	(1,1,1,3,1,1); assumption for industrial, coke and blast furnace gas power production in United States, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	kWh	1.12E-2	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in United States, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.95E-3	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in United States, value: IEA statistics 2008
	electricity, natural gas, at power plant	US	kWh	2.06E-1	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in United States, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	1.25E-2	1	1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in United States: 20%
	electricity, hydropower, at run-of-river power plant	RER	kWh	5.00E-2	1	1.05	(1,1,1,3,1,1); estimated share of ROR hydropower production in United States: 80%
	electricity, hydropower, at pumped storage power plant	US	kWh	6.15E-3	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in United States: 8.97%
	electricity, nuclear, at power plant pressure water reactor	US	kWh	1.29E-1	1	1.05	(1,1,1,1,1,1); assumption for nuclear power production in United States using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, nuclear, at power plant boiling water reactor	US	kWh	6.51E-2	1	1.05	(1,1,1,1,1,1); assumption for nuclear power production in United States using BWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	1.81E-2	1	1.05	(1,1,1,3,1,1); assumption for geothermal power production in United States, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	US	kWh	3.63E-4	1	1.05	(1,1,1,1,1,1); assumption for solar power production in United States, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	9.43E-3	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in United States, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.95E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in United States, value: IEA statistics 2008
electricity from waste, at municipal waste incineration plant	CH	kWh	5.03E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in United States, value: IEA statistics 2008	

Tab. 3.32: Unit process raw data of the electricity supply mix in the United States 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty StandardDe- viation95%	GeneralComment
product	electricity mix	US	kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	US	kWh	4.56E-1	1 1.05	(1,1,1,1,1,1); assumption for hard coal power production in United States, value: IEA statistics 2008
	electricity, lignite, at power plant	UCTE	kWh	1.95E-2	1 1.05	(1,1,1,3,1,1); assumption for lignite power production in United States, value: IEA statistics 2008
	electricity, industrial gas, at power plant	UCTE	kWh	8.62E-4	1 1.05	(1,1,1,3,1,1); assumption for industrial, coke and blast furnace gas power production in United States, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	kWh	1.11E-2	1 1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in United States, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.92E-3	1 1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in United States, value: IEA statistics 2008
	electricity, natural gas, at power plant	US	kWh	2.04E-1	1 1.05	(1,1,1,1,1,1); assumption for natural gas power production in United States, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	1.23E-2	1 1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in United States: 20%
	electricity, hydropower, at run-of-river power plant	RER	kWh	4.93E-2	1 1.05	(1,1,1,3,1,1); estimated share of ROR hydropower production in United States: 80%
	electricity, hydropower, at pumped storage power plant	US	kWh	6.07E-3	1 1.05	(1,1,1,1,1,1); estimated share of pumped storage production in United States: 8.97%
	electricity, nuclear, at power plant pressure water reactor	US	kWh	1.27E-1	1 1.05	(1,1,1,1,1,1); assumption for nuclear power production in United States using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, nuclear, at power plant boiling water reactor	US	kWh	6.42E-2	1 1.05	(1,1,1,1,1,1); assumption for nuclear power production in United States using BWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	1.78E-2	1 1.05	(1,1,1,3,1,1); assumption for geothermal power production in United States, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	US	kWh	3.58E-4	1 1.05	(1,1,1,1,1,1); assumption for solar power production in United States, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	9.30E-3	1 1.05	(1,1,1,3,1,1); assumption for cogeneration power production in United States, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.92E-3	1 1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in United States, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	4.96E-3	1 1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in United States, value: IEA statistics 2008
	electricity mix, domestic production	CA	kWh	1.35E-2	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in United States, value: IEA statistics 2008
	electricity mix, domestic production	MX	kWh	3.12E-4	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in United States, value: IEA statistics 2008

3.4 Asia and Australia

3.4.1 Australia (AU)

Tab. 3.33 shows an overview over the Australian electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Australian power production relies on fossil fuels, mainly hard coal (55 %), lignite (21 %) and natural gas (15 %), as main energy source. Further electricity is produced from hydro power and renewables. No electricity is imported because of the geographical location.

There are no nuclear power plants in Australia (PRIS 2011). Therefore, the nuclear power production is zero.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.2 is taken into account. The share of run-of-river hydropower plants in Australia is 100 %. The share of the storage type hydropower plants is 0 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Australia is 1%.

For the electricity production with wind power the average European dataset is used. For the power production out of renewable resources, either European or Swiss datasets are set as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Australia are shown in Tab. 3.34 and Tab. 3.35.

Tab. 3.33: Composition of the Australian electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	238'885	212'648	92.20	92.20
Hard coal	141'714	126'149	54.70	54.70
Lignite	54'087	48'147	20.88	20.88
Peat	0	0	0.00	0.00
Industrial Gases	1'821	1'621	0.70	0.70
<i>Coke gases</i>	0	0	0.00	0.00
<i>Blast furnace gases</i>	1'821	1'621	0.70	0.70
Petroleum products	2'756	2'453	1.06	1.06
<i>Fuel oil</i>	626	557	0.24	0.24
<i>Diesel</i>	2'130	1'896	0.82	0.82
<i>other petroleum products</i>	0	0	0.00	0.00
Natural Gas	38'507	34'278	14.86	14.86
Other fossil	0	0	0.00	0.00
Hydro	12'057	11'936	5.18	5.18
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	11'909	11'790	5.11	5.11
Pumped storage power plants	148	147	0.06	0.06
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	5'304	5'162	2.24	2.24
Geothermal	0	0	0.00	0.00
Solar	160	150	0.07	0.07
<i>Photovoltaic</i>	156	147	0.06	0.06
<i>Solar thermal</i>	4	4	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	3'941	3'941	1.71	1.71
Wood	1'203	1'071	0.46	0.46
Biogas	0	0	0.00	0.00
Waste	1'001	891	0.39	0.39
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	1'001	891	0.39	0.39
Other	0	0	0.00	0.00
Total domestic	257'247	230'637	100.00	100.00
Imports	0	0	0.00	0.00
Import1	0	0	0.00	0.00
Total	257'247	230'637	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.34: Unit process raw data of the electricity production mix in Australia 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviation95%	GeneralComment			
								Location	InfrastructureProcess	Unit
								AU	0	kWh
product	electricity mix, domestic production	AU	kWh	1.00E+0						
technosphere	electricity, hard coal, at power plant	US	kWh	5.47E-1	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Australia, value: IEA statistics 2008			
	electricity, lignite, at power plant	UCTE	kWh	2.09E-1	1	1.05	(1,1,1,3,1,1); assumption for lignite power production in Australia, value: IEA statistics 2008			
	electricity, industrial gas, at power plant	UCTE	kWh	7.03E-3	1	1.05	(1,1,1,3,1,1); assumption for industrial, coke and blast furnace gas power production in Australia, value: IEA statistics 2008			
	electricity, oil, at power plant	UCTE	kWh	2.42E-3	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Australia, value: IEA statistics 2008			
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	8.22E-3	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Australia, value: IEA statistics 2008			
	electricity, natural gas, at power plant	US	kWh	1.49E-1	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Australia, value: IEA statistics 2008			
	electricity, hydropower, at run-of-river power plant	RER	kWh	5.11E-2	1	1.05	(1,1,1,3,1,1); estimated share of ROR hydropower production in Australia: 100%			
	electricity, hydropower, at pumped storage power plant	AU	kWh	6.35E-4	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Australia: 1.23%			
	electricity, at wind power plant	RER	kWh	1.71E-2	1	1.05	(1,1,1,3,1,1); assumption for geothermal power production in Australia, value: IEA statistics 2008			
	electricity, production mix photovoltaic, at plant	AU	kWh	6.36E-4	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Australia, value: IEA statistics 2008			
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	4.64E-3	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Australia, value: IEA statistics 2008			
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	3.86E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Australia, value: IEA statistics 2008			

Tab. 3.35: Unit process raw data of the electricity supply mix in Australia 2008, at busbar

	Name	Location	Unit	electricity mix	UncertaintyType	StandardDeviation95%	GeneralComment			
								Location	InfrastructureProcess	Unit
								AU	0	kWh
product	electricity mix	AU	kWh	1.00E+0						
technosphere	electricity, hard coal, at power plant	US	kWh	5.47E-1	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Australia, value: IEA statistics 2008			
	electricity, lignite, at power plant	UCTE	kWh	2.09E-1	1	1.05	(1,1,1,3,1,1); assumption for lignite power production in Australia, value: IEA statistics 2008			
	electricity, industrial gas, at power plant	UCTE	kWh	7.03E-3	1	1.05	(1,1,1,3,1,1); assumption for industrial, coke and blast furnace gas power production in Australia, value: IEA statistics 2008			
	electricity, oil, at power plant	UCTE	kWh	2.42E-3	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Australia, value: IEA statistics 2008			
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	8.22E-3	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Australia, value: IEA statistics 2008			
	electricity, natural gas, at power plant	US	kWh	1.49E-1	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Australia, value: IEA statistics 2008			
	electricity, hydropower, at run-of-river power plant	RER	kWh	5.11E-2	1	1.05	(1,1,1,3,1,1); estimated share of ROR hydropower production in Australia: 100%			
	electricity, hydropower, at pumped storage power plant	AU	kWh	6.35E-4	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Australia: 1.23%			
	electricity, at wind power plant	RER	kWh	1.71E-2	1	1.05	(1,1,1,3,1,1); assumption for geothermal power production in Australia, value: IEA statistics 2008			
	electricity, production mix photovoltaic, at plant	AU	kWh	6.36E-4	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Australia, value: IEA statistics 2008			
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	4.64E-3	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Australia, value: IEA statistics 2008			
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	3.86E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Australia, value: IEA statistics 2008			

3.4.2 India (IN)

Co author: Matthias Stucki, Zurich University of Applied Sciences

Tab. 3.53 shows an overview over the Indian electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Indian power production relies on fossil fuels, mainly hard coal

(65 %), natural gas (10 %) and petroleum products (4 %) as main energy source. Further electricity is produced from hydropower (14 %) and from nuclear power (2 %). A share of about 1 % of the electricity is imported mainly from Bhutan. The imported electricity is modelled with the European data set for storage type hydro power for alpine conditions, since the electricity in Bhutan is mainly produced from storage type hydro power in alpine regions.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydro-power generation according to Tab. 3.2 is taken into account. The share of run-of-river hydropower plants in the India is 12 %. The share of the storage type hydropower plants is 88 %. The share of pumped storage in India is 12 %.

Hydropower constitutes of reservoir power plants, run-of-river power plants, and pumped storage power plants. The total hydro power capacity as on 31.03.2008 amounted to 37002.1 MW including a capacity of 4'551 MW pumped storage power plants (CEA 2008). We identified only one large run-of-river power plant with a capacity of 1'500 MW. However, also 2'430 MW of small hydro power plants were installed, which are usually run-of-river power plants as well.

Tab. 3.36 Pumped storage and run-of-river power plants in India

	Capacity (CEA 2008) in MW	Share
Total pumped storage power plants	4551	12.3 %
Run-of-river power plants*	3930	12.1 %
Storage type hydropower	33072	87.9 %
Total non-pumped storage power plants	32451	87.7 %
Total Hydropower including pumped storage Capacity in 2008	37002	100.0 %

*<http://www.eai.in/ref/ae/hyd/hyd.html>

For India the share of the storage type hydro power is differently modelled for the main geographical regions of India. Greenhouse gas emissions from reservoir power plants strongly depend on the climate. In tropical climate, such as in South India, flooding an area leads to higher methane and carbon dioxide emissions compared to emissions from power plants in northern highlands (Svensson et al. 2008). Reservoir power plants in North India are considered with a dataset for alpine hydropower, reservoir power plants in South India with a dataset of Brazilian hydropower, and reservoir power plants in the remaining areas with a dataset of non-alpine hydropower (see Tab. 3.37).

Tab. 3.37 Capacity of large hydropower split up into India's main geographical areas according to Central Statistics Office (CSO 2011)

	Capacity 2008	Share
	GW	%
North India	12.98	36.1%
East India	3.93	10.9%
Northeast India	1.12	3.1%
West India	7.2	20.0%
South India	10.69	29.8%
Total	35.92	100.0%

Power production from nuclear power plants is approximated using the Chinese dataset of pressure water reactors and the UCTE dataset of boiling water reactors. These datasets reflect the conditions of nuclear power production using a mix of PWR and BWR power plants (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of India are shown Tab. 3.54 and Tab. 3.55.

Tab. 3.38: Composition of the Indian electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	685'385	640'384	81.79	80.83
Hard coal	549'750	513'655	65.60	64.84
Lignite	18'130	16'940	2.16	2.14
Peat	0	0	0.00	0.00
Industrial Gases	1'430	1'336	0.17	0.17
<i>Coke gases</i>	0	0	0.00	0.00
<i>Blast furnace gases</i>	0	0	0.00	0.00
Petroleum products	34'148	31'906	4.07	4.03
<i>Fuel oil</i>	0	0	0.00	0.00
<i>Diesel</i>	0	0	0.00	0.00
<i>other petroleum products</i>	0	0	0.00	0.00
Natural Gas	81'927	76'548	9.78	9.66
Other fossil	0	0	0.00	0.00
Hydro	114'295	113'152	14.45	14.28
Reservoir power plants	88'108	87'227	11.14	11.01
Run-of-river power plants	12'129	12'007	1.53	1.52
Pumped storage power plants	14'058	13'918	1.78	1.76
Nuclear	14'713	13'830	1.77	1.75
Pressurised-water reactor (PWR)	13'708	12'885	1.65	1.63
Boiling-water reactor (BWR)	1'005	945	0.12	0.12
Renewables	15'733	15'602	1.99	1.97
Geothermal	0	0	0.00	0.00
Solar	20	19	0.00	0.00
<i>Photovoltaic</i>	20	19	0.00	0.00
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	13'740	13'740	1.75	1.73
Wood	1'973	1'843	0.24	0.23
Biogas	0	0	0.00	0.00
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	830'126	782'969	100.00	98.83
Imports	0	9'249	0.00	1.17
Bhutan	0	9'249	0.00	1.17
Total	830'126	792'218	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.39: Unit process raw data of the electricity production mix in India 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviation%	GeneralComment
product	electricity mix, domestic production	IN	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	CN	kWh	6.56E-1	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in India, value: IEA statistics 2008
	electricity, lignite, at power plant	SK	kWh	2.16E-2	1	1.05	(1,1,1,3,1,1); assumption for lignite power production in India, value: IEA statistics 2008
	electricity, industrial gas, at power plant	CENTREL	kWh	1.71E-3	1	1.05	(1,1,1,3,1,1); assumption for industrial, coke and blast furnace gas power production in India, value: IEA statistics 2008
	electricity, oil, at power plant	SK	kWh	4.07E-2	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in India, value: IEA statistics 2008
	electricity, natural gas, at power plant	CENTREL	kWh	9.78E-2	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in India, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant	BR	kWh	3.32E-2	1	1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in India: 87.9%
	electricity, hydropower, at reservoir power plant, alpine region	RER	kWh	4.03E-2	1	1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in India: 87.9%
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	3.80E-2	1	1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in India: 87.9%
	electricity, hydropower, at run-of-river power plant	RER	kWh	1.53E-2	1	1.05	(1,1,1,3,1,1); estimated share of ROR hydropower production in India: 12.1%
	electricity, hydropower, at pumped storage power plant	SK	kWh	1.78E-2	1	1.05	(1,1,1,3,1,1); estimated share of pumped storage production in India: 12.3%
	electricity, nuclear, at power plant pressure water reactor	CN	kWh	1.65E-2	1	1.05	(1,1,1,3,1,1); assumption for nuclear power production in India using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, nuclear, at power plant boiling water reactor	UCTE	kWh	1.21E-3	1	1.05	(1,1,1,3,1,1); assumption for nuclear power production in India using BWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	1.75E-2	1	1.05	(1,1,1,3,1,1); assumption for geothermal power production in India, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	KR	kWh	2.40E-5	1	1.05	(1,1,1,3,1,1); assumption for solar power production in India, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	2.35E-3	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in India, value: IEA statistics 2008

Tab. 3.40: Unit process raw data of the electricity supply mix in India 2008, at busbar

product	Name	Location	Unit	electricity mix	Uncertainty	Standard Deviation 95%	General Comment
	Location						
	Infrastructure Process Unit						
	electricity mix	IN	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	IN	kWh	6.48E-1	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in India, value: IEA statistics 2008
	electricity, lignite, at power plant	UCTE	kWh	2.14E-2	1	1.05	(1,1,1,3,1,1); assumption for lignite power production in India, value: IEA statistics 2008
	electricity, industrial gas, at power plant	UCTE	kWh	1.69E-3	1	1.05	(1,1,1,3,1,1); assumption for industrial, coke and blast furnace gas power production in India, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	kWh	4.03E-2	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in India, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE	kWh	9.66E-2	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in India, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant	BR	kWh	3.28E-2	1	1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in India: 87.9%
	electricity, hydropower, at reservoir power plant, alpine region	RER	kWh	5.15E-2	1	1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in India: 87.9%
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	3.75E-2	1	1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in India: 87.9%
	electricity, hydropower, at run-of-river power plant	RER	kWh	1.52E-2	1	1.05	(1,1,1,3,1,1); estimated share of ROR hydropower production in India: 12.1%
	electricity, hydropower, at pumped storage power plant	IN	kWh	1.76E-2	1	1.05	(1,1,1,3,1,1); estimated share of pumped storage production in India: 12.3%
	electricity, nuclear, at power plant pressure water reactor	CN	kWh	1.63E-2	1	1.05	(1,1,1,3,1,1); assumption for nuclear power production in India using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, nuclear, at power plant boiling water reactor	UCTE	kWh	1.19E-3	1	1.05	(1,1,1,3,1,1); assumption for nuclear power production in India using BWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	1.73E-2	1	1.05	(1,1,1,3,1,1); assumption for geothermal power production in India, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	KR	kWh	2.37E-5	1	1.05	(1,1,1,3,1,1); assumption for solar power production in India, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	2.33E-3	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in India, value: IEA statistics 2008

3.4.3 Indonesia (ID)

Tab. 3.41 shows an overview over the Indonesian electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Indonesian power production relies on fossil fuels, mainly lignite (41 %), petroleum products (29 %) and natural gas (17 %) as main energy source. Further electricity is produced from hydropower (8 %) and from renewables, mainly geothermal (6 %). No electricity is imported to Indonesia.

There are no nuclear power plants in Indonesia (PRIS 2011). Therefore, the nuclear power production is zero.

The electricity production from hydro power is approximated using the Brazilian dataset for storage type hydropower production. It is assumed that 100 % of the electricity from hydropower comes from storage type hydropower plants. The share of pumped storage in Indonesia is 0 %. The Brazilian dataset is used, because of the similar climatic conditions of Brazil and Indonesia.

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Indonesia are shown Tab. 3.42 and Tab. 3.43.

Tab. 3.41: Composition of the Indonesian electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	129'612	124'946	86.57	86.57
Hard coal	0	0	0.00	0.00
Lignite	61'395	59'185	41.01	41.01
Peat	0	0	0.00	0.00
Industrial Gases	0	0	0.00	0.00
<i>Coke gases</i>	0	0	0.00	0.00
<i>Blast furnace gases</i>	0	0	0.00	0.00
Petroleum products	42'981	41'434	28.71	28.71
<i>Fuel oil</i>	0	0	0.00	0.00
<i>Diesel</i>	0	0	0.00	0.00
<i>other petroleum products</i>	0	0	0.00	0.00
Natural Gas	25'236	24'327	16.86	16.86
Other fossil	0	0	0.00	0.00
Hydro	11'528	11'413	7.91	7.91
Reservoir power plants	11'528	11'413	7.91	7.91
Run-of-river power plants	0	0	0.00	0.00
Pumped storage power plants	0	0	0.00	0.00
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	8'297	7'965	5.52	5.52
Geothermal	8'297	7'965	5.52	5.52
Solar	0	0	0.00	0.00
<i>Photovoltaic</i>	0	0	0.00	0.00
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	0	0	0.00	0.00
Wood	0	0	0.00	0.00
Biogas	0	0	0.00	0.00
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	149'437	144'324	100.00	100.00
Imports	0	0	0.00	0.00
Total	149'437	144'324	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.42: Unit process raw data of the electricity production mix in Indonesia 2008, at busbar

product	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviation95%	GeneralComment
	Location			ID			
	InfrastructureProcess			0			
	Unit			kWh			
	electricity mix, domestic production		ID	kWh	1.00E+0		
	electricity, lignite, at power plant	UCTE		kWh	4.10E-1	1 1.05	(1,1,1,3,1,1); assumption for lignite power production in Indonesia, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE		kWh	2.87E-1	1 1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Indonesia, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE		kWh	1.69E-1	1 1.05	(1,1,1,3,1,1); assumption for natural gas power production in Indonesia, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant	BR		kWh	7.91E-2	1 1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in Indonesia: 100%
	electricity, at wind power plant	RER		kWh	5.52E-2	1 1.05	(1,1,1,3,1,1); assumption for geothermal power production in Indonesia, value: IEA statistics 2008

Tab. 3.43: Unit process raw data of the electricity supply mix in Indonesia 2008, at busbar

product	Name	Location	Unit	electricity mix	UncertaintyType	StandardDeviation95%	GeneralComment
	Location			ID			
	InfrastructureProcess			0			
	Unit			kWh			
	electricity mix		ID	kWh	1.00E+0		
	electricity, lignite, at power plant	UCTE		kWh	4.10E-1	1 1.05	(1,1,1,3,1,1); assumption for lignite power production in Indonesia, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE		kWh	2.87E-1	1 1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Indonesia, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE		kWh	1.69E-1	1 1.05	(1,1,1,3,1,1); assumption for natural gas power production in Indonesia, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant	BR		kWh	7.91E-2	1 1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in Indonesia: 100%
	electricity, at wind power plant	RER		kWh	5.52E-2	1 1.05	(1,1,1,3,1,1); assumption for geothermal power production in Indonesia, value: IEA statistics 2008

3.4.4 Iran (IR)

Tab. 3.41 shows an overview over the Iranian electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Iranian power production relies on fossil fuels, mainly natural gas (81 %) and petroleum products (17 %) as main energy source. Further electricity is produced from hydropower (2 %). No electricity is imported to Iran.

There are no nuclear power plants in Iran (PRIS 2011). Therefore, the nuclear power production is zero.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydro-power generation according to Tab. 3.2 is taken into account. The share of run-of-river hydropower plants in the Iran is 100 %. The share of pumped storage in Iran is 0 %.

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Iran are shown Tab. 3.45 and Tab. 3.46.

Tab. 3.44: Composition of the Iranian electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	209'332	199'384	97.48	97.48
Hard coal	0	0	0.00	0.00
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	390	371	0.18	0.18
<i>Coke gases</i>	0	0	0.00	0.00
<i>Blast furnace gases</i>	0	0	0.00	0.00
Petroleum products	35'543	33'854	16.55	16.55
<i>Fuel oil</i>	0	0	0.00	0.00
<i>Diesel</i>	0	0	0.00	0.00
<i>other petroleum products</i>	0	0	0.00	0.00
Natural Gas	173'399	165'159	80.75	80.75
Other fossil	0	0	0.00	0.00
Hydro	5'003	4'953	2.42	2.42
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	5'003	4'953	2.42	2.42
Pumped storage power plants	0	0	0.00	0.00
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	196	196	0.10	0.10
Geothermal	0	0	0.00	0.00
Solar	0	0	0.00	0.00
<i>Photovoltaic</i>	0	0	0.00	0.00
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	196	196	0.10	0.10
Wood	0	0	0.00	0.00
Biogas	0	0	0.00	0.00
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	214'531	204'533	100.00	100.00
Imports	0	0	0.00	0.00
Total	214'531	204'533	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.45: Unit process raw data of the electricity production mix in Iran 2008, at busbar

product	Name	Location	Unit	electricity mix, domestic production	Uncertainty/Type	StandardDeviation95%	GeneralComment
	Location			IR			
	InfrastructureProcess			0			
	Unit			kWh			
	electricity mix, domestic production	IR	kWh	1.00E+0			
	electricity, industrial gas, at power plant	UCTE	kWh	1.82E-3	1	1.05	(1,1,1,3,1,1); assumption for industrial, coke and blast furnace gas power production in Iran, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	kWh	1.66E-1	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Iran, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE	kWh	8.07E-1	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Iran, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	2.42E-2	1	1.05	(1,1,1,3,1,1); estimated share of ROR hydropower production in Iran: 100%
	electricity, at wind power plant	RER	kWh	9.58E-4	1	1.05	(1,1,1,3,1,1); assumption for geothermal power production in Iran, value: IEA statistics 2008

Tab. 3.46: Unit process raw data of the electricity supply mix in Iran 2008, at busbar

product	Name	Location	Unit	electricity mix	Uncertainty/Type	StandardDeviation95%	GeneralComment
	Location			IR			
	InfrastructureProcess			0			
	Unit			kWh			
	electricity mix	IR	kWh	1.00E+0			
	electricity, industrial gas, at power plant	UCTE	kWh	1.82E-3	1	1.05	(1,1,1,3,1,1); assumption for industrial, coke and blast furnace gas power production in Iran, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	kWh	1.66E-1	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Iran, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE	kWh	8.07E-1	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Iran, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	2.42E-2	1	1.05	(1,1,1,3,1,1); estimated share of ROR hydropower production in Iran: 100%
	electricity, at wind power plant	RER	kWh	9.58E-4	1	1.05	(1,1,1,3,1,1); assumption for geothermal power production in Iran, value: IEA statistics 2008

3.4.5 Japan (JP)

Tab. 3.47 shows an overview over the Japanese electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Japanese power production relies on fossil fuels, mainly hard coal (24 %), natural gas (26 %) and petroleum products (12 %) as main energy source. Further electricity is produced from nuclear power (24 %) and hydro power (8 %). No electricity is imported because of the geographical situation.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.2 is taken into account. The share of run-of-river hydropower plants in Japan is 80 %. The share of the storage type hydropower plants is 20 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Japan is 9.0 %.

Power production from nuclear power plants is approximated using the UCTE datasets for boiling and pressure water reactors. These datasets reflect the conditions of nuclear power production using a mix of PWR (43.6 %) and BWR (56.4 %) power plants (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Japan are shown Tab. 3.48 and Tab. 3.49.

Tab. 3.47: Composition of the Japanese electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	710'577	667'757	65.38	65.38
Hard coal	263'663	247'774	24.26	24.26
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	32'161	30'223	2.96	2.96
<i>Coke gases</i>	<i>8'215</i>	<i>7'720</i>	<i>0.76</i>	<i>0.76</i>
<i>Blast furnace gases</i>	<i>23'946</i>	<i>22'503</i>	<i>2.20</i>	<i>2.20</i>
Petroleum products	131'593	123'663	12.11	12.11
<i>Fuel oil</i>	<i>108'997</i>	<i>102'429</i>	<i>10.03</i>	<i>10.03</i>
<i>Diesel</i>	<i>3'199</i>	<i>3'006</i>	<i>0.29</i>	<i>0.29</i>
<i>other petroleum products</i>	<i>19'397</i>	<i>18'228</i>	<i>1.78</i>	<i>1.78</i>
Natural Gas	283'160	266'097	26.06	26.06
Other fossil	0	0	0.00	0.00
Hydro	83'295	82'462	8.07	8.07
Reservoir power plants	15'248	15'095	1.48	1.48
Run-of-river power plants	60'991	60'381	5.91	5.91
Pumped storage power plants	7'056	6'985	0.68	0.68
Nuclear	258'128	242'640	23.76	23.76
Pressurised-water reactor (PWR)	112'580	105'826	10.36	10.36
Boiling-water reactor (BWR)	145'548	136'815	13.40	13.40
Renewables	22'705	21'551	2.11	2.11
Geothermal	2'752	2'642	0.26	0.26
Solar	2'251	2'116	0.21	0.21
<i>Photovoltaic</i>	<i>2'251</i>	<i>2'116</i>	<i>0.21</i>	<i>0.21</i>
<i>Solar thermal</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Wave and tidal energy	0	0	0.00	0.00
Wind	2'623	2'623	0.26	0.26
Wood	15'079	14'170	1.39	1.39
Biogas	0	0	0.00	0.00
Waste	7'309	6'869	0.67	0.67
Municipal waste	6'837	6'425	0.63	0.63
Industrial waste	472	444	0.04	0.04
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	1'082'014	1'021'279	100.00	100.00
Imports	0	0	0.00	0.00
Total	1'082'014	1'021'279	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.48: Unit process raw data of the electricity production mix in Japan 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production		UncertaintyType	StandardDeviation95%	GeneralComment
				JP	0			
				kWh				
product	electricity mix, domestic production	JP	kWh	1.00E+0				
technosphere	electricity, hard coal, at power plant	JP	kWh	2.43E-1	1	1.05	(1,1,1,1,1,1); assumption for hard coal power production in Japan, value: IEA statistics 2008	
	electricity, industrial gas, at power plant	UCTE	kWh	2.96E-2	1	1.05	(1,1,1,3,1,1); assumption for industrial, coke and blast furnace gas power production in Japan, value: IEA statistics 2008	
	electricity, oil, at power plant	UCTE	kWh	1.18E-1	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Japan, value: IEA statistics 2008	
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	2.94E-3	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Japan, value: IEA statistics 2008	
	electricity, natural gas, at power plant	JP	kWh	2.61E-1	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Japan, value: IEA statistics 2008	
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	1.48E-2	1	1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in Japan: 20%	
	electricity, hydropower, at run-of-river power plant	RER	kWh	5.91E-2	1	1.05	(1,1,1,3,1,1); estimated share of ROR hydropower production in Japan: 80%	
	electricity, hydropower, at pumped storage power plant	JP	kWh	6.84E-3	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Japan: 8.47%	
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	1.04E-1	1	1.05	(1,1,1,1,1,1); assumption for nuclear power production in Japan using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)	
	electricity, nuclear, at power plant boiling water reactor	UCTE	kWh	1.34E-1	1	1.05	(1,1,1,1,1,1); assumption for nuclear power production in Japan using BWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)	
	electricity, at wind power plant	RER	kWh	5.16E-3	1	1.05	(1,1,1,3,1,1); assumption for geothermal power production in Japan, value: IEA statistics 2008	
	electricity, production mix photovoltaic, at plant	JP	kWh	2.07E-3	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Japan, value: IEA statistics 2008	
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.39E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Japan, value: IEA statistics 2008	
	electricity from waste, at municipal waste incineration plant	CH	kWh	6.73E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Japan, value: IEA statistics 2008	

Tab. 3.49: Unit process raw data of the electricity supply mix in Japan 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty Standard Deviations%	GeneralComment
	Location			JP		
	InfrastructureProcess			0		
	Unit			kWh		
product	electricity mix	JP	kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	JP	kWh	2.43E-1	1 1.05	(1,1,1,1,1,1,1); assumption for hard coal power production in Japan, value: IEA statistics 2008
	electricity, industrial gas, at power plant	UCTE	kWh	2.96E-2	1 1.05	(1,1,1,3,1,1,1); assumption for industrial, coke and blast furnace gas power production in Japan, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	kWh	1.18E-1	1 1.05	(1,1,1,3,1,1,1); assumption for petroleum product and fuel oil power production in Japan, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	2.94E-3	1 1.05	(1,1,1,3,1,1,1); assumption for diesel and other fossil fuel power production in Japan, value: IEA statistics 2008
	electricity, natural gas, at power plant	JP	kWh	2.61E-1	1 1.05	(1,1,1,1,1,1,1); assumption for natural gas power production in Japan, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	1.48E-2	1 1.05	(1,1,1,3,1,1,1); estimated share of reservoir hydropower production in Japan: 20%
	electricity, hydropower, at run-of-river power plant	RER	kWh	5.91E-2	1 1.05	(1,1,1,3,1,1,1); estimated share of ROR hydropower production in Japan: 80%
	electricity, hydropower, at pumped storage power plant	JP	kWh	6.84E-3	1 1.05	(1,1,1,1,1,1,1); estimated share of pumped storage production in Japan: 8.47%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	1.04E-1	1 1.05	(1,1,1,1,1,1,1); assumption for nuclear power production in Japan using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, nuclear, at power plant boiling water reactor	UCTE	kWh	1.34E-1	1 1.05	(1,1,1,1,1,1,1); assumption for nuclear power production in Japan using BWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	5.16E-3	1 1.05	(1,1,1,3,1,1,1); assumption for geothermal power production in Japan, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	JP	kWh	2.07E-3	1 1.05	(1,1,1,1,1,1,1); assumption for solar power production in Japan, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.39E-2	1 1.05	(1,1,1,3,1,1,1); assumption for cogeneration power production in Japan, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	6.73E-3	1 1.05	(1,1,1,3,1,1,1); assumption for power production from municipal and industrial waste in Japan, value: IEA statistics 2008

3.4.6 Malaysia (MY)

Tab. 3.50 shows an overview over the Malaysian electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Malaysian power production relies on fossil fuels, mainly natural gas (64 %) and hard coal (27 %), as main energy source. Further electricity is produced from hydropower (8 %). No electricity is imported to Malaysia.

There are no nuclear power plants in Malaysia (PRIS 2011). Therefore, the nuclear power production is zero.

The electricity production from hydro power is approximated using the Brazilian dataset for storage type hydropower production. It is assumed that 100 % of the electricity from hydropower comes from storage type hydropower plants. The share of pumped storage in Malaysia is 0%. The Brazilian dataset is used, because of the similar climatic conditions of Brazil and Malaysia.

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Malaysia are shown Tab. 3.51 and Tab. 3.52.

Tab. 3.50: Composition of the Malaysian electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	89'932	88'224	92.28	92.28
Hard coal	26'177	25'680	26.86	26.86
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	0	0	0.00	0.00
<i>Coke gases</i>	0	0	0.00	0.00
<i>Blast furnace gases</i>	0	0	0.00	0.00
Petroleum products	1'845	1'810	1.89	1.89
<i>Fuel oil</i>	0	0	0.00	0.00
<i>Diesel</i>	0	0	0.00	0.00
<i>other petroleum products</i>	0	0	0.00	0.00
Natural Gas	61'910	60'734	63.52	63.52
Other fossil	0	0	0.00	0.00
Hydro	7'459	7'384	7.72	7.72
Reservoir power plants	7'459	7'384	7.72	7.72
Run-of-river power plants	0	0	0.00	0.00
Pumped storage power plants	0	0	0.00	0.00
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	1	1	0.00	0.00
Geothermal	0	0	0.00	0.00
Solar	1	1	0.00	0.00
<i>Photovoltaic</i>	1	1	0.00	0.00
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	0	0	0.00	0.00
Wood	0	0	0.00	0.00
Biogas	0	0	0.00	0.00
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	97'392	95'609	100.00	100.00
Imports	0	0	0.00	0.00
Total	97'392	95'609	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.51: Unit process raw data of the electricity production mix in Malaysia 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production		UncertaintyType	StandardDeviations%	GeneralComment
				MY	0			
Location								
InfrastructureProcess								
Unit								
product	electricity mix, domestic production	MY	kWh	1.00E+0				
technosphere	electricity, hard coal, at power plant	UCTE	kWh	2.69E-1	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Malaysia, value: IEA statistics 2008	
	electricity, oil, at power plant	UCTE	kWh	1.89E-2	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Malaysia, value: IEA statistics 2008	
	electricity, natural gas, at power plant	UCTE	kWh	6.35E-1	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Malaysia, value: IEA statistics 2008	
	electricity, hydropower, at reservoir power plant	BR	kWh	7.72E-2	1	1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in Malaysia: 100%	
	electricity, production mix photovoltaic, at plant	KR	kWh	9.83E-6	1	1.05	(1,1,1,3,1,1); assumption for solar power production in Malaysia, value: IEA statistics 2008	

Tab. 3.52: Unit process raw data of the electricity supply mix in Malaysia 2008, at busbar

	Name	Location	Unit	electricity mix		UncertaintyType	StandardDeviations%	GeneralComment
				MY	0			
Location								
InfrastructureProcess								
Unit								
product	electricity mix	MY	kWh	1.00E+0				
technosphere	electricity, hard coal, at power plant	UCTE	kWh	2.69E-1	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Malaysia, value: IEA statistics 2008	
	electricity, oil, at power plant	UCTE	kWh	1.89E-2	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Malaysia, value: IEA statistics 2008	
	electricity, natural gas, at power plant	UCTE	kWh	6.35E-1	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Malaysia, value: IEA statistics 2008	
	electricity, hydropower, at reservoir power plant	BR	kWh	7.72E-2	1	1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in Malaysia: 100%	
	electricity, production mix photovoltaic, at plant	KR	kWh	9.83E-6	1	1.05	(1,1,1,3,1,1); assumption for solar power production in Malaysia, value: IEA statistics 2008	

3.4.7 People’s Republic of China (CN)

Tab. 3.53 shows an overview over the Chinese electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Chinese power production relies on fossil fuels, mainly hard coal (77 %), as main energy source. Further electricity is produced from hydropower (19 %) and from nuclear power (2 %). A share of about 0.1 % of the electricity is imported. The imported electricity is modelled with the Russian electricity mix. Because of the low share of the electricity imports, this assumption does not influence the overall result.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.2 is taken into account. The share of run-of-river hydropower plants in China is 25 %. The share of the storage type hydropower plants is 75 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in China is 0%.

Power production from nuclear power plants is approximated using the Chinese dataset for pressure water reactors. These dataset reflects the conditions of nuclear power production using PWR power plants only (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of China are shown Tab. 3.54 and Tab. 3.55.

Tab. 3.53: Composition of the Chinese electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	2'787'719	2'456'745	78.85	78.75
Hard coal	2'711'663	2'389'719	76.70	76.61
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	21'617	19'051	0.61	0.61
<i>Coke gases</i>	0	0	0.00	0.00
<i>Blast furnace gases</i>	0	0	0.00	0.00
Petroleum products	23'411	20'632	0.66	0.66
<i>Fuel oil</i>	0	0	0.00	0.00
<i>Diesel</i>	0	0	0.00	0.00
<i>other petroleum products</i>	0	0	0.00	0.00
Natural Gas	31'028	27'344	0.88	0.88
Other fossil	0	0	0.00	0.00
Hydro	585'187	579'335	18.59	18.57
Reservoir power plants	438'890	434'501	13.95	13.93
Run-of-river power plants	146'297	144'834	4.65	4.64
Pumped storage power plants	0	0	0.00	0.00
Nuclear	68'394	64'290	2.06	2.06
Pressurised-water reactor (PWR)	68'394	64'290	2.06	2.06
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	15'610	15'320	0.49	0.49
Geothermal	0	0	0.00	0.00
Solar	172	162	0.00	0.00
<i>Photovoltaic</i>	172	162	0.01	0.01
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	13'079	13'079	0.42	0.42
Wood	2'359	2'079	0.07	0.07
Biogas	0	0	0.00	0.00
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	3'456'910	3'115'690	100.00	99.88
Imports	0	3'842	0.00	0.12
Chinese Taipeh	0	3'842	0.00	0.12
Total	3'456'910	3'119'532	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.54: Unit process raw data of the electricity production mix in China 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviations95%	GeneralComment
	Location			CN			
	InfrastructureProcess			0			
	Unit			kWh			
product	electricity mix, domestic production	CN	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	CN	kWh	7.67E-1	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in China, value: IEA statistics 2008
	electricity, industrial gas, at power plant	CENTREL	kWh	6.11E-3	1	1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in China, value: IEA statistics 2008
	electricity, oil, at power plant	SK	kWh	6.62E-3	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in China, value: IEA statistics 2008
	electricity, natural gas, at power plant	CENTREL	kWh	8.78E-3	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in China, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	1.39E-1	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in China: 75%
	electricity, hydropower, at run-of-river power plant	RER	kWh	4.65E-2	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in China: 25%
	electricity, nuclear, at power plant pressure water reactor	CN	kWh	2.06E-2	1	1.05	(1,1,1,2,1,1); assumption for nuclear power production in China using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	4.20E-3	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in China, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	KR	kWh	5.19E-5	1	1.05	(1,1,1,1,1,1); assumption for solar power production in China, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	6.67E-4	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in China, value: IEA statistics 2008

Tab. 3.55: Unit process raw data of the electricity supply mix in China 2008, at busbar

	Name	Location	Unit	electricity mix	UncertaintyType	StandardDeviations95%	GeneralComment
	Location			CN			
	InfrastructureProcess			0			
	Unit			kWh			
product	electricity mix	CN	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	CN	kWh	7.66E-1	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in China, value: IEA statistics 2008
	electricity, industrial gas, at power plant	CENTREL	kWh	6.11E-3	1	1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in China, value: IEA statistics 2008
	electricity, oil, at power plant	SK	kWh	6.61E-3	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in China, value: IEA statistics 2008
	electricity, natural gas, at power plant	CENTREL	kWh	8.77E-3	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in China, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	1.39E-1	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in China: 75%
	electricity, hydropower, at run-of-river power plant	RER	kWh	4.64E-2	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in China: 25%
	electricity, nuclear, at power plant pressure water reactor	CN	kWh	2.06E-2	1	1.05	(1,1,1,2,1,1); assumption for nuclear power production in China using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	4.19E-3	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in China, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	KR	kWh	5.18E-5	1	1.05	(1,1,1,1,1,1); assumption for solar power production in China, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	6.66E-4	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in China, value: IEA statistics 2008
	electricity mix, domestic production	RU	kWh	1.23E-3	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in China, value: IEA statistics 2008

3.4.8 Saudi Arabia (SA)

Tab. 3.56 shows an overview over the Saudi Arabian electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Saudi Arabian power production relies on fossil fuels, mainly petroleum products (57 %) and natural gas (43 %), as main energy source. No electricity is imported to Saudi Arabia.

There are no nuclear power plants in Saudi Arabia (PRIS 2011). Therefore, the nuclear power production is zero.

In Saudi Arabia there is no electricity production from hydro power.

The unit process raw data of the electricity production and supply mix of Saudi Arabia are shown Tab. 3.57 and Tab. 3.58.

Tab. 3.56: Composition of the Saudi Arabian electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	204'200	187'532	100.00	100.00
Hard coal	0	0	0.00	0.00
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	0	0	0.00	0.00
Coke gases	0	0	0.00	0.00
Blast furnace gases	0	0	0.00	0.00
Petroleum products	116'238	106'750	56.92	56.92
Fuel oil	0	0	0.00	0.00
Diesel	0	0	0.00	0.00
other petroleum products	0	0	0.00	0.00
Natural Gas	87'962	80'782	43.08	43.08
Other fossil	0	0	0.00	0.00
Hydro	0	0	0.00	0.00
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	0	0	0.00	0.00
Pumped storage power plants	0	0	0.00	0.00
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	0	0	0.00	0.00
Geothermal	0	0	0.00	0.00
Solar	0	0	0.00	0.00
Photovoltaic	0	0	0.00	0.00
Solar thermal	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	0	0	0.00	0.00
Wood	0	0	0.00	0.00
Biogas	0	0	0.00	0.00
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	204'200	187'532	100.00	100.00
Imports	0	0	0.00	0.00
Total	204'200	187'532	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.57: Unit process raw data of the electricity production mix in Saudi Arabia 2008, at busbar

product	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviation95%	GeneralComment
	Location			SA			
	InfrastructureProcess			0			
	Unit			kWh			
	electricity mix, domestic production	SA	kWh	1.00E+0			
	electricity, oil, at power plant	UCTE	kWh	5.69E-1	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Saudi Arabia, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE	kWh	4.31E-1	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Saudi Arabia, value: IEA statistics 2008

Tab. 3.58: Unit process raw data of the electricity supply mix in Saudi Arabia 2008, at busbar

product	Name	Location	Unit	electricity mix	UncertaintyType	StandardDeviation95%	GeneralComment
	Location			SA			
	InfrastructureProcess			0			
	Unit			kWh			
	electricity mix	SA	kWh	1.00E+0			
	electricity, oil, at power plant	UCTE	kWh	5.69E-1	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Saudi Arabia, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE	kWh	4.31E-1	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Saudi Arabia, value: IEA statistics

3.4.9 South Korea (KR)

Tab. 3.59 shows an overview over the South Korean electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The South Korean power production relies on fossil fuels, mainly hard coal (40 %) and natural gas (18 %) as main energy source. Further electricity is produced from nuclear power (34 %) and hydro power (1 %). No electricity is imported to South Korea. Therefore, the production mix and the supply mix are identical.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.2 is taken into account. The share of run-of-river hydropower plants in South Korea is 80 %. The share of the storage type hydropower plants is 20 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in South Korea is 44.8 %.

Power production from nuclear power plants is approximated using the UCTE datasets for pressure water reactors. This dataset reflects the conditions of nuclear power production using PWR power plants only (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of South Korea are shown Tab. 3.60 and Tab. 3.61.

Tab. 3.59: Composition of the South Korean electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	288'444	274'297	64.83	64.83
Hard coal	176'696	168'030	39.71	39.71
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	15'065	14'326	3.39	3.39
<i>Coke gases</i>	<i>1'616</i>	<i>1'537</i>	<i>0.36</i>	<i>0.36</i>
<i>Blast furnace gases</i>	<i>13'449</i>	<i>12'789</i>	<i>3.02</i>	<i>3.02</i>
Petroleum products	15'351	14'598	3.45	3.45
<i>Fuel oil</i>	<i>11'506</i>	<i>10'942</i>	<i>2.59</i>	<i>2.59</i>
<i>Diesel</i>	<i>446</i>	<i>424</i>	<i>0.10</i>	<i>0.10</i>
<i>other petroleum products</i>	<i>3'399</i>	<i>3'232</i>	<i>0.76</i>	<i>0.76</i>
Natural Gas	81'332	77'343	18.28	18.28
Other fossil	0	0	0.00	0.00
Hydro	5'563	5'507	1.30	1.30
Reservoir power plants	614	608	0.14	0.14
Run-of-river power plants	2'456	2'431	0.57	0.57
Pumped storage power plants	2'493	2'468	0.58	0.58
Nuclear	150'958	141'901	33.54	33.54
Pressurised-water reactor (PWR)	150'958	141'901	33.54	33.54
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	765	746	0.18	0.18
Geothermal	0	0	0.00	0.00
Solar	285	268	0.06	0.06
<i>Photovoltaic</i>	<i>285</i>	<i>268</i>	<i>0.06</i>	<i>0.06</i>
<i>Solar thermal</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Wave and tidal energy	0	0	0.00	0.00
Wind	436	436	0.10	0.10
Wood	40	38	0.01	0.01
Biogas	4	4	0.00	0.00
Waste	623	592	0.14	0.14
Municipal waste	157	149	0.04	0.04
Industrial waste	17	16	0.00	0.00
Sewage sludge and landfill gases	449	427	0.10	0.10
Other	75	71	0.02	0.02
Total domestic	446'428	423'114	100.00	100.00
Imports	0	0	0.00	0.00
Total	446'428	423'114	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.60: Unit process raw data of the electricity production mix in South Korea 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviation95%	GeneralComment
				KR 0 kWh			
product	electricity mix, domestic production	KR	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	JP	kWh	3.97E-1	1	1.05	(1,1,1,1,1,1); assumption for hard coal power production in South Korea, value: IEA statistics 2008
	electricity, industrial gas, at power plant	UCTE	kWh	3.39E-2	1	1.05	(1,1,1,3,1,1); assumption for industrial, coke and blast furnace gas power production in South Korea, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	kWh	3.35E-2	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in South Korea, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.00E-3	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in South Korea, value: IEA statistics 2008
	electricity, natural gas, at power plant	JP	kWh	1.83E-1	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in South Korea, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	1.44E-3	1	1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in South Korea: 20%
	electricity, hydropower, at run-of-river power plant	RER	kWh	5.75E-3	1	1.05	(1,1,1,3,1,1); estimated share of ROR hydropower production in South Korea: 80%
	electricity, hydropower, at pumped storage power plant	KR	kWh	5.83E-3	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in South Korea: 44.81%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	3.35E-1	1	1.05	(1,1,1,1,1,1); assumption for nuclear power production in South Korea using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	1.20E-3	1	1.05	(1,1,1,3,1,1); assumption for geothermal power production in South Korea, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	KR	kWh	6.33E-4	1	1.05	(1,1,1,1,1,1); assumption for solar power production in South Korea, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	8.99E-5	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in South Korea, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.02E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in South Korea, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	3.91E-4	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in South Korea, value: IEA statistics 2008

Tab. 3.61: Unit process raw data of the electricity supply mix in South Korea 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty StandardDe- viation95%	GeneralComment
				KR 0 kWh		
product	electricity mix	KR	kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	JP	kWh	3.97E-1	1	1.05 (1,1,1,1,1,1); assumption for hard coal power production in South Korea, value: IEA statistics 2008
	electricity, industrial gas, at power plant	UCTE	kWh	3.39E-2	1	1.05 (1,1,1,3,1,1); assumption for industrial, coke and blast furnace gas power production in South Korea, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	kWh	3.35E-2	1	1.05 (1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in South Korea, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.00E-3	1	1.05 (1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in South Korea, value: IEA statistics 2008
	electricity, natural gas, at power plant	JP	kWh	1.83E-1	1	1.05 (1,1,1,1,1,1); assumption for natural gas power production in South Korea, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	1.44E-3	1	1.05 (1,1,1,3,1,1); estimated share of reservoir hydropower production in South Korea: 20%
	electricity, hydropower, at run-of-river power plant	RER	kWh	5.75E-3	1	1.05 (1,1,1,3,1,1); estimated share of ROR hydropower production in South Korea: 80%
	electricity, hydropower, at pumped storage power plant	KR	kWh	5.83E-3	1	1.05 (1,1,1,1,1,1); estimated share of pumped storage production in South Korea: 44.81%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	3.35E-1	1	1.05 (1,1,1,1,1,1); assumption for nuclear power production in South Korea using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	1.20E-3	1	1.05 (1,1,1,3,1,1); assumption for geothermal power production in South Korea, value: IEA statistics
	electricity, production mix photovoltaic, at plant	KR	kWh	6.33E-4	1	1.05 (1,1,1,1,1,1); assumption for solar power production in South Korea, value: IEA statistics
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	8.99E-5	1	1.05 (1,1,1,3,1,1); assumption for cogeneration power production in South Korea, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.02E-3	1	1.05 (1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in South Korea, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	3.91E-4	1	1.05 (1,1,1,3,1,1); assumption for power production from municipal and industrial waste in South Korea, value: IEA statistics 2008

3.4.10 Chinese Taipei (TW)

Tab. 3.62 shows an overview over the Taiwanese electricity production according to the IEA Statistics (IEA 2010) the year 2008. The Taiwanese power production relies on fossil fuels, mainly hard coal (47 %), natural gas (19 %), petroleum products (6 %) and lignite (4 %) as main energy source. Further electricity is produced from nuclear power (17 %) and hydro power (3 %). No electricity is imported to Taiwan. Therefore, the production mix and the supply mix are identical.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.2 is taken into account. The share of run-of-river hydropower plants in Taiwan is 100 %. The share of the storage type hydropower plants is 0 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Taiwan is 0%.

Power production from nuclear power plants is approximated using the UCTE datasets for boiling water reactors and the Chinese dataset for pressure water reactors. These datasets reflect the conditions of nuclear power production using a mix of BWR (63 %) and PWR (37 %) power plants (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Chinese Taipei are shown Tab. 3.63 and Tab. 3.64.

Tab. 3.62: Composition of the Taiwanese electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	185'630	170'282	77.35	77.35
Hard coal	112'371	103'080	46.82	46.82
Lignite	10'630	9'751	4.43	4.43
Peat	0	0	0.00	0.00
Industrial Gases	2'050	1'881	0.85	0.85
<i>Coke gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Blast furnace gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Petroleum products	14'252	13'074	5.94	5.94
<i>Fuel oil</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Diesel</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>other petroleum products</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Natural Gas	46'327	42'497	19.30	19.30
Other fossil	0	0	0.00	0.00
Hydro	7'772	7'694	3.49	3.49
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	7'772	7'694	3.49	3.49
Pumped storage power plants	0	0	0.00	0.00
Nuclear	40'827	38'377	17.43	17.43
Pressurised-water reactor (PWR)	15'087	14'182	6.44	6.44
Boiling-water reactor (BWR)	25'740	24'196	10.99	10.99
Renewables	1'111	1'068	0.49	0.49
Geothermal	0	0	0.00	0.00
Solar	4	4	0.00	0.00
<i>Photovoltaic</i>	<i>4</i>	<i>4</i>	<i>0.00</i>	<i>0.00</i>
<i>Solar thermal</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Wave and tidal energy	0	0	0.00	0.00
Wind	589	589	0.27	0.27
Wood	518	475	0.22	0.22
Biogas	0	0	0.00	0.00
Waste	2'984	2'737	1.24	1.24
Municipal waste	2'984	2'737	1.24	1.24
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	238'324	220'159	100.00	100.00
Imports	0	0	0.00	0.00
Total	238'324	220'159	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.63: Unit process raw data of the electricity production mix in Chinese Taipei 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	Uncertainty Type	Standard Deviations 95%	General Comment			
								Location	Infrastructure	Process
								Unit		
product	electricity mix, domestic production	TW	kWh	1.00E+0						
technosphere	electricity, hard coal, at power plant	CN	kWh	4.68E-1	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Taiwan, value: IEA statistics 2008			
	electricity, lignite, at power plant	UCTE	kWh	4.43E-2	1	1.05	(1,1,1,3,1,1); assumption for lignite power production in Taiwan, value: IEA statistics 2008			
	electricity, industrial gas, at power plant	UCTE	kWh	8.54E-3	1	1.05	(1,1,1,3,1,1); assumption for industrial, coke and blast furnace gas power production in Taiwan, value: IEA statistics 2008			
	electricity, oil, at power plant	UCTE	kWh	5.94E-2	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Taiwan, value: IEA statistics 2008			
	electricity, natural gas, at power plant	UCTE	kWh	1.93E-1	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Taiwan, value: IEA statistics 2008			
	electricity, hydropower, at run-of-river power plant	RER	kWh	3.49E-2	1	1.05	(1,1,1,3,1,1); estimated share of ROR hydropower production in Taiwan: 100%			
	electricity, nuclear, at power plant pressure water reactor	CN	kWh	6.44E-2	1	1.05	(1,1,1,3,1,1); assumption for nuclear power production in Taiwan using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)			
	electricity, nuclear, at power plant boiling water reactor	UCTE	kWh	1.10E-1	1	1.05	(1,1,1,3,1,1); assumption for nuclear power production in Taiwan using BWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)			
	electricity, at wind power plant	RER	kWh	2.68E-3	1	1.05	(1,1,1,3,1,1); assumption for geothermal power production in Taiwan, value: IEA statistics 2008			
	electricity, production mix photovoltaic, at plant	KR	kWh	1.71E-5	1	1.05	(1,1,1,3,1,1); assumption for solar power production in Taiwan, value: IEA statistics 2008			
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	2.16E-3	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Taiwan, value: IEA statistics 2008			
	electricity from waste, at municipal waste incineration plant	CH	kWh	1.24E-2	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Taiwan, value: IEA statistics 2008			

Tab. 3.64: Unit process raw data of the electricity supply mix in Chinese Taipei 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty Type	Standard Deviations 95%	General Comment			
								Location	Infrastructure	Process
								Unit		
product	electricity mix	TW	kWh	1.00E+0						
technosphere	electricity, hard coal, at power plant	CN	kWh	4.68E-1	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Taiwan, value: IEA statistics 2008			
	electricity, lignite, at power plant	UCTE	kWh	4.43E-2	1	1.05	(1,1,1,3,1,1); assumption for lignite power production in Taiwan, value: IEA statistics 2008			
	electricity, industrial gas, at power plant	UCTE	kWh	8.54E-3	1	1.05	(1,1,1,3,1,1); assumption for industrial, coke and blast furnace gas power production in Taiwan, value: IEA statistics 2008			
	electricity, oil, at power plant	UCTE	kWh	5.94E-2	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Taiwan, value: IEA statistics 2008			
	electricity, natural gas, at power plant	UCTE	kWh	1.93E-1	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Taiwan, value: IEA statistics 2008			
	electricity, hydropower, at run-of-river power plant	RER	kWh	3.49E-2	1	1.05	(1,1,1,3,1,1); estimated share of ROR hydropower production in Taiwan: 100%			
	electricity, nuclear, at power plant pressure water reactor	CN	kWh	6.44E-2	1	1.05	(1,1,1,3,1,1); assumption for nuclear power production in Taiwan using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)			
	electricity, nuclear, at power plant boiling water reactor	UCTE	kWh	1.10E-1	1	1.05	(1,1,1,3,1,1); assumption for nuclear power production in Taiwan using BWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)			
	electricity, at wind power plant	RER	kWh	2.68E-3	1	1.05	(1,1,1,3,1,1); assumption for geothermal power production in Taiwan, value: IEA statistics 2008			
	electricity, production mix photovoltaic, at plant	KR	kWh	1.71E-5	1	1.05	(1,1,1,3,1,1); assumption for solar power production in Taiwan, value: IEA statistics 2008			
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	2.16E-3	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Taiwan, value: IEA statistics 2008			
	electricity from waste, at municipal waste incineration plant	CH	kWh	1.24E-2	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Taiwan, value: IEA statistics 2008			

3.4.11 Thailand (TH)

Tab. 3.62 shows an overview over the Thai electricity production according to the IEA Statistics (IEA 2010) the year 2008. The Thai power production relies on fossil fuels, mainly natural gas (69 %), lignite (12 %) and hard coal (9 %) as main energy source. Further electricity is produced from hydro power (5 %) and renewables, mainly wood (3 %). No electricity is imported to Thailand. Therefore, the production mix and the supply mix are identical. There are no nuclear power plants in Thailand (PRIS 2011). Therefore, the nuclear power production is zero.

The electricity production from hydro power is approximated using the Brazilian dataset for storage type hydropower production. It is assumed that 100 % of the electricity from hydropower comes from storage type hydropower plants. The share of pumped storage in Thailand is 0 %. The Brazilian dataset is used, because of the similar climatic conditions of Brazil and Thailand.

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Thailand are shown Tab. 3.63 and Tab. 3.64.

Tab. 3.65: Composition of the Thai electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	135'474	131'220	91.79	91.79
Hard coal	13'108	12'697	8.88	8.88
Lignite	18'418	17'839	12.48	12.48
Peat	0	0	0.00	0.00
Industrial Gases	0	0	0.00	0.00
<i>Coke gases</i>	0	0	0.00	0.00
<i>Blast furnace gases</i>	0	0	0.00	0.00
Petroleum products	1'662	1'610	1.13	1.13
<i>Fuel oil</i>	0	0	0.00	0.00
<i>Diesel</i>	0	0	0.00	0.00
<i>other petroleum products</i>	0	0	0.00	0.00
Natural Gas	102'286	99'074	69.31	69.31
Other fossil	0	0	0.00	0.00
Hydro	7'113	7'042	4.93	4.93
Reservoir power plants	7'113	7'042	4.93	4.93
Run-of-river power plants	0	0	0.00	0.00
Pumped storage power plants	0	0	0.00	0.00
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	4'840	4'688	3.28	3.28
Geothermal	2	2	0.00	0.00
Solar	3	3	0.00	0.00
<i>Photovoltaic</i>	3	3	0.00	0.00
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	0	0	0.00	0.00
Wood	4'795	4'644	3.25	3.25
Biogas	40	39	0.03	0.03
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	147'427	142'950	100.00	100.00
Imports	0	0	0.00	0.00
Total	147'427	142'950	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.66: Unit process raw data of the electricity production mix in Thailand 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	Uncertainty Type	Standard Deviation95 %	GeneralComment
	Location InfrastructureProcess Unit			TH 0 kWh			
	product	electricity mix, domestic production	TH	kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	UCTE	kWh	8.88E-2	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Thailand, value: IEA statistics 2008
	electricity, lignite, at power plant	UCTE	kWh	1.25E-1	1	1.05	(1,1,1,3,1,1); assumption for lignite power production in Thailand, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	kWh	1.13E-2	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Thailand, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE	kWh	6.93E-1	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Thailand, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant	BR	kWh	4.93E-2	1	1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in Thailand: 100%
	electricity, at wind power plant	RER	kWh	1.34E-5	1	1.05	(1,1,1,3,1,1); assumption for geothermal power production in Thailand, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	KR	kWh	1.97E-5	1	1.05	(1,1,1,3,1,1); assumption for solar power production in Thailand, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	3.25E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Thailand, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	2.71E-4	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Thailand, value: IEA statistics 2008

Tab. 3.67: Unit process raw data of the electricity supply mix in Thailand 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty Type	Standard Deviation95 %	GeneralComment
	Location InfrastructureProcess Unit			TH 0 kWh			
	product	electricity mix	TH	kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	UCTE	kWh	8.88E-2	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Thailand, value: IEA statistics 2008
	electricity, lignite, at power plant	UCTE	kWh	1.25E-1	1	1.05	(1,1,1,3,1,1); assumption for lignite power production in Thailand, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	kWh	1.13E-2	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Thailand, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE	kWh	6.93E-1	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Thailand, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant	BR	kWh	4.93E-2	1	1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in Thailand: 100%
	electricity, at wind power plant	RER	kWh	1.34E-5	1	1.05	(1,1,1,3,1,1); assumption for geothermal power production in Thailand, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	KR	kWh	1.97E-5	1	1.05	(1,1,1,3,1,1); assumption for solar power production in Thailand, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	3.25E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Thailand, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	2.71E-4	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Thailand, value: IEA statistics 2008

3.5 Europe

3.5.1 Austria (AT)

Tab. 3.68 shows an overview of the Austrian electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Austrian power production relies on hydropower (48 %) as main energy source. Further electricity is produced from fossil fuels, mainly natural gas (12 %) and hard coal (6 %), and from Renewables, mainly Wood (3 %) and Wind (2 %). A share of about 24 % of the electricity is imported from Germany, the Czech Republic, Slovenia, Hungary, Switzerland and Italy.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Austria is 75 %, the share of the storage type hydropower plants is 25 %. The storage type hydropower production is approximated using the dataset for alpine conditions. The share of the pumped storage hydropower production in Austria is 7 % of the hydro power production.

There are no nuclear power plants in Austria (PRIS 2011). Therefore, the nuclear power production is zero.

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Austria are shown in Tab. 3.69 and Tab. 3.70.

Tab. 3.68: Composition of the Austrian electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	19'345	16'766	26.43	20.14
Hard coal	5'524	4'788	7.55	5.75
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	1'374	1'191	1.88	1.43
<i>Coke gases</i>	228	198	0.31	0.24
<i>Blast furnace gases</i>	1'146	993	1.57	1.19
Petroleum products	1'243	1'077	1.70	1.29
<i>Fuel oil</i>	544	471	0.74	0.57
<i>Diesel</i>	9	8	0.01	0.01
<i>other petroleum products</i>	690	598	0.94	0.72
Natural Gas	11'204	9'711	15.31	11.67
Other fossil	0	0	0.00	0.00
Hydro	40'678	40'271	63.48	48.38
Reservoir power plants	9'487	9'392	14.80	11.28
Run-of-river power plants	28'460	28'175	44.41	33.85
Pumped storage power plants	2'732	2'705	4.26	3.25
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	6'289	5'721	9.02	6.87
Geothermal	2	2	0.00	0.00
Solar	28	26	0.04	0.03
<i>Photovoltaic</i>	28	26	0.04	0.03
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	2'014	2'014	3.17	2.42
Wood	3'259	2'825	4.45	3.39
Biogas	986	855	1.35	1.03
Waste	772	669	1.05	0.80
Municipal waste	363	315	0.50	0.38
Industrial waste	390	338	0.53	0.41
Sewage sludge and landfill gases	19	16	0.03	0.02
Other	17	15	0.02	0.02
Total domestic	67'101	63'443	100.00	76.22
Imports	0	19'796	0.00	23.78
Czech Republic	0	5'336	0.00	6.41
Germany	0	12'757	0.00	15.33
Hungary	0	722	0.00	0.87
Italy	0	2	0.00	0.00
Slovenia	0	873	0.00	1.05
Switzerland	0	106	0.00	0.13
Total	67'101	83'239	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.69: Unit process raw data of the electricity production mix in Austria 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviation85 %	GeneralComment			
								Location	InfrastructureProcess	Unit
								AT	0	kWh
product	electricity mix, domestic production	AT	kWh	1.00E+0						
technosphere	electricity, hard coal, at power plant	AT	kWh	7.55E-2	1	1.05	(1,1,1,1,1,1); assumption for hard coal power production in Austria, value: IEA statistics 2008			
	electricity, industrial gas , at power plant	AT	kWh	1.88E-2	1	1.05	(1,1,1,1,1,1); assumption for industrial, coke and blast furnace gas power production in Austria, value: IEA statistics 2008			
	electricity, oil, at power plant	AT	kWh	1.69E-2	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Austria, value: IEA statistics 2008			
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.23E-4	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Austria, value: IEA statistics 2008			
	electricity, natural gas, at power plant	AT	kWh	1.53E-1	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Austria, value: IEA statistics 2008			
	electricity, hydropower, at reservoir power plant, alpine region	RER	kWh	1.48E-1	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Austria: 25%			
	electricity, hydropower, at run-of-river power plant	RER	kWh	4.44E-1	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Austria: 75%			
	electricity, hydropower, at pumped storage power plant	AT	kWh	4.26E-2	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Austria: 6.72%			
	electricity, at wind power plant	RER	kWh	3.20E-2	1	1.05	(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in Austria, value: IEA statistics 2008			
	electricity, production mix photovoltaic, at plant	AT	kWh	4.15E-4	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Austria, value: IEA statistics 2008			
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	4.45E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Austria, value: IEA statistics 2008			
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.37E-2	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Austria, value: IEA statistics 2008			
	electricity from waste, at municipal waste incineration plant	CH	kWh	1.03E-2	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Austria, value: IEA statistics 2008			

Tab. 3.70: Unit process raw data of the electricity supply mix in Austria 2008, at busbar

product technosphere	Name	Location	Unit	electricity mix	Uncertainty	StandardDeviations%	GeneralComment
	Location			AT			
	InfrastructureProcess			0			
	Unit			kWh			
	electricity mix	AT	kWh	1.00E+0			
	electricity, hard coal, at power plant	AT	kWh	5.75E-2	1	1.05	(1,1,1,1,1,1); assumption for hard coal power production in Austria, value: IEA statistics 2008
	electricity, industrial gas, at power plant	AT	kWh	1.88E-2	1	1.05	(1,1,1,1,1,1); assumption for industrial, coke and blast furnace gas power production in Austria, value: IEA statistics 2008
	electricity, oil, at power plant	AT	kWh	1.28E-2	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Austria, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	9.37E-5	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Austria, value: IEA statistics 2008
	electricity, natural gas, at power plant	AT	kWh	1.17E-1	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Austria, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, alpine region	RER	kWh	1.13E-1	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Austria: 25%
	electricity, hydropower, at run-of-river power plant	RER	kWh	3.38E-1	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Austria: 75%
	electricity, hydropower, at pumped storage power plant	AT	kWh	3.25E-2	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Austria: 6.72%
	electricity, at wind power plant	RER	kWh	2.44E-2	1	1.05	(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in Austria, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	AT	kWh	3.16E-4	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Austria, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	3.39E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Austria, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.05E-2	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Austria, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	7.84E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Austria, value: IEA statistics 2008
	electricity mix, domestic production	CZ	kWh	6.41E-2	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Austria, value: IEA statistics 2008
	electricity mix, domestic production	DE	kWh	1.53E-1	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Austria, value: IEA statistics 2008
	electricity mix, domestic production	HU	kWh	8.67E-3	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Austria, value: IEA statistics 2008
	electricity mix, domestic production	IT	kWh	2.40E-5	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Austria, value: IEA statistics 2008
	electricity mix, domestic production	SI	kWh	1.05E-2	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Austria, value: IEA statistics 2008
	electricity mix, domestic production	CH	kWh	1.27E-3	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Austria, value: IEA statistics 2008

3.5.2 Belgium (BE)

Tab. 3.71 shows an overview of the Belgian electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Belgian power production relies on nuclear power as main energy source (45 %). Further electricity is produced from fossil fuels, mainly natural gas (23 %) and hard coal, and renewables, mainly wind (2 %). A share of about 18 % of the electricity is imported from the Netherlands, France and Luxembourg.

For the approximation of the hydropower the European dataset for run-of-river is used. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Belgium is 100 % and the share of the pumped storage hydropower production is 77 %.

Power production from nuclear power plants is approximated using the French dataset of pressurised water reactors. This datasets reflects the conditions of nuclear power production using only PWR plants (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Belgium are shown Tab. 3.72 and Tab. 3.73.

Tab. 3.71: Composition of the Belgian electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	32'287	29'073	37.04	30.39
Hard coal	5'547	4'995	6.36	5.22
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	1'688	1'520	1.94	1.59
<i>Coke gases</i>	72	65	0.08	0.07
<i>Blast furnace gases</i>	1'616	1'455	1.85	1.52
Petroleum products	406	366	0.47	0.38
<i>Fuel oil</i>	352	317	0.40	0.33
<i>Diesel</i>	54	49	0.06	0.05
<i>other petroleum products</i>	0	0	0.00	0.00
Natural Gas	24'646	22'193	28.27	23.20
Other fossil	0	0	0.00	0.00
Hydro	1'757	1'739	2.22	1.82
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	410	406	0.52	0.42
Pumped storage power plants	1'347	1'334	1.70	1.39
Nuclear	45'568	42'834	54.57	44.78
Pressurised-water reactor (PWR)	45'568	42'834	54.57	44.78
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	3'452	3'173	4.04	3.32
Geothermal	0	0	0.00	0.00
Solar	42	39	0.00	0.00
<i>Photovoltaic</i>	42	39	0.05	0.04
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	637	637	0.81	0.67
Wood	2'485	2'238	2.85	2.34
Biogas	288	259	0.33	0.27
Waste	1'620	1'459	1.86	1.52
Municipal waste	1'029	927	1.18	0.97
Industrial waste	405	365	0.46	0.38
Sewage sludge and landfill gases	186	167	0.21	0.18
Other	246	222	0.28	0.23
Total domestic	84'930	78'500	100.00	82.06
Imports	0	17'158	0.00	17.94
France	0	7'411	0.00	7.75
Luxembourg	0	1'629	0.00	1.70
Netherlands	0	8'118	0.00	8.49
Total	84'930	95'658	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.72: Unit process raw data of the electricity production mix in Belgium 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production		GeneralComment	
				UncertaintyType	StandardDeviation95%		
							BE
Location	InfrastructureProcess	Unit	BE	0			
product	electricity mix, domestic production	BE	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	BE	kWh	6.36E-2	1	1.05	(1,1,1,1,1,1); assumption for hard coal power production in Belgium, value: IEA statistics 2008
	electricity, industrial gas, at power plant	BE	kWh	1.94E-2	1	1.05	(1,1,1,1,1,1); assumption for industrial, coke and blast furnace gas power production in Belgium, value: IEA statistics 2008
	electricity, oil, at power plant	BE	kWh	4.04E-3	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Belgium, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	6.19E-4	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Belgium, value: IEA statistics 2008
	electricity, natural gas, at power plant	BE	kWh	2.83E-1	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Belgium, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	5.17E-3	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Belgium: 100%
	electricity, hydropower, at pumped storage power plant	BE	kWh	1.70E-2	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Belgium: 76.66%
	electricity, nuclear, at power plant pressure water reactor	FR	kWh	5.46E-1	1	1.05	(1,1,1,3,1,1); assumption for nuclear power production in Belgium using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	1.09E-2	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Belgium, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	BE	kWh	5.03E-4	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Belgium, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	2.85E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Belgium, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	5.44E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Belgium, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	1.64E-2	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Belgium, value: IEA statistics 2008

Tab. 3.73: Unit process raw data of the electricity supply mix in Belgium 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty Standard Deviations%	GeneralComment
	Location			BE		
	InfrastructureProcess			0		
	Unit			kWh		
product	electricity mix	BE	kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	BE	kWh	5.22E-2	1 1.05	(1,1,1,1,1,1); assumption for hard coal power production in Belgium, value: IEA statistics 2008
	electricity, industrial gas, at power plant	BE	kWh	1.59E-2	1 1.05	(1,1,1,1,1,1); assumption for industrial, coke and blast furnace gas power production in Belgium, value: IEA statistics 2008
	electricity, oil, at power plant	BE	kWh	3.31E-3	1 1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Belgium, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	5.08E-4	1 1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Belgium, value: IEA statistics 2008
	electricity, natural gas, at power plant	BE	kWh	2.32E-1	1 1.05	(1,1,1,1,1,1); assumption for natural gas power production in Belgium, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	4.24E-3	1 1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Belgium: 100%
	electricity, hydropower, at pumped storage power plant	BE	kWh	1.39E-2	1 1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Belgium: 76.66%
	electricity, nuclear, at power plant pressure water reactor	FR	kWh	4.48E-1	1 1.05	(1,1,1,3,1,1); assumption for nuclear power production in Belgium using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	8.97E-3	1 1.05	(1,1,1,2,1,1); assumption for geothermal power production in Belgium, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	BE	kWh	4.13E-4	1 1.05	(1,1,1,1,1,1); assumption for solar power production in Belgium, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	2.34E-2	1 1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Belgium, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	4.46E-3	1 1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Belgium, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	1.35E-2	1 1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Belgium, value: IEA statistics 2008
	electricity mix, domestic production	FR	kWh	7.75E-2	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Belgium, value: IEA statistics 2008
	electricity mix, domestic production	LU	kWh	1.70E-2	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Belgium, value: IEA statistics 2008
electricity mix, domestic production	NL	kWh	8.49E-2	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Belgium, value: IEA statistics 2008	

3.5.3 Bosnia and Herzegovina (BA)

Tab. 3.74 shows an overview over the Bosnian electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Bosnian power production relies on fossil fuels, mainly hard coal (31 %) and lignite (18 %), as main energy source. Further electricity is produced from hydro power (29 %). A share of about 21.5 % of the electricity is imported from Croatia (90 %) and Serbia (10 %) according to UCTE (2005). There are no nuclear power plants in Bosnia and Herzegovina (PRIS 2011). Therefore, the nuclear power production is zero.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Bosnia and Herzegovina is 65 % and the share of storage type hydropower plants is 35 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Bosnia and Herzegovina is 0 %.

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Bosnia and Herzegovina are shown Tab. 3.75 and Tab. 3.76.

Tab. 3.74: Composition of the Bosnian electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	8'709	7'729	63.17	49.58
Hard coal	5'374	4'769	38.98	30.59
Lignite	3'122	2'771	22.65	17.77
Peat	0	0	0.00	0.00
Industrial Gases	40	36	0.29	0.23
<i>Coke gases</i>	0	0	0.00	0.00
<i>Blast furnace gases</i>	0	0	0.00	0.00
Petroleum products	173	154	1.25	0.98
<i>Fuel oil</i>	0	0	0.00	0.00
<i>Diesel</i>	0	0	0.00	0.00
<i>other petroleum products</i>	0	0	0.00	0.00
Natural Gas	0	0	0.00	0.00
Other fossil	0	0	0.00	0.00
Hydro	4'552	4'506	36.83	28.91
Reservoir power plants	1'593	1'577	12.89	10.12
Run-of-river power plants	2'959	2'929	23.94	18.79
Pumped storage power plants	0	0	0.00	0.00
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	0	0	0.00	0.00
Geothermal	0	0	0.00	0.00
Solar	0	0	0.00	0.00
<i>Photovoltaic</i>	0	0	0.00	0.00
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	0	0	0.00	0.00
Wood	0	0	0.00	0.00
Biogas	0	0	0.00	0.00
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	13'261	12'236	100.00	78.49
Imports	0	3'354	0.00	21.51
Serbia and Montenegro	0	3'019	0.00	19.36
Kroatia	0	335	0.00	2.15
Total	13'261	15'590	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.75: Unit process raw data of the electricity production mix in Bosnia and Herzegovina 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviations%	GeneralComment
	Location						
	InfrastructureProcess						
	Unit						
product	electricity mix, domestic production	BA	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	HR	kWh	3.90E-1	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Bosnia and Herzegovina, value: IEA
	electricity, lignite, at power plant	BA	kWh	2.26E-1	1	1.05	(1,1,1,3,1,1); assumption for lignite power production in Bosnia and Herzegovina, value: IEA statistics
	electricity, industrial gas, at power plant	CENTREL	kWh	2.90E-3	1	1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Bosnia and Herzegovina, value: IEA statistics 2008
	electricity, oil, at power plant	HR	kWh	1.25E-2	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Bosnia and Herzegovina, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	1.29E-1	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Bosnia and Herzegovina:
	electricity, hydropower, at run-of-river power plant	RER	kWh	2.39E-1	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Bosnia and Herzegovina: 65%

Tab. 3.76: Unit process raw data of the electricity supply mix in Bosnia and Herzegovina 2008, at busbar

	Name	Location	Unit	electricity mix	UncertaintyType	StandardDeviations%	GeneralComment
	Location						
	InfrastructureProcess						
	Unit						
product	electricity mix	BA	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	HR	kWh	3.06E-1	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Bosnia and Herzegovina, value: IEA
	electricity, lignite, at power plant	BA	kWh	1.78E-1	1	1.05	(1,1,1,3,1,1); assumption for lignite power production in Bosnia and Herzegovina, value: IEA
	electricity, industrial gas, at power plant	CENTREL	kWh	2.28E-3	1	1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Bosnia and Herzegovina, value: IEA statistics 2008
	electricity, oil, at power plant	HR	kWh	9.85E-3	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Bosnia and Herzegovina, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	1.01E-1	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Bosnia and
	electricity, hydropower, at run-of-river power plant	RER	kWh	1.88E-1	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Bosnia and
	electricity mix, domestic production	CS	kWh	1.94E-1	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Bosnia and Herzegovina, value: IEA statistics
	electricity mix, domestic production	HR	kWh	2.15E-2	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Bosnia and Herzegovina, value: IEA statistics

3.5.4 Bulgaria (BG)

Tab. 3.77 shows an overview over the Bulgarian electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Bulgarian power production relies on fossil fuels, mainly lignite (34 %), hard coal (12 %) and natural gas (5 %), as main energy source. Further electricity is produced from nuclear power (34 %) and hydro power (7 %). A share of about 7.1 % of the electricity is imported. It is assumed that 100 % of the electricity is imported from Romania.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Bulgaria is 100 % and the share of the storage type hydropower plants is 0 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Bulgaria is 0 %.

Power production from nuclear power plants is approximated using the UCTE dataset for pressurised reactors. This datasets reflects the conditions of nuclear power production using PWR power plants onl (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Bulgaria are shown in Tab. 3.78 and Tab. 3.79.

Tab. 3.77: Composition of the Bulgarian electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	25'857	22'223	54.98	51.06
Hard coal	6'037	5'189	12.84	11.92
Lignite	17'143	14'733	36.45	33.85
Peat	0	0	0.00	0.00
Industrial Gases	40	34	0.09	0.08
<i>Coke gases</i>	0	0	0.00	0.00
<i>Blast furnace gases</i>	0	0	0.00	0.00
Petroleum products	277	238	0.59	0.55
<i>Fuel oil</i>	0	0	0.00	0.00
<i>Diesel</i>	0	0	0.00	0.00
<i>other petroleum products</i>	0	0	0.00	0.00
Natural Gas	2'360	2'028	5.02	4.66
Other fossil	0	0	0.00	0.00
Hydro	3'277	3'244	8.03	7.45
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	3'277	3'244	8.03	7.45
Pumped storage power plants	0	0	0.00	0.00
Nuclear	15'765	14'819	36.66	34.05
Pressurised-water reactor (PWR)	15'765	14'819	36.66	34.05
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	122	122	0.30	0.28
Geothermal	0	0	0.00	0.00
Solar	0	0	0.00	0.00
<i>Photovoltaic</i>	0	0	0.00	0.00
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	122	122	0.30	0.28
Wood	0	0	0.00	0.00
Biogas	0	0	0.00	0.00
Waste	16	14	0.03	0.03
Municipal waste	0	0	0.00	0.00
Industrial waste	16	14	0.03	0.03
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	45'037	40'422	100.00	92.88
Imports	0	3'097	0.00	7.12
Romania	0	3'097	0.00	7.12
Total	45'037	43'519	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.78: Unit process raw data of the electricity production mix in Bulgaria 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production		
				UncertaintyType	StandardDeviations%	GeneralComment
Location	InfrastructureProcess	Unit				
product	electricity mix, domestic production	BG	kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	CENTREL	kWh	1.28E-1	1	1.05 (1,1,1,3,1,1); assumption for hard coal power production in Bulgaria, value: IEA statistics 2008
	electricity, lignite, at power plant	CENTREL	kWh	3.64E-1	1	1.05 (1,1,1,3,1,1); assumption for lignite power production in Bulgaria, value: IEA statistics 2008
	electricity, industrial gas, at power plant	CENTREL	kWh	8.50E-4	1	1.05 (1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Bulgaria, value: IEA statistics 2008
	electricity, oil, at power plant	SK	kWh	5.89E-3	1	1.05 (1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Bulgaria, value: IEA statistics 2008
	electricity, natural gas, at power plant	CENTREL	kWh	5.02E-2	1	1.05 (1,1,1,1,1,1); assumption for natural gas power production in Bulgaria, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	8.03E-2	1	1.05 (1,1,1,2,1,1); estimated share of ROR hydropower production in Bulgaria: 100%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	3.67E-1	1	1.05 (1,1,1,2,1,1); assumption for nuclear power production in Bulgaria using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	3.02E-3	1	1.05 (1,1,1,2,1,1); assumption for geothermal power production in Bulgaria, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	3.40E-4	1	1.05 (1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Bulgaria, value: IEA statistics 2008

Tab. 3.79: Unit process raw data of the electricity supply mix in Bulgaria 2008, at busbar

	Name	Location	Unit	electricity mix		
				UncertaintyType	StandardDeviations%	GeneralComment
Location	InfrastructureProcess	Unit				
product	electricity mix	BG	kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	CENTREL	kWh	1.19E-1	1	1.05 (1,1,1,3,1,1); assumption for hard coal power production in Bulgaria, value: IEA statistics 2008
	electricity, lignite, at power plant	CENTREL	kWh	3.39E-1	1	1.05 (1,1,1,3,1,1); assumption for lignite power production in Bulgaria, value: IEA statistics 2008
	electricity, industrial gas, at power plant	CENTREL	kWh	7.90E-4	1	1.05 (1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Bulgaria, value: IEA statistics 2008
	electricity, oil, at power plant	SK	kWh	5.47E-3	1	1.05 (1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Bulgaria, value: IEA statistics 2008
	electricity, natural gas, at power plant	CENTREL	kWh	4.66E-2	1	1.05 (1,1,1,1,1,1); assumption for natural gas power production in Bulgaria, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	7.45E-2	1	1.05 (1,1,1,2,1,1); estimated share of ROR hydropower production in Bulgaria: 100%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	3.41E-1	1	1.05 (1,1,1,2,1,1); assumption for nuclear power production in Bulgaria using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	2.80E-3	1	1.05 (1,1,1,2,1,1); assumption for geothermal power production in Bulgaria, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	3.16E-4	1	1.05 (1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Bulgaria, value: IEA statistics 2008
	electricity mix, domestic production	RO	kWh	7.12E-2	1	1.05 (1,1,1,1,1,1); assumption for imported electricity in Bulgaria, value: IEA statistics 2008

3.5.5 Croatia (HR)

Tab. 3.80 shows an overview of the Croatian electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Croatian power production relies on fossil fuels, mainly natural gas (11 %), fuel oil (9 %) and hard coal (7 %), as main energy source. Further electricity is produced from hydro power (27 %). A share of about 41 % of the electricity is imported. It is assumed that 66 % of the electricity is imported from Hungary, 33 % from Slovenia and 1 % for Serbia.

There are no nuclear power plants in Croatia (PRIS 2011). Therefore, the nuclear power production is zero.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Croatia is 2 % and the share of the storage type hydropower plants is 98 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Croatia is 8 %.

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Croatia are shown in Tab. 3.81 and Tab. 3.82.

Tab. 3.80: Composition of the Croatian electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	6'939	6'341	54.41	32.00
Hard coal	1'571	1'435	12.32	7.24
Lignite	913	834	7.16	4.21
Peat	0	0	0.00	0.00
Industrial Gases	12	11	0.09	0.05
<i>Coke gases</i>	0	0	0.00	0.00
<i>Blast furnace gases</i>	0	0	0.00	0.00
Petroleum products	1'985	1'814	15.57	9.15
<i>Fuel oil</i>	0	0	0.00	0.00
<i>Diesel</i>	0	0	0.00	0.00
<i>other petroleum products</i>	0	0	0.00	0.00
Natural Gas	2'459	2'247	19.28	11.34
Other fossil	0	0	0.00	0.00
Hydro	5'326	5'273	45.24	26.61
Reservoir power plants	4'802	4'754	40.79	23.99
Run-of-river power plants	98	97	0.83	0.49
Pumped storage power plants	426	422	3.62	2.13
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	40	40	0.34	0.20
Geothermal	0	0	0.00	0.00
Solar	0	0	0.00	0.00
<i>Photovoltaic</i>	0	0	0.00	0.00
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	40	40	0.34	0.20
Wood	0	0	0.00	0.00
Biogas	0	0	0.00	0.00
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	12'326	11'654	100.00	58.81
Imports	0	8'164	0.00	41.19
Hungary	0	5'388	0.00	27.19
Slovenia	0	2'694	0.00	13.59
Serbia and Montenegro	0	82	0.00	0.41
Total	12'326	19'818	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.81: Unit process raw data of the electricity production mix in Croatia 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviation95%	GeneralComment					
								Location	Unit	HR	0	kWh
								InfrastructureProcess	Unit			
product	electricity mix, domestic production	HR	kWh	1.00E+0								
technosphere	electricity, hard coal, at power plant	HR	kWh	1.23E-1	1	1.05	(1,1,1,1,1,1); assumption for hard coal power production in Croatia, value: IEA statistics 2008					
	electricity, lignite, at power plant	BA	kWh	7.16E-2	1	1.05	(1,1,1,3,1,1); assumption for lignite power production in Croatia, value: IEA statistics 2008					
	electricity, industrial gas, at power plant	CENTREL	kWh	9.17E-4	1	1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Croatia, value: IEA statistics 2008					
	electricity, oil, at power plant	HR	kWh	1.56E-1	1	1.05	(1,1,1,2,1,1); assumption for petroleum product and fuel oil power production in Croatia, value: IEA statistics 2008					
	electricity, natural gas, at power plant	CENTREL	kWh	1.93E-1	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Croatia, value: IEA statistics 2008					
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	4.08E-1	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Croatia: 98%					
	electricity, hydropower, at run-of-river power plant	RER	kWh	8.32E-3	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Croatia: 2%					
	electricity, hydropower, at pumped storage power plant	HR	kWh	3.62E-2	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Croatia: 8%					
	electricity, at wind power plant	RER	kWh	3.43E-3	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Croatia, value: IEA statistics 2008					

Tab. 3.82: Unit process raw data of the electricity supply mix in Croatia 2008, at busbar

	Name	Location	Unit	electricity mix	UncertaintyType	StandardDeviation95%	GeneralComment					
								Location	Unit	HR	0	kWh
								InfrastructureProcess	Unit			
product	electricity mix	HR	kWh	1.00E+0								
technosphere	electricity, hard coal, at power plant	HR	kWh	7.24E-2	1	1.05	(1,1,1,1,1,1); assumption for hard coal power production in Croatia, value: IEA statistics 2008					
	electricity, lignite, at power plant	BA	kWh	4.21E-2	1	1.05	(1,1,1,3,1,1); assumption for lignite power production in Croatia, value: IEA statistics 2008					
	electricity, industrial gas, at power plant	CENTREL	kWh	5.40E-4	1	1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Croatia, value: IEA statistics 2008					
	electricity, oil, at power plant	HR	kWh	9.15E-2	1	1.05	(1,1,1,2,1,1); assumption for petroleum product and fuel oil power production in Croatia, value: IEA statistics 2008					
	electricity, natural gas, at power plant	CENTREL	kWh	1.13E-1	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Croatia, value: IEA statistics 2008					
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	2.40E-1	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Croatia: 98%					
	electricity, hydropower, at run-of-river power plant	RER	kWh	4.90E-3	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Croatia: 2%					
	electricity, hydropower, at pumped storage power plant	HR	kWh	2.13E-2	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Croatia: 8%					
	electricity, at wind power plant	RER	kWh	2.02E-3	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Croatia, value: IEA statistics 2008					
	electricity mix, domestic production	HU	kWh	2.72E-1	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Croatia, value: IEA statistics 2008					
	electricity mix, domestic production	SI	kWh	1.36E-1	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Croatia, value: IEA statistics 2008					
	electricity mix, domestic production	CS	kWh	4.12E-3	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Croatia, value: IEA statistics 2008					

3.5.6 Czech Republic (CZ)

Tab. 3.83 shows an overview over the Czech electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Czech power production relies on lignite as main energy source (45 %). Further electricity is produced from nuclear power (30 %) and from hydro power (3 %). A share of about 10 % of the electricity is imported. The electricity is mainly imported from Poland.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in the Czech Republic is 75 % and the share of the storage type hydropower plants is 25 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of the pumped storage hydropower production in the Czech Republic is 15 %.

Power production from nuclear power plants is approximated using the European dataset for pressurised water reactors. This datasets reflects the conditions of nuclear power production using only PWR plants (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Czech Republic are shown Tab. 3.84 and Tab. 3.85.

Tab. 3.83: Composition of the Czech electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	52'873	46'956	61.93	55.67
Hard coal	5'794	5'146	6.79	6.10
Lignite	42'984	38'173	50.35	45.26
Peat	0	0	0.00	0.00
Industrial Gases	1'045	928	1.22	1.10
Coke gases	283	251	0.33	0.30
Blast furnace gases	762	677	0.89	0.80
Petroleum products	131	116	0.15	0.14
Fuel oil	122	108	0.14	0.13
Diesel	9	8	0.01	0.01
other petroleum products	0	0	0.00	0.00
Natural Gas	2'919	2'592	3.42	3.07
Other fossil	0	0	0.00	0.00
Hydro	2'376	2'352	3.10	2.79
Reservoir power plants	506	501	0.66	0.59
Run-of-river power plants	1'518	1'503	1.98	1.78
Pumped storage power plants	352	348	0.46	0.41
Nuclear	26'551	24'958	32.92	29.59
Pressurised-water reactor (PWR)	26'551	24'958	32.92	29.59
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	1'522	1'380	1.82	1.64
Geothermal	0	0	0.00	0.00
Solar	13	12	0.02	0.01
Photovoltaic	13	12	0.02	0.01
Solar thermal	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	245	245	0.32	0.29
Wood	1'171	1'040	1.37	1.23
Biogas	93	83	0.11	0.10
Waste	195	173	0.23	0.21
Municipal waste	19	17	0.02	0.02
Industrial waste	2	2	0.00	0.00
Sewage sludge and landfill gases	174	155	0.20	0.18
Other	1	1	0.00	0.00
Total domestic	83'518	75'820	100.00	89.90
Imports	0	8'520	0.00	10.10
Non-specified/Others	0	1'679	0.00	1.99
Poland	0	6'841	0.00	8.11
Total	83'518	84'340	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.84: Unit process raw data of the electricity production mix in the Czech Republic 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviation95%	GeneralComment
product	electricity mix, domestic production	CZ	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	CZ	kWh	6.79E-2	1	1.05	(1,1,1,1,1,1); assumption for hard coal power production in Czech Republic, value: IEA statistics 2008
	electricity, lignite, at power plant	CZ	kWh	5.03E-1	1	1.05	(1,1,1,1,1,1); assumption for lignite power production in Czech Republic, value: IEA statistics 2008
	electricity, industrial gas, at power plant	CENTREL	kWh	1.22E-2	1	1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Czech Republic, value: IEA statistics 2008
	electricity, oil, at power plant	CZ	kWh	1.43E-3	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Czech Republic, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.05E-4	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Czech Republic, value: IEA statistics 2008
	electricity, natural gas, at power plant	CENTREL	kWh	3.42E-2	1	1.05	(1,1,1,2,1,1); assumption for natural gas power production in Czech Republic, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	6.61E-3	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Czech Republic: 25%
	electricity, hydropower, at run-of-river power plant	RER	kWh	1.98E-2	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Czech Republic: 75%
	electricity, hydropower, at pumped storage power plant	CZ	kWh	4.60E-3	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Czech Republic: 14.81%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	3.29E-1	1	1.05	(1,1,1,2,1,1); assumption for nuclear power production in Czech Republic using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	3.24E-3	1	1.05	(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in Czech Republic, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	CZ	kWh	1.61E-4	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Czech Republic, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.37E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Czech Republic, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	3.13E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Czech Republic, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	2.46E-4	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial in Czech Republic, value: IEA statistics 2008

Tab. 3.85: Unit process raw data of the electricity supply mix in Czech Republic 2008, at busbar

Name	Location	Unit	electricity mix	Uncertainty Standard Deviation 95%	General Comment					
						Location	Unit	electricity mix	Uncertainty Standard Deviation 95%	General Comment
						InfrastructureProcess	Unit	CZ 0 kWh		
product										
electricity mix	CZ	kWh	1.00E+0							
technosphere										
electricity, hard coal, at power plant	CZ	kWh	6.10E-2	1 1.05	(1,1,1,1,1,1); assumption for hard coal power production in Czech Republic, value: IEA statistics 2008					
electricity, lignite, at power plant	CZ	kWh	4.53E-1	1 1.05	(1,1,1,1,1,1); assumption for lignite power production in Czech Republic, value: IEA statistics 2008					
electricity, industrial gas, at power plant	CENTREL	kWh	1.10E-2	1 1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Czech Republic, value: IEA statistics 2008					
electricity, oil, at power plant	CZ	kWh	1.28E-3	1 1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Czech Republic, value: IEA statistics 2008					
electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	9.48E-5	1 1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Czech Republic, value: IEA statistics 2008					
electricity, natural gas, at power plant	CENTREL	kWh	3.07E-2	1 1.05	(1,1,1,2,1,1); assumption for natural gas power production in Czech Republic, value: IEA statistics 2008					
electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	5.94E-3	1 1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Czech Republic: 25%					
electricity, hydropower, at run-of-river power plant	RER	kWh	1.78E-2	1 1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Czech Republic: 75%					
electricity, hydropower, at pumped storage power plant	CZ	kWh	4.13E-3	1 1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Czech Republic: 14.81%					
electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	2.96E-1	1 1.05	(1,1,1,2,1,1); assumption for nuclear power production in Czech Republic using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)					
electricity, at wind power plant	RER	kWh	2.92E-3	1 1.05	(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in Czech Republic, value: IEA statistics 2008					
electricity, production mix photovoltaic, at plant	CZ	kWh	1.45E-4	1 1.05	(1,1,1,1,1,1); assumption for solar power production in Czech Republic, value: IEA statistics 2008					
electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.23E-2	1 1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Czech Republic, value: IEA statistics 2008					
electricity, at cogen with biogas engine, allocation exergy	CH	kWh	2.81E-3	1 1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Czech Republic, value: IEA statistics 2008					
electricity from waste, at municipal waste incineration plant	CH	kWh	2.21E-4	1 1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial in Czech Republic, value: IEA statistics 2008					
electricity mix, domestic production	DE	kWh	1.99E-2	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Czech Republic, value: IEA statistics 2008					
electricity mix, domestic production	PL	kWh	8.11E-2	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Czech Republic, value: IEA statistics 2008					

3.5.7 Denmark (DK)

Tab. 3.86 shows an overview over the Danish electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Danish power production relies on hard coal as main energy source (35 %). Further electricity is produced from wind power (15 %) and from natural gas (14 %). A share of about 27 % of the electricity is imported. The electricity is mainly imported from Germany, Norway and Sweden.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Denmark is 100 % and the share of the storage type hydropower plants is 0 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of the pumped storage hydropower production in Denmark is 0 %.

In Denmark there no operating nuclear reactors according to the PRIS database (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Denmark are shown Tab. 3.87 and Tab. 3.88.

Tab. 3.86: Composition of the Danish electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	25'515	24'045	69.30	50.61
Hard coal	17'457	16'452	47.42	34.63
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	0	0	0.00	0.00
<i>Coke gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Blast furnace gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Petroleum products	1'131	1'066	3.07	2.24
<i>Fuel oil</i>	<i>916</i>	<i>863</i>	<i>2.49</i>	<i>1.82</i>
<i>Diesel</i>	<i>78</i>	<i>74</i>	<i>0.21</i>	<i>0.15</i>
<i>other petroleum products</i>	<i>137</i>	<i>129</i>	<i>0.37</i>	<i>0.27</i>
Natural Gas	6'927	6'528	18.82	13.74
Other fossil	0	0	0.00	0.00
Hydro	26	26	0.07	0.05
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	26	26	0.07	0.05
Pumped storage power plants	0	0	0.00	0.00
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	8'929	8'814	25.40	18.55
Geothermal	0	0	0.00	0.00
Solar	3	3	0.01	0.01
<i>Photovoltaic</i>	<i>3</i>	<i>3</i>	<i>0.01</i>	<i>0.01</i>
<i>Solar thermal</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Wave and tidal energy	0	0	0.00	0.00
Wind	6'928	6'928	19.97	14.58
Wood	1'804	1'700	4.90	3.58
Biogas	194	183	0.53	0.38
Waste	1'921	1'810	5.22	3.81
Municipal waste	1'866	1'759	5.07	3.70
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	55	52	0.15	0.11
Other	0	0	0.00	0.00
Total domestic	36'391	34'695	100.00	73.03
Imports	0	12'815	0.00	26.97
Germany	0	1'365	0.00	2.87
Norway	0	4'813	0.00	10.13
Sweden	0	6'637	0.00	13.97
Total	36'391	47'510	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.87: Unit process raw data of the electricity production mix in Denmark 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviation95%	GeneralComment					
								Location	Unit	DK	0	kWh
								InfrastructureProcess	Unit			
product	electricity mix, domestic production	DK	kWh	1.00E+0								
technosphere	electricity, hard coal, at power plant	NORDEL	kWh	4.74E-1	1	1.05	(1,1,1,2,1,1); assumption for hard coal power production in Denmark, value: IEA statistics 2008					
	electricity, oil, at power plant	DK	kWh	2.86E-2	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Denmark, value: IEA statistics 2008					
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	2.12E-3	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Denmark, value: IEA statistics 2008					
	electricity, natural gas, at power plant	NORDEL	kWh	1.88E-1	1	1.05	(1,1,1,2,1,1); assumption for natural gas power production in Denmark, value: IEA statistics 2008					
	electricity, hydropower, at run-of-river power plant	RER	kWh	7.42E-4	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Denmark: 100%					
	electricity, at wind power plant	RER	kWh	2.00E-1	1	1.05	(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in Denmark, value: IEA statistics 2008					
	electricity, production mix photovoltaic, at plant	DK	kWh	8.13E-5	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Denmark, value: IEA statistics 2008					
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	4.90E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Denmark, value: IEA statistics 2008					
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	6.76E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Denmark, value: IEA statistics 2008					
	electricity from waste, at municipal waste incineration plant	CH	kWh	5.07E-2	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Denmark, value: IEA statistics 2008					

Tab. 3.88: Unit process raw data of the electricity supply mix in Denmark 2008, at busbar

	Name	Location	Unit	electricity mix	UncertaintyType	StandardDeviation95%	GeneralComment					
								Location	Unit	DK	0	kWh
								InfrastructureProcess	Unit			
product	electricity mix	DK	kWh	1.00E+0								
technosphere	electricity, hard coal, at power plant	NORDEL	kWh	3.46E-1	1	1.05	(1,1,1,2,1,1); assumption for hard coal power production in Denmark, value: IEA statistics 2008					
	electricity, oil, at power plant	DK	kWh	2.09E-2	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Denmark, value: IEA statistics 2008					
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.55E-3	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Denmark, value: IEA statistics 2008					
	electricity, natural gas, at power plant	NORDEL	kWh	1.37E-1	1	1.05	(1,1,1,2,1,1); assumption for natural gas power production in Denmark, value: IEA statistics 2008					
	electricity, hydropower, at run-of-river power plant	RER	kWh	5.42E-4	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Denmark: 100%					
	electricity, at wind power plant	RER	kWh	1.46E-1	1	1.05	(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in Denmark, value: IEA statistics 2008					
	electricity, production mix photovoltaic, at plant	DK	kWh	5.94E-5	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Denmark, value: IEA statistics 2008					
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	3.58E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Denmark, value: IEA statistics 2008					
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	4.94E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Denmark, value: IEA statistics 2008					
	electricity from waste, at municipal waste incineration plant	CH	kWh	3.70E-2	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Denmark, value: IEA statistics 2008					
	electricity mix, domestic production	DE	kWh	2.87E-2	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Denmark, value: IEA statistics 2008					
	electricity mix, domestic production	NO	kWh	1.01E-1	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Denmark, value: IEA statistics 2008					
	electricity mix, domestic production	SE	kWh	1.40E-1	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Denmark, value: IEA statistics 2008					

3.5.8 Estonia (EE)

Tab. 3.89 shows an overview over the Estonian electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Estonian power production relies on fossil fuels, mainly lignite (79 %) and natural gas (6 %) as main energy source. Further electricity is produced from Renewables, mainly wind (1 %). A share of about 13.1 % of the electricity is imported. It is assumed that 100 % of the electricity is imported from Russia.

There are no nuclear power plants in Estonia (PRIS 2011). Therefore, the nuclear power production is zero.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Estonia is 100 % and the share of the storage type hydropower plants is 0 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Estonia is 0 %.

For the electricity production with wind power the average European dataset is used. For the power production out of renewable resources, either European or Swiss datasets are set as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Estonia are shown in Tab. 3.90 and Tab. 3.91.

Tab. 3.89: Composition of the Estonian electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	10'384	8'906	97.89	85.09
Hard coal	0	0	0.00	0.00
Lignite	9'625	8'255	90.74	78.87
Peat	20	17	0.19	0.16
Industrial Gases	0	0	0.00	0.00
<i>Coke gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Blast furnace gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Petroleum products	37	32	0.35	0.30
<i>Fuel oil</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Diesel</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>other petroleum products</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Natural Gas	702	602	6.62	5.75
Other fossil	0	0	0.00	0.00
Hydro	28	28	0.30	0.26
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	28	28	0.30	0.26
Pumped storage power plants	0	0	0.00	0.00
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	169	164	1.80	1.57
Geothermal	0	0	0.00	0.00
Solar	0	0	0.00	0.00
<i>Photovoltaic</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Solar thermal</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Wave and tidal energy	0	0	0.00	0.00
Wind	133	133	1.46	1.27
Wood	27	23	0.25	0.22
Biogas	9	8	0.08	0.07
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	10'581	9'098	100.00	86.92
Imports	0	1'369	0.00	13.08
Russia	0	1'369	0.00	13.08
Total	10'581	10'467	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.90: Unit process raw data of the electricity productionmix in Estonia 2008, at busbar

product	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviations%	GeneralComment
	Location			EE			
	InfrastructureProcess			0			
Unit			kWh				
	electricity mix, domestic production	EE	kWh	1.00E+0			
	electricity, lignite, at power plant	CENTREL	kWh	9.07E-1	1	1.05	(1,1,1,3,1,1); assumption for lignite power production in Estonia, value: IEA statistics 2008
	electricity, peat, at power plant	NORDEL	kWh	1.88E-3	1	1.05	(1,1,1,3,1,1); assumption for peat power production in Estonia, value: IEA statistics 2008
	electricity, oil, at power plant	SK	kWh	3.49E-3	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Estonia, value: IEA statistics 2008
	electricity, natural gas, at power plant	CENTREL	kWh	6.62E-2	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Estonia, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	3.05E-3	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Estonia: 100%
	electricity, at wind power plant	RER	kWh	1.46E-2	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Estonia, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	2.55E-3	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Estonia, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	8.48E-4	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Estonia, value: IEA statistics 2008

Tab. 3.91: Unit process raw data of the electricity supply mix in Estonia 2008, at busbar

product	Name	Location	Unit	electricity mix	UncertaintyType	StandardDeviations%	GeneralComment
	Location			EE			
	InfrastructureProcess			0			
Unit			kWh				
	electricity mix	EE	kWh	1.00E+0			
	electricity, lignite, at power plant	CENTREL	kWh	7.89E-1	1	1.05	(1,1,1,3,1,1); assumption for lignite power production in Estonia, value: IEA statistics 2008
	electricity, peat, at power plant	NORDEL	kWh	1.64E-3	1	1.05	(1,1,1,3,1,1); assumption for peat power production in Estonia, value: IEA statistics 2008
	electricity, oil, at power plant	SK	kWh	3.03E-3	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Estonia, value: IEA statistics 2008
	electricity, natural gas, at power plant	CENTREL	kWh	5.75E-2	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Estonia, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	2.65E-3	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Estonia: 100%
	electricity, at wind power plant	RER	kWh	1.27E-2	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Estonia, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	2.21E-3	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Estonia, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	7.37E-4	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Estonia, value: IEA statistics 2008
	electricity mix, domestic production	RU	kWh	1.31E-1	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Estonia, value: IEA statistics 2008

3.5.9 Finland (FI)

Tab. 3.92 shows an overview over the Finnish electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Finnish power production relies on fossil fuels, mainly hard coal (9 %), peat (5 %) and natural gas (12 %), as main energy source. Further electricity is produced from nuclear power (24 %) and from hydro power (19 %). A share of about 18 % of the electricity is imported. The electricity is mainly imported from Estonia, Norway, Russia and Sweden.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydro-power generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Finland is 25 % and the share of the storage type hydropower plants is 75 %. The storage

type hydropower production is approximated using the dataset for alpine conditions. In Finland there are no pumped storage hydropower plants according to the IEA statistics.

Power production from nuclear power plants is approximated using the European dataset for pressurised water reactors and boiling water reactors. These datasets reflect the conditions of nuclear power production using a mix of BWR (64 %) and PWR (36 %) power plants (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration. In Finland a considerable share of the electricity production comes from wooden fuels.

The unit process raw data of the electricity production and supply mix of Finland are shown Tab. 3.93 and Tab. 3.94.

Tab. 3.92: Composition of the Finnish electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	25'982	24'587	33.27	27.32
Hard coal	8'512	8'055	10.90	8.95
Lignite	0	0	0.00	0.00
Peat	5'200	4'921	6.66	5.47
Industrial Gases	598	566	0.77	0.63
<i>Coke gases</i>	45	43	0.06	0.05
<i>Blast furnace gases</i>	553	523	0.71	0.58
Petroleum products	425	402	0.54	0.45
<i>Fuel oil</i>	402	380	0.51	0.42
<i>Diesel</i>	18	17	0.02	0.02
<i>other petroleum products</i>	5	5	0.01	0.01
Natural Gas	11'247	10'643	14.40	11.83
Other fossil	0	0	0.00	0.00
Hydro	17'112	16'941	22.93	18.82
Reservoir power plants	4'278	4'235	5.73	4.71
Run-of-river power plants	12'834	12'706	17.19	14.12
Pumped storage power plants	0	0	0.00	0.00
Nuclear	22'958	21'581	29.20	23.98
Pressurised-water reactor (PWR)	8'250	7'755	10.49	8.62
Boiling-water reactor (BWR)	14'708	13'826	18.71	15.36
Renewables	10'322	9'782	13.24	10.87
Geothermal	0	0	0.00	0.00
Solar	4	4	0.01	0.00
<i>Photovoltaic</i>	4	4	0.01	0.00
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	261	261	0.35	0.29
Wood	10'057	9'517	12.88	10.57
Biogas	0	0	0.00	0.00
Waste	556	526	0.71	0.58
Municipal waste	430	407	0.55	0.45
Industrial waste	39	37	0.05	0.04
Sewage sludge and landfill gases	87	82	0.11	0.09
Other	506	479	0.65	0.53
Total domestic	77'436	73'895	100.00	82.10
Imports	0	16'107	0.00	17.90
Estonia	0	2'250	0.00	2.50
Norway	0	159	0.00	0.18
Russian Federation	0	10'883	0.00	12.09
Sweden	0	2'815	0.00	3.13
Total	77'436	90'002	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.93: Unit process raw data of the electricity production mix in Finland 2008, at busbar

	Name	Location	Unit	electricity, production mix FI			GeneralComment			
				UncertaintyType	StandardDeviation%					
								FI	0	kWh
product	electricity, production mix FI	FI	kWh	1.00E+0						
technosphere	electricity, hard coal, at power plant	NORDEL	kWh	1.09E-1	1	1.05	(1,1,1,2,1,1); assumption for hard coal power production in Finland, value: IEA statistics 2008			
	electricity, peat, at power plant	NORDEL	kWh	6.66E-2	1	1.05	(1,1,1,2,1,1); assumption for peat power production in Finland, value: IEA statistics 2008			
	electricity, industrial gas, at power plant	NORDEL	kWh	7.66E-3	1	1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas gas power production in Finland, value: IEA statistics 2008			
	electricity, oil, at power plant	FI	kWh	5.21E-3	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Finland, value: IEA statistics 2008			
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	2.31E-4	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Finland, value: IEA statistics 2008			
	electricity, natural gas, at power plant	NORDEL	kWh	1.44E-1	1	1.05	(1,1,1,2,1,1); assumption for natural gas power production in Finland, value: IEA statistics 2008			
	electricity, hydropower, at reservoir power plant, alpine region	RER	kWh	5.73E-2	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Finland: 25%			
	electricity, hydropower, at run-of-river power plant	RER	kWh	1.72E-1	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Finland: 75%			
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	1.05E-1	1	1.05	(1,1,1,2,1,1); assumption for nuclear power production in Finland using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)			
	electricity, nuclear, at power plant boiling water reactor	UCTE	kWh	1.87E-1	1	1.05	(1,1,1,2,1,1); assumption for nuclear power production in Finland using BWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)			
	electricity, at wind power plant	RER	kWh	1.00E-2	1	1.05	(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in Finland, value: IEA statistics 2008			
	electricity, production mix photovoltaic, at plant	FI	kWh	5.09E-5	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Finland, value: IEA statistics 2008			
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.29E-1	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Finland, value: IEA statistics 2008			
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.11E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Finland, value: IEA statistics 2008			
	electricity from waste, at municipal waste incineration plant	CH	kWh	6.01E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Finland, value: IEA statistics 2008			

Tab. 3.94: Unit process raw data of the electricity supply mix in Finland 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty	Standard deviation 95%	GeneralComment
product	electricity mix	FI	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	NORDEL	kWh	8.95E-2	1	1.05	(1,1,1,2,1,1); assumption for hard coal power production in Finland, value: IEA statistics 2008
	electricity, peat, at power plant	NORDEL	kWh	5.47E-2	1	1.05	(1,1,1,2,1,1); assumption for peat power production in Finland, value: IEA statistics 2008
	electricity, industrial gas, at power plant	NORDEL	kWh	6.29E-3	1	1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Finland, value: IEA statistics 2008
	electricity, oil, at power plant	FI	kWh	4.28E-3	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Finland, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.89E-4	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Finland, value: IEA statistics 2008
	electricity, natural gas, at power plant	NORDEL	kWh	1.18E-1	1	1.05	(1,1,1,2,1,1); assumption for natural gas power production in Finland, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, alpine region	RER	kWh	4.71E-2	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Finland: 25%
	electricity, hydropower, at run-of-river power plant	RER	kWh	1.41E-1	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Finland: 75%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	8.62E-2	1	1.05	(1,1,1,2,1,1); assumption for nuclear power production in Finland using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, nuclear, at power plant boiling water reactor	UCTE	kWh	1.54E-1	1	1.05	(1,1,1,2,1,1); assumption for nuclear power production in Finland using BWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	8.22E-3	1	1.05	(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in Finland, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	FI	kWh	4.18E-5	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Finland, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.06E-1	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Finland, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	9.15E-4	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Finland, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	4.93E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Finland, value: IEA statistics 2008
	electricity, production mix EE	EE	kWh	2.50E-2	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Finland, value: IEA statistics 2008
	electricity, production mix NO	NO	kWh	1.77E-3	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Finland, value: IEA statistics 2008
electricity, production mix RU	RU	kWh	1.21E-1	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Finland, value: IEA statistics 2008	
electricity, production mix SE	SE	kWh	3.13E-2	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Finland, value: IEA statistics 2008	

3.5.10 France (FR)

Tab. 3.95 shows an overview over the French electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The French power production relies on nuclear power as main energy source (75 %). Further electricity is produced from hydro power (12 %) and from fossil fuels, mainly hard coal (4 %) and natural gas (4 %). A small share of about 2 % of the electricity is imported. France is as an electricity exporting country.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in France is 84 % and the share of the storage type hydropower plants is 16 %. The storage type hydropower production is approximated using the dataset for alpine conditions. The share of pumped storage in France is 7 %.

Power production from nuclear power plants is approximated using the French dataset for pressurised water reactors. This dataset reflects the conditions of nuclear power production using only PWR power plants (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of France are shown Tab. 3.96 and Tab. 3.97.

Tab. 3.95: Composition of the French electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	54'940	49'161	9.08	8.90
Hard coal	23'378	20'919	3.86	3.79
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	3'853	3'448	0.64	0.62
<i>Coke gases</i>	933	835	0.15	0.15
<i>Blast furnace gases</i>	2'920	2'613	0.48	0.47
Petroleum products	5'825	5'212	0.96	0.94
<i>Fuel oil</i>	4'108	3'676	0.68	0.67
<i>Diesel</i>	407	364	0.07	0.07
<i>other petroleum products</i>	1'310	1'172	0.22	0.21
Natural Gas	21'884	19'582	3.62	3.55
Other fossil	0	0	0.00	0.00
Hydro	68'325	67'642	12.49	12.25
Reservoir power plants	10'196	10'094	1.86	1.83
Run-of-river power plants	53'530	52'995	9.79	9.60
Pumped storage power plants	4'599	4'553	0.84	0.82
Nuclear	439'468	413'100	76.30	74.82
Pressurised-water reactor (PWR)	439'468	413'100	76.30	74.82
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	7'696	7'541	1.39	1.37
Geothermal	0	0	0.00	0.00
Solar	41	39	0.01	0.01
<i>Photovoltaic</i>	41	39	0.01	0.01
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	513	513	0.09	0.09
Wind	5'689	5'689	1.05	1.03
Wood	1'433	1'282	0.24	0.23
Biogas	20	18	0.00	0.00
Waste	4'439	3'972	0.73	0.72
Municipal waste	3'776	3'379	0.62	0.61
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	663	593	0.11	0.11
Other	0	0	0.00	0.00
Total domestic	574'868	541'416	100.00	98.07
Imports	0	10'683	0.00	1.93
Belgium	0	2'029	0.00	0.37
Germany	0	1'189	0.00	0.22
Italy	0	1'133	0.00	0.21
Spain	0	1'656	0.00	0.30
Switzerland	0	3'752	0.00	0.68
United Kingdom	0	924	0.00	0.17
Total	574'868	552'099	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.96: Unit process raw data of the electricity production mix in France 2008, at busbar

	Name	Location	Unit	electricity, production mix FR	UncertaintyType	StandardDeviation95 %	GeneralComment
product	electricity, production mix FR	FR	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	FR	kWh	3.86E-2	1	1.05	(1,1,1,1,1,1); assumption for hard coal power production in France, value: IEA statistics 2008
	electricity, industrial gas, at power plant	FR	kWh	6.37E-3	1	1.05	(1,1,1,1,1,1); assumption for industrial, coke and blast furnace gas power production in France, value: IEA statistics 2008
	electricity, oil, at power plant	FR	kWh	8.95E-3	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in France, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	6.73E-4	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in France, value: IEA statistics 2008
	electricity, natural gas, at power plant	FR	kWh	3.62E-2	1	1.05	(1,1,1,2,1,1); assumption for natural gas power production in France, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, alpine region	RER	kWh	1.86E-2	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in France: 16%
	electricity, hydropower, at run-of-river power plant	RER	kWh	9.79E-2	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in France: 84%
	electricity, hydropower, at pumped storage power plant	FR	kWh	8.41E-3	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in France: 6.73%
	electricity, nuclear, at power plant pressure water reactor	FR	kWh	7.63E-1	1	1.05	(1,1,1,1,1,1); assumption for nuclear power production in France using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	1.15E-2	1	1.05	(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in France, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	FR	kWh	7.12E-5	1	1.05	(1,1,1,1,1,1); assumption for solar power production in France, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	2.37E-3	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in France, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.13E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage landfill gas in France, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	6.24E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial in France, value: IEA statistics 2008

Tab. 3.97: Unit process raw data of the electricity supply mix in France 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty Standard Deviation 95%	GeneralComment
	Location InfrastructureProcess Unit					
product	electricity mix	FR	kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	FR	kWh	3.79E-2	1 1.05	(1,1,1,1,1,1); assumption for hard coal power production in France, value: IEA statistics 2008
	electricity, industrial gas, at power plant	FR	kWh	6.24E-3	1 1.05	(1,1,1,1,1,1); assumption for industrial, coke and blast furnace gas power production in France, value: IEA statistics 2008
	electricity, oil, at power plant	FR	kWh	8.78E-3	1 1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in France, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	6.60E-4	1 1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in France, value: IEA statistics 2008
	electricity, natural gas, at power plant	FR	kWh	3.55E-2	1 1.05	(1,1,1,2,1,1); assumption for natural gas power production in France, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, alpine region	RER	kWh	1.83E-2	1 1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in France: 16%
	electricity, hydropower, at run-of-river power plant	RER	kWh	9.60E-2	1 1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in France: 84%
	electricity, hydropower, at pumped storage power plant	FR	kWh	8.25E-3	1 1.05	(1,1,1,1,1,1); estimated share of pumped storage production in France: 6.73%
	electricity, nuclear, at power plant pressure water reactor	FR	kWh	7.48E-1	1 1.05	(1,1,1,1,1,1); assumption for nuclear power production in France using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	1.12E-2	1 1.05	(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in France, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	FR	kWh	6.98E-5	1 1.05	(1,1,1,1,1,1); assumption for solar power production in France, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	2.32E-3	1 1.05	(1,1,1,3,1,1); assumption for cogeneration power production in France, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.11E-3	1 1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage landfill gas in France, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	6.12E-3	1 1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial in France, value: IEA statistics 2008
	electricity, production mix BE	BE	kWh	3.68E-3	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in France, value: IEA statistics 2008
	electricity, production mix DE	DE	kWh	2.15E-3	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in France, value: IEA statistics 2008
	electricity, production mix IT	IT	kWh	2.05E-3	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in France, value: IEA statistics 2008
electricity, production mix ES	ES	kWh	3.00E-3	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in France, value: IEA statistics 2008	
electricity, production mix CH	CH	kWh	6.80E-3	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in France, value: IEA statistics 2008	
electricity, production mix GB	GB	kWh	1.67E-3	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in France, value: IEA statistics 2008	

3.5.11 Germany (DE)

Tab. 3.98 shows an overview over the German electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The German power production relies on fossil fuels, mainly lignite (22 %), hard coal (18 %) and natural gas (13 %) as main energy source. Further electricity is produced from nuclear power (22 %) and from renewables, mainly wind (6 %). A share of about 7 % of the electricity is imported.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Germany is 84 % and the share of the storage type hydropower plants is 16 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Germany is 22 %.

Power production from nuclear power plants is approximated using the German dataset for pressurised and boiling water reactors. These datasets reflect the conditions of nuclear power production using a mix of BWR and PWR power plants (PRIS 2011).

For the electricity production with wind power the average European dataset is used. In Germany a considerable share of the electricity is produced using wind power. For the power production out of other renewable resources, either European or Swiss datasets are set as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Germany are shown Tab. 3.99 and Tab. 3.100.

Tab. 3.98: Composition of the German electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	387'543	350'162	59.59	55.65
Hard coal	125'832	113'695	19.35	18.07
Lignite	155'343	140'359	23.89	22.31
Peat	0	0	0.00	0.00
Industrial Gases	9'470	8'557	1.46	1.36
Coke gases	2'108	1'905	0.32	0.30
Blast furnace gases	7'362	6'652	1.13	1.06
Petroleum products	9'244	8'352	1.42	1.33
Fuel oil	4'348	3'929	0.67	0.62
Diesel	743	671	0.11	0.11
other petroleum products	4'153	3'752	0.64	0.60
Natural Gas	87'654	79'199	13.48	12.59
Other fossil	0	0	0.00	0.00
Hydro	26'963	26'693	4.54	4.24
Reservoir power plants	3'351	3'317	0.56	0.53
Run-of-river power plants	17'591	17'415	2.96	2.77
Pumped storage power plants	6'021	5'961	1.01	0.95
Nuclear	148'495	139'585	23.76	22.18
Pressurised-water reactor (PWR)	116'847	109'836	18.69	17.45
Boiling-water reactor (BWR)	31'648	29'749	5.06	4.73
Renewables	62'901	60'910	10.37	9.68
Geothermal	18	17	0.00	0.00
Solar	4'420	4'155	0.71	0.66
Photovoltaic	4'420	4'155	0.71	0.66
Solar thermal	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	40'574	40'574	6.91	6.45
Wood	8'960	8'096	1.38	1.29
Biogas	8'929	8'068	1.37	1.28
Waste	11'330	10'237	1.74	1.63
Municipal waste	9'012	8'143	1.39	1.29
Industrial waste	356	322	0.05	0.05
Sewage sludge and landfill gases	1'962	1'773	0.30	0.28
Other	0	0	0.00	0.00
Total domestic	637'232	587'587	100.00	93.38
Imports	0	41'670	0.00	6.62
Austria	0	7'012	0.00	1.11
Czech Republic	0	7'938	0.00	1.26
Denmark	0	9'211	0.00	1.46
France	0	10'572	0.00	1.68
Netherlands	0	828	0.00	0.13
Poland	0	95	0.00	0.02
Sweden	0	2'539	0.00	0.40
Switzerland	0	3'475	0.00	0.55
Total	637'232	629'257	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.99: Unit process raw data of the electricity production mix in Germany 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviations	%	GeneralComment
product	electricity mix, domestic production	DE	kWh	1.00E+0				
technosphere	electricity, hard coal, at power plant	DE	kWh	1.93E-1	1	1.05		(1,1,1,1,1,1); assumption for hard coal power production in Germany, value: IEA statistics 2008
	electricity, lignite, at power plant	DE	kWh	2.39E-1	1	1.05		(1,1,1,1,1,1); assumption for lignite power production in Germany, value: IEA statistics 2008
	electricity, industrial gas, at power plant	DE	kWh	1.46E-2	1	1.05		(1,1,1,1,1,1); assumption for industrial gas, coke gas and blast furnace gas power production in Germany, value: IEA statistics 2008
	electricity, oil, at power plant	DE	kWh	1.31E-2	1	1.05		(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Germany, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.14E-3	1	1.05		(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Germany, value: IEA statistics 2008
	electricity, natural gas, at power plant	DE	kWh	1.35E-1	1	1.05		(1,1,1,1,1,1); assumption for natural gas power production in Germany, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	5.65E-3	1	1.05		(1,1,1,2,1,1); estimated share of reservoir hydropower production in Germany: 16%
	electricity, hydropower, at run-of-river power plant	RER	kWh	2.96E-2	1	1.05		(1,1,1,2,1,1); estimated share of ROR hydropower production in Germany: 84%
	electricity, hydropower, at pumped storage power plant	DE	kWh	1.01E-2	1	1.05		(1,1,1,1,1,1); estimated share of pumped storage production in Germany: 22.33%
	electricity, nuclear, at power plant pressure water reactor	DE	kWh	1.87E-1	1	1.05		(1,1,1,1,1,1); assumption for nuclear power production in Germany using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, nuclear, at power plant boiling water reactor	DE	kWh	5.06E-2	1	1.05		(1,1,1,1,1,1); assumption for nuclear power production in Germany using BWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	6.91E-2	1	1.05		(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in Germany, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	DE	kWh	7.07E-3	1	1.05		(1,1,1,1,1,1); assumption for solar power production in Germany, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.38E-2	1	1.05		(1,1,1,3,1,1); assumption for cogeneration power production in Germany, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.67E-2	1	1.05		(1,1,1,3,1,1); assumption for power production from biogas, sewage sludge and landfill gases in Germany, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	1.44E-2	1	1.05		(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Germany, value: IEA statistics 2008

Tab. 3.100: Unit process raw data of the electricity supply mix in Germany 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty	StandardDeviations%	GeneralComment	
	Location							DE
	InfrastructureProcess Unit							0 kWh
product	electricity mix	DE	kWh	1.00E+0				
technosphere	electricity, hard coal, at power plant	DE	kWh	1.81E-1	1	1.05	(1,1,1,1,1,1); assumption for hard coal power production in Germany, value: IEA statistics 2008	
	electricity, lignite, at power plant	DE	kWh	2.23E-1	1	1.05	(1,1,1,1,1,1); assumption for lignite power production in Germany, value: IEA statistics 2008	
	electricity, industrial gas, at power plant	DE	kWh	1.36E-2	1	1.05	(1,1,1,1,1,1); assumption for industrial gas, coke gas and blast furnace gas power production in Germany, value: IEA statistics 2008	
	electricity, oil, at power plant	DE	kWh	1.22E-2	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Germany, value: IEA statistics 2008	
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.07E-3	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Germany, value: IEA statistics 2008	
	electricity, natural gas, at power plant	DE	kWh	1.26E-1	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Germany, value: IEA statistics 2008	
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	5.27E-3	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Germany: 16%	
	electricity, hydropower, at run-of-river power plant	RER	kWh	2.77E-2	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Germany: 84%	
	electricity, hydropower, at pumped storage power plant	DE	kWh	9.47E-3	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Germany: 22.33%	
	electricity, nuclear, at power plant pressure water reactor	DE	kWh	1.75E-1	1	1.05	(1,1,1,1,1,1); assumption for nuclear power production in Germany using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)	
	electricity, nuclear, at power plant boiling water reactor	DE	kWh	4.73E-2	1	1.05	(1,1,1,1,1,1); assumption for nuclear power production in Germany using BWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)	
	electricity, at wind power plant	RER	kWh	6.45E-2	1	1.05	(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in Germany, value: IEA statistics 2008	
	electricity, production mix photovoltaic, at plant	DE	kWh	6.60E-3	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Germany, value: IEA statistics 2008	
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.29E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Germany, value: IEA statistics 2008	
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.56E-2	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage sludge and landfill gases in Germany, value: IEA statistics 2008	
	electricity from waste, at municipal waste incineration plant	CH	kWh	1.35E-2	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Germany, value: IEA statistics 2008	
	electricity mix, domestic production	AU	kWh	1.11E-2	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Germany, value: IEA statistics 2008	
	electricity mix, domestic production	CZ	kWh	1.26E-2	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Germany, value: IEA statistics 2008	
	electricity mix, domestic production	DK	kWh	1.46E-2	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Germany, value: IEA statistics 2008	
	electricity mix, domestic production	FR	kWh	1.68E-2	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Germany, value: IEA statistics 2008	
electricity mix, domestic production	NL	kWh	1.32E-3	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Germany, value: IEA statistics 2008		
electricity mix, domestic production	PL	kWh	1.51E-4	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Germany, value: IEA statistics 2008		
electricity mix, domestic production	SE	kWh	4.03E-3	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Germany, value: IEA statistics 2008		
electricity mix, domestic production	CH	kWh	5.52E-3	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Germany, value: IEA statistics 2008		

3.5.12 Greece (GR)

Tab. 3.101 shows an overview over the Greek electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Greek power production relies on fossil fuels, mainly lignite (46 %), natural gas (19 %) and petroleum products (14 %) as main energy source. Further electricity is produced from hydro power (6 %) and from renewables, mainly wind (3 %). A share of about 12 % of the electricity is imported. The electricity is imported from Bulgaria, Macedonia and Italy.

There are no nuclear power plants in Greece (PRIS 2011). Therefore, the nuclear power production is zero.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Greece is 100 % and the share of the storage type hydropower plants is 0 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Greece is 20.2 %.

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Greece are shown Tab. 3.102 and Tab. 3.103.

Tab. 3.101: Composition of the Greek electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	57'143	50'274	88.49	78.08
Hard coal	0	0	0.00	0.00
Lignite	33'356	29'346	51.65	45.58
Peat	0	0	0.00	0.00
Industrial Gases	0	0	0.00	0.00
<i>Coke gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Blast furnace gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Petroleum products	9'990	8'789	15.47	13.65
<i>Fuel oil</i>	<i>7'447</i>	<i>6'552</i>	<i>11.53</i>	<i>10.18</i>
<i>Diesel</i>	<i>1'807</i>	<i>1'590</i>	<i>2.80</i>	<i>2.47</i>
<i>other petroleum products</i>	<i>736</i>	<i>648</i>	<i>1.14</i>	<i>1.01</i>
Natural Gas	13'797	12'139	21.37	18.85
Other fossil	0	0	0.00	0.00
Hydro	4'149	4'108	7.23	6.38
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	3'312	3'279	5.77	5.09
Pumped storage power plants	837	829	1.46	1.29
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	2'247	2'247	3.95	3.49
Geothermal	0	0	0.00	0.00
Solar	5	5	0.01	0.01
<i>Photovoltaic</i>	<i>5</i>	<i>5</i>	<i>0.01</i>	<i>0.01</i>
<i>Solar thermal</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Wave and tidal energy	0	0	0.00	0.00
Wind	2'242	2'242	3.95	3.48
Wood	0	0	0.00	0.00
Biogas	0	0	0.00	0.00
Waste	210	185	0.33	0.29
Municipal waste	0	0	0.00	0.00
Industrial waste	19	17	0.03	0.03
Sewage sludge and landfill gases	191	168	0.30	0.26
Other	0	0	0.00	0.00
Total domestic	63'749	56'813	100.00	88.24
Imports	0	7'575	0.00	11.76
Bulgaria	0	4'628	0.00	7.19
Former Republic of Macedonia	0	1'188	0.00	1.85
Italy	0	1'759	0.00	2.73
Total	63'749	64'388	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.102: Unit process raw data of the electricity production mix in Greece 2008, at busbar

Name	Location	Unit	electricity mix, domestic production	Uncertainty Standard Deviation 95%	GeneralComment						
						Location	InfrastructureProcess	Unit	electricity mix, domestic production	Uncertainty Standard Deviation 95%	GeneralComment
									GR 0 kWh		
product											
electricity mix, domestic production	GR	kWh	1.00E+0								
electricity, lignite, at power plant	GR	kWh	5.17E-1	1 1.05	(1,1,1,1,1,1); assumption for lignite power production in Greece, value: IEA statistics 2008						
electricity, oil, at power plant	GR	kWh	1.27E-1	1 1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Greece, value: IEA statistics 2008						
electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	2.80E-2	1 1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Greece, value: IEA statistics 2008						
electricity, natural gas, at power plant	IT	kWh	2.14E-1	1 1.05	(1,1,1,3,1,1); assumption for natural gas power production in Greece, value: IEA statistics 2008						
electricity, hydropower, at run-of-river power plant	RER	kWh	5.77E-2	1 1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Greece: 100%						
electricity, hydropower, at pumped storage power plant	GR	kWh	1.46E-2	1 1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Greece: 20.17%						
electricity, at wind power plant	RER	kWh	3.95E-2	1 1.05	(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in Greece, value: IEA statistics 2008						
electricity, production mix photovoltaic, at plant	GR	kWh	8.27E-5	1 1.05	(1,1,1,1,1,1); assumption for solar power production in Greece, value: IEA statistics 2008						
electricity, at cogen with biogas engine, allocation exergy	CH	kWh	2.96E-3	1 1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage sludge and landfill gases in Greece, value: IEA statistics 2008						
electricity from waste, at municipal waste incineration plant	CH	kWh	2.94E-4	1 1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Greece, value: IEA statistics 2008						

Tab. 3.103: Unit process raw data of the electricity supply mix in Greece 2008, at busbar

Name	Location	Unit	electricity mix	Uncertainty Standard Deviation 95%	GeneralComment						
						Location	InfrastructureProcess	Unit	electricity mix	Uncertainty Standard Deviation 95%	GeneralComment
									GR 0 kWh		
product											
electricity mix	GR	kWh	1.00E+0								
electricity, lignite, at power plant	GR	kWh	4.56E-1	1 1.05	(1,1,1,1,1,1); assumption for lignite power production in Greece, value: IEA statistics 2008						
electricity, oil, at power plant	GR	kWh	1.12E-1	1 1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Greece, value: IEA statistics 2008						
electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	2.47E-2	1 1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Greece, value: IEA statistics 2008						
electricity, natural gas, at power plant	IT	kWh	1.89E-1	1 1.05	(1,1,1,3,1,1); assumption for natural gas power production in Greece, value: IEA statistics 2008						
electricity, hydropower, at run-of-river power plant	RER	kWh	5.09E-2	1 1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Greece: 100%						
electricity, hydropower, at pumped storage power plant	GR	kWh	1.29E-2	1 1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Greece: 20.17%						
electricity, at wind power plant	RER	kWh	3.48E-2	1 1.05	(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in Greece, value: IEA statistics 2008						
electricity, production mix photovoltaic, at plant	GR	kWh	7.30E-5	1 1.05	(1,1,1,1,1,1); assumption for solar power production in Greece, value: IEA statistics 2008						
electricity, at cogen with biogas engine, allocation exergy	CH	kWh	2.61E-3	1 1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage sludge and landfill gases in Greece, value: IEA statistics 2008						
electricity from waste, at municipal waste incineration plant	CH	kWh	2.60E-4	1 1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Greece, value: IEA statistics 2008						
electricity mix, domestic production	BG	kWh	7.19E-2	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Greece, value: IEA statistics 2008						
electricity mix, domestic production	MK	kWh	1.85E-2	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Greece, value: IEA statistics 2008						
electricity mix, domestic production	IT	kWh	2.73E-2	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Greece, value: IEA statistics 2008						

3.5.13 Hungary (HU)

Tab. 3.104 shows an overview over the Hungarian electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Hungarian power production relies on fossil fuels, mainly natural gas (32 %) and lignite (14 %) as main energy source. Further electricity is produced from nuclear power (34 %) and from renewables, mainly wood (4 %). A share of about 13 % of the electricity is imported. The electricity is imported from Austria, Croatia, Romania and Ukraine.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydro-power generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Hungary is 100 % and the share of the storage type hydropower plants is 0 %. The storage

type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Hungary is 0 %.

Power production from nuclear power plants is approximated using the European dataset for pressurised water reactors. These datasets reflect the conditions of nuclear power production using PWR power plants (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Hungary are shown Tab. 3.105 and Tab. 3.106.

Tab. 3.104: Composition of the Hungarian electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	22'736	19'491	54.76	47.64
Hard coal	571	489	1.38	1.20
Lignite	6'515	5'585	15.69	13.65
Peat	0	0	0.00	0.00
Industrial Gases	119	102	0.29	0.25
<i>Coke gases</i>	30	26	0.07	0.06
<i>Blast furnace gases</i>	89	76	0.21	0.19
Petroleum products	355	304	0.85	0.74
<i>Fuel oil</i>	242	207	0.58	0.51
<i>Diesel</i>	18	15	0.04	0.04
<i>other petroleum products</i>	95	81	0.23	0.20
Natural Gas	15'176	13'010	36.55	31.80
Other fossil	0	0	0.00	0.00
Hydro	213	211	0.59	0.52
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	213	211	0.59	0.52
Pumped storage power plants	0	0	0.00	0.00
Nuclear	14'818	13'929	39.13	34.04
Pressurised-water reactor (PWR)	14'818	13'929	39.13	34.04
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	2'003	1'746	4.91	4.27
Geothermal	0	0	0.00	0.00
Solar	1	1	0.00	0.00
<i>Photovoltaic</i>	1	1	0.00	0.00
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	205	205	0.58	0.50
Wood	1'760	1'509	4.24	3.69
Biogas	37	32	0.09	0.08
Waste	255	219	0.61	0.53
Municipal waste	218	187	0.53	0.46
Industrial waste	5	4	0.01	0.01
Sewage sludge and landfill gases	32	27	0.08	0.07
Other	0	0	0.00	0.00
Total domestic	40'025	35'596	100.00	87.00
Imports	0	5'318	0.00	13.00
Austria	0	840	0.00	2.05
Croatia	0	5	0.00	0.01
Romania	0	720	0.00	1.76
Ukraine	0	3'753	0.00	9.17
Total	40'025	40'914	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.105: Unit process raw data of the electricity production mix in Hungary 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	Uncertainty	Type	Standard Deviations %	GeneralComment			
									Location	Infrastructure	Process
									Unit		
product	electricity mix, domestic production	HU	kWh	1.00E+0							
technosphere	electricity, hard coal, at power plant	HR	kWh	1.38E-2	1	1.05	(1,1,1,1,1,1); assumption for hard coal power production in Hungary, value: IEA statistics 2008				
	electricity, lignite, at power plant	HU	kWh	1.57E-1	1	1.05	(1,1,1,1,1,1); assumption for lignite power production in Hungary, value: IEA statistics 2008				
	electricity, industrial gas, at power plant	AT	kWh	2.87E-3	1	1.05	(1,1,1,3,1,1); assumption for industrial gas, coke gas and blast furnace gas power production in Hungary, value: IEA statistics 2008				
	electricity, oil, at power plant	HU	kWh	8.12E-3	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Hungary, value: IEA statistics 2008				
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	4.34E-4	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Hungary, value: IEA statistics 2008				
	electricity, natural gas, at power plant	AT	kWh	3.65E-1	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Hungary, value: IEA statistics 2008				
	electricity, hydropower, at run-of-river power plant	RER	kWh	5.92E-3	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Hungary: 100%				
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	3.91E-1	1	1.05	(1,1,1,2,1,1); assumption for nuclear power production in Hungary using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)				
	electricity, at wind power plant	RER	kWh	5.76E-3	1	1.05	(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in Hungary, value: IEA statistics 2008				
	electricity, production mix photovoltaic, at plant	HU	kWh	2.64E-5	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Hungary, value: IEA statistics 2008				
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	4.24E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Hungary, value: IEA statistics 2008				
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.66E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage sludge and landfill gases in Hungary, value: IEA statistics 2008				
	electricity from waste, at municipal waste incineration plant	CH	kWh	5.37E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Hungary, value: IEA statistics 2008				

Tab. 3.106: Unit process raw data of the electricity supply mix in Hungary 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty	Standard Deviations %	GeneralComment			
								Location	Infrastructure	Process
								Unit		
product	electricity mix	HU	kWh	1.00E+0						
technosphere	electricity, hard coal, at power plant	HR	kWh	1.20E-2	1	1.05	(1,1,1,1,1,1); assumption for hard coal power production in Hungary, value: IEA statistics 2008			
	electricity, lignite, at power plant	HU	kWh	1.37E-1	1	1.05	(1,1,1,1,1,1); assumption for lignite power production in Hungary, value: IEA statistics 2008			
	electricity, industrial gas, at power plant	AT	kWh	2.49E-3	1	1.05	(1,1,1,3,1,1); assumption for industrial gas, coke gas and blast furnace gas power production in Hungary, value: IEA statistics 2008			
	electricity, oil, at power plant	HU	kWh	7.06E-3	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Hungary, value: IEA statistics 2008			
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	3.77E-4	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Hungary, value: IEA statistics 2008			
	electricity, natural gas, at power plant	AT	kWh	3.18E-1	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Hungary, value: IEA statistics 2008			
	electricity, hydropower, at run-of-river power plant	RER	kWh	5.15E-3	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Hungary: 100%			
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	3.40E-1	1	1.05	(1,1,1,2,1,1); assumption for nuclear power production in Hungary using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)			
	electricity, at wind power plant	RER	kWh	5.01E-3	1	1.05	(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in Hungary, value: IEA statistics 2008			
	electricity, production mix photovoltaic, at plant	HU	kWh	2.30E-5	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Hungary, value: IEA statistics 2008			
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	3.69E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Hungary, value: IEA statistics 2008			
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.45E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage sludge and landfill gases in Hungary, value: IEA statistics 2008			
	electricity from waste, at municipal waste incineration plant	CH	kWh	4.67E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Hungary, value: IEA statistics 2008			
	electricity mix, domestic production	AT	kWh	2.05E-2	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Hungary, value: IEA statistics 2008			
	electricity mix, domestic production	HR	kWh	1.22E-4	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Hungary, value: IEA statistics 2008			
	electricity mix, domestic production	RO	kWh	1.76E-2	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Hungary, value: IEA statistics 2008			
	electricity mix, domestic production	UA	kWh	9.17E-2	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Hungary, value: IEA statistics 2008			

3.5.14 Iceland (IS)

Tab. 3.107 shows an overview over the Icelandic electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Icelandic power production relies on hydro power as main energy source (76 %). Further electricity is produced from renewables, mainly geothermal (24 %). The electricity imports are zero because of the geographical location (island).

There are no nuclear power plants in Iceland (PRIS 2011). Therefore, the nuclear power production is zero.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydro-power generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Iceland is estimated 0 % and the share of the storage type hydropower plants is estimated 100 %. These shares correspond to the shares in Norway (cf. Tab. 3.1). The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Iceland is 0 %.

For the geothermal electricity production the average European wind power dataset is used as approximation. For the power production out of other renewable resources, either European or Swiss datasets are set as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Iceland are shown Tab. 3.108 and Tab. 3.109.

Tab. 3.107: Composition of the Icelandic electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	2	2	0.01	0.01
Hard coal	0	0	0.00	0.00
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	0	0	0.00	0.00
<i>Coke gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Blast furnace gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Petroleum products	2	2	0.01	0.01
<i>Fuel oil</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Diesel</i>	<i>2</i>	<i>2</i>	<i>0.01</i>	<i>0.01</i>
<i>other petroleum products</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Natural Gas	0	0	0.00	0.00
Other fossil	0	0	0.00	0.00
Hydro	12'427	12'303	76.03	76.03
Reservoir power plants	12'427	12'303	76.03	76.03
Run-of-river power plants	0	0	0.00	0.00
Pumped storage power plants	0	0	0.00	0.00
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	4'038	3'876	23.96	23.96
Geothermal	4'038	3'876	23.96	23.96
Solar	0	0	0.00	0.00
<i>Photovoltaic</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Solar thermal</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Wave and tidal energy	0	0	0.00	0.00
Wind	0	0	0.00	0.00
Wood	0	0	0.00	0.00
Biogas	0	0	0.00	0.00
Waste	1	1	0.01	0.01
Municipal waste	1	1	0.01	0.01
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	16'468	16'182	100.00	100.00
Imports	0	0	0.00	0.00
Total	16'468	16'182	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.108: Unit process raw data of the electricity production mix in Iceland 2008, at busbar

product	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviation95%	GeneralComment
	Location			IE			
	InfrastructureProcess			0			
Unit			kWh	1.00E+0			
	electricity mix, domestic production	IE	kWh	1.00E+0			
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.20E-4	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Ireland, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	7.60E-1	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Ireland: 100%
	electricity, at wind power plant	RER	kWh	2.40E-1	1	1.05	(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in Ireland, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	6.01E-5	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Ireland, value: IEA statistics 2008

Tab. 3.109: Unit process raw data of the electricity supply mix in Iceland 2008, at busbar

product	Name	Location	Unit	electricity mix	Uncertainty	StandardDeviation95%	GeneralComment
	Location			IE			
	InfrastructureProcess			0			
Unit			kWh	1.00E+0			
	electricity mix	IE	kWh	1.00E+0			
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.20E-4	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Ireland, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	7.60E-1	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Ireland: 100%
	electricity, at wind power plant	RER	kWh	2.40E-1	1	1.05	(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in Ireland, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	6.01E-5	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Ireland, value: IEA statistics 2008

3.5.15 Ireland (IE)

Tab. 3.110 shows an overview over the Irish electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Irish power production relies on fossil fuels, mainly natural gas (54 %), hard coal (17 %) and peat (9 %) as main energy source. Further electricity is produced from renewables (mainly wind) and from hydro power. The electricity imports are zero because of the geographical location (island). There are no nuclear power plants in Ireland (PRIS 2011). Therefore, the nuclear power production is zero. Furthermore, there is almost no electricity produced using photovoltaic power.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Ireland is 100 %. The share of the storage type hydropower plants is 0 % and the storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Ireland is 26 %.

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Ireland are shown Tab. 3.111 and Tab. 3.112. The electricity generation using peat is modelled according to the average NORDEL peat power plan described in Röder et al. (2007).

Tab. 3.110: Composition of the Irish electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	25'814	24'083	86.23	86.23
Hard coal	5'228	4'877	17.46	17.46
Lignite	0	0	0.00	0.00
Peat	2'790	2'603	9.32	9.32
Industrial Gases	0	0	0.00	0.00
<i>Coke gases</i>	0	0	0.00	0.00
<i>Blast furnace gases</i>	0	0	0.00	0.00
Petroleum products	1'731	1'615	5.78	5.78
<i>Fuel oil</i>	1'649	1'538	5.51	5.51
<i>Diesel</i>	50	47	0.17	0.17
<i>other petroleum products</i>	32	30	0.11	0.11
Natural Gas	16'065	14'988	53.66	53.66
Other fossil	0	0	0.00	0.00
Hydro	1'300	1'287	4.61	4.61
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	969	959	3.43	3.43
Pumped storage power plants	331	328	1.17	1.17
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	2'443	2'441	8.74	8.74
Geothermal	0	0	0.00	0.00
Solar	0	0	0.00	0.00
<i>Photovoltaic</i>	0	0	0.00	0.00
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	2'410	2'410	8.63	8.63
Wood	33	31	0.11	0.11
Biogas	0	0	0.00	0.00
Waste	128	119	0.43	0.43
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	128	119	0.43	0.43
Other	0	0	0.00	0.00
Total domestic	29'685	27'930	100.00	100.00
Imports	0	0	0.00	0.00
Total	29'685	27'930	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.111: Unit process raw data of the electricity production mix in Ireland 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	Uncertainty Type	Standard Deviation 95%	GeneralComment
	Location	InfrastructureProcess	Unit	IE	0	kWh	
	Unit						
product	electricity mix, domestic production	IE	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	UCTE	kWh	1.75E-1	1	1.05	(1,1,1,2,1,1); assumption for hard coal power production in Ireland, value: IEA statistics 2008
	electricity, peat, at power plant	NORDEL	kWh	9.32E-2	1	1.05	(1,1,1,3,1,1); assumption for peat power production in Ireland, value: IEA statistics 2008
	electricity, oil, at power plant	IE	kWh	5.61E-2	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Ireland, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.67E-3	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Ireland, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE	kWh	5.37E-1	1	1.05	(1,1,1,2,1,1); assumption for natural gas power production in Ireland, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	3.43E-2	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Ireland: 100%
	electricity, hydropower, at pumped storage power plant	IE	kWh	1.17E-2	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Ireland: 25.46%
	electricity, at wind power plant	RER	kWh	8.63E-2	1	1.05	(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in Ireland, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.10E-3	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Ireland, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	4.28E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage sludge and landfill gases in Ireland, value: IEA statistics 2008

Tab. 3.112: Unit process raw data of the electricity supply mix in Ireland 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty Type	Standard Deviation 95%	GeneralComment
	Location	InfrastructureProcess	Unit	IE	0	kWh	
	Unit						
product	electricity mix	IE	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	UCTE	kWh	1.75E-1	1	1.05	(1,1,1,2,1,1); assumption for hard coal power production in Ireland, value: IEA statistics 2008
	electricity, peat, at power plant	NORDEL	kWh	9.32E-2	1	1.05	(1,1,1,3,1,1); assumption for peat power production in Ireland, value: IEA statistics 2008
	electricity, oil, at power plant	IE	kWh	5.61E-2	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Ireland, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.67E-3	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Ireland, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE	kWh	5.37E-1	1	1.05	(1,1,1,2,1,1); assumption for natural gas power production in Ireland, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	3.43E-2	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Ireland: 100%
	electricity, hydropower, at pumped storage power plant	IE	kWh	1.17E-2	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Ireland: 25.46%
	electricity, at wind power plant	RER	kWh	8.63E-2	1	1.05	(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in Ireland, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.10E-3	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Ireland, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	4.28E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage sludge and landfill gases in Ireland, value: IEA statistics 2008

3.5.16 Italy (IT)

Tab. 3.113 shows an overview over the Italian electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Italian power production relies on fossil fuels, mainly natural gas (46 %) hard coal (12 %) and petroleum products (8 %) as main energy source. Further electricity is produced from hydro power. A share of about 13 % of the electricity is imported. The electricity is imported from Austria, France, Greece, Slovenia and Switzerland.

There are no nuclear power plants in Italy (PRIS 2011). Therefore, the nuclear power production is zero.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydro-power generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Italy is 36 % and the share of the storage type hydropower plants is 64 %. The storage type

hydropower production is approximated using the dataset for alpine conditions. The share of pumped storage in Italy is 12 %.

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Italy are shown Tab. 3.114 and Tab. 3.115.

Tab. 3.113: Composition of the Italian electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	252'749	229'463	77.96	67.93
Hard coal	43'073	39'105	13.29	11.58
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	5'518	5'010	1.70	1.48
Coke gases	1'633	1'483	0.50	0.44
Blast furnace gases	3'885	3'527	1.20	1.04
Petroleum products	31'459	28'561	9.70	8.46
Fuel oil	15'724	14'275	4.85	4.23
Diesel	688	625	0.21	0.18
other petroleum products	15'047	13'661	4.64	4.04
Natural Gas	172'699	156'788	53.27	46.42
Other fossil	0	0	0.00	0.00
Hydro	47'227	46'755	15.88	13.84
Reservoir power plants	26'639	26'372	8.96	7.81
Run-of-river power plants	14'984	14'834	5.04	4.39
Pumped storage power plants	5'604	5'548	1.88	1.64
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	13'614	13'102	4.45	3.88
Geothermal	5'520	5'299	1.80	1.57
Solar	193	181	0.06	0.05
Photovoltaic	193	181	0.06	0.05
Solar thermal	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	4'861	4'861	1.65	1.44
Wood	2'746	2'493	0.85	0.74
Biogas	294	267	0.09	0.08
Waste	4'624	4'198	1.43	1.24
Municipal waste	3'112	2'825	0.96	0.84
Industrial waste	143	130	0.04	0.04
Sewage sludge and landfill gases	1'369	1'243	0.42	0.37
Other	916	832	0.28	0.25
Total domestic	319'130	294'349	100.00	87.14
Imports	0	43'433	0.00	12.86
Austria	0	1'360	0.00	0.40
France	0	12'990	0.00	3.85
Greece	0	179	0.00	0.05
Slovenia	0	4'726	0.00	1.40
Switzerland	0	24'178	0.00	7.16
Total	319'130	337'782	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.114: Unit process raw data of the electricity production mix in Italy 2008, at busbar

	Name	Location	Unit	electricity, production mix IT	Uncertainty/Type	StandardDeviation95 %	GeneralComment			
								Location	Unit	IT
								InfrastructureProcess	Unit	0 kWh
product	electricity, production mix IT	IT	kWh	1.00E+0						
technosphere	electricity, hard coal, at power plant	IT	kWh	1.33E-1	1	1.05	(1,1,1,1,1,1); assumption for hard coal power production in Italy, value: IEA statistics 2008			
	electricity, industrial gas, at power plant	IT	kWh	1.70E-2	1	1.05	(1,1,1,1,1,1); assumption for industrial gas, coke gas and blast furnace gas power production in Italy, value: IEA statistics 2008			
	electricity, oil, at power plant	IT	kWh	9.49E-2	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Italy, value: IEA statistics 2008			
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	2.12E-3	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Italy, value: IEA statistics 2008			
	electricity, natural gas, at power plant	IT	kWh	5.33E-1	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Italy, value: IEA statistics 2008			
	electricity, hydropower, at reservoir power plant, alpine region	RER	kWh	8.96E-2	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Italy: 64%			
	electricity, hydropower, at run-of-river power plant	RER	kWh	5.04E-2	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Italy: 36%			
	electricity, hydropower, at pumped storage power plant	IT	kWh	1.88E-2	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Italy: 11.87%			
	electricity, at wind power plant	RER	kWh	3.73E-2	1	1.05	(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in Italy, value: IEA statistics 2008			
	electricity, production mix photovoltaic, at plant	IT	kWh	6.16E-4	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Italy, value: IEA statistics 2008			
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	8.47E-3	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Italy, value: IEA statistics 2008			
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	5.13E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage sludge and landfill gases in Italy, value: IEA statistics 2008			
	electricity from waste, at municipal waste incineration plant	CH	kWh	1.00E-2	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Italy, value: IEA statistics 2008			

Tab. 3.115: Unit process raw data of the electricity supply mix in Italy 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty Standard Deviation 95%	GeneralComment
product	electricity mix	IT	kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	IT	kWh	1.16E-1	1 1.05	(1,1,1,1,1,1); assumption for hard coal power production in Italy, value: IEA statistics 2008
	electricity, industrial gas, at power plant	IT	kWh	1.48E-2	1 1.05	(1,1,1,1,1,1); assumption for industrial gas, coke gas and blast furnace gas power production in Italy, value: IEA statistics 2008
	electricity, oil, at power plant	IT	kWh	8.27E-2	1 1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Italy, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.85E-3	1 1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Italy, value: IEA statistics 2008
	electricity, natural gas, at power plant	IT	kWh	4.64E-1	1 1.05	(1,1,1,1,1,1); assumption for natural gas power production in Italy, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, alpine region	RER	kWh	7.81E-2	1 1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Italy: 64%
	electricity, hydropower, at run-of-river power plant	RER	kWh	4.39E-2	1 1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Italy: 36%
	electricity, hydropower, at pumped storage power plant	IT	kWh	1.64E-2	1 1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Italy: 11.87%
	electricity, at wind power plant	RER	kWh	3.25E-2	1 1.05	(1,1,1,2,1,1); assumption for wind, geothermal, solar thermal, tidal and other power production in Italy, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	IT	kWh	5.37E-4	1 1.05	(1,1,1,1,1,1); assumption for solar power production in Italy, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	7.38E-3	1 1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Italy, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	4.47E-3	1 1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage sludge and landfill gases in Italy, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	8.75E-3	1 1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Italy, value: IEA statistics 2008
	electricity, production mix AT	AT	kWh	4.03E-3	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Italy, value: IEA statistics 2008
	electricity, production mix FR	FR	kWh	3.85E-2	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Italy, value: IEA statistics 2008
	electricity, production mix GR	GR	kWh	5.30E-4	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Italy, value: IEA statistics 2008
	electricity, production mix SI	SI	kWh	1.40E-2	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Italy, value: IEA statistics 2008
electricity, production mix CH	CH	kWh	7.16E-2	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Italy, value: IEA statistics 2008	

3.5.17 Latvia (LV)

Tab. 3.116 shows an overview over the Latvian electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Latvian power production relies on hydro power as main energy source (32 %). Further electricity is produced from fossil fuels, mainly natural gas (20 %). A share of about 48 % of the electricity is imported. It is assumed that 100 % of the electricity is imported from Russia. Latvia strongly depends on foreign energy resources.

There are no nuclear power plants in Latvia (PRIS 2011). Therefore, the nuclear power production is zero.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Latvia is 100 %. The share of the storage type hydropower plants is 0 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Latvia is 0 %.

For the electricity production with wind power the average European dataset is used.

For the power production out of renewable resources, either European or Swiss datasets are set as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Latvia are shown in Tab. 3.117 and Tab. 3.118.

Tab. 3.116: Composition of the Latvian electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	2'062	1'918	37.64	19.70
Hard coal	2	2	0.04	0.02
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	0	0	0.00	0.00
<i>Coke gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Blast furnace gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Petroleum products	2	2	0.04	0.02
<i>Fuel oil</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Diesel</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>other petroleum products</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Natural Gas	2'058	1'914	37.57	19.66
Other fossil	0	0	0.00	0.00
Hydro	3'109	3'078	60.40	31.60
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	3'109	3'078	60.40	31.60
Pumped storage power plants	0	0	0.00	0.00
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	103	100	1.96	1.03
Geothermal	0	0	0.00	0.00
Solar	0	0	0.00	0.00
<i>Photovoltaic</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Solar thermal</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Wave and tidal energy	0	0	0.00	0.00
Wind	59	59	1.16	0.61
Wood	9	8	0.16	0.08
Biogas	35	33	0.64	0.34
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	5'274	5'096	100.00	52.33
Imports	0	4'643	0.00	47.67
Russia	0	4'643	0.00	47.67
Total	5'274	9'739	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.117: Unit process raw data of the electricity productionmix in Latvia 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviations%	GeneralComment
	Location			LV			
	InfrastructureProcess			0			
product	Unit			kWh			
	electricity mix, domestic production	LV	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	CENTREL	kWh	3.65E-4	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Latvia, value: IEA statistics 2008
	electricity, oil, at power plant	SK	kWh	3.65E-4	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Latvia, value: IEA statistics 2008
	electricity, natural gas, at power plant	CENTREL	kWh	3.76E-1	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Latvia, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	6.04E-1	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Latvia: 100%
	electricity, at wind power plant	RER	kWh	1.16E-2	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Latvia, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.61E-3	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Latvia, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	6.43E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Latvia, value: IEA statistics 2008

Tab. 3.118: Unit process raw data of the electricity supply mix in Latvia 2008, at busbar

	Name	Location	Unit	electricity mix	UncertaintyType	StandardDeviations%	GeneralComment
	Location			LV			
	InfrastructureProcess			0			
product	Unit			kWh			
	electricity mix	LV	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	CENTREL	kWh	1.91E-4	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Latvia, value: IEA statistics 2008
	electricity, oil, at power plant	SK	kWh	1.91E-4	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Latvia, value: IEA statistics 2008
	electricity, natural gas, at power plant	CENTREL	kWh	1.97E-1	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Latvia, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	3.16E-1	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Latvia: 100%
	electricity, at wind power plant	RER	kWh	6.06E-3	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Latvia, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	8.41E-4	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Latvia, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	3.36E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Latvia, value: IEA statistics 2008
	electricity mix, domestic production	RU	kWh	4.77E-1	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Latvia, value: IEA statistics 2008

3.5.18 Lithuania (LT)

Tab. 3.120 shows an overview over the Lithuanian electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Lithuanian power production relies on nuclear power as main energy source (51 %). Further electricity is produced from fossil fuels, mainly natural gas (9 %) and petroleum products (2 %), and hydro power. A share of about 31 % of the electricity is imported. It is assumed that 100 % of the electricity is imported from Russia.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Lithuania is 100 %. The share of the storage type hydropower plants is 0 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Lithuania is 0 %.

Power production from nuclear power plants is approximated using the UCTE dataset for pressurised reactors. This dataset reflects the conditions of nuclear power production using PWR power plants only (PRIS 2011). Being part of the European Union, Lithuania is committed to close down Ignalina NPP until December 2009. In order to close this gap of energy supply, Lithuania will have to import electricity from Russia until a new power plant (most probably nuclear) is on line. The established data set represents the situation in 2008, i.e. Ignalina still on line.

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Lithuania are shown in Tab. 3.120 and Tab. 3.121.

Tab. 3.119: Composition of the Lithuanian electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	2'592	2'053	16.16	11.18
Hard coal	0	0	0.00	0.00
Lignite	0	0	0.00	0.00
Peat	1	1	0.01	0.00
Industrial Gases	0	0	0.00	0.00
<i>Coke gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Blast furnace gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Petroleum products	566	448	3.53	2.44
<i>Fuel oil</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Diesel</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>other petroleum products</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Natural Gas	2'025	1'604	12.62	8.74
Other fossil	0	0	0.00	0.00
Hydro	988	978	7.70	5.33
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	988	978	7.70	5.33
Pumped storage power plants	0	0	0.00	0.00
Nuclear	9'894	9'300	73.20	50.67
Pressurised-water reactor (PWR)	9'894	9'300	73.20	50.67
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	200	186	1.46	1.01
Geothermal	0	0	0.00	0.00
Solar	0	0	0.00	0.00
<i>Photovoltaic</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Solar thermal</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Wave and tidal energy	0	0	0.00	0.00
Wind	131	131	1.03	0.71
Wood	59	47	0.37	0.26
Biogas	10	8	0.06	0.04
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	238	188	1.48	1.03
Total domestic	13'912	12'705	100.00	69.22
Imports	0	5'649	0.00	30.78
Russia	0	5'649	0.00	30.78
Total	13'912	18'354	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.120: Unit process raw data of the electricity production mix in Lithuania 2008, at busbar

product	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviations%	GeneralComment
	Location			LT			
	InfrastructureProcess			0			
	Unit			kWh			
	electricity mix, domestic production	LT	kWh	1.00E+0			
	electricity, peat, at power plant	NORDEL	kWh	6.23E-5	1	1.05	(1,1,1,3,1,1); assumption for peat power production in Lithuania, value: IEA statistics 2008
	electricity, oil, at power plant	SK	kWh	3.53E-2	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Lithuania, value: IEA statistics 2008
	electricity, natural gas, at power plant	CENTREL	kWh	1.26E-1	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Lithuania, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	7.70E-2	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Lithuania: 100%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	7.32E-1	1	1.05	(1,1,1,2,1,1); assumption for nuclear power production in Lithuania using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	2.51E-2	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Lithuania, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	3.69E-3	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Lithuania, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	6.14E-4	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Lithuania, value: IEA statistics 2008

Tab. 3.121: Unit process raw data of the electricity supply mix in Lithuania 2008, at busbar

product	Name	Location	Unit	electricity mix	UncertaintyType	StandardDeviations%	GeneralComment
	Location			LT			
	InfrastructureProcess			0			
	Unit			kWh			
	electricity mix	LT	kWh	1.00E+0			
	electricity, peat, at power plant	NORDEL	kWh	4.31E-5	1	1.05	(1,1,1,3,1,1); assumption for peat power production in Lithuania, value: IEA statistics 2008
	electricity, oil, at power plant	SK	kWh	2.44E-2	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Lithuania, value: IEA statistics 2008
	electricity, natural gas, at power plant	CENTREL	kWh	8.74E-2	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Lithuania, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	5.33E-2	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Lithuania: 100%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	5.07E-1	1	1.05	(1,1,1,2,1,1); assumption for nuclear power production in Lithuania using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	1.74E-2	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Lithuania, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	2.55E-3	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Lithuania, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	4.25E-4	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Lithuania, value: IEA statistics 2008
	electricity mix, domestic production	RU	kWh	3.08E-1	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Lithuania, value: IEA statistics 2008

3.5.19 Luxembourg (LU)

Tab. 3.122 shows an overview over the Luxembourgian electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Luxembourgian power production relies on fossil fuels, mainly natural gas as main energy source (17 %). Further electricity is produced from hydro power (10 %). About 72 % of the electricity in the supply mix of Luxembourg is imported from Belgium and Germany.

There are no nuclear power plants in Luxembourg (PRIS 2011). Therefore, the nuclear power production is zero.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Luxembourg is 100 %. The share of the storage type hydropower plants is 0 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Luxembourg is 86 %.

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Luxembourg are shown in Tab. 3.123 and Tab. 3.124.

Tab. 3.122: Composition of the Luxembourgian electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	2'402	1'591	58.96	16.70
Hard coal	0	0	0.00	0.00
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	0	0	0.00	0.00
<i>Coke gases</i>	0	0	0.00	0.00
<i>Blast furnace gases</i>	0	0	0.00	0.00
Petroleum products	0	0	0.00	0.00
<i>Fuel oil</i>	0	0	0.00	0.00
<i>Diesel</i>	0	0	0.00	0.00
<i>other petroleum products</i>	0	0	0.00	0.00
Natural Gas	2'402	1'591	58.96	16.70
Other fossil	0	0	0.00	0.00
Hydro	965	955	35.41	10.03
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	132	131	4.84	1.37
Pumped storage power plants	833	825	30.56	8.65
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	125	109	4.04	1.14
Geothermal	0	0	0.00	0.00
Solar	20	19	0.00	0.00
<i>Photovoltaic</i>	20	19	0.70	0.20
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	61	61	2.26	0.64
Wood	0	0	0.00	0.00
Biogas	44	29	1.08	0.31
Waste	65	43	1.60	0.45
Municipal waste	65	43	1.60	0.45
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	3'557	2'698	100.00	28.32
Imports	0	6'830	0.00	71.68
Belgium	0	1'524	0.00	15.99
Germany	0	5'306	0.00	55.69
Total	3'557	9'528	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.123: Unit process raw data of the electricity production mix in Luxembourg 2008, at busbar

product	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviation95%	GeneralComment
	Location			LU			
	InfrastructureProcess			0			
Unit			kWh				
	electricity mix, domestic production	LU	kWh	1.00E+0			
	electricity, natural gas, at power plant	LU	kWh	5.90E-1	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Luxembourg, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	4.84E-2	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Luxembourg: 100%
	electricity, hydropower, at pumped storage power plant	LU	kWh	3.06E-1	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Luxembourg: 86.32%
	electricity, at wind power plant	RER	kWh	2.26E-2	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Luxembourg, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	LU	kWh	6.97E-3	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Luxembourg, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.08E-2	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Luxembourg, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	1.60E-2	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Luxembourg, value: IEA statistics 2008

Tab. 3.124: Unit process raw data of the electricity supply mix in Luxembourg 2008, at busbar

product	Name	Location	Unit	electricity mix	UncertaintyType	StandardDeviation95%	GeneralComment
	Location			LU			
	InfrastructureProcess			0			
Unit			kWh				
	electricity mix	LU	kWh	1.00E+0			
	electricity, natural gas, at power plant	LU	kWh	1.67E-1	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Luxembourg, value: IEA statistics
	electricity, hydropower, at run-of-river power plant	RER	kWh	1.37E-2	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Luxembourg: 100%
	electricity, hydropower, at pumped storage power plant	LU	kWh	8.65E-2	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Luxembourg: 86.32%
	electricity, at wind power plant	RER	kWh	6.40E-3	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Luxembourg, value: IEA statistics
	electricity, production mix photovoltaic, at plant	LU	kWh	1.97E-3	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Luxembourg, value: IEA statistics
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	3.06E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Luxembourg, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	4.52E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Luxembourg, value: IEA statistics 2008
	electricity mix, domestic production	BE	kWh	1.60E-1	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Luxembourg, value: IEA statistics 2008
	electricity mix, domestic production	DE	kWh	5.57E-1	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Luxembourg, value: IEA statistics 2008

3.5.20 Macedonia (MK)

Tab. 3.125 shows an overview over the Macedonian electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Macedonian power production relies on fossil fuels, mainly lignite (56 %) and petroleum products (2 %), as main energy source. Further electricity is produced from hydro power (10 %). A share of about 32 % of the electricity is imported. It is assumed that 5 % of the electricity is imported from Greece and 95 % is imported from Serbia.

There are no nuclear power plants in Macedonia (PRIS 2011). Therefore, the nuclear power production is zero.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Macedonia is 18 %. The share of the storage type hydropower plants is 82 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Macedonia is 0 %.

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Macedonia are shown in Tab. 3.126 and Tab. 3.127.

Tab. 3.125: Composition of the Macedonian electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	5'471	4'862	85.39	57.70
Hard coal	0	0	0.00	0.00
Lignite	5'289	4'700	82.55	55.78
Peat	0	0	0.00	0.00
Industrial Gases	0	0	0.00	0.00
Coke gases	0	0	0.00	0.00
Blast furnace gases	0	0	0.00	0.00
Petroleum products	182	162	2.84	1.92
Fuel oil	0	0	0.00	0.00
Diesel	0	0	0.00	0.00
other petroleum products	0	0	0.00	0.00
Natural Gas	0	0	0.00	0.00
Other fossil	0	0	0.00	0.00
Hydro	840	832	14.61	9.87
Reservoir power plants	689	682	11.98	8.09
Run-of-river power plants	151	150	2.63	1.78
Pumped storage power plants	0	0	0.00	0.00
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	0	0	0.00	0.00
Geothermal	0	0	0.00	0.00
Solar	0	0	0.00	0.00
Photovoltaic	0	0	0.00	0.00
Solar thermal	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	0	0	0.00	0.00
Wood	0	0	0.00	0.00
Biogas	0	0	0.00	0.00
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	6'311	5'693	100.00	67.57
Imports	0	2'733	0.00	32.43
Greece	0	137	0.00	1.62
Serbia and Montenegro	0	2'596	0.00	30.81
Total	6'311	8'426	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.126: Unit process raw data of the electricity production mix in Macedonia 2008, at busbar

product	Name	Location	Unit	electricity mix, domestic production	Uncertainty/Type	StandardDeviation95%	GeneralComment
	Location			MK			
	InfrastructureProcess			0			
Unit			kWh				
	electricity mix, domestic production	MK	kWh	1.00E+0			
	electricity, lignite, at power plant	MK	kWh	8.26E-1	1	1.05	(1,1,1,1,1,1); assumption for lignite power production in Macedonia, value: IEA statistics 2008
	electricity, oil, at power plant	HR	kWh	2.84E-2	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Macedonia, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	1.20E-1	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Macedonia is: 82%
	electricity, hydropower, at run-of-river power plant	RER	kWh	2.63E-2	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Macedonia: 18%

Tab. 3.127: Unit process raw data of the electricity supply mix in Macedonia 2008, at busbar

product	Name	Location	Unit	electricity mix	Uncertainty/Type	StandardDeviation95%	GeneralComment
	Location			MK			
	InfrastructureProcess			0			
Unit			kWh				
	electricity mix	MK	kWh	1.00E+0			
	electricity, lignite, at power plant	MK	kWh	5.58E-1	1	1.05	(1,1,1,1,1,1); assumption for lignite power production in Macedonia, value: IEA statistics 2008
	electricity, oil, at power plant	HR	kWh	1.92E-2	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Macedonia, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	8.09E-2	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Macedonia: 82%
	electricity, hydropower, at run-of-river power plant	RER	kWh	1.78E-2	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Macedonia: 18%
	electricity mix, domestic production	GR	kWh	1.62E-2	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Macedonia, value: IEA statistics 2008
	electricity mix, domestic production	CS	kWh	3.08E-1	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Macedonia, value: IEA statistics 2008

3.5.21 Netherlands (NL)

Tab. 3.128 shows an overview over the Dutch electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Dutch power production relies on fossil fuels, mainly natural gas (47 %) and hard coal (17 %), as main energy source. Further electricity is produced from renewables and from nuclear power generation. A share of about 20 % of the electricity is imported. The electricity is imported from Belgium, Germany and Norway.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in the Netherlands is 100 %. The share of the storage type hydropower plants is 0 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in the Netherlands is 0 %.

Power production from nuclear power plants is approximated using the UCTE dataset for pressurised water reactors. These datasets reflect the conditions of nuclear power production using PWR power plants only (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of the Netherlands are shown in Tab. 3.129 and Tab. 3.130.

Tab. 3.128: Composition of the Dutch electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	92'285	83'976	85.28	68.03
Hard coal	23'469	21'356	21.69	17.30
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	3'328	3'028	3.08	2.45
Coke gases	304	277	0.28	0.22
Blast furnace gases	3'024	2'752	2.79	2.23
Petroleum products	2'065	1'879	1.91	1.52
Fuel oil	0	0	0.00	0.00
Diesel	53	48	0.05	0.04
other petroleum products	2'012	1'831	1.86	1.48
Natural Gas	63'423	57'713	58.61	46.75
Other fossil	0	0	0.00	0.00
Hydro	102	101	0.10	0.08
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	102	101	1.03	0.08
Pumped storage power plants	0	0	0.00	0.00
Nuclear	4'169	3'919	3.98	3.17
Pressurised-water reactor (PWR)	4'169	3'919	3.98	3.17
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	7'760	7'446	7.56	6.03
Geothermal	0	0	0.00	0.00
Solar	38	36	0.00	0.00
Photovoltaic	38	36	0.04	0.03
Solar thermal	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	4'260	4'260	4.33	3.45
Wood	2'563	2'332	2.37	1.89
Biogas	899	818	0.83	0.66
Waste	3'181	2'895	2.94	2.34
Municipal waste	2'922	2'659	2.70	2.15
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	259	236	0.24	0.19
Other	148	135	0.14	0.11
Total domestic	107'645	98'471	100.00	79.77
Imports	0	24'967	0.00	20.23
Belgium	0	2'984	0.00	2.42
Germany	0	18'896	0.00	15.31
Norway	0	3'087	0.00	2.50
Total	107'645	123'438	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.129: Unit process raw data of the electricity production mix in the Netherlands 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production		
				UncertaintyType	StandardDeviation95%	GeneralComment
Location	InfrastructureProcess	Unit				
product	electricity mix, domestic production	NL	kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	NL	kWh	2.17E-1	1	1.05 (1,1,1,1,1,1); assumption for hard coal power production in Netherlands, value: IEA statistics 2008
	electricity, industrial gas, at power plant	NL	kWh	3.08E-2	1	1.05 (1,1,1,1,1,1); assumption for industrial, coke and blast furnace gas power production in Netherlands, value: IEA statistics 2008
	electricity, oil, at power plant	NL	kWh	1.86E-2	1	1.05 (1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Netherlands, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	4.90E-4	1	1.05 (1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Netherlands, value: IEA statistics 2008
	electricity, natural gas, at power plant	NL	kWh	5.86E-1	1	1.05 (1,1,1,2,1,1); assumption for natural gas power production in Netherlands, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	1.03E-3	1	1.05 (1,1,1,2,1,1); estimated share of ROR hydropower production in Netherlands: 100%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	3.98E-2	1	1.05 (1,1,1,2,1,1); assumption for nuclear power production in Netherlands using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	4.46E-2	1	1.05 (1,1,1,2,1,1); assumption for geothermal power production in Netherlands, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	NL	kWh	3.63E-4	1	1.05 (1,1,1,1,1,1); assumption for solar power production in Netherlands, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	2.37E-2	1	1.05 (1,1,1,3,1,1); assumption for cogeneration power production in Netherlands, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.07E-2	1	1.05 (1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Netherlands, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	2.70E-2	1	1.05 (1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Netherlands, value: IEA statistics 2008

Tab. 3.130: Unit process raw data of the electricity supply mix in the Netherlands 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty Standard Deviations%	GeneralComment
	Location InfrastructureProcess			NL 0 kWh		
product	electricity mix	NL	kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	NL	kWh	1.73E-1	1 1.05	(1,1,1,1,1,1); assumption for hard coal power production in Netherlands, value: IEA statistics 2008
	electricity, industrial gas, at power plant	NL	kWh	2.45E-2	1 1.05	(1,1,1,1,1,1); assumption for industrial, coke and blast furnace gas power production in Netherlands, value: IEA statistics 2008
	electricity, oil, at power plant	NL	kWh	1.48E-2	1 1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Netherlands, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	3.91E-4	1 1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Netherlands, value: IEA statistics 2008
	electricity, natural gas, at power plant	NL	kWh	4.68E-1	1 1.05	(1,1,1,2,1,1); assumption for natural gas power production in Netherlands, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	8.18E-4	1 1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Netherlands: 100%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	3.17E-2	1 1.05	(1,1,1,2,1,1); assumption for nuclear power production in Netherlands using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	3.56E-2	1 1.05	(1,1,1,2,1,1); assumption for geothermal power production in Netherlands, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	NL	kWh	2.89E-4	1 1.05	(1,1,1,1,1,1); assumption for solar power production in Netherlands, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.89E-2	1 1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Netherlands, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	8.54E-3	1 1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Netherlands, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	2.15E-2	1 1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Netherlands, value: IEA statistics 2008
	electricity mix, domestic production	BE	kWh	2.42E-2	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Netherlands, value: IEA statistics 2008
	electricity mix, domestic production	DE	kWh	1.53E-1	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Netherlands, value: IEA statistics 2008
electricity mix, domestic production	NO	kWh	2.50E-2	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Netherlands, value: IEA statistics 2008	

3.5.22 Norway (NO)

Tab. 3.131 shows an overview over the Norwegian electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Norwegian power production relies on hydro power as main energy source (96 %). A share of about 2 % of the electricity is imported. The electricity is imported from Denmark, Finland, the Netherlands, Russia and Sweden.

There are no nuclear power plants in Norway (PRIS 2011). Therefore, the nuclear power production is zero.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Norway is 0 %. The share of the storage type hydropower plants is 100 %. The storage type hydropower production is approximated using the dataset for alpine conditions. The share of pumped storage in Norway is 1 %.

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Norway are shown in Tab. 3.132 and Tab. 3.133.

Tab. 3.131: Composition of the Norwegian electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	607	580	0.41	0.40
Hard coal	65	62	0.04	0.04
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	94	90	0.06	0.06
<i>Coke gases</i>	0	0	0.00	0.00
<i>Blast furnace gases</i>	94	90	0.06	0.06
Petroleum products	16	15	0.01	0.01
<i>Fuel oil</i>	0	0	0.00	0.00
<i>Diesel</i>	16	15	0.01	0.01
<i>other petroleum products</i>	0	0	0.00	0.00
Natural Gas	432	413	0.29	0.29
Other fossil	0	0	0.00	0.00
Hydro	140'522	139'117	98.52	96.19
Reservoir power plants	139'554	138'158	97.84	95.53
Run-of-river power plants	0	0	0.00	0.00
Pumped storage power plants	968	958	0.68	0.66
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	1'242	1'227	0.87	0.85
Geothermal	0	0	0.00	0.00
Solar	0	0	0.00	0.00
<i>Photovoltaic</i>	0	0	0.00	0.00
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	917	917	0.65	0.63
Wood	325	310	0.22	0.21
Biogas	0	0	0.00	0.00
Waste	128	122	0.09	0.08
Municipal waste	112	107	0.08	0.07
Industrial waste	10	10	0.01	0.01
Sewage sludge and landfill gases	6	6	0.00	0.00
Other	170	162	0.11	0.11
Total domestic	142'669	141'208	100.00	97.64
Imports	0	3'412	0.00	2.36
Denmark	0	427	0.00	0.30
Finland	0	59	0.00	0.04
Netherlands	0	326	0.00	0.23
Russian Federation	0	176	0.00	0.12
Sweden	0	2'424	0.00	1.68
Total	142'669	144'620	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.132: Unit process raw data of the electricity production mix in Norway 2008, at busbar

	Name	Location	Unit	electricity, production mix NO	UncertaintyType StandardDeviation95%	GeneralComment
	Location					
	InfrastructureProcess					
	Unit			NO kWh		
product	electricity, production mix NO	NO	kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	NORDEL	kWh	4.40E-4	1 1.05	(1,1,1,2,1,1); assumption for hard coal power production in Norway, value: IEA statistics 2008
	electricity, industrial gas, at power plant	NORDEL	kWh	6.36E-4	1 1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Norway, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.08E-4	1 1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Norway, value: IEA statistics 2008
	electricity, natural gas, at power plant	NORDEL	kWh	2.92E-3	1 1.05	(1,1,1,2,1,1); assumption for natural gas power production in Norway, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, alpine region	RER	kWh	9.78E-1	1 1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Norway: 100%
	electricity, hydropower, at pumped storage power plant	NO	kWh	6.79E-3	1 1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Norway: 0.69%
	electricity, at wind power plant	RER	kWh	7.64E-3	1 1.05	(1,1,1,2,1,1); assumption for geothermal power production in Norway, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	2.20E-3	1 1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Norway, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	4.06E-5	1 1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Norway, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	8.25E-4	1 1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Norway, value: IEA statistics 2008

Tab. 3.133: Unit process raw data of the electricity supply mix in Norway 2008, at busbar

	Name	Location	Unit	electricity mix NO	UncertaintyType StandardDeviation95%	GeneralComment
	Location					
	InfrastructureProcess					
	Unit			NO kWh		
product	electricity mix	NO	kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	NORDEL	kWh	4.29E-4	1 1.05	(1,1,1,2,1,1); assumption for hard coal power production in Norway, value: IEA statistics 2008
	electricity, industrial gas, at power plant	NORDEL	kWh	6.21E-4	1 1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Norway, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.06E-4	1 1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Norway, value: IEA statistics 2008
	electricity, natural gas, at power plant	NORDEL	kWh	2.85E-3	1 1.05	(1,1,1,2,1,1); assumption for natural gas power production in Norway, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, alpine region	RER	kWh	9.55E-1	1 1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Norway: 100%
	electricity, hydropower, at pumped storage power plant	NO	kWh	6.63E-3	1 1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Norway: 0.69%
	electricity, at wind power plant	RER	kWh	7.46E-3	1 1.05	(1,1,1,2,1,1); assumption for geothermal power production in Norway, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	2.15E-3	1 1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Norway, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	3.96E-5	1 1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Norway, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	8.06E-4	1 1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Norway, value: IEA statistics 2008
	electricity, production mix DK	DK	kWh	2.95E-3	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Norway, value: IEA statistics 2008
	electricity, production mix FI	FI	kWh	4.08E-4	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Norway, value: IEA statistics 2008
	electricity, production mix NL	NL	kWh	2.25E-3	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Norway, value: IEA statistics 2008
	electricity, production mix RU	RU	kWh	1.22E-3	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Norway, value: IEA statistics 2008
	electricity, production mix SE	SE	kWh	1.68E-2	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Norway, value: IEA statistics 2008

3.5.23 Poland (PL)

Tab. 3.134 shows an overview over the Polish electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Polish power production relies on fossil fuels, mainly hard coal (50 %) and lignite (34 %), as main energy source. A share of about 6 % of the electricity is imported. The electricity is imported from the Czech Republic, Germany, Slovakia, Sweden and Ukraine.

There are no nuclear power plants in Poland (PRIS 2011). Therefore, the nuclear power production is zero.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Poland is 100 %. The share of the storage type hydropower plants is 0 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Poland is 22 %.

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Poland are shown in Tab. 3.135 and Tab. 3.136.

Tab. 3.134: Composition of the Polish electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	148'858	125'574	94.93	89.21
Hard coal	83'914	70'788	53.51	50.29
Lignite	57'262	48'305	36.52	34.32
Peat	0	0	0.00	0.00
Industrial Gases	2'193	1'850	1.40	1.31
Coke gases	1'667	1'406	1.06	1.00
Blast furnace gases	526	444	0.34	0.32
Petroleum products	2'323	1'960	1.48	1.39
Fuel oil	2'119	1'788	1.35	1.27
Diesel	31	26	0.02	0.02
other petroleum products	173	146	0.11	0.10
Natural Gas	3'166	2'671	2.02	1.90
Other fossil	0	0	0.00	0.00
Hydro	2'747	2'720	2.06	1.93
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	2'152	2'130	1.61	1.51
Pumped storage power plants	595	589	0.45	0.42
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	4'045	3'543	2.68	2.52
Geothermal	0	0	0.00	0.00
Solar	0	0	0.00	0.00
Photovoltaic	0	0	0.00	0.00
Solar thermal	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	837	837	0.63	0.59
Wood	3'200	2'699	2.04	1.92
Biogas	8	7	0.01	0.00
Waste	527	445	0.34	0.32
Municipal waste	7	6	0.00	0.00
Industrial waste	277	234	0.18	0.17
Sewage sludge and landfill gases	243	205	0.15	0.15
Other	0	0	0.00	0.00
Total domestic	156'177	132'281	100.00	93.98
Imports	0	8'480	0.00	6.02
Czech Republic	0	29	0.00	0.02
Germany	0	5'576	0.00	3.96
Slovak Republic	0	31	0.00	0.02
Sweden	0	2'065	0.00	1.47
Ukraine	0	779	0.00	0.55
Total	156'177	140'761	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.135: Unit process raw data of the electricity production mix in Poland 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviation95 %	GeneralComment
				PL			
				0 kWh			
product	electricity mix, domestic production	PL	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	PL	kWh	5.35E-1	1	1.05	(1,1,1,1,1,1); assumption for hard coal power production in Poland, value: IEA statistics 2008
	electricity, lignite, at power plant	PL	kWh	3.65E-1	1	1.05	(1,1,1,1,1,1); assumption for lignite power production in Poland, value: IEA statistics 2008
	electricity, industrial gas, at power plant	CENTREL	kWh	1.40E-2	1	1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Poland, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	kWh	1.46E-2	1	1.05	(1,1,1,2,1,1); assumption for petroleum product and fuel oil power production in Poland, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.98E-4	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Poland, value: IEA statistics 2008
	electricity, natural gas, at power plant	CENTREL	kWh	2.02E-2	1	1.05	(1,1,1,2,1,1); assumption for natural gas power production in Poland, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	1.61E-2	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Poland: 100%
	electricity, hydropower, at pumped storage power plant	PL	kWh	4.45E-3	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Poland: 21.66%
	electricity, at wind power plant	RER	kWh	6.33E-3	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Poland, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	2.04E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Poland, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.60E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Poland, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	1.81E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Poland, value: IEA statistics 2008

Tab. 3.136: Unit process raw data of the electricity supply mix in Poland 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty StandardDe viation95%	GeneralComment
				PL 0 kWh		
product	electricity mix	PL	kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	PL	kWh	5.03E-1	1 1.05	(1,1,1,1,1,1); assumption for hard coal power production in Poland, value: IEA statistics 2008
	electricity, lignite, at power plant	PL	kWh	3.43E-1	1 1.05	(1,1,1,1,1,1); assumption for lignite power production in Poland, value: IEA statistics 2008
	electricity, industrial gas, at power plant	CENTREL	kWh	1.31E-2	1 1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Poland, value: IEA statistics 2008
	electricity, oil, at power plant	UCTE	kWh	1.37E-2	1 1.05	(1,1,1,2,1,1); assumption for petroleum product and fuel oil power production in Poland, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.86E-4	1 1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Poland, value: IEA statistics 2008
	electricity, natural gas, at power plant	CENTREL	kWh	1.90E-2	1 1.05	(1,1,1,2,1,1); assumption for natural gas power production in Poland, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	1.51E-2	1 1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Poland: 100%
	electricity, hydropower, at pumped storage power plant	PL	kWh	4.18E-3	1 1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Poland: 21.66%
	electricity, at wind power plant	RER	kWh	5.95E-3	1 1.05	(1,1,1,2,1,1); assumption for geothermal power production in Poland, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.92E-2	1 1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Poland, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.50E-3	1 1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Poland, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	1.70E-3	1 1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Poland, value: IEA statistics 2008
	electricity mix, domestic production	CZ	kWh	2.06E-4	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Poland, value: IEA statistics 2008
	electricity mix, domestic production	DE	kWh	3.96E-2	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Poland, value: IEA statistics 2008
	electricity mix, domestic production	SK	kWh	2.20E-4	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Poland, value: IEA statistics 2008
	electricity mix, domestic production	SE	kWh	1.47E-2	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Poland, value: IEA statistics 2008
electricity mix, domestic production	UA	kWh	5.53E-3	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Poland, value: IEA statistics 2008	

3.5.24 Portugal (PT)

Tab. 3.137 shows an overview over the Portuguese electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Portuguese power production relies on fossil fuels, mainly natural gas (26 %), hard coal (19 %) and petroleum products (7 %), as main energy source. Further electricity is produced from hydropower (13 %) and from renewables, mainly wind (10 %). A share of about 20 % of the electricity is imported. The electricity is imported from Spain.

There are no nuclear power plants in Portugal (PRIS 2011). Therefore, the nuclear power production is zero.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Portugal is 66 %. The share of the storage type hydropower plants is 34 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Portugal is 7 %.

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Portugal are shown in Tab. 3.138 and Tab. 3.139.

Tab. 3.137: Composition of the Portuguese electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	30'543	28'640	65.31	52.46
Hard coal	11'196	10'498	23.94	19.23
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	0	0	0.00	0.00
<i>Coke gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Blast furnace gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Petroleum products	4'148	3'890	8.87	7.12
<i>Fuel oil</i>	<i>3'938</i>	<i>3'693</i>	<i>8.42</i>	<i>6.76</i>
<i>Diesel</i>	<i>75</i>	<i>70</i>	<i>0.16</i>	<i>0.13</i>
<i>other petroleum products</i>	<i>135</i>	<i>127</i>	<i>0.29</i>	<i>0.23</i>
Natural Gas	15'199	14'252	32.50	26.11
Other fossil	0	0	0.00	0.00
Hydro	7'296	7'223	16.47	13.23
Reservoir power plants	2'311	2'288	5.22	4.19
Run-of-river power plants	4'487	4'442	10.13	8.14
Pumped storage power plants	498	493	1.12	0.90
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	7'559	7'451	16.99	13.65
Geothermal	192	184	0.42	0.34
Solar	38	36	0.00	0.00
<i>Photovoltaic</i>	<i>38</i>	<i>36</i>	<i>0.08</i>	<i>0.07</i>
<i>Solar thermal</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Wave and tidal energy	0	0	0.00	0.00
Wind	5'757	5'757	13.13	10.55
Wood	1'501	1'407	3.21	2.58
Biogas	71	67	0.15	0.12
Waste	571	535	1.22	0.98
Municipal waste	562	527	1.20	0.97
Industrial waste	9	8	0.02	0.02
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	45'969	43'850	100.00	80.32
Imports	0	10'744	0.00	19.68
Spain	0	10'744	0.00	19.68
Total	45'969	54'594	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.138: Unit process raw data of the electricity production mix in Portugal 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production		UncertaintyType	StandardDeviation95%	GeneralComment
				PT	0			
				kWh				
	LocationInfrastructureProcess							
	Unit							
product	electricity mix, domestic production	PT	kWh	1.00E+0				
technosphere	electricity, hard coal, at power plant	PT	kWh	2.39E-1	1	1.05	(1,1,1,1,1,1); assumption for hard coal power production in Portugal, value: IEA statistics 2008	
	electricity, oil, at power plant	PT	kWh	8.71E-2	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Portugal, value: IEA statistics 2008	
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.60E-3	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Portugal, value: IEA statistics 2008	
	electricity, natural gas, at power plant	UCTE	kWh	3.25E-1	1	1.05	(1,1,1,2,1,1); assumption for natural gas power production in Portugal, value: IEA statistics 2008	
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	5.22E-2	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Portugal: 34%	
	electricity, hydropower, at run-of-river power plant	RER	kWh	1.01E-1	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Portugal: 66%	
	electricity, hydropower, at pumped storage power plant	PT	kWh	1.12E-2	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Portugal: 6.83%	
	electricity, at wind power plant	RER	kWh	1.35E-1	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Portugal, value: IEA statistics 2008	
	electricity, production mix photovoltaic, at plant	PT	kWh	8.15E-4	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Portugal, value: IEA statistics 2008	
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	3.21E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Portugal, value: IEA statistics 2008	
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.52E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Portugal, value: IEA statistics 2008	
	electricity from waste, at municipal waste incineration plant	CH	kWh	1.22E-2	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Portugal, value: IEA statistics 2008	

Tab. 3.139: Unit process raw data of the electricity supply mix in Portugal 2008, at busbar

	Name	Location	Unit	electricity mix		UncertaintyType	StandardDeviation95%	GeneralComment
				PT	0			
				kWh				
	LocationInfrastructureProcess							
	Unit							
product	electricity mix	PT	kWh	1.00E+0				
technosphere	electricity, hard coal, at power plant	PT	kWh	1.92E-1	1	1.05	(1,1,1,1,1,1); assumption for hard coal power production in Portugal, value: IEA statistics 2008	
	electricity, oil, at power plant	PT	kWh	7.00E-2	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Portugal, value: IEA statistics 2008	
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.29E-3	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Portugal, value: IEA statistics 2008	
	electricity, natural gas, at power plant	UCTE	kWh	2.61E-1	1	1.05	(1,1,1,2,1,1); assumption for natural gas power production in Portugal, value: IEA statistics 2008	
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	4.19E-2	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Portugal: 34%	
	electricity, hydropower, at run-of-river power plant	RER	kWh	8.14E-2	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Portugal: 66%	
	electricity, hydropower, at pumped storage power plant	PT	kWh	9.03E-3	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Portugal: 6.83%	
	electricity, at wind power plant	RER	kWh	1.09E-1	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Portugal, value: IEA statistics 2008	
	electricity, production mix photovoltaic, at plant	PT	kWh	6.54E-4	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Portugal, value: IEA statistics 2008	
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	2.58E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Portugal, value: IEA statistics 2008	
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.22E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Portugal, value: IEA statistics 2008	
	electricity from waste, at municipal waste incineration plant	CH	kWh	9.81E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Portugal, value: IEA statistics 2008	
	electricity mix, domestic production	ES	kWh	1.97E-1	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Portugal, value: IEA statistics 2008	

3.5.25 Romania (RO)

Tab. 3.140 shows an overview over the Romanian electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Romanian power production relies on fossil fuels, mainly lignite (36 %) and natural gas (14 %), as main energy source. Further electricity is produced from hydro power (29 %) and nuclear power (18 %). A share of about 2 % of the electricity is imported. It is assumed that 50 % of the electricity is imported from Ukraine and 50 % from Bulgaria.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Romania is 100 %. The share of the storage type hydropower plants is 0 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Romania is 0 %.

Power production from nuclear power plants is approximated using the UCTE dataset for pressurised reactors. This dataset reflects the conditions of nuclear power production using PWR power plants onl (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Romania are shown in Tab. 3.141 and Tab. 3.142.

Tab. 3.140: Composition of the Romanian electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	36'506	30'359	52.38	51.56
Hard coal	110	91	0.16	0.16
Lignite	25'712	21'383	36.89	36.32
Peat	0	0	0.00	0.00
Industrial Gases	60	50	0.09	0.08
<i>Coke gases</i>	0	0	0.00	0.00
<i>Blast furnace gases</i>	0	0	0.00	0.00
Petroleum products	700	582	1.00	0.99
<i>Fuel oil</i>	0	0	0.00	0.00
<i>Diesel</i>	0	0	0.00	0.00
<i>other petroleum products</i>	0	0	0.00	0.00
Natural Gas	9'924	8'253	14.24	14.02
Other fossil	0	0	0.00	0.00
Hydro	17'195	17'023	29.37	28.91
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	17'195	17'023	29.37	28.91
Pumped storage power plants	0	0	0.00	0.00
Nuclear	11'226	10'552	18.21	17.92
Pressurised-water reactor (PWR)	11'226	10'552	18.21	17.92
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	29	25	0.04	0.04
Geothermal	0	0	0.00	0.00
Solar	0	0	0.00	0.00
<i>Photovoltaic</i>	0	0	0.00	0.00
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	5	5	0.01	0.01
Wood	24	20	0.03	0.03
Biogas	0	0	0.00	0.00
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	64'956	57'960	100.00	98.44
Imports	0	921	0.00	1.56
Ukraine	0	461	0.00	0.78
Bulgaria	0	461	0.00	0.78
Total	64'956	58'881	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.141: Unit process raw data of the electricity production mix in Romania 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	Uncertainty Standard Deviations %	GeneralComment			
							Location	Infrastructure	Process
							Unit		
product	electricity mix, domestic production	RO	kWh	1.00E+0					
technosphere	electricity, hard coal, at power plant	CENTREL	kWh	1.58E-3	1 1.05	(1,1,1,3,1,1); assumption for hard coal power production in Romania, value: IEA statistics 2008			
	electricity, lignite, at power plant	CENTREL	kWh	3.69E-1	1 1.05	(1,1,1,3,1,1); assumption for lignite power production in Romania, value: IEA statistics 2008			
	electricity, industrial gas, at power plant	CENTREL	kWh	8.61E-4	1 1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Romania, value: IEA statistics 2008			
	electricity, oil, at power plant	SK	kWh	1.00E-2	1 1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Romania, value: IEA statistics 2008			
	electricity, natural gas, at power plant	CENTREL	kWh	1.42E-1	1 1.05	(1,1,1,1,1,1); assumption for natural gas power production in Romania, value: IEA statistics 2008			
	electricity, hydropower, at run-of-river power plant	RER	kWh	2.94E-1	1 1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Romania: 100%			
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	1.82E-1	1 1.05	(1,1,1,2,1,1); assumption for nuclear power production in Romania using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)			
	electricity, at wind power plant	RER	kWh	8.63E-5	1 1.05	(1,1,1,2,1,1); assumption for geothermal power production in Romania, value: IEA statistics 2008			
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	3.44E-4	1 1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Romania, value: IEA statistics 2008			

Tab. 3.142: Unit process raw data of the electricity supply mix in Romania 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty Standard Deviations %	GeneralComment			
							Location	Infrastructure	Process
							Unit		
product	electricity mix	RO	kWh	1.00E+0					
technosphere	electricity, hard coal, at power plant	CENTREL	kWh	1.55E-3	1 1.05	(1,1,1,3,1,1); assumption for hard coal power production in Romania, value: IEA statistics 2008			
	electricity, lignite, at power plant	CENTREL	kWh	3.63E-1	1 1.05	(1,1,1,3,1,1); assumption for lignite power production in Romania, value: IEA statistics 2008			
	electricity, industrial gas, at power plant	CENTREL	kWh	8.47E-4	1 1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Romania, value: IEA statistics 2008			
	electricity, oil, at power plant	SK	kWh	9.89E-3	1 1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Romania, value: IEA statistics 2008			
	electricity, natural gas, at power plant	CENTREL	kWh	1.40E-1	1 1.05	(1,1,1,1,1,1); assumption for natural gas power production in Romania, value: IEA statistics 2008			
	electricity, hydropower, at run-of-river power plant	RER	kWh	2.89E-1	1 1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Romania: 100%			
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	1.79E-1	1 1.05	(1,1,1,2,1,1); assumption for nuclear power production in Romania using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)			
	electricity, at wind power plant	RER	kWh	8.49E-5	1 1.05	(1,1,1,2,1,1); assumption for geothermal power production in Romania, value: IEA statistics 2008			
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	3.39E-4	1 1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Romania, value: IEA statistics 2008			
	electricity mix, domestic production	UA	kWh	7.82E-3	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Romania, value: IEA statistics 2008			
electricity mix, domestic production	BG	kWh	7.82E-3	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Romania, value: IEA statistics 2008				

3.5.26 Russia (RU)

Tab. 3.143 shows an overview over the Russian electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Russian power production relies on fossil fuels, mainly natural gas (45 %), hard coal (11 %) and lignite (7 %), as main energy source. Further electricity is produced

from hydro power (18 %) and nuclear power (17 %). A share of about 0.3 % of the electricity is imported. It is assumed that 100 % of the electricity is imported from Ukraine.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Russia is 75 %. The share of the storage type hydropower plants is 25 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Russia is 0 %.

Power production from nuclear power plants is approximated using the UCTE dataset for pressurised water reactors. This dataset reflects the conditions of nuclear power production using PWR power plants only (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Russia are shown in Tab. 3.144 and Tab. 3.145.

Tab. 3.143: Composition of the Russian electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	707'569	579'684	64.37	64.15
Hard coal	115'945	94'990	10.55	10.51
Lignite	73'573	60'276	6.69	6.67
Peat	460	377	0.04	0.04
Industrial Gases	6'770	5'547	0.62	0.61
<i>Coke gases</i>	0	0	0.00	0.00
<i>Blast furnace gases</i>	0	0	0.00	0.00
Petroleum products	16'104	13'193	1.47	1.46
<i>Fuel oil</i>	0	0	0.00	0.00
<i>Diesel</i>	0	0	0.00	0.00
<i>other petroleum products</i>	0	0	0.00	0.00
Natural Gas	494'716	405'302	45.01	44.85
Other fossil	0	0	0.00	0.00
Hydro	166'711	165'044	18.33	18.26
Reservoir power plants	41'678	41'261	4.58	4.57
Run-of-river power plants	125'033	123'783	13.75	13.70
Pumped storage power plants	0	0	0.00	0.00
Nuclear	163'085	153'300	17.02	16.96
Pressurised-water reactor (PWR)	89'645	84'267	9.36	9.32
Boiling-water reactor (BWR)	73'440	69'033	7.67	7.64
Renewables	494	471	0.05	0.05
Geothermal	465	446	0.05	0.05
Solar	0	0	0.00	0.00
<i>Photovoltaic</i>	0	0	0.00	0.00
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	5	5	0.00	0.00
Wood	24	20	0.00	0.00
Biogas	0	0	0.00	0.00
Waste	2'520	2'065	0.23	0.23
Municipal waste	0	0	0.00	0.00
Industrial waste	2'520	2'065	0.23	0.23
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	1'040'379	900'564	100.00	99.66
Imports	0	3'105	0.00	0.34
Ukraine	0	3'105	0.00	0.34
Total	1'040'379	903'669	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.144: Unit process raw data of the electricity production mix in Russia 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	Uncertainty Standard Deviations %	GeneralComment			
							Location	Infrastructure	Process
							Unit		
product	electricity mix, domestic production	RU	kWh	1.00E+0					
technosphere	electricity, hard coal, at power plant	CENTREL	kWh	1.05E-1	1 1.05	(1,1,1,3,1,1); assumption for hard coal power production in Russia, value: IEA statistics 2008			
	electricity, lignite, at power plant	CENTREL	kWh	6.69E-2	1 1.05	(1,1,1,3,1,1); assumption for lignite power production in Russia, value: IEA statistics 2008			
	electricity, peat, at power plant	NORDEL	kWh	4.18E-4	1 1.05	(1,1,1,3,1,1); assumption for peat power production in Russia, value: IEA statistics 2008			
	electricity, industrial gas, at power plant	CENTREL	kWh	6.16E-3	1 1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Russia, value: IEA statistics 2008			
	electricity, oil, at power plant	SK	kWh	1.47E-2	1 1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Russia, value: IEA statistics 2008			
	electricity, natural gas, at power plant	CENTREL	kWh	4.50E-1	1 1.05	(1,1,1,1,1,1); assumption for natural gas power production in Russia, value: IEA statistics 2008			
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	4.58E-2	1 1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Russia: 25%			
	electricity, hydropower, at run-of-river power plant	RER	kWh	1.37E-1	1 1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Russia: 75%			
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	9.36E-2	1 1.05	(1,1,1,2,1,1); assumption for nuclear power production in Russia using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)			
	electricity, nuclear, at power plant boiling water reactor	UCTE	kWh	7.67E-2	1 1.05	(1,1,1,2,1,1); assumption for nuclear power production in Russia using BWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)			
	electricity, at wind power plant	RER	kWh	5.01E-4	1 1.05	(1,1,1,2,1,1); assumption for geothermal power production in Russia, value: IEA statistics 2008			
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	2.18E-5	1 1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Russia, value: IEA statistics 2008			
	electricity from waste, at municipal waste incineration plant	CH	kWh	2.29E-3	1 1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Russia, value: IEA statistics 2008			

Tab. 3.145: Unit process raw data of the electricity supply mix in Russia 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty Standard Deviations %	GeneralComment			
							Location	Infrastructure	Process
							Unit		
product	electricity mix	RU	kWh	1.00E+0					
technosphere	electricity, hard coal, at power plant	CENTREL	kWh	1.05E-1	1 1.05	(1,1,1,3,1,1); assumption for hard coal power production in Russia, value: IEA statistics 2008			
	electricity, lignite, at power plant	CENTREL	kWh	6.67E-2	1 1.05	(1,1,1,3,1,1); assumption for lignite power production in Russia, value: IEA statistics 2008			
	electricity, peat, at power plant	NORDEL	kWh	4.17E-4	1 1.05	(1,1,1,3,1,1); assumption for peat power production in Russia, value: IEA statistics 2008			
	electricity, industrial gas, at power plant	CENTREL	kWh	6.14E-3	1 1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Russia, value: IEA statistics 2008			
	electricity, oil, at power plant	SK	kWh	1.46E-2	1 1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Russia, value: IEA statistics 2008			
	electricity, natural gas, at power plant	CENTREL	kWh	4.49E-1	1 1.05	(1,1,1,1,1,1); assumption for natural gas power production in Russia, value: IEA statistics 2008			
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	4.57E-2	1 1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Russia: 25%			
	electricity, hydropower, at run-of-river power plant	RER	kWh	1.37E-1	1 1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Russia: 75%			
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	9.32E-2	1 1.05	(1,1,1,2,1,1); assumption for nuclear power production in Russia using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)			
	electricity, nuclear, at power plant boiling water reactor	UCTE	kWh	7.64E-2	1 1.05	(1,1,1,2,1,1); assumption for nuclear power production in Russia using BWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)			
	electricity, at wind power plant	RER	kWh	5.00E-4	1 1.05	(1,1,1,2,1,1); assumption for geothermal power production in Russia, value: IEA statistics 2008			
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	2.18E-5	1 1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Russia, value: IEA statistics 2008			
	electricity from waste, at municipal waste incineration plant	CH	kWh	2.28E-3	1 1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Russia, value: IEA statistics 2008			
electricity mix, domestic production	UA	kWh	3.44E-3	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Russia, value: IEA statistics 2008				

3.5.27 Serbia (CS)

Tab. 3.146 shows an overview over the Serbian electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Serbian power production relies on fossil fuels, mainly lignite (55 %), as main energy source. Further electricity is produced from hydro power (23 %). A share of about 21 % of the electricity is imported. It is assumed that 40 % of the electricity is imported from Bulgaria, 30 % from Hungary and 30 % from Romania. There are no nuclear power plants in Serbia (PRIS 2011). Therefore, the nuclear power production is zero.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Serbia is 86 %. The share of the storage type hydropower plants is 12 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Serbia is estimated to be 5 %.

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Serbia are shown in Tab. 3.147 and Tab. 3.148.

Tab. 3.146: Composition of the Serbian electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	27'209	24'083	70.64	56.05
Hard coal	0	0	0.00	0.00
Lignite	26'560	23'508	68.96	54.71
Peat	0	0	0.00	0.00
Industrial Gases	62	55	0.16	0.13
<i>Coke gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Blast furnace gases</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Petroleum products	172	152	0.45	0.35
<i>Fuel oil</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Diesel</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>other petroleum products</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Natural Gas	415	367	1.08	0.85
Other fossil	0	0	0.00	0.00
Hydro	10'109	10'008	29.36	23.29
Reservoir power plants	1'537	1'521	4.46	3.54
Run-of-river power plants	8'067	7'986	23.43	18.59
Pumped storage power plants	505	500	1.47	1.16
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	0	0	0.00	0.00
Geothermal	0	0	0.00	0.00
Solar	0	0	0.00	0.00
<i>Photovoltaic</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
<i>Solar thermal</i>	<i>0</i>	<i>0</i>	<i>0.00</i>	<i>0.00</i>
Wave and tidal energy	0	0	0.00	0.00
Wind	0	0	0.00	0.00
Wood	0	0	0.00	0.00
Biogas	0	0	0.00	0.00
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	37'318	34'090	100.00	79.34
Imports	0	8'875	0.00	20.66
Bularia	0	3'550	0.00	8.26
Hungary	0	2'663	0.00	6.20
Romania	0	2'663	0.00	6.20
Total	37'318	42'965	100.00	100.00

Tab. 3.147: Unit process raw data of the electricity production mix in Serbia 2008, at busbar

product	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviations%	GeneralComment
	Location			CS			
	InfrastructureProcess			0			
Unit			kWh				
	electricity mix, domestic production	CS	kWh	1.00E+0			
	electricity, lignite, at power plant	CS	kWh	6.90E-1	1	1.05	(1,1,1,1,1,1); assumption for lignite power production in Serbia and Montenegro, value: IEA statistics 2008
	electricity, industrial gas, at power plant	CENTREL	kWh	1.61E-3	1	1.05	(1,1,1,3,1,1); assumption for industrial, coke and blast furnace gas power production in Serbia and Montenegro, value: IEA statistics 2008
	electricity, oil, at power plant	CS	kWh	4.47E-3	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Serbia and Montenegro, value: IEA statistics 2008
	electricity, natural gas, at power plant	CENTREL	kWh	1.08E-2	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Serbia and Montenegro, value: IEA
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	4.46E-2	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Serbia and Montenegro:
	electricity, hydropower, at run-of-river power plant	RER	kWh	2.34E-1	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Serbia and Montenegro: 84%
	electricity, hydropower, at pumped storage power plant	CS	kWh	1.47E-2	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Serbia and Montenegro: 5%

Tab. 3.148: Unit process raw data of the electricity supply mix in Serbia 2008, at busbar

product	Name	Location	Unit	electricity mix	UncertaintyType	StandardDeviations%	GeneralComment
	Location			CS			
	InfrastructureProcess			0			
Unit			kWh				
	electricity mix	CS	kWh	1.00E+0			
	electricity, lignite, at power plant	CS	kWh	5.47E-1	1	1.05	(1,1,1,1,1,1); assumption for lignite power production in Serbia and Montenegro, value: IEA
	electricity, industrial gas, at power plant	CENTREL	kWh	1.28E-3	1	1.05	(1,1,1,3,1,1); assumption for industrial, coke and blast furnace gas power production in Serbia and Montenegro, value: IEA statistics 2008
	electricity, oil, at power plant	CS	kWh	3.54E-3	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Serbia and Montenegro, value: IEA statistics 2008
	electricity, natural gas, at power plant	CENTREL	kWh	8.55E-3	1	1.05	(1,1,1,3,1,1); assumption for natural gas power production in Serbia and Montenegro, value: IEA
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	3.54E-2	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Serbia and Montenegro:
	electricity, hydropower, at run-of-river power plant	RER	kWh	1.86E-1	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Serbia and Montenegro:
	electricity, hydropower, at pumped storage power plant	CS	kWh	1.16E-2	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Serbia and Montenegro: 5%
	electricity mix, domestic production	BG	kWh	8.26E-2	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Serbia and Montenegro, value: IEA statistics 2008
	electricity mix, domestic production	HU	kWh	6.20E-2	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Serbia and Montenegro, value: IEA statistics 2008
	electricity mix, domestic production	RO	kWh	6.20E-2	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Serbia and Montenegro, value: IEA statistics 2008

3.5.28 Slovakia (SK)

Tab. 3.149 shows an overview over the Slovak electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Slovak power production relies on nuclear power as main energy source (43 %). Further electricity is produced from fossil fuels, mainly hard coal (6 %), lignite (5 %) and natural gas (4 %) and from hydro power (12 %). A share of about 26 % of the electricity is imported. The electricity is imported from Czech Republic, Poland and Ukraine.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydro-power generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Slovakia is 75 %. The share of the storage type hydropower plants is 25 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Slovakia is 5 %.

Power production from nuclear power plants is approximated using the UCTE dataset for pressurised reactors. These datasets reflect the conditions of nuclear power production using PWR power plants only (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Slovakia are shown in Tab. 3.150 and Tab. 3.151.

Tab. 3.149: Composition of the Slovak electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	7'437	6'484	24.11	17.86
Hard coal	2'458	2'143	7.97	5.90
Lignite	2'214	1'930	7.18	5.32
Peat	0	0	0.00	0.00
Industrial Gases	477	416	1.55	1.15
Coke gases	190	166	0.62	0.46
Blast furnace gases	287	250	0.93	0.69
Petroleum products	681	594	2.21	1.64
Fuel oil	619	540	2.01	1.49
Diesel	0	0	0.00	0.00
other petroleum products	62	54	0.20	0.15
Natural Gas	1'607	1'401	5.21	3.86
Other fossil	0	0	0.00	0.00
Hydro	4'241	4'199	15.61	11.57
Reservoir power plants	1'010	1'000	3.72	2.75
Run-of-river power plants	3'029	2'999	11.15	8.26
Pumped storage power plants	202	200	0.74	0.55
Nuclear	16'703	15'701	58.39	43.25
Pressurised-water reactor (PWR)	16'703	15'701	58.39	43.25
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	489	427	1.59	1.18
Geothermal	0	0	0.00	0.00
Solar	0	0	0.00	0.00
Photovoltaic	0	0	0.00	0.00
Solar thermal	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	7	7	0.03	0.02
Wood	480	418	1.56	1.15
Biogas	2	2	0.01	0.00
Waste	53	46	0.17	0.13
Municipal waste	39	34	0.13	0.09
Industrial waste	1	1	0.00	0.00
Sewage sludge and landfill gases	13	11	0.04	0.03
Other	39	34	0.13	0.09
Total domestic	28'962	26'891	100.00	74.07
Imports	0	9'412	0.00	25.93
Czech Republic	0	6'683	0.00	18.41
Poland	0	2'551	0.00	7.03
Ukraine	0	178	0.00	0.49
Total	28'962	36'303	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.150: Unit process raw data of the electricity production mix in Slovakia 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviation95 %	GeneralComment			
								Location	Infrastructure	Process
								Unit		
product	electricity mix, domestic production	SK	kWh	1.00E+0						
technosphere	electricity, hard coal, at power plant	SK	kWh	7.97E-2	1	1.05	(1,1,1,1,1,1); assumption for hard coal power production in Slovakia, value: IEA statistics 2008			
	electricity, lignite, at power plant	SK	kWh	7.18E-2	1	1.05	(1,1,1,1,1,1); assumption for lignite power production in Slovakia, value: IEA statistics 2008			
	electricity, industrial gas, at power plant	CENTREL	kWh	1.55E-2	1	1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Slovakia, value: IEA statistics 2008			
	electricity, oil, at power plant	SK	kWh	2.21E-2	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Slovakia, value: IEA statistics 2008			
	electricity, natural gas, at power plant	UCTE	kWh	5.21E-2	1	1.05	(1,1,1,2,1,1); assumption for natural gas power production in Slovakia, value: IEA statistics 2008			
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	3.72E-2	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Slovakia: 25%			
	electricity, hydropower, at run-of-river power plant	RER	kWh	1.12E-1	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Slovakia: 75%			
	electricity, hydropower, at pumped storage power plant	SK	kWh	7.44E-3	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Slovakia: 4.76%			
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	5.84E-1	1	1.05	(1,1,1,2,1,1); assumption for nuclear power production in Slovakia using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)			
	electricity, at wind power plant	RER	kWh	1.52E-3	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Slovakia, value: IEA statistics 2008			
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.56E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Slovakia, value: IEA statistics 2008			
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	4.86E-4	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Slovakia, value: IEA statistics 2008			
	electricity from waste, at municipal waste incineration plant	CH	kWh	1.30E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Slovakia, value: IEA statistics 2008			

Tab. 3.151: Unit process raw data of the electricity supply mix in Slovakia 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty Standard Deviations%	GeneralComment
	Location			SK		
	InfrastructureProcess			0		
	Unit			kWh		
product	electricity mix	SK	kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	SK	kWh	5.90E-2	1 1.05	(1,1,1,1,1,1); assumption for hard coal power production in Slovakia, value: IEA statistics 2008
	electricity, lignite, at power plant	SK	kWh	5.32E-2	1 1.05	(1,1,1,1,1,1); assumption for lignite power production in Slovakia, value: IEA statistics 2008
	electricity, industrial gas, at power plant	CENTREL	kWh	1.15E-2	1 1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Slovakia, value: IEA statistics 2008
	electricity, oil, at power plant	SK	kWh	1.64E-2	1 1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Slovakia, value: IEA statistics 2008
	electricity, natural gas, at power plant	UCTE	kWh	3.86E-2	1 1.05	(1,1,1,2,1,1); assumption for natural gas power production in Slovakia, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	2.75E-2	1 1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Slovakia: 25%
	electricity, hydropower, at run-of-river power plant	RER	kWh	8.26E-2	1 1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Slovakia: 75%
	electricity, hydropower, at pumped storage power plant	SK	kWh	5.51E-3	1 1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Slovakia: 4.76%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	4.32E-1	1 1.05	(1,1,1,2,1,1); assumption for nuclear power production in Slovakia using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	1.13E-3	1 1.05	(1,1,1,2,1,1); assumption for geothermal power production in Slovakia, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.15E-2	1 1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Slovakia, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	3.60E-4	1 1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Slovakia, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	9.61E-4	1 1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Slovakia, value: IEA statistics 2008
	electricity mix, domestic production	CZ	kWh	1.84E-1	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Slovakia, value: IEA statistics 2008
	electricity mix, domestic production	PL	kWh	7.03E-2	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Slovakia, value: IEA statistics 2008
electricity mix, domestic production	UA	kWh	4.90E-3	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Slovakia, value: IEA statistics 2008	

3.5.29 Slovenia (SI)

Tab. 3.125 shows an overview over the Slovenian electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Slovenian power production relies on nuclear power as main energy source (27 %). Further electricity is produced from fossil fuels, mainly lignite (20 %), hard coal (2 %) and natural gas (2 %) and hydro power. A share of about 29 % of the electricity is imported. It is assumed that 55 % of the electricity is imported from Austria, 5 % from Italy and 40 % from Croatia.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Slovenia is 100 %. The share of the storage type hydropower plants is 0 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Slovenia is 0 %.

Power production from nuclear power plants is approximated using the UCTE dataset for pressurised reactors. This dataset reflects the conditions of nuclear power production using PWR power plants only (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approxima-

tion. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Slovenia are shown in Tab. 3.153 and Tab. 3.154.

Tab. 3.152: Composition of the Slovenian electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	5'815	5'396	34.72	24.80
Hard coal	519	482	3.10	2.21
Lignite	4'804	4'458	28.69	20.49
Peat	0	0	0.00	0.00
Industrial Gases	0	0	0.00	0.00
Coke gases	0	0	0.00	0.00
Blast furnace gases	0	0	0.00	0.00
Petroleum products	16	15	0.10	0.07
Fuel oil	0	0	0.00	0.00
Diesel	0	0	0.00	0.00
other petroleum products	0	0	0.00	0.00
Natural Gas	476	442	2.84	2.03
Other fossil	0	0	0.00	0.00
Hydro	4'018	3'978	25.60	18.28
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	4'018	3'978	25.60	18.28
Pumped storage power plants	0	0	0.00	0.00
Nuclear	6'273	5'897	37.95	27.10
Pressurised-water reactor (PWR)	6'273	5'897	37.95	27.10
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	290	269	1.73	1.24
Geothermal	0	0	0.00	0.00
Solar	1	1	0.00	0.00
Photovoltaic	1	1	0.01	0.00
Solar thermal	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	0	0	0.00	0.00
Wood	229	213	1.37	0.98
Biogas	60	55	0.36	0.26
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	16'399	15'540	100.00	71.42
Imports	0	6'218	0.00	28.58
Austria	0	3'420	0.00	15.72
Croatia	0	2'487	0.00	11.43
Italy	0	311	0.00	1.43
Total	16'399	21'758	100.00	100.00

3. Life cycle inventories of electricity mixes

Tab. 3.153: Unit process raw data of the electricity production mix in Slovenia 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	Uncertainty Standard Deviations %	GeneralComment			
							Location	Infrastructure	Process
							Unit		
product	electricity mix, domestic production	SI	kWh	1.00E+0					
technosphere	electricity, hard coal, at power plant	HR	kWh	3.10E-2	1 1.05	(1,1,1,3,1,1); assumption for hard coal power production in Slovenia, value: IEA statistics 2008			
	electricity, lignite, at power plant	CS	kWh	2.87E-1	1 1.05	(1,1,1,3,1,1); assumption for lignite power production in Slovenia, value: IEA statistics 2008			
	electricity, oil, at power plant	SI	kWh	9.55E-4	1 1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Slovenia, value: IEA statistics 2008			
	electricity, natural gas, at power plant	CENTREL	kWh	2.84E-2	1 1.05	(1,1,1,3,1,1); assumption for natural gas power production in Slovenia, value: IEA statistics 2008			
	electricity, hydropower, at run-of-river power plant	RER	kWh	2.56E-1	1 1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Slovenia: 100%			
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	3.79E-1	1 1.05	(1,1,1,2,1,1); assumption for nuclear power production in Slovenia using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)			
	electricity, production mix photovoltaic, at plant	AT	kWh	6.05E-5	1 1.05	(1,1,1,3,1,1); assumption for solar power production in Slovenia, value: IEA statistics 2008			
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.37E-2	1 1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Slovenia, value: IEA statistics 2008			
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	3.57E-3	1 1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Slovenia, value: IEA statistics 2008			

Tab. 3.154: Unit process raw data of the electricity supply mix in Slovenia 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty Standard Deviations %	GeneralComment			
							Location	Infrastructure	Process
							Unit		
product	electricity mix	SI	kWh	1.00E+0					
technosphere	electricity, hard coal, at power plant	HR	kWh	2.21E-2	1 1.05	(1,1,1,3,1,1); assumption for hard coal power production in Slovenia, value: IEA statistics 2008			
	electricity, lignite, at power plant	CS	kWh	2.05E-1	1 1.05	(1,1,1,3,1,1); assumption for lignite power production in Slovenia, value: IEA statistics 2008			
	electricity, oil, at power plant	SI	kWh	6.82E-4	1 1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Slovenia, value: IEA statistics 2008			
	electricity, natural gas, at power plant	CENTREL	kWh	2.03E-2	1 1.05	(1,1,1,3,1,1); assumption for natural gas power production in Slovenia, value: IEA statistics 2008			
	electricity, hydropower, at run-of-river power plant	RER	kWh	1.83E-1	1 1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Slovenia: 100%			
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	2.71E-1	1 1.05	(1,1,1,2,1,1); assumption for nuclear power production in Slovenia using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)			
	electricity, production mix photovoltaic, at plant	AT	kWh	4.32E-5	1 1.05	(1,1,1,3,1,1); assumption for solar power production in Slovenia, value: IEA statistics 2008			
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	9.78E-3	1 1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Slovenia, value: IEA statistics 2008			
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	2.55E-3	1 1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Slovenia, value: IEA statistics 2008			
	electricity mix, domestic production	AT	kWh	1.57E-1	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Slovenia, value: IEA statistics 2008			
	electricity mix, domestic production	HR	kWh	1.14E-1	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Slovenia, value: IEA statistics 2008			
	electricity mix, domestic production	IT	kWh	1.43E-2	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Slovenia, value: IEA statistics 2008			

3.5.30 Spain (ES)

Tab. 3.155 shows an overview over the Spanish electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Spanish power production relies on fossil fuels, mainly natural gas (37 %), hard coal (15 %) and petroleum products (6 %) as main energy source. Further electricity is produced from nuclear power and from renewables (mainly wind). A share of about 2 % of the electricity is imported. The electricity is imported from France and Portugal.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Spain is 66 %. The share of the storage type hydropower plants is 34 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Spain is 10 %.

Power production from nuclear power plants is approximated using the UCTE datasets for pressurised reactors and boiling water reactors are used. These datasets reflect the conditions of nuclear power production using a mix of BWR (23 %) and PWR (77 %) power plants (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Spain are shown in Tab. 3.156 and Tab. 3.157.

Tab. 3.155: Composition of the Spanish electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	189'536	175'895	59.46	58.30
Hard coal	48'714	45'208	15.28	14.98
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	1'259	1'168	0.39	0.39
<i>Coke gases</i>	285	264	0.09	0.09
<i>Blast furnace gases</i>	974	904	0.31	0.30
Petroleum products	18'002	16'706	5.65	5.54
<i>Fuel oil</i>	10'474	9'720	3.29	3.22
<i>Diesel</i>	4'700	4'362	1.47	1.45
<i>other petroleum products</i>	2'828	2'624	0.89	0.87
Natural Gas	121'561	112'812	38.13	37.39
Other fossil	0	0	0.00	0.00
Hydro	26'112	25'851	8.74	8.57
Reservoir power plants	7'990	7'910	2.67	2.62
Run-of-river power plants	15'510	15'355	5.19	5.09
Pumped storage power plants	2'612	2'586	0.87	0.86
Nuclear	58'973	55'435	18.74	18.37
Pressurised-water reactor (PWR)	45'390	42'667	14.42	14.14
Boiling-water reactor (BWR)	13'583	12'768	4.32	4.23
Renewables	36'724	36'429	12.31	12.07
Geothermal	0	0	0.00	0.00
Solar	2'578	2'423	0.00	0.00
<i>Photovoltaic</i>	2'562	2'408	0.81	0.80
<i>Solar thermal</i>	16	15	0.01	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	32'203	32'203	10.89	10.67
Wood	1'888	1'752	0.59	0.58
Biogas	55	51	0.02	0.02
Waste	2'094	1'943	0.66	0.64
Municipal waste	1'564	1'451	0.49	0.48
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	530	492	0.17	0.16
Other	307	285	0.10	0.09
Total domestic	313'746	295'838	100.00	98.05
Imports	0	5'881	0.00	1.95
France	0	4'552	0.00	1.51
Portugal	0	1'314	0.00	0.44
Total	313'746	301'719	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.156: Unit process raw data of the electricity production mix in Spain 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production			GeneralComment
				UncertaintyType	StandardDeviation95%		
product	Location InfrastructureProcess Unit						
	electricity mix, domestic production	ES	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	ES	kWh	1.53E-1	1	1.05	(1,1,1,1,1,1); assumption for hard coal power production in Spain, value: IEA statistics 2008
	electricity, industrial gas, at power plant	ES	kWh	3.95E-3	1	1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Spain, value: IEA statistics 2008
	electricity, oil, at power plant	ES	kWh	4.17E-2	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Spain, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.47E-2	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Spain, value: IEA statistics 2008
	electricity, natural gas, at power plant	ES	kWh	3.81E-1	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Spain, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	2.67E-2	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Spain: 34%
	electricity, hydropower, at run-of-river power plant	RER	kWh	5.19E-2	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Spain: 66%
	electricity, hydropower, at pumped storage power plant	ES	kWh	8.74E-3	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Spain: 10%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	1.44E-1	1	1.05	(1,1,1,2,1,1); assumption for nuclear power production in Spain using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, nuclear, at power plant boiling water reactor	UCTE	kWh	4.32E-2	1	1.05	(1,1,1,2,1,1); assumption for nuclear power production in Spain using BWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	1.10E-1	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Spain, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	ES	kWh	8.14E-3	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Spain, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	5.92E-3	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Spain, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.84E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Spain, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	4.91E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Spain, value: IEA statistics 2008

Tab. 3.157: Unit process raw data of the electricity supply mix in Spain 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty Standard Deviation 95%	GeneralComment
	Location			ES		
	InfrastructureProcess			0		
	Unit			kWh		
product	electricity mix	ES	kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	ES	kWh	1.50E-1	1 1.05	(1,1,1,1,1,1); assumption for hard coal power production in Spain, value: IEA statistics 2008
	electricity, industrial gas, at power plant	ES	kWh	3.87E-3	1 1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Spain, value: IEA statistics 2008
	electricity, oil, at power plant	ES	kWh	4.09E-2	1 1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Spain, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.45E-2	1 1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Spain, value: IEA statistics 2008
	electricity, natural gas, at power plant	ES	kWh	3.74E-1	1 1.05	(1,1,1,1,1,1); assumption for natural gas power production in Spain, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	2.62E-2	1 1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Spain: 34%
	electricity, hydropower, at run-of-river power plant	RER	kWh	5.09E-2	1 1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Spain: 66%
	electricity, hydropower, at pumped storage power plant	ES	kWh	8.57E-3	1 1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Spain: 10%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	1.41E-1	1 1.05	(1,1,1,2,1,1); assumption for nuclear power production in Spain using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, nuclear, at power plant boiling water reactor	UCTE	kWh	4.23E-2	1 1.05	(1,1,1,2,1,1); assumption for nuclear power production in Spain using BWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	1.08E-1	1 1.05	(1,1,1,2,1,1); assumption for geothermal power production in Spain, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	ES	kWh	7.98E-3	1 1.05	(1,1,1,1,1,1); assumption for solar power production in Spain, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	5.81E-3	1 1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Spain, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.80E-3	1 1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Spain, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	4.81E-3	1 1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Spain, value: IEA statistics 2008
	electricity mix, domestic production	FR	kWh	1.51E-2	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Spain, value: IEA statistics 2008
	electricity mix, domestic production	FR	kWh	4.97E-5	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Spain, value: IEA statistics 2008
electricity mix, domestic production	PT	kWh	4.36E-3	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Spain, value: IEA statistics 2008	

3.5.31 Sweden (SE)

Tab. 3.158 shows an overview over the Swedish electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Swedish power production relies on hydropower as main energy source (43 %). Further electricity is produced from nuclear power (38 %) and from renewables, mainly wood (5 %). A share of about 8 % of the electricity is imported from Denmark, Finland, Germany, Norway and Poland.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Sweden is 80 %. The share of the storage type hydropower plants is 20 %. The storage type hydropower production is approximated using the dataset for alpine conditions. The share of pumped storage in Sweden is 0.2 %.

Power production from nuclear power plants is approximated using the UCTE datasets for pressurised reactors and boiling water reactors are used. These datasets reflect the conditions of nuclear power production using a mix of BWR (78 %) and PWR (22 %) power plants (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Sweden are shown in Tab. 3.159 and Tab. 3.160.

Tab. 3.158: Composition of the Swedish electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	3'711	3'545	2.45	2.25
Hard coal	514	491	0.34	0.31
Lignite	0	0	0.00	0.00
Peat	616	588	0.41	0.37
Industrial Gases	1'105	1'056	0.73	0.67
Coke gases	81	77	0.05	0.05
Blast furnace gases	1'024	978	0.68	0.62
Petroleum products	873	834	0.58	0.53
Fuel oil	778	743	0.51	0.47
Diesel	80	76	0.05	0.05
other petroleum products	15	14	0.01	0.01
Natural Gas	603	576	0.40	0.37
Other fossil	0	0	0.00	0.00
Hydro	69'211	68'519	47.31	43.48
Reservoir power plants	13'814	13'676	9.44	8.68
Run-of-river power plants	55'255	54'703	37.77	34.71
Pumped storage power plants	142	141	0.10	0.09
Nuclear	63'889	60'056	41.46	38.11
Pressurised-water reactor (PWR)	14'215	13'362	9.23	8.48
Boiling-water reactor (BWR)	49'674	46'693	32.24	29.63
Renewables	11'039	10'634	7.34	6.75
Geothermal	0	0	0.00	0.00
Solar	4	4	0.00	0.00
Photovoltaic	4	4	0.00	0.00
Solar thermal	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	1'996	1'996	1.38	1.27
Wood	8'932	8'532	5.89	5.41
Biogas	107	102	0.07	0.06
Waste	2'186	2'088	1.44	1.32
Municipal waste	2'115	2'020	1.39	1.28
Industrial waste	42	40	0.03	0.03
Sewage sludge and landfill gases	29	28	0.02	0.02
Other	0	0	0.00	0.00
Total domestic	150'036	144'841	100.00	91.91
Imports	0	12'754	0.00	8.09
Denmark	0	1'368	0.00	0.87
Finland	0	3'088	0.00	1.96
Germany	0	512	0.00	0.32
Norway	0	7'641	0.00	4.85
Poland	0	145	0.00	0.09
Total	150'036	157'595	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.159: Unit process raw data of the electricity production mix in Sweden 2008, at busbar

	Name	Location	Unit	electricity, production mix SE	UncertaintyType StandardDeviation95 %	GeneralComment
	Location			SE		
	InfrastructureProcess			0		
	Unit			kWh		
product	electricity, production mix SE	SE	kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	NORDEL	kWh	3.39E-3	1 1.05	(1,1,1,2,1,1); assumption for hard coal power production in Sweden, value: IEA statistics 2008
	electricity, peat, at power plant	NORDEL	kWh	4.06E-3	1 1.05	(1,1,1,3,1,1); assumption for peat power production in Sweden, value: IEA statistics 2008
	electricity, industrial gas, at power plant	NORDEL	kWh	7.29E-3	1 1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Sweden, value: IEA statistics 2008
	electricity, oil, at power plant	SE	kWh	5.23E-3	1 1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Sweden, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	5.28E-4	1 1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Sweden, value: IEA statistics 2008
	electricity, natural gas, at power plant	NORDEL	kWh	3.98E-3	1 1.05	(1,1,1,2,1,1); assumption for natural gas power production in Sweden, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, alpine region	RER	kWh	9.44E-2	1 1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Sweden: 20%
	electricity, hydropower, at run-of-river power plant	RER	kWh	3.78E-1	1 1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Sweden: 80%
	electricity, hydropower, at pumped storage power plant	SE	kWh	9.71E-4	1 1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Sweden: 0.21%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	9.23E-2	1 1.05	(1,1,1,2,1,1); assumption for nuclear power production in Sweden using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, nuclear, at power plant boiling water reactor	UCTE	kWh	3.22E-1	1 1.05	(1,1,1,2,1,1); assumption for nuclear power production in Sweden using BWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	1.38E-2	1 1.05	(1,1,1,2,1,1); assumption for geothermal power production in Sweden, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	SE	kWh	2.60E-5	1 1.05	(1,1,1,1,1,1); assumption for solar power production in Sweden, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	5.89E-2	1 1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Sweden, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	8.97E-4	1 1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Sweden, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	1.42E-2	1 1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Sweden, value: IEA statistics 2008

Tab. 3.160: Unit process raw data of the electricity supply mix in Sweden 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty StandardDe viation95%	GeneralComment	
	Location			SE			
	InfrastructureProcess			0			
	Unit			kWh			
product	electricity mix	SE	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	NORDEL	kWh	3.12E-3	1	1.05	(1,1,1,2,1,1); assumption for hard coal power production in Sweden, value: IEA statistics 2008
	electricity, peat, at power plant	NORDEL	kWh	3.73E-3	1	1.05	(1,1,1,3,1,1); assumption for peat power production in Sweden, value: IEA statistics 2008
	electricity, industrial gas, at power plant	NORDEL	kWh	6.70E-3	1	1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Sweden, value: IEA statistics 2008
	electricity, oil, at power plant	SE	kWh	4.81E-3	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in Sweden, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	4.85E-4	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Sweden, value: IEA statistics 2008
	electricity, natural gas, at power plant	NORDEL	kWh	3.65E-3	1	1.05	(1,1,1,2,1,1); assumption for natural gas power production in Sweden, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, alpine region	RER	kWh	8.68E-2	1	1.05	(1,1,1,2,1,1); estimated share of reservoir hydropower production in Sweden: 20%
	electricity, hydropower, at run-of-river power plant	RER	kWh	3.47E-1	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Sweden: 80%
	electricity, hydropower, at pumped storage power plant	SE	kWh	8.92E-4	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in Sweden: 0.21%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	8.48E-2	1	1.05	(1,1,1,2,1,1); assumption for nuclear power production in Sweden using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, nuclear, at power plant boiling water reactor	UCTE	kWh	2.96E-1	1	1.05	(1,1,1,2,1,1); assumption for nuclear power production in Sweden using BWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	1.27E-2	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Sweden, value: IEA statistics 2008
	electricity, production mix photovoltaic, at plant	SE	kWh	2.39E-5	1	1.05	(1,1,1,1,1,1); assumption for solar power production in Sweden, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	5.41E-2	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Sweden, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	8.24E-4	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Sweden, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	1.31E-2	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Sweden, value: IEA statistics 2008
	electricity, production mix DK	DK	kWh	8.68E-3	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Sweden, value: IEA statistics 2008
	electricity, production mix FI	FI	kWh	1.96E-2	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Sweden, value: IEA statistics 2008
	electricity, production mix DE	DE	kWh	3.25E-3	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Sweden, value: IEA statistics 2008
	electricity, production mix NO	NO	kWh	4.85E-2	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Sweden, value: IEA statistics 2008
electricity, production mix PL	PL	kWh	9.20E-4	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Sweden, value: IEA statistics 2008	

3.5.32 Switzerland (CH)

For Switzerland four different electricity mixes are modelled. These four electricity mixes are the Swiss production mix, the Swiss consumer mix, the mix of certified electricity sold in Switzerland and the Swiss supply mix. The Swiss electricity supply mix modelled in ecoinvent data v2.2 excludes the volume of certified electricity sold in dedicated electricity products and the volume of electricity produced and used by the Swiss Railways. In order to model the electricity mix at the Swiss grid more accurately, it is important to differ between the consumer mix and the actual supply mix, which excludes electricity sold in certified electricity products.

The Swiss consumer mix is based the on Swiss electricity characterisation of the Federal Office for Energy (BFE 2012) and additional information⁷. It shows the provenance of the electricity sold to

⁷ Personal communication: Ruedi Zurbrugg, Verkaufsoptimierung GmbH, 11.01.2012

Swiss customers, including certified electricity sold separately but excluding the electricity generated for and used by the Swiss Railways. The shares of the different technologies for electricity generation according to the Swiss electricity characterisation are shown in Tab. 3.167.

The results of this inquiry corrected by the volume of separately sold certified electricity substitute the model of the Swiss supply mix in the ecoinvent data v2.2.

In addition, the results of the inquiry without any major further corrections are used to model the BFE consumer mix. Finally, the mix of Swiss certified electricity is modelled based on the statistics of VUE (VUE 2011). The data sets listed in Tab. 3.161 are established. All statistical data refer to electricity production and consumption in 2009.

Tab. 3.161: Names and explanation of the electricity mixes modelled for Switzerland

Electricity	Ecoinvent name	Remark
Electricity production mix	electricity, production mix CH/CH/kWh	Includes all electricity produced in Switzerland 2009
	electricity, high voltage, production CH, at grid/kWh/CH	Electricity produced in Switzerland, includes transmission infrastructure and emissions to air
	electricity, medium voltage, production CH, at grid/kWh/CH	Electricity produced in Switzerland, includes losses from conversion and distribution, transmission and SF ₆ emission
	electricity, low voltage, production CH, at grid/kWh/CH	Electricity produced in Switzerland, includes losses from conversion and distribution, transmission and SF ₆ emission
Certified electricity	electricity, certified electricity/kWh/CH	Contains all certified electricity from renewable sources sold in 2009 in Switzerland
	electricity, high voltage, certified electricity, at grid/kWh/CH	Certified electricity, includes transmission infrastructure and emissions to air
	electricity, medium voltage, certified electricity, at grid/kWh/CH	Electricity from certified sources, includes losses from conversion and distribution, transmission and SF ₆ emission
	electricity, low voltage, certified electricity, at grid/kWh/CH	Electricity from certified sources, includes losses from conversion and distribution, transmission and SF ₆ emission
Consumer mix	electricity, consumer mix, at grid/CH/kWh	Represents the Swiss supply mix including the amounts of electricity sold in certified electricity products.
	electricity, high voltage, consumer mix, at grid/CH/kWh	Consumer mix, includes transmission infrastructure and emissions to air
	electricity, medium voltage, consumer mix, at grid/CH/kWh	Consumer mix, includes losses from conversion and distribution, transmission and SF ₆ emission
	electricity, low voltage, consumer mix, at grid/CH/kWh	Consumer mix, includes losses from conversion and distribution, transmission and SF ₆ emission
Supply mix	electricity mix/CH/kWh	Represents the Swiss supply mix excluding the amount of electricity sold in certified electricity products.
	electricity, high voltage, at grid/CH/kWh	Electricity mix, includes transmission infrastructure and emissions to air
	electricity, medium voltage, at grid/CH/kWh	Consumer mix, includes losses from conversion and distribution, transmission and SF ₆ emission
	electricity, low voltage, at grid/CH/kWh	Consumer mix, includes losses from conversion and distribution, transmission and SF ₆ emission

Tab. 3.162: Composition of the Swiss electricity mix according to the Swiss electricity characterisation for the year 2009⁷

	Total	From Switzerland	Import
Renewables	37.102%	31.881%	5.221%
Hydropower	36.005%	30.931%	5.074%
Other Renewables	0.397%	0.250%	0.147%
<i>Solar</i>	<i>0.060%</i>	<i>0.054%</i>	<i>0.006%</i>
<i>Wind</i>	<i>0.156%</i>	<i>0.032%</i>	<i>0.124%</i>
<i>Biomass</i>	<i>0.181%</i>	<i>0.164%</i>	<i>0.017%</i>
<i>Geothermal</i>	<i>0.000%</i>	<i>0.000%</i>	<i>0.000%</i>
Funded Electricity	0.700%	0.700%	0.000%
Non-renewables	43.318%	31.108%	12.210%
Nuclear power	41.660%	30.852%	10.808%
Fossil Fuels	1.657%	0.256%	1.401%
<i>Fuel oil</i>	<i>0.074%</i>	<i>0.053%</i>	<i>0.021%</i>
<i>Natural gas</i>	<i>1.500%</i>	<i>0.200%</i>	<i>1.300%</i>
<i>Hard Coal</i>	<i>0.084%</i>	<i>0.003%</i>	<i>0.081%</i>
Waste	1.420%	1.402%	0.018%
Non-verifiable / unknown	18.165%	0.000%	18.165%
Total	100.005%	64.391%	35.614%

The category funded electricity is reassigned to the different renewable technologies according to Tab. 3.163. The funded electricity is mainly produced from biomass (52.1 %) and hydropower (42.6 %). The shares of wind (1.3 %) and photovoltaic (3.9 %) are considerably lower.

Tab. 3.163: Technology shares of the funded electricity in Switzerland (KEV 2009)

Technology	Amount	Share
Unit	GWh	%
Total	390.5	100.00%
Wind	5.1	1.32%
Hydropower	166.4	42.60%
Biomass	203.6	52.13%
Photovoltaics	15.4	3.95%

The electricity produced from biomass can be further divided into electricity generated from wood, agricultural biogas and industrial biogas. These shares are obtained from Swiss statistics for electricity generation from renewable biomass (BFE 2009). The shares of the different technologies are shown in Tab. 3.164.

Tab. 3.164: Technology shares of the electricity from biomass in Switzerland (BFE 2009)

Technology	Amount	Share
Unit	GWh	%
Total	222.3	100.00%
Wood	154.4	69.45%
Biogas agricultural	37.4	16.85%
Biogas industrial	30.4	13.70%

The electricity produced from hydropower is divided into run-of-river hydropower, storage type hydropower and small hydropower. The shares of these three different technologies are shown in Tab. 3.166. The shares for run-of-river and storage type hydropower are derived from the Swiss electricity statistics (BFE 2010) and the share for small hydropower is taken from Flury & Frischknecht (2012).

Tab. 3.165: Technology shares of the electricity from hydropower in Switzerland (BFE 2010, Flury & Frischknecht 2012)

Technology	Production mix	Share production mix	Consumer mix	Share consumer mix
Unit	GWh	%	GWh	%
Total	37136.0	100.00%	34612.9	100.00%
Run-of-river hydropower	12710.0	34.23%	12710.0	36.72%
Storage type hydropower	19701.0	53.05%	18502.9	53.46%
Small hydropower	3400.0	9.16%	3400.0	9.82%
Pumped storage hydropower	1325.0	3.57%	0.0	0.00%

The shares of the different energy sources in the certified electricity mix are calculated using the figures listed in the VUE statistics (VUE 2011). The VUE statistics provide information on the energy sources per technology. According to the values presented in Tab. 3.166 hydropower accounts for the majority of certified electricity. All hydropower originates from Swiss hydroelectric power plants, which includes reservoir and run-off river hydropower. The same situation applies to electricity from photovoltaic. 54 % of the wind electricity is produced in Switzerland; the remaining part is imported from European countries.

For the Swiss supply mix the certified electricity produced in Switzerland and sold separately is subtracted from the Swiss consumer mix. The amount and the overall shares of the certified electricity in the Swiss consumer mix are shown in Tab. 3.166. The total production of certified electricity is taken from VUE (2011).

Tab. 3.166: Technology shares of the certified electricity produced in Switzerland (VUE 2011)

Technology	Amount	Share certified	Share on Swiss consumer mix
Unit	GWh	%	%
Total	5722.4	100.00%	9.26%
Photovoltaic	37.5	0.66%	0.06%
Wind	47.3	0.83%	0.08%
Hydropower	5595.6	97.78%	9.05%
Biomass	41.9	0.73%	0.07%

Power production from nuclear power plants is modelled using the Swiss dataset for pressurised and boiling water reactors. These datasets reflect the conditions of nuclear power production using a mix of BWR (48 %) and PWR (52 %) power plants (PRIS 2011).

The Swiss electricity production mix, the Swiss consumer mix, the certified electricity mix and the Swiss supply mix are shown in Tab. 3.167.

In Switzerland the electricity is mainly produced from hydropower (55.5 %) followed by nuclear power (44.5 %) and wastes. The Swiss consumer mix differs from the Swiss production mix. The Share of hydropower is considerably lower (31.9 %) as well as the share of nuclear power (30.8 %). A total share of 35.6 % of the electricity used in Switzerland is imported. The origin of more than half of the imports is not known. The share of 18.2 % of electricity from unknown origin in the Swiss consumer mix is modelled with the European electricity mix. 10 % of the electricity consumed in Switzerland is imported from French nuclear power plants and about 5 % is imported from French hydropower plants.

About 9.2 % of the electricity used in Switzerland is certified electricity. Most of the certified electricity is produced with hydropower (97.8 %). Within the other renewables, wind has the highest share (0.8 %).

Tab. 3.167: Composition of the Swiss electricity production, the Swiss consumer, the Swiss supply mix and the Swiss electricity mix for certified electricity products for the year 2009

Technologie	Produktions- Strommix	Produktions- Strommix	Lieferanten- Strommix	Zertifizierter Strommix	Egal- Strommix
Einheit	GWh	%	%	%	%
Inlandproduktion	66'494.0	100.000%	62.934%	99.619%	59.030%
Erneuerbare Energien	38'050.0	57.223%	33.181%	99.619%	26.092%
Wasserkraft	37'136.0	55.849%	32.502%	97.786%	25.537%
<i>Laufwasserkraft</i>	12'710.0	19.115%	11.935%	33.468%	9.637%
<i>Speicherwasserkraft</i>	19'701.0	29.628%	17.375%	55.365%	13.322%
<i>Kleinwasserkraft</i>	3'400.0	5.113%	3.193%	8.953%	2.578%
<i>Pumpspeicherkraft</i>	1'325.0	1.993%	0.000%	0.000%	0.000%
Andere erneuerbare Energien	914.0	1.375%	0.678%	1.833%	0.555%
<i>Sonne</i>	114.5	0.172%	0.085%	0.655%	0.024%
<i>Wind</i>	57.8	0.087%	0.043%	0.445%	0.000%
<i>Holz</i>	515.2	0.775%	0.382%	0.509%	0.369%
<i>Biogas Landwirtschaft</i>	125.0	0.188%	0.093%	0.123%	0.089%
<i>Biogas Industrie</i>	101.6	0.153%	0.075%	0.100%	0.073%
<i>Geothermie</i>	0.0	0.000%	0.000%	0.000%	0.000%
Nicht erneuerbare Energien	26'478.0	39.820%	32.376%	0.000%	35.822%
Kernenergie	26'119.0	39.280%	32.110%	0.000%	35.527%
<i>Druckwasserreaktor</i>	13'780.0	20.724%	16.941%	0.000%	18.743%
<i>Siedewasserreaktor</i>	12'339.0	18.557%	15.169%	0.000%	16.783%
Fossile Energieträger	359.0	0.540%	0.266%	0.000%	0.295%
<i>Erdöl</i>	74.3	0.112%	0.055%	0.000%	0.061%
<i>Erdgas</i>	280.5	0.422%	0.208%	0.000%	0.230%
<i>Kohle</i>	4.2	0.006%	0.003%	0.000%	0.003%
Abfälle	1'966.0	2.957%	1.459%	0.000%	1.614%
Nicht überprüfbare Energieträger	0.0	0.000%	0.000%	0.000%	0.000%
Pumpenstrombedarf	0.0	0.000%	-4.082%	0.000%	-4.498%
Importe	0.0	0.000%	37.066%	0.381%	40.970%
Erneuerbare Energien	0.0	0.000%	5.434%	0.381%	5.971%
Wasserkraft	0.0	0.000%	5.281%	0.000%	5.843%
<i>Laufwasserkraft</i>	0.0	0.000%	4.436%	0.000%	4.908%
<i>Speicherwasserkraft</i>	0.0	0.000%	0.845%	0.000%	0.935%
<i>Kleinwasserkraft</i>	0.0	0.000%	0.000%	0.000%	0.000%
Andere erneuerbare Energien	0.0	0.000%	0.153%	0.381%	0.129%
<i>Sonne</i>	0.0	0.000%	0.006%	0.000%	0.007%
<i>Wind</i>	0.0	0.000%	0.129%	0.381%	0.102%
<i>Holz</i>	0.0	0.000%	0.012%	0.000%	0.014%
<i>Biogas Landwirtschaft</i>	0.0	0.000%	0.003%	0.000%	0.003%
<i>Biogas Industrie</i>	0.0	0.000%	0.002%	0.000%	0.003%
<i>Geothermie</i>	0.0	0.000%	0.000%	0.000%	0.000%
Nicht erneuerbare Energien	0.0	0.000%	12.708%	0.000%	14.060%
Kernenergie	0.0	0.000%	11.249%	0.000%	12.446%
<i>Druckwasserreaktor</i>	0.0	0.000%	11.249%	0.000%	12.446%
<i>Siedewasserreaktor</i>	0.0	0.000%	0.000%	0.000%	0.000%
Fossile Energieträger	0.0	0.000%	1.458%	0.000%	1.613%
<i>Erdöl</i>	0.0	0.000%	0.022%	0.000%	0.024%
<i>Erdgas</i>	0.0	0.000%	1.353%	0.000%	1.497%
<i>Kohle</i>	0.0	0.000%	0.084%	0.000%	0.093%
Abfälle	0.0	0.000%	0.019%	0.000%	0.021%
Nicht überprüfbare Energieträger	0.0	0.000%	18.906%	0.000%	20.917%
Total	66'494.0	100.000%	100.000%	100.000%	100.000%

The unit process raw data of the Swiss electricity mixes are shown in Tab. 3.168, Tab. 3.169, Tab. 3.170 and Tab. 3.171.

3. Life cycle inventories of electricity mixes

Tab. 3.169: Unit process raw data of the electricity consumer mix in Switzerland 2009, at busbar

product technosphere	Name	Location	Unit	electricity, consumer mix	UncertaintyType	StandardDeviation95 %	GeneralComment
	Location			CH			
	InfrastructureProcess			0			
	Unit			kWh			
	electricity, consumer mix	CH	kWh	1.00E+0			
	electricity, hydropower, at run-of-river power plant	CH	kWh	1.19E-1	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for run-of-river hydropower production in Switzerland, own calculations
	electricity, hydropower, net, at reservoir power plant	CH	kWh	1.74E-1	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for storage type hydropower production in Switzerland, own calculations
	electricity, hydropower, at small hydropower plant	CH	kWh	3.19E-2	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for small hydropower production in , own calculations
	electricity, production mix photovoltaic, at plant	CH	kWh	8.50E-4	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from photovoltaics in Switzerland, own calculations
	electricity, at wind power plant	CH	kWh	4.29E-4	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from wind in Switzerland, own calculations
	electricity, at cogen 6400kWh, wood, emission control, allocation exergy	CH	kWh	3.82E-3	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from wood in Switzerland, own calculations
	electricity, at cogen with biogas engine, agricultural covered, alloc. exergy	CH	kWh	9.57E-4	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from agricultural biogas in Switzerland, own calculations
	electricity, at cogen with biogas engine, methane 96%-vol allocation exergy	CH	kWh	7.78E-4	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from biogas in Switzerland, own calculations
	electricity, nuclear, at power plant pressure water reactor	CH	kWh	1.69E-1	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from nuclear power (PWR) in Switzerland, own calculations
	electricity, nuclear, at power plant boiling water reactor	CH	kWh	1.52E-1	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from nuclear power (BWR) in Switzerland, own calculations
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	5.52E-4	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from fuel oil in Switzerland, own calculations
	electricity, at cogen 500kWe lean burn, allocation exergy	CH	kWh	2.08E-3	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from natural gas in Switzerland, own calculations
	electricity, hard coal, at power plant	DE	kWh	3.12E-5	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from natural gas in Switzerland, own calculations
	electricity from waste, at municipal waste incineration plant	CH	kWh	1.48E-2	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from waste in Switzerland, own calculations
	electricity, hydropower, at run-of-river power plant	RER	kWh	4.44E-2	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for Swiss electricity imports generated from run-of-river hydropower, own calculations
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	8.45E-3	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for Swiss electricity imports generated from storage type hydropower, own calculations
	electricity, production mix photovoltaic, at plant	DE	kWh	6.24E-5	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for Swiss electricity imports generated from photovoltaics, own calculations
	electricity, at wind power plant	RER	kWh	1.29E-3	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for Swiss electricity imports generated from wind, own calculations
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.23E-4	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from wood in Switzerland, own calculations
	electricity, nuclear, at power plant pressure water reactor	FR	kWh	1.12E-1	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for Swiss electricity imports generated from nuclear power (PWR), own calculations
	electricity, oil, at power plant	UCTE	kWh	2.19E-4	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for Swiss electricity imports generated from natural gas, own calculations
	electricity, natural gas, at power plant	UCTE	kWh	1.35E-2	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for Swiss electricity imports generated from natural gas, own calculations
	electricity, hard coal, at power plant	UCTE	kWh	8.43E-4	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for Swiss electricity imports generated from natural gas, own calculations
	electricity, production mix ENTSO	ENTSO	kWh	1.89E-1	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for Swiss electricity imports generated from hydropower, own calculations

3. Life cycle inventories of electricity mixes

Tab. 3.170: Unit process raw data of the certified electricity mix in Switzerland 2009, at busbar

product	Name	Location	Unit	electricity, certified electricity	UncertaintyType	StandardDeviation95 %	GeneralComment			
								Location	InfrastructureProcess	Unit
								CH	0	kWh
product	electricity, certified electricity	CH	kWh	1.00E+0						
technosphere	electricity, hydropower, at run-of-river power plant	CH	kWh	3.35E-1	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for run-of-river hydropower production in Switzerland, own calculations			
	electricity, hydropower, net, at reservoir power plant	CH	kWh	5.54E-1	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for storage type hydropower production in Switzerland, own calculations			
	electricity, hydropower, at small hydropower plant	CH	kWh	8.95E-2	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for small hydropower production in , own calculations			
	electricity, production mix photovoltaic, at plant	CH	kWh	6.55E-3	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from photovoltaics in Switzerland, own calculations			
	electricity, at wind power plant	CH	kWh	4.45E-3	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from wind in Switzerland, own calculations			
	electricity, at cogen 6400kWh, wood, emission control, allocation exergy	CH	kWh	5.09E-3	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from wood in Switzerland, own calculations			
	electricity, at cogen with biogas engine, agricultural covered, alloc. exergy	CH	kWh	1.23E-3	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from agricultural biogas in Switzerland, own calculations			
	electricity, at cogen with biogas engine, methane 96%-vol allocation exergy	CH	kWh	1.00E-3	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from biogas in Switzerland, own calculations			
	electricity, at wind power plant	RER	kWh	3.81E-3	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for Swiss electricity imports generated from wind, own calculations			

Tab. 3.171: Unit process raw data of the electricity supply mix in Switzerland 2009, at busbar

product	Name	Location	Unit	electricity mix	UncertaintyType	StandardDeviation95 %	GeneralComment			
								Location	InfrastructureProcess	Unit
								CH	0	kWh
product	electricity mix	CH	kWh	1.00E+0						
technosphere	electricity, hydropower, at run-of-river power plant	CH	kWh	9.64E-2	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for run-of-river hydropower production in Switzerland, own calculations			
	electricity, hydropower, net, at reservoir power plant	CH	kWh	1.33E-1	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for storage type hydropower production in Switzerland, own calculations			
	electricity, hydropower, at small hydropower plant	CH	kWh	2.58E-2	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for small hydropower production in , own calculations			
	electricity, production mix photovoltaic, at plant	CH	kWh	2.42E-4	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from photovoltaics in Switzerland, own calculations			
	electricity, at cogen 6400kWh, wood, emission control, allocation exergy	CH	kWh	3.69E-3	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from wood in Switzerland, own calculations			
	electricity, at cogen with biogas engine, agricultural covered, alloc. exergy	CH	kWh	9.28E-4	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from agricultural biogas in Switzerland, own calculations			
	electricity, at cogen with biogas engine, methane 96%-vol allocation exergy	CH	kWh	7.54E-4	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from biogas in Switzerland, own calculations			
	electricity, nuclear, at power plant pressure water reactor	CH	kWh	1.87E-1	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from nuclear power (PWR) in Switzerland, own calculations			
	electricity, nuclear, at power plant boiling water reactor	CH	kWh	1.68E-1	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from nuclear power (BWR) in Switzerland, own calculations			
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	6.10E-4	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from fuel oil in Switzerland, own calculations			
	electricity, at cogen 500kWe lean burn, allocation exergy	CH	kWh	2.30E-3	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from natural gas in Switzerland, own calculations			
	electricity, hard coal, at power plant	DE	kWh	3.45E-5	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from natural gas in Switzerland, own calculations			
	electricity from waste, at municipal waste incineration plant	CH	kWh	1.64E-2	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption electricity generation from waste in Switzerland, own calculations			
	electricity, hydropower, at run-of-river power plant	RER	kWh	4.91E-2	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for Swiss electricity imports generated from run-of-river hydropower, own calculations			
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	9.35E-3	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for Swiss electricity imports generated from storage type hydropower, own calculations			
	electricity, production mix photovoltaic, at plant	DE	kWh	6.91E-5	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for Swiss electricity imports generated from photovoltaics, own calculations			
	electricity, at wind power plant	RER	kWh	1.02E-3	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for Swiss electricity imports generated from wind, own calculations			
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.36E-4	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for Swiss electricity imports generated from wind, own calculations			
	electricity, nuclear, at power plant pressure water reactor	FR	kWh	1.24E-1	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for Swiss electricity imports generated from nuclear power (PWR), own calculations			
	electricity, oil, at power plant	UCTE	kWh	2.42E-4	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for Swiss electricity imports generated from natural gas, own calculations			
	electricity, natural gas, at power plant	UCTE	kWh	1.50E-2	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for Swiss electricity imports generated from natural gas, own calculations			
	electricity, hard coal, at power plant	UCTE	kWh	9.33E-4	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for Swiss electricity imports generated from natural gas, own calculations			
	electricity, production mix ENTSO	ENTSO	kWh	2.09E-1	1	1.07	(1,1,1,1,1,3,BU:1.05); assumption for Swiss electricity imports generated from hydropower, own calculations			

3.5.33 Turkey (TR)

Tab. 3.172 shows an overview over the Turkish electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The Turkish power production relies on fossil fuels, mainly natural gas (49 %), lignite (21 %) and hard coal (7 %), as main energy source. Further electricity is produced from hydro power. A share of about 26 % of the electricity is imported from Azerbaijan, Georgia, Greece and Turkmenistan. The Russian electricity mix is used for Azerbaijan, Georgia and Turkmenistan.

There are no nuclear power plants in Turkey (PRIS 2011). Therefore, the nuclear power production is zero.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Turkey is assumed to be 50 %. The share of the storage type hydropower plants is assumed to be 50 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Turkey is 0 %.

For the electricity production with wind power the average European dataset is used.

For the power production out of renewable resources, either European or Swiss datasets are set as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Turkey are shown Tab. 3.173 and Tab. 3.174.

Tab. 3.172: Composition of the Turkish electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	163'920	154'679	81.92	81.58
Hard coal	14'517	13'699	7.25	7.22
Lignite	41'858	39'498	20.92	20.83
Peat	0	0	0.00	0.00
Industrial Gases	1'341	1'265	0.67	0.67
<i>Coke gases</i>	497	469	0.25	0.25
<i>Blast furnace gases</i>	844	796	0.42	0.42
Petroleum products	7'519	7'095	3.76	3.74
<i>Fuel oil</i>	7'209	6'803	3.60	3.59
<i>Diesel</i>	266	251	0.13	0.13
<i>other petroleum products</i>	44	42	0.02	0.02
Natural Gas	98'685	93'122	49.32	49.11
Other fossil	0	0	0.00	0.00
Hydro	33'270	32'937	17.44	17.37
Reservoir power plants	16'635	16'469	8.72	8.69
Run-of-river power plants	16'635	16'469	8.72	8.69
Pumped storage power plants	0	0	0.00	0.00
Nuclear	0	0	0.00	0.00
Pressurised-water reactor (PWR)	0	0	0.00	0.00
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	1'148	1'134	0.60	0.60
Geothermal	162	156	0.08	0.08
Solar	0	0	0.00	0.00
<i>Photovoltaic</i>	0	0	0.00	0.00
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	847	847	0.45	0.45
Wood	24	23	0.01	0.01
Biogas	115	109	0.06	0.06
Waste	80	75	0.04	0.04
Municipal waste	0	0	0.00	0.00
Industrial waste	77	73	0.04	0.04
Sewage sludge and landfill gases	3	3	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	198'418	188'825	100.00	99.58
Imports	0	789	0.00	0.42
Azerbaijan	0	94	0.00	0.05
Georgia	0	215	0.00	0.11
Greece	0	30	0.00	0.02
Turkmenistan	0	450	0.00	0.24
Total	198'418	189'614	100.00	100.00

 red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.173: Unit process raw data of the electricity production mix in Turkey 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	UncertaintyType StandardDeviations% %	GeneralComment
	Location InfrastructureProcess Unit			TR 0 kWh		
	product	electricity mix, domestic production	TR	kWh		
technosphere	electricity, hard coal, at power plant	SK	kWh	7.25E-2	1 1.05	(1,1,1,3,1,1); assumption for hard coal power production in Turkey, value: IEA statistics 2008
	electricity, lignite, at power plant	SK	kWh	2.09E-1	1 1.05	(1,1,1,3,1,1); assumption for lignite power production in Turkey, value: IEA statistics 2008
	electricity, industrial gas, at power plant	CENTREL	kWh	6.70E-3	1 1.05	(1,1,1,3,1,1); assumption for industrial, coke and blast furnace gas power production in Turkey, value: IEA statistics 2008
	electricity, oil, at power plant	SK	kWh	3.62E-2	1 1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Turkey, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.33E-3	1 1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Turkey, value: IEA statistics 2008
	electricity, natural gas, at power plant	CENTREL	kWh	4.93E-1	1 1.05	(1,1,1,3,1,1); assumption for natural gas power production in Turkey, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	8.72E-2	1 1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in Turkey: 50%
	electricity, at wind power plant	RER	kWh	5.31E-3	1 1.05	(1,1,1,3,1,1); assumption for geothermal power production in Turkey, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.20E-4	1 1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Turkey, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	5.90E-4	1 1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Turkey, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	3.85E-4	1 1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Turkey, value: IEA statistics 2008

Tab. 3.174: Unit process raw data of the electricity supply mix in Turkey 2008, at busbar

	Name	Location	Unit	electricity mix	UncertaintyType StandardDeviations% %	GeneralComment
	Location InfrastructureProcess Unit			TR 0 kWh		
	product	electricity mix	TR	kWh		
technosphere	electricity, hard coal, at power plant	SK	kWh	7.22E-2	1 1.05	(1,1,1,3,1,1); assumption for hard coal power production in Turkey, value: IEA statistics 2008
	electricity, lignite, at power plant	SK	kWh	2.08E-1	1 1.05	(1,1,1,3,1,1); assumption for lignite power production in Turkey, value: IEA statistics 2008
	electricity, industrial gas, at power plant	CENTREL	kWh	6.67E-3	1 1.05	(1,1,1,3,1,1); assumption for industrial, coke and blast furnace gas power production in Turkey, value: IEA statistics 2008
	electricity, oil, at power plant	SK	kWh	3.61E-2	1 1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Turkey, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	1.32E-3	1 1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in Turkey, value: IEA statistics 2008
	electricity, natural gas, at power plant	CENTREL	kWh	4.91E-1	1 1.05	(1,1,1,3,1,1); assumption for natural gas power production in Turkey, value: IEA statistics 2008
	electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	8.69E-2	1 1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in Turkey: 50%
	electricity, at wind power plant	RER	kWh	5.29E-3	1 1.05	(1,1,1,3,1,1); assumption for geothermal power production in Turkey, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	1.19E-4	1 1.05	(1,1,1,3,1,1); assumption for cogeneration power production in Turkey, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	5.87E-4	1 1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Turkey, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	3.83E-4	1 1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in Turkey, value: IEA statistics 2008
	electricity mix, domestic production	RU	kWh	4.96E-4	1 1.05	(1,1,1,3,1,1); assumption for imported electricity in Turkey, value: IEA statistics 2008
	electricity mix, domestic production	RU	kWh	1.13E-3	1 1.05	(1,1,1,3,1,1); assumption for imported electricity in Turkey, value: IEA statistics 2008
	electricity mix, domestic production	GR	kWh	1.58E-4	1 1.05	(1,1,1,1,1,1); assumption for imported electricity in Turkey, value: IEA statistics 2008
	electricity mix, domestic production	RU	kWh	2.37E-3	1 1.05	(1,1,1,3,1,1); assumption for imported electricity in Turkey, value: IEA statistics 2008

3.5.34 Ukraine (UA)

Tab. 3.175 shows an overview over the Ukrainian electricity production according to the IEA Statistics (IEA 2010) for the year 2008. The Ukrainian power production relies on nuclear power as main energy source (48 %). Further electricity is produced from fossil fuels, mainly hard coal (32 %) and natural gas (11 %), and hydro power (6 %). A share of about 1 % of the electricity is imported. It is assumed that 100 % of the electricity is imported from Russia.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in Ukraine is 100 %. The share of the storage type hydropower plants is 0 %. The storage type hydropower production is approximated using the dataset for non-alpine conditions. The share of pumped storage in Ukraine is 0 %.

Power production from nuclear power plants is approximated using the UCTE dataset for pressurised water reactors. This dataset reflects the conditions of nuclear power production using PWR power plants onl (PRIS 2011).

For the electricity production with wind power the average European dataset is used.

For the power production out of renewable resources, either European or Swiss datasets are set as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of Ukraine are shown in Tab. 3.176 and Tab. 3.177.

Tab. 3.175: Composition of the Ukrainian electricity production and supply mix including electricity imports (IEA 2010)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	91'188	77'629	44.74	44.20
Hard coal	65'026	55'357	31.90	31.52
Lignite	250	213	0.12	0.12
Peat	0	0	0.00	0.00
Industrial Gases	3'190	2'716	1.57	1.55
<i>Coke gases</i>	0	0	0.00	0.00
<i>Blast furnace gases</i>	0	0	0.00	0.00
Petroleum products	687	585	0.34	0.33
<i>Fuel oil</i>	0	0	0.00	0.00
<i>Diesel</i>	0	0	0.00	0.00
<i>other petroleum products</i>	0	0	0.00	0.00
Natural Gas	22'035	18'759	10.81	10.68
Other fossil	0	0	0.00	0.00
Hydro	11'512	11'397	6.57	6.49
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	11'512	11'397	6.57	6.49
Pumped storage power plants	0	0	0.00	0.00
Nuclear	89'841	84'451	48.67	48.09
Pressurised-water reactor (PWR)	89'841	84'451	48.67	48.09
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	45	45	0.03	0.03
Geothermal	0	0	0.00	0.00
Solar	0	0	0.00	0.00
<i>Photovoltaic</i>	0	0	0.00	0.00
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	45	45	0.03	0.03
Wood	0	0	0.00	0.00
Biogas	0	0	0.00	0.00
Waste	0	0	0.00	0.00
Municipal waste	0	0	0.00	0.00
Industrial waste	0	0	0.00	0.00
Sewage sludge and landfill gases	0	0	0.00	0.00
Other	0	0	0.00	0.00
Total domestic	192'586	173'521	100.00	98.80
Imports	0	2'101	0.00	1.20
Russia	0	2'101	0.00	1.20
Total	192'586	175'622	100.00	100.00

 red marked: Data is not available by IEA-statistics

Tab. 3.176: Unit process raw data of the electricity production mix in Ukraine 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production			GeneralComment
				Uncertainty	Type	StandardDeviation95%	
Location	InfrastructureProcess	Unit					
product	electricity mix, domestic production	UA	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	CENTREL	kWh	3.19E-1	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Ukraine, value: IEA statistics 2008
	electricity, lignite, at power plant	CENTREL	kWh	1.23E-3	1	1.05	(1,1,1,3,1,1); assumption for lignite power production in Ukraine, value: IEA statistics 2008
	electricity, industrial gas, at power plant	CENTREL	kWh	1.57E-2	1	1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Ukraine, value: IEA statistics 2008
	electricity, oil, at power plant	SK	kWh	3.37E-3	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Ukraine, value: IEA statistics 2008
	electricity, natural gas, at power plant	CENTREL	kWh	1.08E-1	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Ukraine, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	6.57E-2	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Ukraine: 100%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	4.87E-1	1	1.05	(1,1,1,2,1,1); assumption for nuclear power production in Ukraine using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	2.59E-4	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Ukraine, value: IEA statistics 2008

Tab. 3.177: Unit process raw data of the electricity supply mix in Ukraine 2008, at busbar

	Name	Location	Unit	electricity mix			GeneralComment
				Uncertainty	Type	StandardDeviation95%	
Location	InfrastructureProcess	Unit					
product	electricity mix	UA	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	CENTREL	kWh	3.15E-1	1	1.05	(1,1,1,3,1,1); assumption for hard coal power production in Ukraine, value: IEA statistics 2008
	electricity, lignite, at power plant	CENTREL	kWh	1.21E-3	1	1.05	(1,1,1,3,1,1); assumption for lignite power production in Ukraine, value: IEA statistics 2008
	electricity, industrial gas, at power plant	CENTREL	kWh	1.55E-2	1	1.05	(1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in Ukraine, value: IEA statistics 2008
	electricity, oil, at power plant	SK	kWh	3.33E-3	1	1.05	(1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in Ukraine, value: IEA statistics 2008
	electricity, natural gas, at power plant	CENTREL	kWh	1.07E-1	1	1.05	(1,1,1,1,1,1); assumption for natural gas power production in Ukraine, value: IEA statistics 2008
	electricity, hydropower, at run-of-river power plant	RER	kWh	6.49E-2	1	1.05	(1,1,1,2,1,1); estimated share of ROR hydropower production in Ukraine: 100%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	4.81E-1	1	1.05	(1,1,1,2,1,1); assumption for nuclear power production in Ukraine using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	2.56E-4	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in Ukraine, value: IEA statistics 2008
	electricity mix, domestic production	RU	kWh	1.20E-2	1	1.05	(1,1,1,1,1,1); assumption for imported electricity in Ukraine, value: IEA statistics 2008

3.5.35 United Kingdom (GB)

Tab. 3.178 shows an overview over the British electricity production according to the IEA Statistics (IEA 2011) for the year 2008. The British power production relies on fossil fuels, mainly hard coal (31 %) and natural gas (44 %), as main energy source. Further electricity is produced from nuclear

power (13 %) and from renewables, mainly wind (2 %). A share of about 3 % of the electricity is imported, mainly from France.

The electricity production from hydro power is approximated using the European dataset for run-of-river and storage type hydropower production. The share of the run-of-river and storage type hydropower generation according to Tab. 3.1 is taken into account. The share of run-of-river hydropower plants in United Kingdom is 100 %. The share of pumped storage in United Kingdom is 44 %.

Power production from nuclear power plants is approximated using the UCTE dataset for pressurised water reactors. This dataset reflects the conditions of nuclear power production using GCR and PWR power plants (PRIS 2011).

For the electricity production with wind power the average European dataset is used. For the power production from other renewable resources, either European or Swiss datasets are used as approximation. This includes the electricity generation from wood, with biogas, sewage or landfill gas and the electricity generation from municipal solid waste incineration.

The unit process raw data of the electricity production and supply mix of United Kingdom are shown Tab. 3.179 and Tab. 3.180.

Tab. 3.178: Composition of the British electricity production and supply mix including electricity imports (IEA 2011)

	Gross Production	Net Production	Production Mix	Supply Mix
	GWh	GWh	%	%
Fossil fuels	309'548	285'195	79.02	76.42
Hard coal	125'316	115'457	31.99	30.94
Lignite	0	0	0.00	0.00
Peat	0	0	0.00	0.00
Industrial Gases	1'383	1'274	0.35	0.34
<i>Coke gases</i>	328	302	0.08	0.08
<i>Blast furnace gases</i>	1'055	972	0.27	0.26
Petroleum products	6'101	5'621	1.56	1.51
<i>Fuel oil</i>	4'397	4'051	1.12	1.09
<i>Diesel</i>	250	230	0.06	0.06
<i>other petroleum products</i>	1'454	1'340	0.37	0.36
Natural Gas	176'748	162'843	45.12	43.63
Other fossil	0	0	0.00	0.00
Hydro	9'257	9'164	2.54	2.46
Reservoir power plants	0	0	0.00	0.00
Run-of-river power plants	5'168	5'116	1.42	1.37
Pumped storage power plants	4'089	4'048	1.12	1.08
Nuclear	52'486	49'337	13.67	13.22
Pressurised-water reactor (PWR)	52'486	49'337	13.67	13.22
Boiling-water reactor (BWR)	0	0	0.00	0.00
Renewables	9'881	9'662	2.68	2.59
Geothermal	0	0	0.00	0.00
Solar	17	16	0.00	0.00
<i>Photovoltaic</i>	17	16	0.00	0.00
<i>Solar thermal</i>	0	0	0.00	0.00
Wave and tidal energy	0	0	0.00	0.00
Wind	7'097	7'097	1.97	1.90
Wood	2'767	2'549	0.71	0.68
Biogas	0	0	0.00	0.00
Waste	8'194	7'549	2.09	2.02
Municipal waste	1'962	1'808	0.50	0.48
Industrial waste	909	837	0.23	0.22
Sewage sludge and landfill gases	5'323	4'904	1.36	1.31
Other	0	0	0.00	0.00
Total domestic	389'366	360'908	100.00	96.71
Imports	0	12'294	0.00	3.29
France	0	12'142	0.00	3.25
Ireland	0	152	0.00	0.04
Total	389'366	373'202	100.00	100.00



red marked: Data is not available by IEA-statistics

3. Life cycle inventories of electricity mixes

Tab. 3.179: Unit process raw data of the electricity production mix in United Kingdom 2008, at busbar

	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviation95%	GeneralComment
				GB 0 kWh			
product	electricity mix, domestic production	GB	kWh	1.00E+0			
technosphere	electricity, hard coal, at power plant	UCTE	kWh	3.20E-1	1	1.05	(1,1,1,2,1,1); assumption for hard coal power production in United Kingdom, value: IEA statistics (1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in United Kingdom, value: IEA statistics 2008
	electricity, industrial gas, at power plant	UCTE	kWh	3.53E-3	1	1.05	(1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in United Kingdom, value: IEA statistics 2008
	electricity, oil, at power plant	GB	kWh	1.49E-2	1	1.05	(1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in United Kingdom, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	6.38E-4	1	1.05	(1,1,1,2,1,1); assumption for natural gas power production in United Kingdom, value: IEA statistics (1,1,1,2,1,1); estimated share of ROR hydropower production in United Kingdom: 100%
	electricity, natural gas, at power plant	GB	kWh	4.51E-1	1	1.05	(1,1,1,1,1,1); estimated share of pumped storage production in United Kingdom: 44.17%
	electricity, hydropower, at run-of-river power plant	RER	kWh	1.42E-2	1	1.05	(1,1,1,2,1,1); assumption for nuclear power production in United Kingdom using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, hydropower, at pumped storage power plant	GB	kWh	1.12E-2	1	1.05	(1,1,1,2,1,1); assumption for geothermal power production in United Kingdom, value: IEA statistics (1,1,1,1,1,1); assumption for solar power production in United Kingdom, value: IEA statistics 2008
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	1.37E-1	1	1.05	(1,1,1,3,1,1); assumption for cogeneration power production in United Kingdom, value: IEA statistics (1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in United Kingdom, value: IEA statistics 2008
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	7.06E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from municipal and industrial waste in United Kingdom, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.36E-2	1	1.05	
	electricity from waste, at municipal waste incineration plant	CH	kWh	7.33E-3	1	1.05	

Tab. 3.180: Unit process raw data of the electricity supply mix in United Kingdom 2008, at busbar

	Name	Location	Unit	electricity mix	Uncertainty Standard Deviation 95%	GeneralComment
	Location			GB		
	InfrastructureProcess			0		
	Unit			kWh		
product	electricity mix	GB	kWh	1.00E+0		
technosphere	electricity, hard coal, at power plant	UCTE	kWh	3.09E-1	1	1.05 (1,1,1,2,1,1); assumption for hard coal power production in United Kingdom, value: IEA
	electricity, industrial gas, at power plant	UCTE	kWh	3.41E-3	1	1.05 (1,1,1,2,1,1); assumption for industrial, coke and blast furnace gas power production in United Kingdom, value: IEA statistics 2008
	electricity, oil, at power plant	GB	kWh	1.44E-2	1	1.05 (1,1,1,1,1,1); assumption for petroleum product and fuel oil power production in United Kingdom, value: IEA statistics 2008
	electricity, at cogen 200kWe diesel SCR, allocation exergy	CH	kWh	6.17E-4	1	1.05 (1,1,1,3,1,1); assumption for diesel and other fossil fuel power production in United Kingdom, value: IEA statistics 2008
	electricity, natural gas, at power plant	GB	kWh	4.36E-1	1	1.05 (1,1,1,1,1,1); assumption for natural gas power production in United Kingdom, value: IEA
	electricity, hydropower, at run-of-river power plant	RER	kWh	1.37E-2	1	1.05 (1,1,1,2,1,1); estimated share of ROR hydropower production in United Kingdom: 100%
	electricity, hydropower, at pumped storage power plant	GB	kWh	1.08E-2	1	1.05 (1,1,1,1,1,1); estimated share of pumped storage production in United Kingdom: 44.17%
	electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	1.32E-1	1	1.05 (1,1,1,2,1,1); assumption for nuclear power production in United Kingdom using PWR, value: IEA statistics 2008, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	1.90E-2	1	1.05 (1,1,1,2,1,1); assumption for geothermal power production in United Kingdom, value: IEA
	electricity, production mix photovoltaic, at plant	GB	kWh	4.28E-5	1	1.05 (1,1,1,1,1,1); assumption for solar power production in United Kingdom, value: IEA
	electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	6.83E-3	1	1.05 (1,1,1,3,1,1); assumption for cogeneration power production in United Kingdom, value: IEA statistics 2008
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	1.31E-2	1	1.05 (1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in United Kingdom, value: IEA statistics 2008
	electricity from waste, at municipal waste incineration plant	CH	kWh	7.09E-3	1	1.05 (1,1,1,3,1,1); assumption for power production from municipal and industrial waste in United Kingdom, value: IEA statistics 2008
	electricity mix, domestic production	FR	kWh	3.25E-2	1	1.05 (1,1,1,1,1,1); assumption for imported electricity in United Kingdom, value: IEA statistics 2008
	electricity mix, domestic production	IE	kWh	4.07E-4	1	1.05 (1,1,1,1,1,1); assumption for imported electricity in United Kingdom, value: IEA statistics 2008

3.6 Companies and networks

3.6.1 Swiss Railways (SBB)

The electricity mix used by the Swiss Railways for the year 2011 consists of 72.77 % hydropower, 27.01 % nuclear power and 0.23 % new renewables. The electricity generated from hydropower is divided in electricity produced from Swiss run-of-river power plants, Swiss storage type power plants and French run-of-river power plants. The purchased hydropower is modelled as European run-of-river hydropower. The storage type hydropower is modelled using the net data set for storage type hydropower production because the electricity demand for the pumps is already accounted for in the statistics provided by the Swiss Railways.

For the electricity production using nuclear power, the production using Swiss boiling water and pressure-water power plants and French pressure-water power plants is distinguished according to the shares of the different technologies in the corresponding countries (PRIS 2011). 80 % of the electricity purchased produced from nuclear power stems from French nuclear power plants. Therefore, the French dataset of nuclear power from pressure-water reactors is used.

0.4 % of the total electricity used by the Swiss Railways stems from the production funded by the foundation KEV. This share is split in the different technologies according to the annual report of the foundation KEV (KEV 2009). The shares of the different technologies are shown in Tab. 3.181.

Tab. 3.181: Electricity funded by the foundation KEV in the year 2009 according to KEV 2009

Funded electricity KEV	Annual report KEV 2009	Share
Total / GWh	390.5	100.0%
Wind / GWh	5.1	1.3%
Hydropower/ GWh	166.4	42.6%
Biomass / GWh	203.6	52.1%
Photovoltaics / GWh	15.4	4.0%

Tab. 3.183 shows the electricity production of the Swiss railways for the year 2011 split into the different technologies and in the self production and the purchased electricity

Tab. 3.182: Shares of the electricity production of the Swiss railways for the year 2011 based on data of the Swiss Railways⁸

		Production SBB	Purchased electricity	Production	Production Mix
		GWh	GWh	GWh	-
Hydropower		1574.3	158.0	1732.3	72.77%
Run-of-river CH	44%	759.3		759.3	31.97%
Storage type CH	47%	815.0		815.0	34.20%
Run-of-river FR	9%		158.0	158.0	6.60%
Nuclear Power			643.0	643.0	27.01%
Pressure-water reactor CH (PWR)	15%		98.8	98.8	4.15%
Boiling-water reactor CH (BWR)	14%		91.2	91.2	3.83%
Pressure-water reactor FR (PWR)	70%		453.0	453.0	19.03%
Renewables			5.7	5.7	0.23%
Biomass			5.2	5.2	0.21%
Photovoltaics			0.4	0.4	0.02%
Wind			0.1	0.1	0.01%
Total		1574.3	806.7	2381.0	100.01%

The unit process raw data of the production mix of the Swiss Railways 2011 is shown in Tab. 3.183.

⁸ Personal communication, Markus Halder, BahnUmwelt-Center, SBB AG Bern, 01.02.2012

Tab. 3.183: Unit process raw data of the electricity production mix Swiss Railways 2011, at busbar

product	Name	Location	Unit	electricity mix, domestic production	UncertaintyType	StandardDeviation85 %	GeneralComment
	Location			SBB			
	InfrastructureProcess			0			
Unit			kWh				
	electricity mix, domestic production	SBB	kWh	1.00E+0			
	electricity, hydropower, net, at reservoir power plant	CH	kWh	3.42E-1	1	1.05	(1,1,1,3,1,1); estimated share of reservoir hydropower production in Swiss Railways
	electricity, hydropower, at run-of-river power plant	RER	kWh	3.19E-1	1	1.05	(1,1,1,3,1,1); estimated share of ROR hydropower production in Swiss Railways
	electricity, hydropower, at run-of-river power plant with reservoir	RER	kWh	6.60E-2	1	1.05	(1,1,1,3,1,1); estimated share of pumped storage production in Swiss Railways
	electricity, nuclear, at power plant pressure water reactor	CH	kWh	4.16E-2	1	1.05	(1,1,1,3,1,1); assumption for nuclear power production in Swiss Railways using PWR, SBB 2010, fraction: IAEA Database 2010 (PRIS)
	electricity, nuclear, at power plant boiling water reactor	CH	kWh	3.84E-2	1	1.05	(1,1,1,3,1,1); assumption for nuclear power production in Swiss Railways using BWR, SBB 2011, fraction: IAEA Database 2010 (PRIS)
	electricity, nuclear, at power plant pressure water reactor	FR	kWh	1.90E-1	1	1.05	(1,1,1,3,1,1); assumption for nuclear power production in Swiss Railways using BWR, SBB 2011, fraction: IAEA Database 2010 (PRIS)
	electricity, at wind power plant	RER	kWh	5.26E-5	1	1.05	(1,1,1,3,1,1); assumption for geothermal power production in Swiss Railways, SBB 2011
	electricity, production mix photovoltaic, at plant	CH	kWh	1.58E-4	1	1.05	(1,1,1,3,1,1); assumption for solar power production in Swiss Railways, SBB 2011
	electricity, at cogen with biogas engine, allocation exergy	CH	kWh	2.09E-3	1	1.05	(1,1,1,3,1,1); assumption for power production from biogas, sewage and landfill gas in Swiss Railways, value: IEA statistics 2008

3.6.2 European Aluminium Association (EAA)

For the smelting of aluminium for the European market, the European Aluminium Association uses a special electricity mix model. This model is based on the environmental profile report of the European Aluminium Association (EAA 2008). This results in an electricity mix shown in Tab. 3.184. According to the environmental profile of the EAA 26.5 % of the electricity used for the aluminium production is made from fossil fuels, 55 % of the electricity is generated with hydropower, about 15 % of the electricity is generated from nuclear power and 0.5 % of the electricity is generated from biomass or other fuels.

Tab. 3.184: Shares of the electricity production of the European aluminium industry for the year 2005 based on the environmental profile report 2008 (EAA 2008)

	Production Mix
	%
Fossil fuels	26.50
Hard coal	10.90
Lignite	3.70
Fuel oil	2.10
Natural Gas	9.80
Hydro	58.00
Reservoir power plants	30.74
Run-of-river power plants	27.26
Pumped storage power plants	0.00
Nuclear	15.00
Pressurised-water reactor (PWR)	11.40
Boiling-water reactor (BWR)	3.60
Renewables	0.30
Wood	0.30
Waste	0.00
Other	0.20
Total	100.00

The unit process raw data of the production mix of the European aluminium industry 2005 is shown in Tab. 3.185.

Tab. 3.185: Unit process raw data of the electricity production mix European aluminium industry 2005, at busbar

Name	Location	Unit	electricity mix, aluminium industry	UncertaintyType	StandardDeviation95	%	GeneralComment
Location			GLO				
InfrastructureProcess			0				
Unit			kWh				
product			electricity mix, aluminium industry	GLO	kWh	1.00E+0	
technosphere			electricity, hard coal, at power plant	UCTE	kWh	1.09E-1	1 1.05 (1,1,1,3,1,1); assumption for hard coal power production in European Aluminium Industry, EAA 2005
			electricity, lignite, at power plant	UCTE	kWh	3.70E-2	1 1.05 (1,1,1,3,1,1); assumption for lignite power production in European Aluminium Industry, EAA 2005
			electricity, oil, at power plant	UCTE	kWh	2.10E-2	1 1.05 (1,1,1,3,1,1); assumption for petroleum product and fuel oil power production in European Aluminium Industry, EAA 2005
			electricity, natural gas, at power plant	UCTE	kWh	9.80E-2	1 1.05 (1,1,1,3,1,1); assumption for natural gas power production in European Aluminium Industry, EAA 2005
			electricity, hydropower, at reservoir power plant, non alpine regions	RER	kWh	3.07E-1	1 1.05 (1,1,1,3,1,1); estimated share of reservoir hydropower production in European Aluminium Industry: 53%
			electricity, hydropower, at run-of-river power plant	RER	kWh	2.73E-1	1 1.05 (1,1,1,3,1,1); estimated share of ROR hydropower production in European Aluminium Industry: 47%
			electricity, nuclear, at power plant pressure water reactor	UCTE	kWh	1.14E-1	1 1.05 (1,1,1,3,1,1); assumption for nuclear power production in European Aluminium Industry using PWR, EAA 2005, fraction: IAEA Database 2010 (PRIS)
			electricity, nuclear, at power plant boiling water reactor	UCTE	kWh	3.60E-2	1 1.05 (1,1,1,3,1,1); assumption for nuclear power production in European Aluminium Industry using BWR, EAA 2005, fraction: IAEA Database 2010 (PRIS)
			electricity, at wind power plant	RER	kWh	2.00E-3	1 1.05 (1,1,1,3,1,1); assumption for geothermal power production in European Aluminium Industry, EAA 2005
			electricity, at cogen 6400kWh, wood, allocation exergy	CH	kWh	3.00E-3	1 1.05 (1,1,1,3,1,1); assumption for cogeneration power production in European Aluminium Industry, EAA 2005

3.6.3 European Network of Transmission System Operators for electricity (ENTSO-E)

The 27 member states of the European Union and Norway, Iceland, Switzerland and the states of the former Yugoslavia form the European Network of Transmission System Operators for electricity (ENTSO-E). The production shares of the countries are calculated according to the net electricity production. Germany, France, United Kingdom, Spain and Italy are the most important producers within the ENTSO-E network. These five countries make up for about 61 % of the electricity generated within ENTSO-E. Tab. 3.186 shows the net electricity production of the countries within the ENTSO-E.

The production volumes taken from the IEA statistics (IEA 2011, IEA 2010) match the production volumes documented in the annual statistics of the ENTSO-E (ENTSO-E 2009). The IEA statistics for the year 2008 lead to a total net electricity production of 3'404'418 GWh for the ENTSO-E network. This is comparable to the total net electricity production documented in the annual statistics of the ENTSO-E members for the year 2009, which corresponds to 3'294'266 GWh.

Tab. 3.186: Net electricity production within the ENTSO-E network for the year 2008 based on the production volumes documented in this report

Country	Code	Fossil fuel	Hydropower	Pumped Storage Hydro power	Nuclear Power	Renewables	Wastes	Other	Total production
		GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh
Austria	AT	16'766	40'271	2'705	0	5'721	669	15	63'443
Belgium	BE	29'073	1'739	1'334	42'834	3'173	1'459	222	78'500
Bosnia and Herzegovina	BA	7'729	4'506	0	0	0	0	0	12'236
Bulgaria	BG	22'223	3'244	0	14'819	122	14	0	40'422
Croatia	HR	6'341	5'273	422	0	40	0	0	11'654
Czech Republic	CZ	46'956	2'352	348	24'958	1'380	173	1	75'820
Denmark	DK	24'045	26	0	0	8'814	1'810	0	34'695
Estonia	EE	8'906	28	0	0	164	0	0	9'098
Finland	FI	24'587	16'941	0	21'581	9'782	526	479	73'895
France	FR	49'161	67'642	4'553	413'100	7'541	3'972	0	541'416
Germany	DE	350'162	26'693	5'691	139'585	60'910	10'237	0	587'587
Greece	GR	50'274	4'108	829	0	2'247	185	0	56'813
Hungary	HU	19'491	211	0	13'929	1'746	219	0	35'596
Ireland	IE	24'083	1'287	328	0	2'441	119	0	27'930
Island	IS	2	12'303	0	0	3'876	1	0	16'182
Italy	IT	229'463	46'755	5'548	0	13'102	4'198	832	294'349
Latvia	LV	1'918	3'078	0	0	100	0	0	5'096
Lithuania	LT	2'053	978	0	9'300	186	0	188	12'705
Luxembourg	LU	1'591	955	825	0	109	43	0	2'698
Macedonia	MK	4'862	832	0	0	0	0	0	5'693
Netherlands	NL	83'976	101	0	3'919	7'446	2'895	135	98'471
Norway	NO	580	139'117	958	0	1'227	122	162	141'208
Poland	PL	125'574	2'720	589	0	3'543	445	0	132'281
Portugal	PT	28'640	7'223	493	0	7'451	535	0	43'850
Romania	RO	30'359	17'023	0	10'552	25	0	0	57'960
Serbia and Montenegro	CS	24'083	10'008	500	0	0	0	0	34'090
Slovakia	SK	6'484	4'199	200	15'701	427	46	34	26'891
Slovenia	SI	5'396	3'978	0	5'897	269	0	0	15'540
Spain	ES	175'895	25'851	2'586	55'435	36'429	1'943	285	295'838
Sweden	SE	3'545	68'519	141	60'056	10'634	2'088	0	144'841
Switzerland	CH	836	37'556	1'880	26'038	245	2'038	0	66'712
United Kingdom	UK	285'195	9'164	4'048	49'337	9'662	7'549	0	360'908
European Network of Transmission System Operators	ENTSO	1'690'249	564'681	33'978	907'041	198'812	41'286	2'353	3'404'418
Statistics ENTSO 2009	ENTSO	1'639'225	549'468	-	875'021	219'566	-	10'987	3'294'266

Tab. 3.187 shows the shares of the electricity production of the countries within the ENTSO-E network for the year 2008 based on the production volumes in this report. About 50 % of the electricity production in the ENTSO-E network uses fossil fuels, about 17 % of the electricity is generated from hydropower, about 27 % from nuclear power and about 6 % is produced from renewables, wastes and other sources.

The net electricity production of the ENTSO-E members for the year 2008 in this report is slightly higher than the production documented in the annual report of the ENTSO-E network for the year 2009. This difference is reasonable considering that the statistics are for two different years, but the shares of the different technologies match very well.

Tab. 3.187: Shares of the electricity production of the countries within the ENTSO-E network for the year 2008 based on the production volumes documented in this report

County	Code	Fossil fuel	Hydropower	Pumped Storage Hydro power	Nuclear Power	Renewables	Wastes	Other	Total production	Shares
		-	-	-	-	-	-	-	GWh	-
Austria	AT	26.43%	63.48%	4.26%	0.00%	9.02%	1.05%	0.02%	63'443	1.86%
Belgium	BE	37.04%	2.22%	1.70%	54.57%	4.04%	1.86%	0.28%	78'500	2.31%
Bosnia and Herzegovina	BA	63.17%	36.83%	0.00%	0.00%	0.00%	0.00%	0.00%	12'236	0.36%
Bulgaria	BG	54.98%	8.03%	0.00%	36.66%	0.30%	0.03%	0.00%	40'422	1.19%
Croatia	HR	54.41%	45.25%	3.62%	0.00%	0.34%	0.00%	0.00%	11'654	0.34%
Czech Republic	CZ	61.93%	3.10%	0.46%	32.92%	1.82%	0.23%	0.00%	75'820	2.23%
Denmark	DK	69.30%	0.07%	0.00%	0.00%	25.40%	5.22%	0.00%	34'695	1.02%
Estonia	EE	97.89%	0.31%	0.00%	0.00%	1.80%	0.00%	0.00%	9'098	0.27%
Finland	FI	33.27%	22.93%	0.00%	29.20%	13.24%	0.71%	0.65%	73'895	2.17%
France	FR	9.08%	12.49%	0.84%	76.30%	1.39%	0.73%	0.00%	541'416	15.90%
Germany	DE	59.59%	4.54%	0.97%	23.76%	10.37%	1.74%	0.00%	587'587	17.26%
Greece	GR	88.49%	7.23%	1.46%	0.00%	3.96%	0.33%	0.00%	56'813	1.67%
Hungary	HU	54.76%	0.59%	0.00%	39.13%	4.91%	0.62%	0.00%	35'596	1.05%
Ireland	IE	86.23%	4.61%	1.17%	0.00%	8.74%	0.43%	0.00%	27'930	0.82%
Island	IS	0.01%	76.03%	0.00%	0.00%	23.95%	0.01%	0.00%	16'182	0.48%
Italy	IT	77.96%	15.88%	1.88%	0.00%	4.45%	1.43%	0.28%	294'349	8.65%
Latvia	LV	37.64%	60.40%	0.00%	0.00%	1.96%	0.00%	0.00%	5'096	0.15%
Lithuania	LT	16.16%	7.70%	0.00%	73.20%	1.46%	0.00%	1.48%	12'705	0.37%
Luxembourg	LU	58.97%	35.40%	30.58%	0.00%	4.04%	1.59%	0.00%	2'698	0.08%
Macedonia	MK	85.40%	14.61%	0.00%	0.00%	0.00%	0.00%	0.00%	5'693	0.17%
Netherlands	NL	85.28%	0.10%	0.00%	3.98%	7.56%	2.94%	0.14%	98'471	2.89%
Norway	NO	0.41%	98.52%	0.68%	0.00%	0.87%	0.09%	0.11%	141'208	4.15%
Poland	PL	94.93%	2.06%	0.45%	0.00%	2.68%	0.34%	0.00%	132'281	3.89%
Portugal	PT	65.31%	16.47%	1.12%	0.00%	16.99%	1.22%	0.00%	43'850	1.29%
Romania	RO	52.38%	29.37%	0.00%	18.21%	0.04%	0.00%	0.00%	57'960	1.70%
Serbia and Montenegro	CS	70.65%	29.36%	1.47%	0.00%	0.00%	0.00%	0.00%	34'090	1.00%
Slovakia	SK	24.11%	15.61%	0.74%	58.39%	1.59%	0.17%	0.13%	26'891	0.79%
Slovenia	SI	34.72%	25.60%	0.00%	37.95%	1.73%	0.00%	0.00%	15'540	0.46%
Spain	ES	59.46%	8.74%	0.87%	18.74%	12.31%	0.66%	0.10%	295'838	8.69%
Sweden	SE	2.45%	47.31%	0.10%	41.46%	7.34%	1.44%	0.00%	144'841	4.25%
Switzerland	CH	1.25%	56.30%	2.82%	39.03%	0.37%	3.05%	0.00%	66'712	1.96%
United Kingdom	UK	79.02%	2.54%	1.12%	13.67%	2.68%	2.09%	0.00%	360'908	10.60%
European Network of Transmission System Operators	ENTSO	49.65%	16.59%	1.00%	26.64%	5.84%	1.21%	0.07%	3'404'418	100.00%
Statistics ENTSO 2009	ENTSO	49.76%	16.68%	0.00%	26.56%	6.67%	0.00%	0.33%	3'294'266	103.34%

The unit process raw data of the production mix ENTSO-E 2008 is shown in Tab. 3.188.

Tab. 3.189: Shares of the electricity production of the countries within the outdated networks (UCTE, CENTREL, NORDEL, RER) for the year 2008 based on the production volumes documented in this report

Country	UCTE		NORDEL		CENTREL		RER	
	GWh	Shares UCTE	GWh	Shares NORDEL	GWh	Shares CENTREL	GWh	Shares RER
Austria	63'443	2.46%	0	0.00%	0	0.00%	63'443	1.89%
Belgium	78'500	3.05%	0	0.00%	0	0.00%	78'500	2.34%
Bosnia and Herzegovina	12'236	0.47%	0	0.00%	0	0.00%	12'236	0.36%
Bulgaria	40'422	1.57%	0	0.00%	0	0.00%	40'422	1.20%
Croatia	11'654	0.45%	0	0.00%	0	0.00%	11'654	0.35%
Czech Republic	75'820	2.94%	0	0.00%	75'820	28.02%	75'820	2.26%
Denmark	0	0.00%	34'695	8.79%	0	0.00%	34'695	1.03%
Estonia	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Finland	0	0.00%	73'895	18.72%	0	0.00%	73'895	2.20%
France	541'416	21.00%	0	0.00%	0	0.00%	541'416	16.11%
Germany	587'587	22.79%	0	0.00%	0	0.00%	587'587	17.48%
Greece	56'813	2.20%	0	0.00%	0	0.00%	56'813	1.69%
Hungary	35'596	1.38%	0	0.00%	35'596	13.16%	35'596	1.06%
Ireland	0	0.00%	0	0.00%	0	0.00%	27'930	0.83%
Island	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Italy	294'349	11.42%	0	0.00%	0	0.00%	294'349	8.76%
Latvia	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Lithuania	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Luxembourg	2'698	0.10%	0	0.00%	0	0.00%	2'698	0.08%
Macedonia	5'693	0.22%	0	0.00%	0	0.00%	5'693	0.17%
Netherlands	98'471	3.82%	0	0.00%	0	0.00%	98'471	2.93%
Norway	0	0.00%	141'208	35.78%	0	0.00%	141'208	4.20%
Poland	132'281	5.13%	0	0.00%	132'281	48.89%	132'281	3.94%
Portugal	43'850	1.70%	0	0.00%	0	0.00%	43'850	1.30%
Romania	57'960	2.25%	0	0.00%	0	0.00%	57'960	1.72%
Serbia and Montenegro	34'090	1.32%	0	0.00%	0	0.00%	34'090	1.01%
Slovakia	26'891	1.04%	0	0.00%	26'891	9.94%	26'891	0.80%
Slovenia	15'540	0.60%	0	0.00%	0	0.00%	15'540	0.46%
Spain	295'838	11.48%	0	0.00%	0	0.00%	295'838	8.80%
Sweden	0	0.00%	144'841	36.70%	0	0.00%	144'841	4.31%
Switzerland	66'712	2.59%	0	0.00%	0	0.00%	66'712	1.98%
United Kingdom	0	0.00%	0	0.00%	0	0.00%	360'908	10.74%
Total	2'577'860	100.00%	394'639	100.00%	270'588	100.00%	3'361'337	100.00%

The unit process raw data of the production mix of the outdated networks is shown in Tab. 3.190.

3. Life cycle inventories of electricity mixes

Tab. 3.191: Global net electricity production for the year 2008 based on the production volumes documented in this report

Country	Code	Fossil fuels	Hydropower	Pumped Storage Hydropower	Nuclear Power	Renewables	Wastes	Other	Total production
		GWh	GWh	GWh	GWh	GWh	GWh	GWh	GWh
Australia	AU	212'648	11'936	147	0	5'162	891	0	230'637
Austria	AT	16'766	40'271	2'705	0	5'721	669	15	63'443
Belgium	BE	29'073	1'739	1'334	42'834	3'173	1'459	222	78'500
Bosnia and Herzegovina	BA	7'729	4'506	0	0	0	0	0	12'236
Brazil	BR	56'784	365'860	0	13'131	19'677	0	239	455'691
Bulgaria	BG	22'223	3'244	0	14'819	122	14	0	40'422
Canada	CA	149'867	378'754	110	88'314	10'828	855	0	628'618
Chile	CL	31'160	23'951	0	0	3'004	0	0	58'115
China	CN	2'456'745	579'335	0	64'290	15'320	0	0	3'115'690
Croatia	HR	6'341	5'273	422	0	40	0	0	11'654
Czech Republic	CZ	46'956	2'352	348	24'958	1'380	173	1	75'820
Denmark	DK	24'045	26	0	0	8'814	1'810	0	34'695
Estonia	EE	8'906	28	0	0	164	0	0	9'098
Finland	FI	24'587	16'941	0	21'581	9'782	526	479	73'895
France	FR	49'161	67'642	4'553	413'100	7'541	3'972	0	541'416
Germany	DE	350'162	26'693	5'961	139'585	60'910	10'237	0	587'587
Greece	GR	50'274	4'108	829	0	2'247	185	0	56'813
Hungary	HU	19'491	211	0	13'929	1'746	219	0	35'596
India	IN	640'384	113'152	13'918	13'830	15'602	0	0	782'969
Indonesia	ID	124'946	11'413	0	0	7'965	0	0	144'324
Iran	IR	199'384	4'953	0	0	196	0	0	204'533
Ireland	IE	24'083	1'287	328	0	2'441	119	0	27'930
Island	IS	2	12'303	0	0	3'876	1	0	16'182
Italy	IT	229'463	46'755	5'548	0	13'102	4'198	832	294'349
Japan	JP	667'757	82'462	6'985	242'640	21'551	6'869	0	1'021'279
Latvia	LV	1'918	3'078	0	0	100	0	0	5'096
Lithuania	LT	2'053	978	0	9'300	186	0	188	12'705
Luxembourg	LU	1'591	955	825	0	109	43	0	2'698
Macedonia	MK	4'862	832	0	0	0	0	0	5'693
Malaysia	MY	88'224	7'384	0	0	1	0	0	95'609
Mexico	MX	190'367	38'786	0	9'216	7'743	63	0	246'175
Netherlands	NL	83'976	101	0	3'919	7'446	2'895	135	98'471
Norway	NO	580	139'117	958	0	1'227	122	162	141'208
Peru	PE	12'679	18'850	0	0	490	0	0	32'019
Poland	PL	125'574	2'720	589	0	3'543	445	0	132'281
Portugal	PT	28'640	7'223	493	0	7'451	535	0	43'850
Romania	RO	30'359	17'023	0	10'552	25	0	0	57'960
Russia	RU	579'684	165'044	0	153'300	471	2'065	0	900'564
Saudia Arabia	SA	187'532	0	0	0	0	0	0	187'532
Serbia and Montenegro	CS	24'083	10'008	500	0	0	0	0	34'090
Slovakia	SK	6'484	4'199	200	15'701	427	46	34	26'891
Slovenia	SI	5'396	3'978	0	5'897	269	0	0	15'540
South Africa	ZA	212'381	3'992	2'714	12'224	281	0	0	228'878
South Korea	KR	274'297	5'507	2'468	141'901	746	592	71	423'114
Spain	ES	175'895	25'851	2'586	55'435	36'429	1'943	285	295'838
Sweden	SE	3'545	68'519	141	60'056	10'634	2'088	0	144'841
Switzerland	CH	836	37'556	1'325	26'038	245	2'038	0	66'712
Taiwan	TW	170'282	7'694	0	38'377	1'068	2'737	0	220'159
Tanzania	TZ	1'712	2'628	0	0	0	0	0	4'340
Thailand	TH	131'220	7'042	0	0	4'688	0	0	142'950
Tunisia	TN	14'508	38	0	0	39	0	0	14'584
Turkey	TR	154'679	32'937	0	0	1'134	75	0	188'825
Ukraine	UA	77'629	11'397	0	84'451	45	0	0	173'521
United Kingdom	UK	285'195	9'164	4'048	49'337	9'662	7'549	0	360'908
United States	US	2'858'063	279'175	25'028	787'536	113'391	27'662	726	4'066'553
Total	GLO	11'183'181	2'716'971	85'063	2'556'251	428'214	83'095	3'389	16'971'097
World IEA	GLO	13'674'797	3'287'554	85'063	2'730'823	494'328	69'327	4'009	20'260'838

Tab. 3.192 shows the shares of the global electricity production for the year 2008 based on the production volumes in this report. About 66 % of the global electricity production uses fossil fuels, about 16 % of the electricity is generated from hydropower, about 15 % from nuclear power and about 3 % is produced from renewables, wastes and other sources.

3. Life cycle inventories of electricity mixes

The global net electricity production for the year 2008 in this report is 16 % lower than the production documented in the annual statistics of the IEA for the year 2008. This difference is reasonable considering that more than 100 country specific electricity mixes are not described in this report, but the shares of the different technologies match very well.

Tab. 3.192: Shares of the global electricity production for the year 2008 based on the production volumes documented in this report

Country	Code	Fossil fuels	Hydropower	Pumped Storage Hydropower	Nuclear Power	Renewables	Wastes	Other	Total production	Shares
		-	-	-	-	-	-	-	GWh	-
Australia	AU	92.20%	5.18%	0.06%	0.00%	2.24%	0.39%	0.00%	230'637	1.36%
Austria	AT	26.43%	63.48%	4.26%	0.00%	9.02%	1.05%	0.02%	63'443	0.37%
Belgium	BE	37.04%	2.22%	1.70%	54.57%	4.04%	1.86%	0.28%	78'500	0.46%
Bosnia and Herzegovina	BA	63.17%	36.83%	0.00%	0.00%	0.00%	0.00%	0.00%	12'236	0.07%
Brazil	BR	12.46%	80.29%	0.00%	2.88%	4.32%	0.00%	0.05%	455'691	2.69%
Bulgaria	BG	54.98%	8.03%	0.00%	36.66%	0.30%	0.03%	0.00%	40'422	0.24%
Canada	CA	23.84%	60.25%	0.02%	14.05%	1.72%	0.14%	0.00%	628'618	3.70%
Chile	CL	53.62%	41.21%	0.00%	0.00%	5.17%	0.00%	0.00%	58'115	0.34%
China	CN	78.85%	18.59%	0.00%	2.06%	0.49%	0.00%	0.00%	3'115'690	18.36%
Croatia	HR	54.41%	45.25%	3.62%	0.00%	0.34%	0.00%	0.00%	11'654	0.07%
Czech Republic	CZ	61.93%	3.10%	0.46%	32.92%	1.82%	0.23%	0.00%	75'820	0.45%
Denmark	DK	69.30%	0.07%	0.00%	0.00%	25.40%	5.22%	0.00%	34'695	0.20%
Estonia	EE	97.89%	0.31%	0.00%	0.00%	1.80%	0.00%	0.00%	9'098	0.05%
Finland	FI	33.27%	22.93%	0.00%	29.20%	13.24%	0.71%	0.65%	73'895	0.44%
France	FR	9.08%	12.49%	0.84%	76.30%	1.39%	0.73%	0.00%	541'416	3.19%
Germany	DE	59.59%	4.54%	0.97%	23.76%	10.37%	1.74%	0.00%	587'587	3.46%
Greece	GR	88.49%	7.23%	1.46%	0.00%	3.96%	0.33%	0.00%	56'813	0.33%
Hungary	HU	54.76%	0.59%	0.00%	39.13%	4.91%	0.62%	0.00%	35'596	0.21%
India	IN	81.79%	14.45%	1.78%	1.77%	1.99%	0.00%	0.00%	782'969	4.61%
Indonesia	ID	86.57%	7.91%	0.00%	0.00%	5.52%	0.00%	0.00%	144'324	0.85%
Iran	IR	97.48%	2.42%	0.00%	0.00%	0.10%	0.00%	0.00%	204'533	1.21%
Ireland	IE	86.23%	4.61%	1.17%	0.00%	8.74%	0.43%	0.00%	27'930	0.16%
Island	IS	0.01%	76.03%	0.00%	0.00%	23.95%	0.01%	0.00%	16'182	0.10%
Italy	IT	77.96%	15.88%	1.88%	0.00%	4.45%	1.43%	0.28%	294'349	1.73%
Japan	JP	65.38%	8.07%	0.68%	23.76%	2.11%	0.67%	0.00%	1'021'279	6.02%
Latvia	LV	37.64%	60.40%	0.00%	0.00%	1.96%	0.00%	0.00%	5'096	0.03%
Lithuania	LT	16.16%	7.70%	0.00%	73.20%	1.46%	0.00%	1.48%	12'705	0.07%
Luxembourg	LU	58.97%	35.40%	30.58%	0.00%	4.04%	1.59%	0.00%	2'698	0.02%
Macedonia	MK	85.40%	14.61%	0.00%	0.00%	0.00%	0.00%	0.00%	5'693	0.03%
Malaysia	MY	92.28%	7.72%	0.00%	0.00%	0.00%	0.00%	0.00%	95'609	0.56%
Mexico	MX	77.33%	15.76%	0.00%	3.74%	3.15%	0.03%	0.00%	246'175	1.45%
Netherlands	NL	85.28%	0.10%	0.00%	3.98%	7.56%	2.94%	0.14%	98'471	0.58%
Norway	NO	0.41%	98.52%	0.68%	0.00%	0.87%	0.09%	0.11%	141'208	0.83%
Peru	PE	39.60%	58.87%	0.00%	0.00%	1.53%	0.00%	0.00%	32'019	0.19%
Poland	PL	94.93%	2.06%	0.45%	0.00%	2.68%	0.34%	0.00%	132'281	0.78%
Portugal	PT	65.31%	16.47%	1.12%	0.00%	16.99%	1.22%	0.00%	43'850	0.26%
Romania	RO	52.38%	29.37%	0.00%	18.21%	0.04%	0.00%	0.00%	57'960	0.34%
Russia	RU	64.37%	18.33%	0.00%	17.02%	0.05%	0.23%	0.00%	900'564	5.31%
Saudia Arabia	SA	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	187'532	1.11%
Serbia and Montenegro	CS	70.65%	29.36%	1.47%	0.00%	0.00%	0.00%	0.00%	34'090	0.20%
Slovakia	SK	24.11%	15.61%	0.74%	58.39%	1.59%	0.17%	0.13%	26'891	0.16%
Slovenia	SI	34.72%	25.60%	0.00%	37.95%	1.73%	0.00%	0.00%	15'540	0.09%
South Africa	ZA	92.79%	1.74%	0.00%	5.34%	0.12%	0.00%	0.00%	228'878	1.35%
South Korea	KR	64.83%	1.30%	0.58%	33.54%	0.18%	0.14%	0.02%	423'114	2.49%
Spain	ES	59.46%	8.74%	0.87%	18.74%	12.31%	0.66%	0.10%	295'838	1.74%
Sweden	SE	2.45%	47.31%	0.10%	41.46%	7.34%	1.44%	0.00%	144'841	0.85%
Switzerland	CH	1.25%	56.30%	2.82%	39.03%	0.37%	3.05%	0.00%	66'712	0.39%
Taiwan	TW	77.35%	3.49%	0.00%	17.43%	0.49%	1.24%	0.00%	220'159	1.30%
Tanzania	TZ	39.45%	60.55%	0.00%	0.00%	0.00%	0.00%	0.00%	4'340	0.03%
Thailand	TH	91.79%	4.93%	0.00%	0.00%	3.28%	0.00%	0.00%	142'950	0.84%
Tunisia	TN	99.48%	0.26%	0.00%	0.00%	0.27%	0.00%	0.00%	14'584	0.09%
Turkey	TR	81.92%	17.44%	0.00%	0.00%	0.60%	0.04%	0.00%	188'825	1.11%
Ukraine	UA	44.74%	6.57%	0.00%	48.67%	0.03%	0.00%	0.00%	173'521	1.02%
United Kingdom	UK	79.02%	2.54%	1.12%	13.67%	2.68%	2.09%	0.00%	360'908	2.13%
United States	US	70.28%	6.87%	0.62%	19.37%	2.79%	0.68%	0.02%	4'066'553	23.96%
Total	GLO	65.90%	16.01%	0.49%	15.06%	2.52%	0.49%	0.02%	16'971'097	100.00%
World IEA	GLO	67.49%	16.23%	0.41%	13.48%	2.44%	0.34%	0.02%	20'260'838	83.76%

The unit process raw data of the global production mix for the year 2008 is shown in Tab. 3.193.

4 Life cycle inventories of electricity grid

4.1 Overview

The electricity produced in Swiss, European and other power plants is transmitted and distributed to the consumers (industry, households, etc.). In this chapter the electricity network, transmission and distribution are described.

The electricity distribution network in Switzerland is operated by about 1'160 operators (Wild 2000), of which about 460 are members of the VSE (VSEVSE (Verband Schweizerischer Elektrizitätsunternehmen) 2002). The high number of grid operators is a Swiss particularity. The technical structure of the electricity transmission and distribution network in European countries does not differ strongly from the Swiss one. Therefore, the detailed Swiss inventories are used as an approximation of the European electricity distribution.

The inventory of the Swiss electricity grid is based on available information regarding electricity transmission and distribution. The most important components are aerial lines, cables and masts as well as transformers, switchgear and substations.

The functional unit of the transmission and distribution datasets is 1 km electricity network of the following three voltage levels:

- High voltage level above 24 kV (large scale industry)
- Medium voltage level between 1 kV and 24 kV (medium to small scale industry, service sector and public buildings)
- Low voltage level below 1 kV (Households)

The system boundaries reach from the feeding of the electricity into the electricity grid (Power plants) to the electricity demand on the high, medium and low voltage level. The electricity losses in buildings of the small scale consumers are estimated.

The existing data set representing long-distance transmission of electricity ("transmission network, long-distance/UCTE/1/km" is replaced by the data set representing electricity transmission on the high voltage level ("transmission network, electricity, high voltage/CH/1/km").

4.2 Transmission and distribution network

4.2.1 Electricity demand and losses

For Switzerland no statistics on the electricity demand on the different voltage levels are available. In Tab. 4.1 the shares of the electricity demand is shown for the different voltage levels for the city of Zürich.

The total available electricity and the total losses are given in the Swiss electricity statistics (BFE 2010). For the year 2009 the total electricity losses were 4'320 GWh. This corresponds to about 7 % of the available electricity (this value did not change significantly over the last 10 years).

The assignment of the electricity losses to the different voltage levels is based on data of the EWZ⁹.

⁹ Personal communication: Gerhard Emch, EWZ, 22.06.2011

Tab. 4.1 Electricity demand and transmission and distribution losses in 2009 on the different voltage levels

	Share of electricity demand ¹⁾	Share of losses ¹⁾	Available electricity ²⁾	Demand of electricity	Total losses ²⁾	Losses	Losses cumulated
Unit	%	%	GWh	GWh	GWh	%	%
Domestic Supply	100 %	100 %	61'814	57'494	4'320	6.99 %	0.00 %
High voltage level	4 %	39 %	60'129	2'300	1'685	2.80 %	2.80 %
Medium voltage level	32 %	13 %	57'268	18'398	562	0.98 %	3.81 %
Low voltage level	64 %	48 %	36'796	36'796	2'074	5.64 %	9.66 %

1) Personal Communication Gerhard Emch, EWZ, 22.06.2011

2) Swiss electricity statistics 2009 (BFE 2010)

The resulting electricity demand on the different voltage levels is shown in Fig. 4.1.

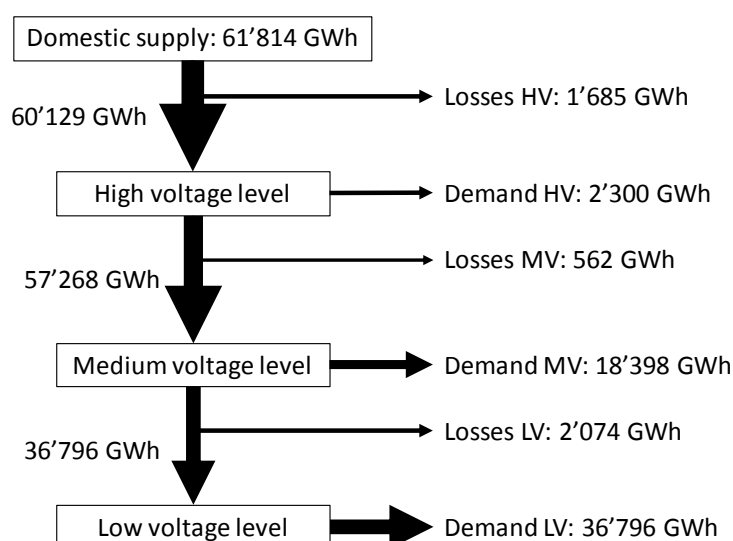


Fig. 4.1 Model of the electricity distribution in Switzerland for the year 2009

The electricity losses during long-distance transmission are described in section 4.3.4.

4.2.2 Material use

Overview and life time of the different elements of the electricity grid

In this section the material use of the whole electricity grid is estimated. The electricity grid is divided into three different levels, namely low, medium and high voltage. The life time of the different elements of the electricity grid are shown in Tab. 4.2. The possible technical life time can be higher, but most of the elements are replaced earlier because of organisational, structural or operational reasons (mainly transformers and cables).

Tab. 4.2 Average life time of the different elements of the electricity grid

	Life time years
Aerial line (low voltage)	40
Aerial line (medium and high voltage)	40
Cables (underground)	40
Masts (low and medium voltage)	40
Masts (high voltage)	60
Transformers and other electro technical equipment	40
Buildings	40
SF ₆ gas insulated switchgear	40

Length of the Swiss electricity grid

The Swiss electricity grid has four different voltage levels for electricity transmission and three different levels for electricity transformation. Tab. 4.3 shows the length of the currents lines on the four different transmission levels based on a report of the Swiss Federal Electricity Commission (EiCom 2011). This report is the basis of the calculations of the material demand of the electricity grid in this study.

In this study the high voltage level and the highest voltage level are merged. The term high voltage level used in this study describes the combination of the high and highest voltage level.

The shares of the underground cables and the aerial lines are modelled according to Tab. 4.3 except for the low voltage level. Since no LCI of the aerial line on the low voltage level was available, the LCI of the low voltage cable was used as an approximation for the low voltage aerial line.

Tab. 4.3 Installed current lines per voltage level in Switzerland split into aerial line and cable (underground) according to EiCom (2011)

	Cable	Aerial line	Total	Cable	Aerial line	Total
Unit	km	km	km	%	%	%
Total low voltage <1kV	115'926	12'720	128'646	61.94%	6.80%	68.74%
Total medium voltage 1-20kV	29'629	13'042	42'671	15.83%	6.97%	22.80%
High voltage 20-150kV	1'843	7'238	9'081	0.98%	3.87%	4.85%
Highest voltage >150kV	0	6'750	6'750	0.00%	3.61%	3.61%
Total high voltage >20kV	1'843	13'988	15'831	0.98%	7.47%	8.46%
Total	147'398	39'750	187'148	78.76%	21.24%	100.00%

Tab. 4.4 shows the number of masts in the Swiss transmission network. The number of masts is derived from the total length of aerial line on the different voltage levels of the transmission and distribution network. Different distances between the masts have been calculated on the low, medium and high voltage levels based on the existing data (Frischknecht et al. 2007a). The grid length in m per mast used for the calculations is shown in Tab. 4.4. The average grid length per mast on the high voltage level was reduced from 600 m per mast (Frischknecht et al. 2007a) to 330 m¹⁰.

¹⁰ Personal communication Gerhard Emch, EWZ, 02.02.2012

Tab. 4.4 Masts in the transmission and distribution network

Masts	Low voltage	Medium voltage	High voltage
Unit	#	#	#
Grid length in m per mast	33	50	330
Steel masts	-	2'437	21'933
Other masts	388'574	257'426	-
Total masts	388'574	259'863	21'933

Material use of transmission and distribution network

Tab. 4.5 shows the material use per kilometre of (underground) cable on the low voltage level. The inventory is based on the material use of the low voltage electricity grid of the EWZ (see footnote 10). The material use of resin pack, plastics and gravel per kilometre of low voltage cable duct (highlighted with grey colour) is assumed to be equal to the material use per kilometre of medium voltage cable (see Tab. 4.6)

Tab. 4.5 Material used per kilometre of cable on the low voltage level

Cable LV	Material	Unit	EWZ 2011 ¹⁾	This study
Cable including insulation	Copper	kg/km	4590.2	4600
	Aluminium	kg/km	0.0	0
	Steel	kg/km	0.9	1
	Lead	kg/km	2111.4	2100
	PVC	kg/km	1012.0	1000
	Paper	kg/km	445.7	450
	Mineral oil	kg/km	398.8	400
Cable duct	Steel	kg/km	0.9	1
	Concrete	m ³ /km	31.9	32
	Resin pack /	kg/km	0.0	25
	Plastics	kg/km	0.0	25
	Gravel	kg/km	0.0	53325

1) Personal Communication Gerhard Emch, EWZ, 02.02.2012

No information on the material use of low voltage aerial lines was available. Therefore, the material use of the low voltage cable was assumed for the total length of the low voltage electricity grid.

Tab. 4.6 shows the material use per kilometre of underground cable on the medium voltage level. The total material use is based on three different data sources. Bumby at al. (2010) as well as Jones & McManus (2010) provide detailed inventory data on material use of cables for the electricity transmission network on the medium voltage level. Further data are provided by the EWZ (see Tab. 4.6). The average material use of the cables according the three data sources is used to establish the life cycle inventories of the medium voltage cables (excluding cable ducts).

The cable duct is modelled with a different approach. Bumby at al. (2010) model a cable duct made out of concrete with steel reels and Jones & McManus (2010) model one filled with gravel. According to the EWZ¹¹ a share of 30 % of the medium and low voltage cables is built in a cable duct made of concrete. The EWZ¹² report a concrete demand of 0.2 kg per km cable duct and a steel demand of 21.2 kg per km. The concrete and steel demand per kilometre of cable duct reported by the EWZ are much lower compared to Bumby at al. (2010). For this study the material demand reported by the

¹¹ Personal communication: Gerhard Emch, EWZ, Email 05.06.2012

¹² Personal communication Gerhard Emch, EWZ, Email 02.02.2012

EWZ in combination with the material demand for cable duct made of gravel reported by Jones & McManus (2010) are used. This results in the material used for the cable duct shown in Tab. 4.6 (highlighted with grey colour). The same material demand of resin pack, plastics and gravel is used for the inventories of the low voltage cables (see Tab. 4.5).

The wood poles used for the masts on the medium voltage level are preserved with an inorganic wood preservative in order to protect them against fouling or fungal decay <Graf 1988>. The amount of preservative used depends on the preservative and the preserved wood. Further information can be found in Werner (2003). In Switzerland, it is not allowed to use Arsenic, Mercury, Lindane or Pentachlorophenol containing preservatives. Therefore, the use of an inorganic, Cr-containing Salt was assumed. Between 6 and 12 kg of wood preservative per m³ of wood are needed for pressure-impregnated wood (Werner et al. 2003). According to Künniger et al. (1995) 17.8 kg/m³ are used including the post-treatment. The latter value is used for the preservative consumption. The Chromium (VI), Copper, Boron and Fluorine are washed out of the preserved pole. These emissions are considered as emission into soil, unspecified. The leaching rate is 60 %, 75 %, 95 % and 80 % for the previously named elements.

Tab. 4.6 Material use per kilometre of cable on the medium voltage level according to Bumby et al. (2010) and Jones and McManus (2010)

Underground cable MV	Material	Unit	Jones & McManus 2010	Bumby et al. 2010	EWZ 2011 ¹⁾	This study
Cables	Copper	kg/km	2664.6	1413.9	4273.7	2784
	Aluminium	kg/km	4081.3	4179.5	0.0	2754
	PET	kg/km	507.0	4597.6	828.1	1978
	EPR	kg/km	1089.0	0.0	0.0	363
Cable duct	Steel	kg/km	0.0	11299.7	21.2	21
	Concrete	m ³ /km	0.0	309.7	12.3	12
	Resin pack / epoxy	kg/km	35.0	0.0	0.0	25
	Plastics	kg/km	35.0	0.0	0.0	25
	Gravel	kg/km	76179.0	0.0	0.0	53325

1) Personal Communication Gerhard Emch, EWZ, 02.02.2012

Tab. 4.7 shows the material use per kilometre of aerial line on the medium voltage level. The total material use is based on two different data sources. Bumby et al. (2010) as well as Jones and McManus (2010) provide detailed inventory data on material use of aerial lines for the electricity transmission network on the medium voltage level. The average of these two data sources is used in the inventory. This implies that half of the aerial lines have copper and aluminium conductors, respectively.

Tab. 4.7 Material use per kilometre of aerial line on the medium voltage level (Bumby et al. 2010; Jones & McManus 2010)

Aerial line MV	Material	Unit	Jones & McManus 2010	Bumby et al. 2010	This study
Cables	Copper	kg/km	4663.1	0.0	2330.0
	Aluminium	kg/km	0.0	1888.7	940.0
	PE Polyethylene	kg/km	0.0	56.2	28.0
	Silicon rubber	kg/km	30.0	0.0	15.0
Cable reels, brackets and masts	Steel	kg/km	1079.0	767.7	923.0
	Porcelain	kg/km	134.0	0.0	67.0
	Timber	m ³ /km	7.9	8.7	8.3

Tab. 4.8, Tab. 4.9 and Tab. 4.10 show the material use for underground cables and aerial lines for the high and highest voltage level based on Jorge et al. (2011a).

Tab. 4.8 Material use per kilometre of underground cable on the high voltage level according to Jorge et al. (2011a)

1km cable HV (150kV)	Materials	Unit	Manufacturing	Maintenance
Cable	Copper	kg/km	8600	0
	Paper	kg/km	3800	0
	Insulation oil	kg/km	4000	0
	Lead	kg/km	13900	80
	Bronze	kg/km	3200	2.2
	Asphalt	kg/km	700	3.4
	Polypropylene	kg/km	1900	0.2
Cable trace	Sand	kg/km	1600000	0
	Concrete	kg/km	35000	0
	Asphalt	kg/km	75000	147

Tab. 4.9 Material use per kilometre of aerial line on the high voltage level according to Jorge et al. (2011a)

1km aerial line HV (150 kV)	Materials	Unit	Manufacturing	Maintenance
Foundation	Concrete	kg/km	129600	0
	Iron	kg/km	6000	0
Masts	Steel	kg/km	18000	0
	Zinc	kg/km	200	80
Insulators	Hard glass	kg/km	562	2.2
	Steel	kg/km	852	3.4
	Cement	kg/km	48	0.2
Conductors	Steel	kg/km	2570	0
	Aluminium	kg/km	7020	0
	Mineral fat	kg/km	490	147
earth conductor	Steel	kg/km	460	0
	Aluminium	kg/km	280	0
	Mineral fat	kg/km	14	4

Tab. 4.10 Material use per kilometre of aerial line on the highest voltage level according to Jorge et al. (2011a)

1km aerial line HHV (400 kV)	Materials	Unit	Manufacturing	Maintenance
Foundation	Concrete	kg/km	288000	0
	Iron	kg/km	15000	0
Masts	Steel	kg/km	53000	0
	Zinc	kg/km	1600	640
Insulators 400kV	Hard glass	kg/km	1350	5.4
	Steel	kg/km	816	3.3
	Cement	kg/km	63	0.3
Insulators 150kV	Hard glass	kg/km	281	1.1
	Steel	kg/km	462	1.7
	Cement	kg/km	24	0.1
Conductors 400kV	Steel	kg/km	4320	0
	Aluminium	kg/km	11940	0
	Mineral fat	kg/km	378	113
Conductors 150kV	Steel	kg/km	2160	0
	Aluminium	kg/km	5970	0
	Mineral fat	kg/km	189	57
earth conductor	Steel	kg/km	928	0
	Aluminium	kg/km	556	0
	Mineral fat	kg/km	28	57

Transformers are essential components of the electricity grid. They connect the different voltage levels. Big power plants feed the electricity at a very high voltage to the electricity grid. Transformers between 600 MVA and 80 MVA can be found in substations, where the high transmission voltage is transformed to the medium distribution voltage. In an additional step the medium voltage is transformed to low voltage using transformers below 2.5 MVA. The small transformers below 2.5 MVA are allocated to the low voltage level, whereas all the other transformers are allocated to the medium voltage level. The material used in the different transformers is based on Jorge et al. (2011b) and is shown in Tab. 4.11 and Tab. 4.12.

Tab. 4.11 Material used in transformers with different capacity (Jorge et al. 2011b)

Transformers	Insulation oil	Copper	Steel	Aluminium
Unit	kg	kg	kg	kg
0.3 MVA	340	0	857	200
16/20 MVA	10'206	8'673	20'417	64
63 MVA	20'000	18'360	35'679	0

Tab. 4.12 Material use of transformers installed in the Swiss electricity grid

Transformers	Number	Insulation oil	Copper	Steel	Aluminium
Source	Schwab 1991, VSE 1988	Jorge et al. 2011	Jorge et al. 2011	Jorge et al. 2011	Jorge et al. 2011
Unit	#	kg	kg	kg	kg
Low voltage	45'000	15'300'000	0	38'565'000	8'991'000
Medium voltage	800	12'164'800	10'610'400	23'469'400	51'200
High voltage	200	0	0	0	0

SF₆ (sulphur hexafluoride) is used as quenching and insulation gas in gas-insulated switchgear. SF₆ has physically ideal properties for the use in high and medium voltage switchgear. Most of the SF₆ used in Switzerland is used in electrical equipment (Metz et al. 2001, S. 215).

According to Liechti (2002) the total amount of SF₆ used in switchgear in Switzerland is 235'700 kg. According to the Swiss greenhouse gas statistics of the year 2009 342'000 kg of SF₆ are used in Switzerland¹³. In this study the total value derived from the Swiss greenhouse gas statistics is used (see Tab. 4.13).

The SF₆ used in the high voltage switchgear account for 80-85 % of the total amount according to Klaus & Dinkel (1999) and 90 % according to the EWZ¹⁴. In this study we use a share of 90 % for the high voltage switchgear and 10 % for the medium voltage switchgear. The SF₆ use and emissions of the high voltage level switchgear are allocated to the medium voltage level and the medium voltage switchgear is allocated to the low voltage level, respectively. The average life time of the switchgear is estimated to be between 40 years. Therefore, the material used is supposed to change slowly.

During production about 1 % of the total amount of SF₆ is emitted (Klaus & Dinkel 1999; Liechti 2002). The emissions during deconstruction are estimated to amount to another 1 %. This leads to an overall emission of 2 % of the SF₆ during construction and disposal. The emission factors applied in this study are shown in Tab. 4.13.

Tab. 4.13 Overall amount of SF₆ in switchgear in Switzerland and the corresponding emissions during construction and disposal of gas-insulated switchgear, see explanation in the text and Footnote 13

	Unit	Total	high voltage	medium voltage
Overall amount of SF ₆	kg	342000	307800	34200
emissions in use-phase	kg/a	6840	6498	342

The transformers and switchgear are located in buildings or boxes made of steel. Tab. 4.14 shows the inventory of the buildings used. The buildings are divided proportionally to the electricity demand on the different voltage levels. An average height of 7 m is assumed for the buildings.

Tab. 4.14 Buildings for substations, switchgear and transformers Source: <VSE 1988> and own calculations

Buildings	Unit	Total	Share LV	Share MV	Share HV
Electricity demand	%	100%	64%	32%	4%
Building halls, volume	m ³	180'000	115'200	57'600	7'200
Building halls, surface (average height: 7m)	m ²	25'714	16'457	8'229	1'029
Office buildings, volume	m ³	1'000'000	640'000	320'000	40'000

Material use for the distribution of electricity in buildings

Additional losses that occur during distribution in buildings are considered for consumers on the low voltage level. Detailed information on the material use is not available and the material use is estimated. The basis of the estimation is the average material use in Swiss households (see Tab. 4.15). The material use and the electricity losses are added to the low voltage level distribution of electricity. It is assumed that the copper in the cables in buildings is recycled and that the plastics are disposed of in a municipal waste incineration plant.

¹³ <http://www.bafu.admin.ch/klima/09570/09574/index.html?lang=de> (14.11.2011)

¹⁴ Personal communication Peter Fessler, EWZ, 27.08.2002.

Tab. 4.15 Material use and losses for the distribution of electricity in buildings of low voltage electricity consumers

	Unit	Amount
Distribution in buildings	GWh/a	
Losses ¹⁾	%	0.4
Life time cables	a	50
Cable length ³⁾	m	50
Copper demand	t ²⁾	44'500
	mg/kWh	44
Plastics (PVC)	t ²⁾	5'200
	mg/kWh	5.5

¹⁾: Losses according to <Fritsche et al. 1989>: 0.008 %/m.

²⁾: Extrapolated for a life time of 30 years

³⁾: Copper: 0.4 kg/m, PVC (insulation): 0.05 kg/m according to <Brugg 1993>

4.2.3 Construction and disposal

The components and materials used have to be transported from the factory to the construction site. The standard distances according to Frischknecht et al. (2007b) are used to calculate the transport services needed. The excavation during construction of the cables is taken into account. Tab. 4.16 shows the total excavated volume for all voltage levels. It is assumed that 80 % of the cables are recycled.

Tab. 4.16 Excavation volume during construction and deconstruction of cables lines

	Length cables	Excavated volume per km	Excavated volume construction	Excavated volume deconstruction	Total excavated volume
Unit	km	m ³ /km	m ³	m ³	m ³
Low voltage	115'926	30	3'477'780	2'782'224	6'260'004
Medium voltage	29'629	300	8'888'700	7'110'960	15'999'660
High voltage	1'843	480	884'640	707'712	1'592'352
Source	EICom 2011	VSE 1993			

4.2.4 Land use

The land use corresponds to the area occupied by masts, transformers and substations of the electricity grid and the construction of underground cables and aerial lines. The cables and aerial lines are commonly built on agricultural land. Therefore, it can be assumed that the land use is not changed after the construction, except the area occupied by the masts itself. If the current lines pass a forest, the area needed for construction is cleared.

Detailed information on the land use is missing. Therefore, the occupied area is estimated. The estimation is based on the land use of the masts, substations and the transformers (see Tab. 4.17). For steel masts, the area between the concrete sockets is treated as "industrial area, vegetation" because of the lack of a better approximation. The number of masts used on the different voltage levels is taken from Tab. 4.4.

A total land use of 24 m² per steel mast is assumed. 4 m² are occupied by the sockets of the mast and the unused area below the mast is 20 m². A land use 0.06 m² is assumed for the other masts. The amount of transformer stations is based on information from <VSE 1988>.

Tab. 4.17 Land use of the different elements of the Swiss electricity grid (own calculations and assumptions)

	Volume	Amount	Specific land use	Share HV	Land use LV	Land use MV	Land use HV
Unit	m3	#	m ² per mast	%	m ²	m ²	m ²
Masts, steel		24'370					
Industrial area, built up			4	90.00%	0	9'748	87'733
Industrial area, vegetation			20	90.00%	0	48'741	438'667
Total			24	90.00%	0	58'489	526'400
Other masts		646'000					
Industrial area, built up			0.06	0.00%	23'314	15'446	0
Buildings	1180000						
Industrial area, built up			0.4	4.00%	302080	151040	18880
Transformer stations		317					
Industrial area, built up			500	100.00%	0	0	158'500
Total land use					325'394	224'974	703'780
Industrial area, built up					325'394	176'234	265'113
Industrial area, vegetation					0	48'741	438'667
Total land use change					325'394	224'974	703'780
Forest					144'402	99'838	312'321
Arable land					180'992	125'136	391'459

4.2.5 Life cycle inventory of the electricity grid

Tab. 4.18 shows the total material use per kilometre of all the three voltage levels of the Swiss electricity grid for a life time of 30 years. Transports are calculated according the standard distances as described in Frischknecht et al. (2007b). The density of wood and concrete is 650 kg/m³ and 2200 kg/m³, respectively. The heavy metals leached from the pressure-impregnated wood poles are assessed in the infrastructure datasets, even though the emissions occur during the operation. The documentation of the calculations can be found in sections 4.2.2 to 4.2.4.

Tab. 4.18 Material use per kilometre of the Swiss electricity grid for a life time of 30 years (components with a higher or lower lifetime are converted to a life time of 30 year (see Tab. 4.2)

Swiss electricity grid		Unit	LV	MV	HV
Length	total	km	128'646	42'671	15'831
Materials	Aluminium	kg/km	69.9	2200.8	11211.1
	Cement	m ³ /km	0.0	0.0	59.3
	Concrete	m ³ /km	31.9	8.5	57.0
	Hard glass	kg/km	0.0	0.0	956.1
	Lead	kg/km	2100.0	0.0	1627.5
	Wood	m ³ /km	0.0	2.5	0.0
	Treatment wood	m ³ /km	0.0	2.5	0.0
	Bronze	kg/km	0.0	0.0	372.8
	Resin pack / epoxy resin	kg/km	24.5	17.0	0.0
	EPR / EPDM	kg/km	24.5	269.1	0.0
	Wood preservative	kg/km	0.0	45.2	0.0
	Copper	kg/km	4600.0	2893.9	1001.2
	Mineral Oil	kg/km	518.9	285.1	1115.6
	Gravel	kg/km	53325.3	37026.9	0.0
	PET	kg/km	0.0	1373.4	0.0
	PE	kg/km	0.0	8.6	0.0
	PVC	kg/km	1000.0	0.0	0.0
	PP	kg/km	0.0	0.0	221.2
	Paper	kg/km	450.0	0.0	442.4
	Porcelain	kg/km	0.0	20.5	0.0
Sand	kg/km	0.0	0.0	186267.4	
Silicone	kg/km	0.0	4.6	0.0	
Steel, low-alloyed	kg/km	0.0	0.0	1175.0	
Steel, unalloyed	kg/km	301.7	846.8	30951.5	
Sulphur hexafluoride	kg/km	0.2	5.4	0.0	
Zinc	kg/km	0.0	0.0	722.1	
Total	Total	kg/km	78771	28089	357616
Transports	Transport Lorry	tkm/km	2902	1594	8618
	Transport Rail	tkm/km	4726	3134	23765
Excavation	Excavation	m ³ /km	48.7	375.0	100.6
Disposal	Disposal concrete	kg/km	70180	18789	125442
	Disposal wood	kg/km	0.0	1648.9	0.0
	Disposal PE	kg/km	0.0	8.6	0.0
	Disposal PVC	kg/km	1000.0	0.0	0.0
	Disposal mineral oil	kg/km	518.9	285.1	1115.6
Buildings	Building, steel construction	m ³ /km	0.1	0.2	0.1
	Building, multi-storey	m ³ /km	5.0	7.5	2.5
Land use	Occupation, industrial area, built up	m ² /a/km	101.2	165.2	669.9
	Occupation, industrial area, vegetation	m ² /a/km	0.0	45.7	1108.4
	Transformation, from arable	m ² /km	1.4	2.9	24.7
	Transformation, from forest	m ² /km	1.1	2.3	19.7
	Transformation, to industrial area, built up	m ² /km	2.5	4.1	16.7
	Transformation, to industrial area, vegetation	m ² /km	0.0	1.1	27.7
Emissions to air	Emission SF ₆	kg/km	0.0	0.1	0.0
Emissions to soil	Chromate VI	kg/km	0.0	5.3	0.0
	Copper	kg/km	0.0	3.3	0.0
	Boron	kg/km	0.0	0.9	0.0
	Fluoride	kg/km	0.0	3.6	0.0

Tab. 4.19 shows the unit process raw data of the different voltage levels of the electricity grid. The uncertainties are estimated with the pedigree approach (Frischknecht et al. 2007b).

Tab. 4.19 Unit process raw data of the different voltage levels of the electricity distribution and transmission network

product	Name	Location	InfrastructurePr	Unit	distribution network, electricity, low voltage	transmission network, electricity, high voltage	transmission network, electricity, medium voltage	transmission network, long-distance	UncertaintyType	StandardDeviation5%	GeneralComment
					CH 1 km	CH 1 km	CH 1 km	UCTE 1 km			
					km	km	km	km			
	distribution network, electricity, low voltage	CH	1	km	1	0	0	0			
	transmission network, electricity, high voltage	CH	1	km	0	1	0	0			
	transmission network, electricity, medium voltage	CH	1	km	0	0	1	0			
	transmission network, long-distance	UCTE	1	km	0	0	0	1			
technosphere	aluminium, production mix, at plant	RER	0	kg	6.99E+1	1.12E+4	2.20E+3	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	bronzes, at plant	CH	0	kg	0	3.73E+2	0	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	portland cement, strength class Z 42.5, at plant	CH	0	kg	0	5.93E+1	0	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	ceramic tiles, at regional storage	CH	0	kg	0	0	2.05E+1	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	concrete, normal, at plant	CH	0	m3	3.19E+1	5.70E+1	8.54E+0	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	epoxy resin, liquid, at plant	RER	0	kg	2.45E+1	0	1.70E+1	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	flat glass, uncoated, at plant	RER	0	kg	0	9.56E+2	0	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	lead, at regional storage	RER	0	kg	2.10E+3	1.63E+3	0	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	round wood, softwood, debarked, u=70% at forest road	RER	0	m3	0	0	2.54E+0	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	preservative treatment, logs, pressure vessel	RER	0	m3	0	0	2.54E+0	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	wood preservative, inorganic salt, containing Cr, at plant	RER	0	kg	0	0	4.52E+1	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	copper, at regional storage	RER	0	kg	4.60E+3	1.00E+3	2.89E+3	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	light fuel oil, at regional storage	RER	0	kg	5.19E+2	1.12E+3	2.85E+2	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	gravel, unspecified, at mine	CH	0	kg	5.33E+4	0	3.70E+4	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	synthetic rubber, at plant	RER	0	kg	2.45E+1	0	2.69E+2	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	packaging film, LDPE, at plant	RER	0	kg	0	0	8.56E+0	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	polyethylene terephthalate, granulate, amorphous, at plant	RER	0	kg	0	0	1.37E+3	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	polyvinylchloride, at regional storage	RER	0	kg	1.00E+3	0	0	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	polypropylene, granulate, at plant	RER	0	kg	0	2.21E+2	0	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	paper, wood-containing, LWC, at regional storage	CH	0	kg	4.50E+2	4.42E+2	0	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	silicone product, at plant	RER	0	kg	0	0	4.58E+0	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	steel, low-alloyed, at plant	RER	0	kg	0	1.18E+3	0	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	steel, converter, unalloyed, at plant	RER	0	kg	3.02E+2	3.10E+4	8.47E+2	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	sulphur hexafluoride, liquid, at plant	RER	0	kg	1.99E-1	0	5.41E+0	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	zinc, primary, at regional storage	RER	0	kg	0	7.22E+2	0	0	1	1.22	(1,3,1,3,1,5,BU:1.05); Literature data; HV: Jorge et al. 2011, MV: Bumy et al. 2010, Jones and McManus 2010, LV: Personal communication ewz
	transport, lorry>16t, fleet average	RER	0	tkm	2.90E+3	8.62E+3	1.59E+3	0	1	2.10	(4,2,2,2,1,5,BU:2); Estimation; calculation scointent report nr 1
	transport, freight, rail	RER	0	tkm	4.73E+3	2.38E+4	3.13E+3	0	1	2.10	(4,2,2,2,1,5,BU:2); Estimation; calculation scointent report nr 1
	excavation, hydraulic digger	RER	0	m3	4.87E+1	1.01E+2	3.75E+2	0	1	1.24	(2,3,2,1,5,BU:1.05); Literature data; VSE 1993
	building, hall, steel construction	CH	1	m2	1.28E-1	6.50E-2	1.93E-1	0	1	3.09	(4,2,2,2,1,5,BU:3); Estimation; own calculation
	building, multi-storey	RER	1	m3	4.97E+0	2.53E+0	7.50E+0	0	1	3.09	(4,2,2,2,1,5,BU:3); Estimation; own calculation
	disposal, concrete, 5% water, to inert material landfill	CH	0	kg	7.02E+4	1.25E+5	1.88E+4	0	1	1.30	(4,2,2,2,1,5,BU:1.05); Estimation; 100% disposed
	disposal, wood pole, chrome preserved, 20% water, to municipal incineration	CH	0	kg	0	0	1.65E+3	0	1	1.30	(4,2,2,2,1,5,BU:1.05); Estimation; 100% disposed
disposal, polyethylene, 0.4% water, to municipal incineration	CH	0	kg	0	0	8.56E+0	0	1	1.30	(4,2,2,2,1,5,BU:1.05); Estimation; 100% disposed	
disposal, polyvinylchloride, 0.2% water, to municipal incineration	CH	0	kg	1.00E+3	0	0	0	1	1.30	(4,2,2,2,1,5,BU:1.05); Estimation; 100% disposed	
disposal, used mineral oil, 10% water, to hazardous waste incineration	CH	0	kg	5.19E+2	1.12E+3	2.85E+2	0	1	1.30	(4,2,2,2,1,5,BU:1.05); Estimation; 100% disposed	
transmission network, electricity, high voltage	CH	1	km	0	0	0	1.00E+0	1	3.00	(1,1,1,1,1,1,BU:3); Assumption; replaced by high voltage transmission network	
emission resource, land	Occupation, industrial area, built up	-	-	m2a	1.01E+2	6.70E+2	1.65E+2	0	1	1.60	(2,4,3,2,1,5,BU:1.5); Literature data; VSE 1988, own calculation
	Occupation, industrial area, vegetation	-	-	m2a	0	1.11E+3	4.57E+1	0	1	1.60	(2,4,3,2,1,5,BU:1.5); Literature data; VSE 1988, own calculation
	Transformation, from arable	-	-	m2	1.41E+0	2.47E+1	2.93E+0	0	1	1.34	(2,4,3,2,1,5,BU:1.2); Literature data; VSE 1988, own calculation
	Transformation, from forest	-	-	m2	1.12E+0	1.97E+1	2.34E+0	0	1	2.08	(2,4,3,2,1,5,BU:2); Literature data; VSE 1988, own calculation
	Transformation, to industrial area, built up	-	-	m2	2.53E+0	1.67E+1	4.13E+0	0	1	2.08	(2,4,3,2,1,5,BU:2); Literature data; VSE 1988, own calculation
Transformation, to industrial area, vegetation	-	-	m2	0	2.77E+1	1.14E+0	0	1	2.08	(2,4,3,2,1,5,BU:2); Literature data; VSE 1988, own calculation	
emission air, unspecified	Sulfur hexafluoride	-	-	kg	3.99E-3	0	1.08E-1	0	1	1.50	(1,2,1,1,1,1,BU:1.5); Literature data; FOEN 2009, greenhouse gas statistics
emission soil, unspecified	Chromium VI	-	-	kg	0	0	5.34E+0	0	1	1.58	(2,4,1,1,1,5,BU:1.5); Estimation; own calculation
	Copper	-	-	kg	0	0	3.33E+0	0	1	1.58	(2,4,1,1,1,5,BU:1.5); Estimation; own calculation
	Boron	-	-	kg	0	0	9.44E-1	0	1	1.58	(2,4,1,1,1,5,BU:1.5); Estimation; own calculation
	Fluoride	-	-	kg	0	0	3.61E+0	0	1	1.58	(2,4,1,1,1,5,BU:1.5); Estimation; own calculation

4.2.6 Comparison with ecoinvent datasets v2.2

Fig. 4.2 shows the environmental impact per km of electricity grid described in this study according to ecological scarcity 2006 compared to the environmental impact of electricity grid according to the ecoinvent data v2.2. Main contributors to the total environmental impacts of the electricity grid are the materials used for the current lines in case of the low and medium voltage level and the materials of the current lines and the construction materials on the high voltage level. The emissions of the heavy metals lead and cadmium into air during copper production have the highest contribution to the total environmental impact according to the ecological scarcity method 2006.

The environmental impacts per km of low voltage electricity grid increase from about 144 to 291 mio eco-points. This is mainly due to the increased copper demand of the current lines (from 1'800 to 4'600 kg/km) and the increased steel demand (from 2'300 to 3'700 kg/km).

The environmental impacts per km of medium voltage electricity grid increase from 171 to 248 mio eco-points. The copper demand is increased from 2'000 to 2'890 kg/km, the aluminium demand is increased from 600 to 2200 kg/km, the concrete demand is increased from 3.5 to 65 m³/km and the steel demand from 1100 to 3190 kg/km. On the medium voltage level more aluminium is used for the current lines instead of copper. This causes a reduced environmental impact compared to the low voltage level, even if thicker current lines are used.

In ecoinvent data v2.2 two data sets represent the high voltage grids, the “transmission network high voltage” and the “transmission network long-distance”. The environmental impacts of the long-distance transmission network (505 mio eco-points) are significantly higher than the high voltage transmission network (67.4 mio eco-points). In this study the two datasets representing high voltage and long distance transmission are replaced with one data set describing the transmission infrastructure on the high voltage level. The environmental impacts of the high voltage transmission network in this study (299 mio eco-points) lie between the two ecoinvent data sets.

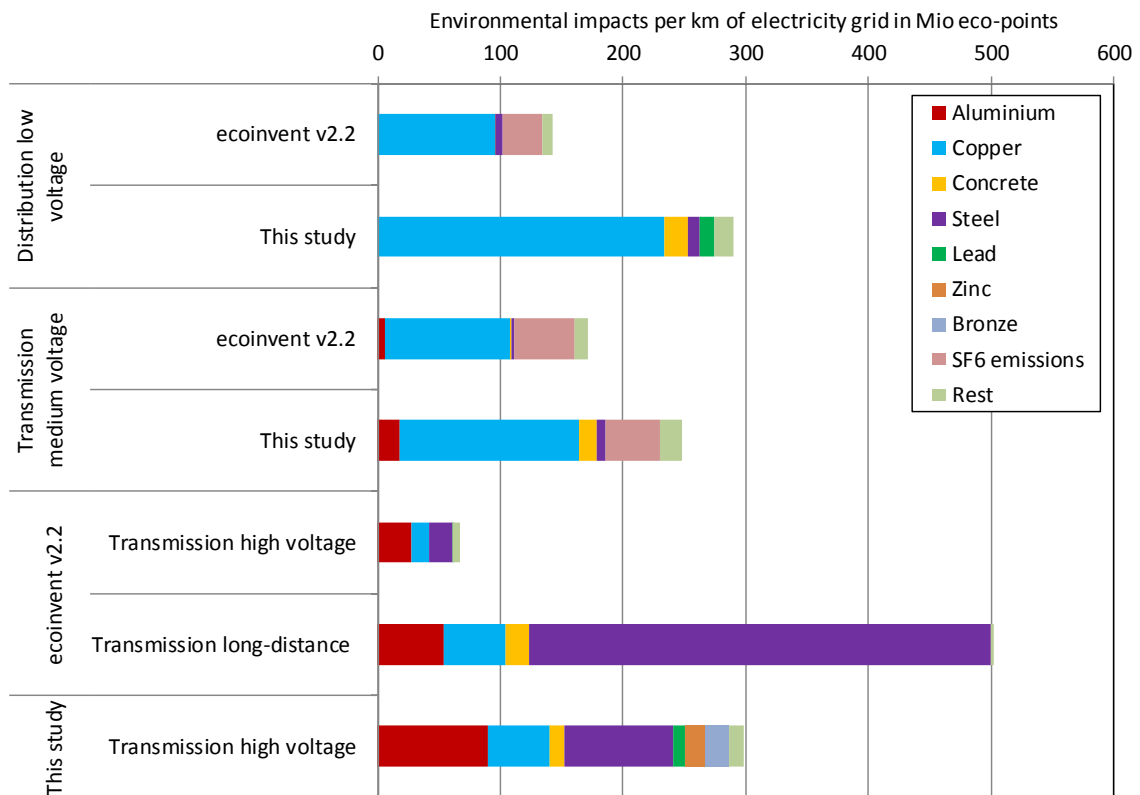


Fig. 4.2: Comparison of the environmental impacts per km of the electricity grid on the different voltage levels described in this study and according to the ecoinvent data 2.2 using the ecological scarcity method 2006

Fig. 4.3 shows increased greenhouse gas emissions of the new modelling compared to the modelling according to ecoinvent data v2.2 similar to the increased environmental impacts shown in Fig. 4.2. The greenhouse gas emissions per km of low level electricity grid are 52.1 tons CO₂-eq compared to 12.6 tons CO₂-eq according to the datasets in ecoinvent data v2.2. The greenhouse gas emission per km of medium voltage grid in this study are 56.7 tons CO₂-eq compared to 18.4 tons CO₂-eq according to the datasets in ecoinvent data v2.2.

The greenhouse gas emission per km of high voltage grid lies between the value of the high voltage transmission grid and the long-distance transmission grid as modelled in ecoinvent data v2.2. The

greenhouse gas emission per km of high voltage grid in this study are 178 tons CO₂-eq compared to 43.1 tons CO₂-eq (high voltage transmission grid) and 336 tons CO₂-eq (long-distance transmission grid)

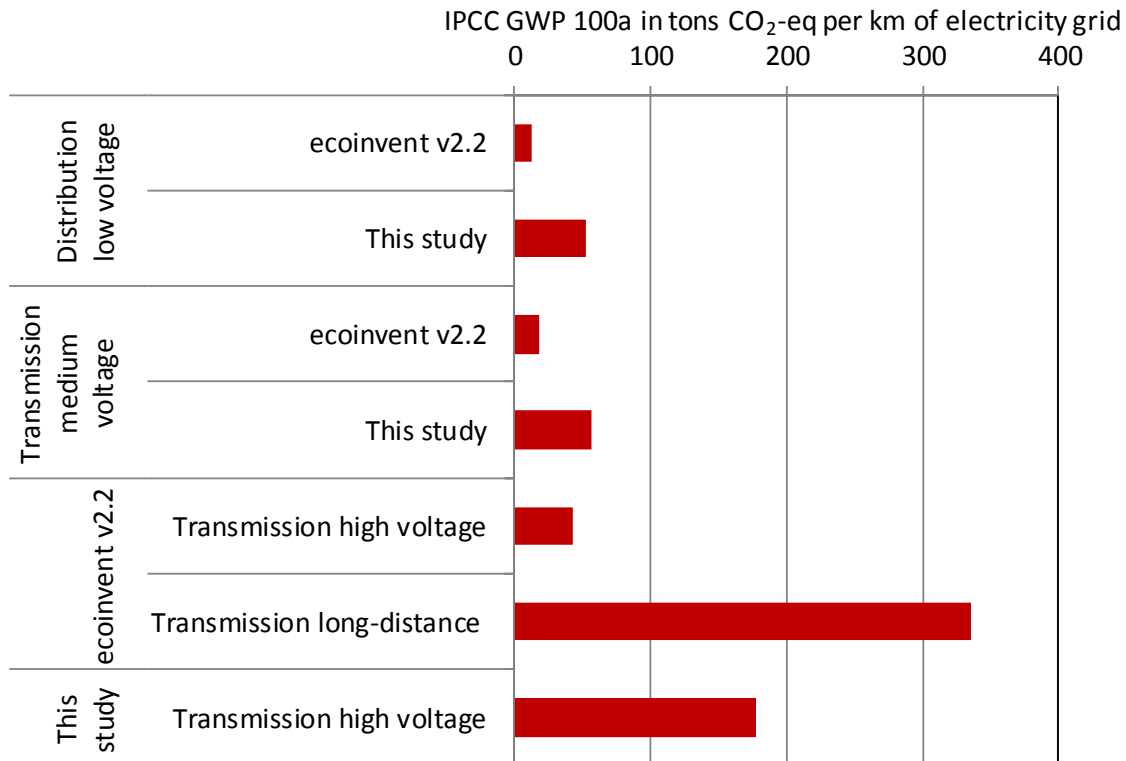


Fig. 4.3: Comparison of the greenhouse gas emissions in tons of CO₂-eq (according to IPCC GWP 2007 100 a) per km of the electricity grid on the different voltage levels described in this study and in the datasets of ecoinvent data v2.2

The total length of the Swiss electricity grid (see Tab. 4.3) is considerably shorter than the total length used in ecoinvent data v2.2. The total current line was reduced from 277'040 to 128'464 km on the low voltage level and from 48'950 to 42671 km on the medium voltage level. On the other hand, the current line was increased from 8'227 to 9'081 km on the high voltage level and from 5'963 to 6'750 km on the highest voltage level. Overall this corresponds to a reduction of the total grid length of 153'032 km (from 340'180 to 187'148 km).

In addition the lifetime of all the cables and the aerial lines on the low voltage level was increased from 30 to 40 years, which corresponds to the indications given by the cable manufacturers.

4.3 Electricity transmission and distribution

4.3.1 Overview

Three different voltage levels, namely low, medium and high voltage, are considered. In Subchapter 4.2 the LCI of the construction and manufacture of the transmission and distribution network is described. In this section the LCI of the operation of the electricity grid is described using the example of the Swiss electricity mix.

Several pollutants are emitted during operation:

- Nitrous oxide and ozone, formed at the corona of aerial lines

- SF₆ emissions from gas insulated switchgear
- Heat from transmission and distribution losses in underground cables and aerial lines
- Wood preservatives from wood poles (described in Subchapter 4.2)
- Coating for corrosion protection used for steel masts
- Insulation oil from cables transformers and different electro technical equipment
- Electro-magnetic radiation near aerial lines and electro technical devices

4.3.2 Emissions during operation

Ozone and N₂O-emissions

The electro-magnetic field near high voltage aerial lines can lead to the ionisation of air molecules and to the formation of nitrous oxide and ozone. This reaction happens in a boundary layer called corona. The formation of pollutants depends on the weather and the surface of the conductor. Therefore, only a few general assumptions can be made.

<Bohlin et al. 1991> and <Böhringer et al. 1988> report very low ozone concentrations near the corona, which hardly can be measured. For Switzerland the yearly ozone emissions are estimated to amount to a total of 50 to 1'250 tons (Knoepfel 1995, S.99). For this study the geometric average is used. This corresponds to a yearly emission of 250 tons in the Swiss high voltage grid. The total of 60'129 GWh of electricity transmitted on the high voltage level results in an emission factor of 4.2 kg per GWh or 4.5 mg per kWh. The uncertainty of this emission rate is assumed to correspond to a lognormal distribution with a 95 % standard deviation of 5.

<Hill et al. 1984> report a nitrous oxide formation rate between 0.01 and 0.21 g per kWh of electricity transmitted. <DeLuchi 1991> uses this emission factor in their study. The emission rates are reduced by a factor of 10 to account for the shorter transmission distances in Switzerland. The geometric average results in 0.005 kg per kWh with a 95 % standard deviation of 4.6.

SF₆-emissions

The SF₆-emissions are modelled for five different countries: Switzerland, Germany, Japan, Brazil, India and the USA. SF₆ is used as insulation gas for switchgear. Most of SF₆-emissions are caused by the high voltage level switchgear, which are allocated to the electricity demand on medium voltage. In Tab. 4.26 the SF₆-emissions rates are shown for all the countries considered in this study. If no information is available for the respective countries the values for Switzerland, Germany, Brazil, Japan or the United States are taken.

Tab. 4.20 shows the SF₆ filling capacity, emissions and emission factors for the high and medium voltage level of the Swiss electricity grid. The estimated emission rate of SF₆ according to Klaus & Dinkel (1999) corresponds to 1 % of the overall amount used in switchgear. For Switzerland (overall amount 342'000 kg) this corresponds to an emission rate of 52 g/GWh. For Austria (UBA 1999) and Denmark (Elkraft System 2001) an emission rate of 1 % of the overall amount is reported like for Switzerland. The SF₆ emissions of the EWZ in the year 2000 are 41 kg with an overall stock of 11'000 kg (EWZ 2001). This corresponds to 0.4 % of the overall amount and 7.3 g per GWh of electricity supplied (total electricity supplied by EWZ 2000: 5'600 GWh). This emission rate is considerably lower than the emission rate reported by Klaus & Dinkel (1999). The yearly losses range between 0.5 % for newer and 8 % for older switchgear. In this study the emission rate from Klaus & Dinkel (1999) is selected. The amount of SF₆ used on the high voltage level corresponds to about 90 % of the overall amount¹⁵ and the emission rates are higher on the high voltage level. Therefore, 95 % of the

¹⁵ Personal communication Peter Fessler, ewz, 27.08.2002

yearly emissions are allocated to the medium voltage level (transformers from high to medium voltage) and the remaining 5 % are allocated to the low voltage level¹⁵.

Tab. 4.20 SF₆ filling capacity, emissions and emission factors of the operation of high and medium voltage switchgear according to the Swiss greenhouse gas statistics¹⁶

	Unit	Total	High voltage ¹⁾	Medium voltage ²⁾
Overall amount of SF ₆	kg	342000	307800	34200
Handled electricity	GWh	61'814	60129	57268
SF ₆ per handled electricity	kg/GWh	5.72	5.12	0.60
Emissions in use-phase	kg/a	3420	3249	171
Emissions per GWh	kg/GWh	0.057	0.054	0.003
Emissions per kWh	kg/kWh	5.70E-08	5.40E-08	2.99.E-09
Emission rate in %		1.00%	1.06%	0.50%

¹⁾: allocated to medium voltage level

²⁾: allocated to low voltage level

The SF₆ emissions in Germany are based on the Swiss emission factors per kWh (shown in Tab. 4.20) with an adjusted emission rate. For Germany an emission rate of 2.1 % is reported (UNFCCC-DE n.d.). The German emission rates are shown in Tab. 4.21.

Tab. 4.21 SF₆ emissions and emission factors of the operation of high and medium voltage switchgear in Germany (own calculation)

SF ₆ per handled electricity	kg/GWh	5.72	5.12	0.60
Emissions in use-phase	kg/a	7182	6823	359
Emissions per GWh	kg/GWh	0.120	0.113	0.006
Emissions per kWh	kg/kWh	1.20E-07	1.13E-07	6.27.E-09
Emission rate in %		2.10%	2.22%	1.05%

¹⁾: allocated to medium voltage level

²⁾: allocated to low voltage level

Tab. 4.22 shows the SF₆ filling capacity, emissions and emission factors for the high and medium voltage level of the Japanese electricity grid. The emission rates of SF₆ are regulated with an optional action plan. The aim for the year 2005 was an emission rate of 3 % of the filling capacity during construction, 3 % during operation and 1 % during deconstruction (Sugimura & Aoyama 2004). The Japanese greenhouse gas inventory (Ministry of the Environment 2006) states a total filling capacity of 8'600'000 kg SF₆ in electro technical switchgear for the distribution and transmission of 866'000 GWh electricity in the year 2004. This corresponds to about 9.95 kg of SF₆ per transmitted GWh of electricity (about twice as high as for Switzerland). Nevertheless, the emission rates during operation in Japan are only 12'400 kg SF₆ per year, this corresponds to 0.14 % of the filling capacity¹⁷ (see Tab. 4.22).

It is important to consider that these emission rates are estimates and have a high uncertainty.

¹⁶ <http://www.bafu.admin.ch/climatereporting/00545/11269/index.html?lang=en> (06.12.2011)

¹⁷ For the production of the switchgear 1'895 t of SF₆ were used in the year 2004, the emission rate during construction was 1.7 % (Ministry of the Environment 2006) and is considerably higher than the infrastructure emissions in the data sets of the Swiss electricity grid. However, the generation of Japanese transmission and distribution infrastructure data sets was not possible within this study.

Tab. 4.22 SF₆ filling capacity, emissions and emission factors of the operation of high and medium voltage switch-gear according to the Japanese greenhouse gas statistics. Source: Ministry of the Environment (2006)

	Unit	Total	High voltage ¹⁾	Medium voltage ²⁾
Overall amount of SF ₆	kg	8600000	7740000	860000
Handled electricity	GWh	n.a.	861851	774002
SF ₆ per handled electricity	kg/GWh	n.a.	8.98	1.11
Emissions in use-phase	kg/a	12040	11438	602
Emissions per GWh	kg/GWh	n.a.	0.013	0.001
Emissions per kWh	kg/kWh	n.a.	1.33E-08	7.78E-10
Emission rate in %		0.14%	0.15%	0.07%

¹⁾: allocated to medium voltage level

²⁾: allocated to low voltage level

Tab. 4.23 shows the SF₆ filling capacity, emissions and emission factors on the high and medium voltage level of the Brazilian electricity grid. The greenhouse gas inventory of Brazil (Ministry of Science and Technology 2004) indicates a filling capacity of 208 t in electrical equipment and diffuse emissions of 1.8 t per year for an electricity production of 247 TWh (Ministry of Science and Technology 2004, clforum 2006). An extrapolation of these values to the electricity production in the year 2005 is made.

Compared to Switzerland these values are very low. Nevertheless, one has to consider that the Brazilian electricity grid is divided in separate sub-grids¹⁸, avoiding the need of high and highest voltage switchgear.

It is assumed that 95 % of the SF₆ emissions occur on the high voltage level (allocated to medium voltage) and 5 % on the medium voltage level (allocated to the low voltage level). This corresponds to the European model.

Tab. 4.23 SF₆ filling capacity, emissions and emission factors of the operation of high and medium voltage switch-gear extrapolated from the Brazilian greenhouse gas inventory 2004

	Unit	Total	High voltage ¹⁾	Medium voltage ²⁾
Overall amount of SF ₆	kg	338265	304439	33827
Handled electricity	GWh	n.a.	407429	364270
SF ₆ per handled electricity	kg/GWh	n.a.	0.75	0.09
Emissions in use-phase	kg/a	2934	2787	147
Emissions per GWh	kg/GWh	n.a.	0.0068	0.0004
Emissions per kWh	kg/kWh	n.a.	6.84E-09	4.03E-10
Emission rate in %		0.87%	0.92%	0.43%

¹⁾: allocated to medium voltage level

²⁾: allocated to low voltage level

Tab. 4.24 shows the SF₆ filling capacity, emissions and emission factors on the high and medium voltage level of the US American electricity grid. The SF₆ emissions due to electricity transmission and distribution in the USA have been reduced significantly in the past 10 years and are comparable to the emissions in Europe. The US Greenhouse Gas Emissions Report¹⁹ reports a total emission of 540'000 kg of SF₆. This results in an emission rate that is twice as high as the emission rate of Switzerland and comparable to the emission rate in Germany.

¹⁸ According to Bosi (2000) there are two main subgrids with more than 300 isolated local subgrids.

¹⁹ <http://epa.gov/climatechange/emissions/usinventoryreport.html> (24.07.2007)

Tab. 4.24 SF₆ filling capacity, emissions and emission factors of the operation of high and medium voltage switch-gear according to the US Greenhouse Gas Emissions Report (see footnote 19)

	Unit	Total	High voltage ¹⁾	Medium voltage ²⁾
Overall amount of SF ₆	kg	n.a.	n.a.	n.a.
Handled electricity	GWh	n.a.	3963336	3465299
SF ₆ per handled electricity	kg/GWh	n.a.	n.a.	n.a.
Emissions in use-phase	kg/a	540000	513000	27000
Emissions per GWh	kg/GWh	n.a.	0.1294	0.0078
Emissions per kWh	kg/kWh	n.a.	1.29E-07	7.79E-09
Emission rate in %		n.a.	n.a.	n.a.

¹⁾: allocated to medium voltage level

²⁾: allocated to low voltage level

The SF₆ Emission Reduction Partnership for Electric Power Systems reports an SF₆ emission rate of 9.4 % and a total emission of 188'000 kg of SF₆ in the year 2004. This partnership represents 42 % of the transmission and distribution sector²⁰. The extrapolation of the total emissions would result in a yearly emission of 448'000 kg, which is lower than the total emissions reported by USEPA (2007). It is assumed that the yearly emission rate in the USA exceeds 10 %.

Tab. 4.25 shows the SF₆ filling capacity, emissions and emission factors on the high and medium voltage level of the Indian electricity grid. In 2005, 191.03 tons of SF₆ were emitted from electrical equipment.²¹ Between 2005 and 2009 the electricity consumption in India has increased by 43 % (Central Statistics Office 2011). Assuming a linear correlation between the SF₆ emissions from electrical equipment and the power supply, the total emissions of SF₆ amount to 273.2 tons. Due to the lack of more specific data 95 % of these emissions are allocated to medium voltage electricity and 5 % to low voltage electricity. Tab. 4.25 shows the emission rate for the Indian electricity supply.

Tab. 4.25 SF₆ filling capacity, emissions and emission factors of the operation of high and medium voltage switch-gear in India

	Unit	Total	High voltage ¹⁾	Medium voltage ²⁾
Overall amount of SF ₆	kg	n.a.	n.a.	n.a.
Handled electricity	GWh	864348	826568	783276
SF ₆ per handled electricity	kg/GWh	n.a.	n.a.	n.a.
Emissions in use-phase	kg/a	273200	259540	13660
Emissions per GWh	kg/GWh	0.331	0.314	0.017
Emissions per kWh	kg/kWh	3.31E-07	3.14E-07	1.74E-08
Emission rate in %		n.a.	n.a.	n.a.

¹⁾: allocated to medium voltage level

²⁾: allocated to low voltage level

Only limited information is available for other countries. For France an emission rate of 0.86% (UNFCCC-FR 2001) and for Austria an emission rate of 1 % is reported (UBA 1999). Since no information was available on the SF₆ emissions per handled electricity the value of the Swiss electricity grid is used to calculate the emission rates. This means that the German SF₆ emissions are twice as high as the Swiss ones due to the increased emission rate. For France and Austria there are only slight differences since the emission rate does not differ from the Swiss emission rate.

²⁰ <http://www.epa.gov/electricpower-sf6/accomplish.html> (24.07.2007)

²¹ <http://edgar.jrc.ec.europa.eu/index.php> (access on 25.02.2011) Emissions Database for Global Atmospheric Research (EDGAR)

Other emissions

The heat losses of the year 2009 correspond to the electrical transmission and distribution losses which are 0.101 MJ/kWh for electricity supplied on the high voltage level, 0.035 MJ/kWh on the medium voltage level and 0.203 MJ/kWh on the low voltage level (see Tab. 4.1).

Steel masts used for aerial lines are coated in order to prevent corrosion. The commonly used process is hot-dip galvanising using zinc as anticorrosive. In general a duplex process is used applying a zinc and paint coating to further improve the corrosion protection. In addition, the selection of the colour can improve the embedding into the landscape <van Oeteren 1988>. With this additional protection the zinc emissions into soil can be neglected <van Oeteren 1988>.

Insulation oil from cables and electro technical equipment (transformers, switchgear and circuit breakers) can leak in case of accidental release. Measures are taken to prevent the leakage of insulation oil into soil or surface water <VSE 1989>. Detailed information on the emissions is not available and mineral oil emissions into soil and surface water are not included in the inventory of this study.

Electromagnetic fields are a side effect of electricity transmission. The regulation for protection of non-ionising radiation (NISV 1999) describes the limit for emissions of electromagnetic radiation. The emission of electromagnetic radiation is not considered in this study, because there is no usable quantitative information available. Nevertheless, the emission of electromagnetic radiation should not be trivialised. The discussion on the potential health effects of electromagnetic waves will have an effect on the planning of electricity grids in the future.

The heavy metal emissions caused by the impregnated wood poles use for aerial lines are modelled in the infrastructure data sets and described in chapter 4.2.

4.3.3 Losses during electricity transmission and distribution

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Because of the lack of country specific information on the distribution of the losses on the different voltage levels, the Swiss shares of the electricity demand and losses (shown in Tab. 4.1) are used for all countries covered in this study. The total share of electricity losses on the electricity delivered in a country is different for each country using the total amount of losses given in the statistics of the IEA (IEA 2010, 2011).

The electricity losses depend on the population density in the different countries and on the technology level of the infrastructure. Tab. 4.26 shows the country-specific electricity losses on the different voltage levels.

The losses in the networks ENTSO, UCTE, NORDEL, CENTREL and RER are weighted averages according to losses in the countries and the respective production volumes. The losses of the electricity mix of the Swiss Railways corresponds to the losses and SF₆ emissions in Switzerland and the losses of the electricity mix of the European Aluminium Association corresponds to the world average.

The electricity transmission and distribution have the lowest losses in Luxembourg (1.5 % total, 1.9 % cumulated on the low voltage level) and the highest losses in Bosnia and Herzegovina (22.8 % total, 38.7 % cumulated on the low voltage level). In Europe (ENTSO-E network) the transmission and distribution cause 6.7 % losses (9.2 % cumulated on the low voltage level). On a global level the transmission and distribution cause losses of about 8.2 % (11.5 % cumulated on the low voltage level).

For India, total electricity losses in transmission and distribution as reported by the Central Statistics Office (CSO 2011) amounted to 192'092 GWh in 2008/2009, which is equal to 27.0 % relative to the total amount of electricity available for supply which was 712'540 GWh. According to Kumar (2008) major electricity losses in India are due to technical losses, direct theft, incorrect metering, billing process deficiencies, collection inefficiency, and others. From an LCA point of view, only technical losses should be allocated evenly to all electricity consumers, whereas losses due to unpaid electricity

consumption shall still be allocated to the corresponding consumer and not to increase the environmental load of the average paid and consumed electricity.

Kumar (2008), analysed the electricity losses in the Northern and North-Western Parts of Delhi (North Delhi Power Ltd.) in the year 2002 which were as high as 53 %. 7.5 % of all losses were transmission losses and 15 % of the non-transmission losses were technical distribution losses. Hence, the total technical losses were 14.3 % of generated electricity. We estimate that this amount of technical losses was representative for India in 2002 and the higher total electricity loss in Northern Delhi raised from a higher unpaid consumption of electricity. In order to estimate the average technical electricity loss from transformation and distribution in 2008/2009, we correct the factor of technical losses with the reduction of total electricity losses in India between 2001/2002 and 2008/2009. During this time, the total electricity losses were reduced from 34.0 % to 23.1 % of total electricity available for supply. Therefore, we estimate that 62 % of electricity losses are due to technical reasons. The remaining 38 % of non-technical electricity loss (e.g. theft) is not considered in the inventory.

4. Life cycle inventories of electricity grid

Tab. 4.26 Electricity losses on the different voltage levels for all countries considered in this study

Country	Code	Total electricity supply	Total transmission losses	Share Losses	Share Losses HV ¹⁾	Share Losses MV	Share Losses LV	Cumulated Losses LV	SF ₆ Emissions ²⁾	Source: Losses / SF ₆ emissions
		GWh	GWh	%	%	%	%	%	%	
Australia	AU	239'900	16'800	7.0	2.81	0.98	5.6	9.7	not available	IEA 2010 / wie US
Austria	AT	64'400	3'400	5.3	2.10	0.73	4.2	7.2	1.0	IEA 2010 / UBA 1999
Belgium	BE	90'200	4'300	4.8	1.89	0.66	3.8	6.4	2.1	IEA 2010 / wie DE
Bosnia and Herzegovina	BA	10'100	2'300	22.8	9.75	3.48	22.1	38.7	2.1	IEA 2010 / wie DE
Brazil	BR	487'200	77'100	15.8	6.58	2.33	14.1	24.4	0.9	IEA 2010 / Ministry of S and T 2004
Bulgaria	BG	34'600	4'700	13.6	5.59	1.97	11.8	20.37	2.1	IEA 2010 / wie DE
Canada	CA	598'400	50'500	8.4	3.40	1.19	6.9	11.9	not available	IEA 2010 / wie US
Chile	CL	59'200	5'100	8.6	3.48	1.22	7.1	12.1	0.9	IEA 2010 / wie BR
China	CN	3'177'400	191'800	6.0	2.41	0.84	4.8	8.3	2.1	IEA 2010 / wie IN
Croatia	HR	18'200	1'700	9.3	3.78	1.33	7.7	13.3	2.1	IEA 2010 / wie DE
Czech Republic	CZ	65'100	4'700	7.2	2.90	1.01	5.8	10.0	2.1	IEA 2010 / wie DE
Denmark	DK	36'700	2'400	6.5	2.62	0.92	5.2	9.0	2.1	IEA 2010 / wie DE
Estonia	EE	8'600	1'100	12.8	5.25	1.85	11.0	19.0	2.1	IEA 2010 / wie DE
Finland	FI	87'100	3'300	3.8	1.50	0.52	3.0	5.0	2.1	IEA 2010 / wie DE
France	FR	495'100	32'900	6.6	2.66	0.93	5.3	9.1	0.86	IEA 2010 / UNFCCC report FR
Germany	DE	570'900	30'100	5.3	2.10	0.73	4.2	7.1	2.1	IEA 2010 / UNFCCC report DE
Greece	GR	63'800	5'100	8.0	3.22	1.13	6.5	11.2	2.1	IEA 2010 / wie DE
Hungary	HU	41'300	3'900	9.4	3.82	1.34	7.8	13.4	2.1	IEA 2010 / wie DE
India	IN	784'500	112'346	14.3	5.92	2.09	12.5	21.7	not available	IEA 2010 / Central Statistics Office and own calculations
Indonesia	ID	144'100	15'000	10.4	4.23	1.49	8.7	15.0	2.1	IEA 2010 / wie IN
Iran	IR	204'000	38'000	18.6	7.83	2.78	17.2	29.9	2.1	IEA 2010 / wie IN
Ireland	IE	28'300	2'200	7.8	3.13	1.10	6.3	10.8	2.1	IEA 2010 / wie DE
Iceland	IS	16'000	600	3.8	1.48	0.52	2.9	5.0	2.1	IEA 2010 / wie DE
Italy	IT	339'500	20'400	6.0	2.40	0.84	4.8	8.2	2.1	IEA 2010 / wie DE
Japan	JP	1'030'200	51'300	5.0	1.98	0.69	3.9	6.7	0.1	IEA 2010 / MoE 2004
Latvia	LV	7'600	800	10.5	4.28	1.50	8.8	15.2	2.1	IEA 2010 / wie DE
Lithuania	LT	11'000	1'000	9.1	3.68	1.29	7.5	12.9	2.1	IEA 2010 / wie DE
Luxembourg	LU	6'700	100	1.5	0.59	0.20	1.1	1.9	2.1	IEA 2010 / wie DE
Macedonia	MK	8'500	1'400	16.5	6.86	2.43	14.8	25.6	2.1	IEA 2010 / wie DE
Malaysia	MY	103'300	2'500	2.4	0.95	0.33	1.9	3.2	2.1	IEA 2010 / wie IN
Mexico	MX	250'500	43'000	17.2	7.17	2.54	15.5	27.0	not available	IEA 2010 / wie US
Netherlands	NL	119'200	4'700	3.9	1.56	0.54	3.1	5.3	2.1	IEA 2010 / wie DE
Norway	NO	125'600	10'200	8.1	3.27	1.15	6.6	11.4	2.1	IEA 2010 / wie DE
Peru	PE	31'900	2'700	8.5	3.41	1.20	6.9	11.9	0.9	IEA 2010 / wie BR
Poland	PL	140'400	12'700	9.0	3.66	1.28	7.5	12.8	2.1	IEA 2010 / wie DE
Portugal	PT	53'400	4'200	7.9	3.16	1.11	6.4	11.0	2.1	IEA 2010 / wie DE
Romania	RO	55'900	7'200	12.9	5.29	1.86	11.1	19.1	2.1	IEA 2010 / wie DE
Russia	RU	952'600	109'200	11.5	4.68	1.65	9.71	16.7	2.1	IEA 2010 / wie DE
Saudia Arabia	SA	198'800	17'500	8.8	3.56	1.25	7.24	12.4	2.1	IEA 2010 / wie IN
Serbia	CS	33'900	5'900	17.4	7.28	2.58	15.80	27.4	2.1	IEA 2010 / wie DE
Slovakia	SK	26'900	1'000	3.7	1.47	0.51	2.90	4.9	2.1	IEA 2010 / wie DE
Slovenia	SI	13'800	800	5.8	2.31	0.81	4.62	7.9	2.1	IEA 2010 / wie DE
South Africa	ZA	235'900	22'500	9.5	3.86	1.36	7.91	13.6	2.1	IEA 2010 / wie DE
South Korea	KR	425'500	16'100	3.8	1.50	0.52	2.95	5.0	0.1	IEA 2010 / wie JP
Spain	ES	286'900	15'000	5.2	2.08	0.73	4.14	7.1	2.1	IEA 2010 / wie DE
Sweden	SE	142'500	11'000	7.7	3.10	1.09	6.27	10.8	2.1	IEA 2010 / wie DE
Switzerland	CH	61'814	4'320	7.0	2.80	0.98	5.64	9.7	1.0	BFE 2010 / THG Stat 2009
Chinese Taipei	TW	222'900	8'600	3.9	1.53	0.53	3.01	5.1	2.1	IEA 2010 / wie IN
Tanzania	TZ	4'400	900	20.5	8.67	3.09	19.29	33.6	2.1	IEA 2010 / wie DE
Thailand	TH	144'400	9'000	6.2	2.49	0.87	4.99	8.5	2.1	IEA 2010 / wie IN
Tunisia	TN	14'600	1'900	13.0	5.35	1.88	11.22	19.4	2.1	IEA 2010 / wie DE
Turkey	TR	189'400	27'500	14.5	6.00	2.12	12.74	22.0	2.1	IEA 2010 / wie DE
Ukraine	UA	170'500	22'400	13.1	5.40	1.90	11.34	19.6	2.1	IEA 2010 / wie DE
United Kingdom	UK	378'700	28'200	7.4	2.99	1.05	6.03	10.3	2.1	IEA 2010 / wie DE
United States	US	4'154'200	246'100	5.9	2.37	0.83	4.72	8.1	not available	IEA 2010 / Ministry of S and T 2004
ENTSO-E	ENTSO	3'368'214	225'920	6.7	2.69	0.94	5.39	9.2	not available	IEA 2010 / own calculation
UCTE	UCTE	2'600'614	170'820	6.6	2.63	0.92	5.27	9.0	not available	IEA 2010 / own calculation
NORDEL	NORDEL	391'900	26'900	6.9	2.75	0.96	5.53	9.5	not available	IEA 2010 / own calculation
CENTREL	CENTREL	273'700	22'300	8.1	3.28	1.15	6.65	11.4	not available	IEA 2010 / own calculation
RER	RER	3'399'514	228'120	6.7	2.69	0.94	5.39	9.2	not available	IEA 2010 / own calculation
World	GLO	17'266'514	1'319'466	7.6	3.07	1.08	6.21	10.6	calculated	calculated
World IEA	GLO	20'259'085	1'656'467	8.2	3.29	1.15	6.7	11.5		IEA 2010

1) For all countries 0.5 % electricity losses are added due to long-distance transport for electricity trading

4.3.4 LCI of electricity transmission and distribution

Besides the losses and the N₂O, ozone and SF₆ emissions, grid infrastructure is needed for the transmission and the distribution of the electricity. The demand of infrastructure is based on the Swiss electricity demand on the different voltage levels in the year 2009 and a life time of 40 years. In the year 2009 the total electricity demand on the low voltage level was 36'796 GWh. On the medium voltage 57'268 GWh are demanded including the electricity demand on the low voltage level and losses. 60'129 GWh are demanded on the high voltage level including the demand on the low and medium

voltage level and the respective losses. Combined with the total length of the Swiss electricity grid (Tab. 4.3), the average demand of the electricity transmission and distribution network can be calculated. The demand corresponds to 0.09 mm/kWh, 0.019 mm/kWh and 0.007 mm/kWh on the low, medium and high voltage level, respectively.

According to OECD/IEA (2006) 8.3 % of the total electricity production in Europe (about 3'500 TWh) are commonly exported to neighbouring countries. The average transport distances between production and consumption are not available. It is assumed that 10 % of the European electricity production is transmitted over a distance of about 500 km before the electricity is fed into the local distribution network.

The infrastructure used for the long distance transmission of electricity is modelled with the high voltage transmission line data sets. The demand of infrastructure for 50 km of long distance transport on the high voltage level is calculated with a capacity of 1 GW with a work load of 60 % and a life time of 40 years. This corresponds to an additional demand of 0.00024 mm/kWh. The losses caused by the additional long distance transmission of the electricity are 0.5 % on the high voltage level.

Tab. 4.27 Summary of the of data sets “electricity, low voltage, at grid”, “electricity, medium voltage, at grid” and “electricity, high voltage, at grid”; Regional and local electricity demand and distribution are based on the data for Switzerland in 2009²²

	Unit	Low voltage kWh	Medium voltage kWh	High voltage kWh
Output				
Electricity, low voltage, at grid	kWh	1		
Electricity, medium voltage, at grid	kWh		1	
Electricity, high voltage, at grid	kWh			1
Input				
Electricity, medium voltage, at grid ²⁾	kWh	1.060		
Electricity, high voltage, at grid	kWh		1.010	
Electricity mix ³⁾	kWh			1.033
Distribution network, low voltage	km	8.74E-08		
Transmission network, medium voltage	km		1.86E-08	
Transmission network, high voltage	km			6.82E-09
Emissions into air				
Waste heat ¹⁾	MJ	6.52E-02	2.12E-02	1.13E-01
Ozone	kg			4.50E-06
N ₂ O	kg			5.00E-06
SF ₆	kg	2.99E-09	5.40E-08	
Emissions into soil				
Waste heat ¹⁾	MJ	1.52E-01	1.41E-02	5.94E-03

¹⁾ low voltage: 25% of waste heat into air, 75% into soil; medium: voltage 55% of waste heat into air, 45% into soil; high voltage: 95% of the waste heat into air, 5% into soil; losses see Tab. 4.1

²⁾ losses in buildings included (0.4%), cf. Tab. 4.15.

³⁾ losses of long distance transmission included (0.5%)

In Tab. 4.28 the unit process raw data of the electricity distribution on high, medium and low voltage level are shown on the example of the electricity mix of Switzerland. For the other countries only the total amount of losses and the SF₆ emission are subject to change. Therefore, detailed inventories of electricity supply of all countries are not shown. They can be derived from Tab. 4.20 to Tab. 4.27.

²² Transport distances and electricity demand calculated based on the electricity use in Switzerland 2009.

5 Results

In this chapter the results of the LCIA of the different electricity mixes are shown. Three selected indicators are evaluated, namely cumulative energy demand (CED; total, fossil, nuclear and renewable), greenhouse gas emissions (IPCC global warming potential 2007 100 a, GWP) and total environmental impact (ecological scarcity method 2006). The results are shown on the level “electricity mix, at plant”, “electricity, high voltage, at grid”, “electricity, medium voltage, at grid” and “electricity, low voltage, at grid”.

The functional unit is 1 kWh of electricity at plant and on the high, medium and low voltage level, respectively.

5.1 Electricity at plant (at the busbar)

Tab. 5.1 shows the results on the level “electricity mix, at plant”. Greek electricity has the highest CED per kWh of electricity produced (14.85 MJ-oil-eq/kWh), followed by Indian electricity (13.61 MJ-oil-eq/kWh), Macedonian electricity (13.06 MJ-oil-eq/kWh), Polish electricity (12.75 MJ-oil-eq/kWh) and Hungarian electricity (12.53 MJ-oil-eq/kWh). The CED of electricity is high in countries with a high share of electricity production using lignite, hard coal or nuclear energy.

Icelandic electricity causes the lowest CED with 3.89 MJ-oil-eq/kWh followed by Norwegian electricity (4.00 MJ-oil-eq/kWh), Brazilian electricity (5.06 MJ-oil-eq/kWh), electricity used by the Swiss railways (6.39 MJ-oil-eq/kWh) and Tanzanian electricity (6.65 MJ-oil-eq/kWh). The CED of electricity is low in countries with a high share of electricity production using hydro power.

French electricity causes the highest nuclear CED (10.21 MJ-oil-eq/kWh) followed by Lithuanian electricity (7.03 MJ-oil-eq/kWh), Belgian electricity (7.03 MJ-oil-eq/kWh), Swiss electricity (6.88 MJ-oil-eq/kWh) and Slovakian electricity (6.31 MJ-oil-eq/kWh). The CED nuclear of electricity is high in countries with a high share of electricity production using nuclear power.

Icelandic electricity causes the highest renewable CED (3.81 MJ-oil-eq/kWh), followed by Norwegian electricity (3.76 MJ-oil-eq/kWh), Brazilian electricity (3.21 MJ-oil-eq/kWh), electricity produced in the NORDEL network (2.86 MJ-oil-eq/kWh) and the electricity consumed by the Swiss Railways (2.76 MJ-oil-eq/kWh).

The highest greenhouse gas emissions per kWh of electricity generated has China (1111 g CO₂-eq/kWh), followed by Estonia (1058 g CO₂-eq/kWh), Poland (1053 g CO₂-eq/kWh), Australia (1032 g CO₂-eq/kWh) and Macedonia (1029 g CO₂-eq/kWh). The greenhouse gas emissions of electricity are high in countries with a high share of electricity generation using lignite and hard coal as fuel.

The electricity consumed by the Swiss Railways cause lowest greenhouse gas emissions per kWh of electricity (5.6g CO₂-eq/kWh), followed by Icelandic electricity (15.4 g CO₂-eq/kWh), Norwegian electricity (24.0 g CO₂-eq/kWh), Swedish electricity (43.7 g CO₂-eq/kWh) and French electricity (90.3 g CO₂-eq/kWh). The greenhouse gas emissions are low for countries with a high share of hydro-electric or nuclear power.

The Indian electricity causes the highest environmental impact in eco-points per kWh (2471 eco-points/kWh) followed by Macedonian electricity (1253 eco-points/kWh), Chinese electricity (963 eco-points /kWh), Serbian electricity (953 eco-points kWh) and Chinese Taipei electricity (811 eco-points /kWh). The high environmental impacts of the Indian electricity mixed are caused by air emissions (mainly the heavy metals lead and cadmium emitted by the coal power plants). However, these are preliminary data which still are under review.

Electricity supplied in Iceland causes the lowest environmental impacts in eco-points per kWh (16 eco-points /kWh), followed by Norwegian electricity (22 eco-points /kWh), Brazilian electricity (110 eco-points /kWh), Tanzanian electricity (142 eco-points /kWh) and the electricity consumed by the Swiss Railways (175 eco-points /kWh).

Tab. 5.1 Selected LCA results of the electricity mixes 2008 described in this study, on the level „electricity mix, at plant“

Region / Company	Country	Country Code	CED total	CED fossil	CED nuclear	CED renewable	GWP g CO ₂ -eq	Ecological scarcity 2006 eco-points	
			MJ-oil-eq	MJ-oil-eq	MJ-oil-eq	MJ-oil-eq			
Africa	South Africa	ZA	12.06	10.98	0.80	0.28	973.4	631	
	Tanzania	TZ	6.65	4.31	0.03	2.31	291.0	142	
	Tunesia	TN	11.02	10.90	0.07	0.05	658.9	347	
Americas	Brazil	BR	5.06	1.51	0.34	3.21	151.9	110	
	Canada	CA	8.01	3.24	2.39	2.37	274.8	248	
	Chile	CL	8.81	6.59	0.08	2.14	515.4	389	
	Mexico	MX	10.60	9.22	0.62	0.75	610.1	559	
	Peru	PE	6.90	4.45	0.03	2.42	311.8	185	
	United States of America	US	12.39	8.72	3.19	0.48	731.7	595	
Asia and Australia	Australia	AU	12.11	11.66	0.09	0.36	1031.9	710	
	China	CN	10.64	9.50	0.32	0.82	1110.8	963	
	Chinese Taipei	TW	12.08	9.42	2.41	0.25	924.9	811	
	India ¹⁾	IN	13.61	12.54	0.38	0.69	1022.2	2471	
	Indonesia	ID	11.56	10.93	0.10	0.54	869.2	615	
	Iran	IR	10.94	10.75	0.07	0.12	662.5	370	
	Japan	JP	11.51	7.80	3.19	0.52	619.7	541	
	Malaysia	MY	10.79	10.37	0.09	0.33	713.3	383	
	Saudia Arabia	SA	11.69	11.57	0.10	0.03	776.2	570	
	South Korea	KR	12.12	7.63	4.40	0.09	660.7	624	
	Thailand	TH	11.10	10.43	0.08	0.59	702.9	386	
	Europe	Austria	AT	7.72	4.40	0.87	2.45	341.9	253
		Belgium	BE	11.74	4.27	7.03	0.44	310.9	536
Bosnia and Herzegovina		BA	10.01	8.50	0.13	1.39	783.8	730	
Bulgaria		BG	11.65	6.75	4.50	0.40	623.9	582	
Croatia		HR	10.59	7.19	2.10	1.30	542.8	503	
Czech Republic		CZ	11.23	7.06	3.86	0.31	770.4	581	
Denmark		DK	8.45	5.80	0.88	1.77	459.8	277	
Estonia		EE	11.72	11.15	0.37	0.20	1057.8	628	
Finland		FI	9.89	4.24	3.49	2.16	335.1	351	
France		FR	11.77	1.02	10.21	0.54	90.1	587	
Germany		DE	10.57	6.97	2.92	0.68	610.9	400	
Greece		GR	14.85	13.97	0.45	0.42	931.4	670	
Hungary		HU	12.53	7.03	4.91	0.59	509.1	493	
Iceland		IS	3.89	0.06	0.01	3.81	15.4	16	
Ireland		IE	10.43	9.82	0.09	0.52	695.6	390	
Italy		IT	9.67	7.81	0.93	0.93	558.7	365	
Latvia		LV	9.54	6.90	1.05	1.59	455.8	284	
Lithuania		LT	11.83	4.26	7.03	0.53	286.6	495	
Luxembourg		LU	12.05	8.34	3.14	0.57	632.3	438	
Macedonia		MK	13.06	12.22	0.11	0.73	1029.1	1253	
Netherlands		NL	10.27	8.63	1.06	0.58	633.8	355	
Norway		NO	4.00	0.14	0.10	3.76	24.0	22	
Poland		PL	12.75	11.95	0.37	0.44	1052.6	713	
Portugal		PT	9.19	7.24	0.56	1.40	519.2	397	
Romania		RO	9.94	6.44	2.38	1.12	567.3	437	
Russia		RU	11.62	8.69	2.20	0.73	606.0	428	
Serbia and Montenegro		CS	12.15	10.22	0.92	1.00	880.2	953	
Slovakia		SK	11.36	4.38	6.31	0.66	438.7	614	
Slovenia		SI	10.30	5.33	3.47	1.50	432.6	579	
Spain		ES	9.76	6.30	2.59	0.87	448.9	413	
Sweden		SE	7.92	0.42	4.92	2.57	43.7	253	
Switzerland		CH	9.76	1.46	6.88	1.42	113.1	343	
Turkey		TR	12.25	11.46	0.07	0.72	889.2	659	
Ukraine	UA	12.45	6.03	6.12	0.30	503.1	598		
United Kingdom	GB	10.61	8.24	2.11	0.26	604.9	447		
Networks	CENTREL Network	CENTREL	12.22	9.15	2.64	0.43	839.0	644	
	ENTSO Network	ENTSO	10.29	5.81	3.52	0.96	462.1	439	
	NORDEL Network	NORDEL	6.96	1.46	2.64	2.86	124.1	192	
	RER Network	RER	10.32	5.84	3.53	0.95	463.9	440	
	UCTE Network	UCTE	10.79	6.09	3.94	0.76	491.2	479	
Company	European Aluminium Association	EAA	7.37	3.19	1.92	2.26	251.3	242	
	Swiss Railways	SBB	6.39	0.05	3.58	2.76	5.6	175	
All	World	GLO	11.14	8.17	2.18	0.79	721.2	680	

1) The Indian electricity production of hard coal power plants is modelled with preliminary data

5.2 Electricity supplied to high, medium and low voltage customers

The life cycle inventories of electricity consumed by industry, agriculture, trade and private customers include electricity transmission and distribution and the losses. In this subchapter the results of the electricity mixes on the high, medium and low voltage level are discussed. The environmental impacts per kWh of electricity on the high, medium and low voltage level are shown in Tab. 5.2, Tab. 5.3 and Tab. 5.4.

In general, there is only a small influence of the electricity transmission and distribution on the cumulative results. The electricity of the ENSTO-E network with a share 9.2 % of cumulated losses from the busbar to the low voltage level shows an increase in impacts of 11.0 % (CED), 12.7 % (GWP) and 17.9 % (ecological scarcity). The electricity grid and the direct emissions during transmission and distribution (N₂O, Ozone and SF₆) only have a minor contribution to the overall result.

In case of environmentally friendlier electricity mixes like in Iceland or Norway the relative contribution of the electricity grid and the direct emissions during transmission and distribution are higher. Norway with a share of 11.4 % of cumulated losses from the busbar to the low voltage level shows an increase in impacts of 14.6% (CED), 60.4 % (GWP) and 164 % (ecological scarcity). In the case of Norway the losses during electricity distribution, the transmission infrastructure and the direct emissions cause higher environmental impacts than the electricity generation itself (not taking into account the trade with renewables certificates, see Section 2.2.5).

The losses of all countries and networks described in this study are shown in Tab. 4.26.

5.2.1 High voltage level

Tab. 5.2 Selected LCA results of the electricity mixes 2008 described in this study, on the level „electricity, high voltage, at grid “

Region / Company	Country	Country Code	CED total	CED fossil	CED nuclear	CED renewable	GWP	Ecological scarcity 2006
			MJ-oil-eq	MJ-oil-eq	MJ-oil-eq	MJ-oil-eq	g CO ₂ -eq	eco-points
Africa	South Africa	ZA	12.61	11.47	0.84	0.29	1018.5	661
	Tanzania	TZ	7.28	4.72	0.03	2.52	320.4	158
	Tunisia	TN	11.68	11.55	0.08	0.05	700.2	370
Americas	Brazil	BR	5.44	1.63	0.37	3.44	165.3	120
	Canada	CA	8.34	3.38	2.49	2.47	288.2	260
	Chile	CL	9.18	6.87	0.09	2.23	538.7	406
	Mexico	MX	11.43	9.95	0.67	0.81	659.6	604
	Peru	PE	7.19	4.63	0.04	2.52	326.7	195
	United States of America	US	12.75	8.98	3.28	0.50	754.8	614
Asia and Australia	Australia	AU	12.53	12.06	0.10	0.37	1068.7	736
	China	CN	10.97	9.79	0.33	0.84	1145.8	994
	Chinese Taipei	TW	12.35	9.63	2.46	0.25	946.3	830
	India ¹⁾	IN	14.50	13.36	0.40	0.74	1090.5	2632
	Indonesia	ID	12.13	11.46	0.10	0.56	913.0	647
	Iran	IR	11.87	11.66	0.08	0.13	720.4	404
	Japan	JP	11.82	8.00	3.27	0.54	637.7	557
	Malaysia	MY	10.97	10.54	0.09	0.34	726.4	391
	Saudia Arabia	SA	12.19	12.06	0.10	0.03	810.4	596
	South Korea	KR	12.38	7.80	4.49	0.09	676.6	639
	Thailand	TH	11.45	10.76	0.08	0.61	726.6	400
	Europe	Austria	AT	7.94	4.53	0.90	2.52	353.5
Belgium		BE	12.04	4.39	7.20	0.45	321.1	552
Bosnia and Herzegovina		BA	11.05	9.38	0.14	1.53	866.8	807
Bulgaria		BG	12.38	7.18	4.77	0.43	664.6	620
Croatia		HR	11.06	7.52	2.19	1.36	568.7	527
Czech Republic		CZ	11.63	7.31	3.99	0.33	799.3	603
Denmark		DK	8.73	6.00	0.91	1.83	476.9	288
Estonia		EE	12.41	11.80	0.39	0.21	1121.4	667
Finland		FI	10.11	4.34	3.56	2.20	344.5	360
France		FR	12.16	1.07	10.53	0.56	95.7	608
Germany		DE	10.86	7.16	3.00	0.70	629.5	413
Greece		GR	15.42	14.51	0.47	0.44	968.7	698
Hungary		HU	13.09	7.35	5.12	0.62	533.8	517
Iceland		IS	3.99	0.08	0.01	3.89	18.4	19
Ireland		IE	10.82	10.19	0.09	0.54	723.5	407
Italy		IT	9.96	8.05	0.96	0.96	577.6	378
Latvia		LV	10.01	7.25	1.10	1.66	480.3	300
Lithuania		LT	12.34	4.45	7.33	0.55	301.3	518
Luxembourg		LU	12.20	8.44	3.18	0.58	641.9	445
Macedonia		MK	14.04	13.13	0.12	0.79	1107.5	1348
Netherlands		NL	10.50	8.82	1.09	0.59	649.5	365
Norway		NO	4.17	0.15	0.11	3.90	27.6	26
Poland		PL	13.30	12.46	0.38	0.46	1099.1	745
Portugal		PT	9.55	7.52	0.58	1.45	540.9	414
Romania		RO	10.53	6.83	2.52	1.19	602.8	464
Russia		RU	12.24	9.16	2.32	0.77	640.1	453
Serbia and Montenegro		CS	13.11	11.03	1.00	1.08	951.4	1030
Slovakia		SK	11.60	4.48	6.44	0.67	450.1	629
Slovenia		SI	10.61	5.49	3.57	1.54	447.4	598
Spain		ES	10.03	6.48	2.66	0.89	463.2	426
Sweden	SE	8.22	0.45	5.10	2.67	48.0	264	
Switzerland	CH	10.10	1.52	7.11	1.47	119.6	357	
Turkey	TR	13.07	12.22	0.08	0.76	949.8	705	
Ukraine	UA	13.20	6.40	6.49	0.32	535.4	636	
United Kingdom	GB	11.00	8.54	2.19	0.27	628.7	465	
Networks	CENTREL Network	CENTREL	12.70	9.51	2.74	0.45	873.5	671
	ENTSO Network	ENTSO	10.64	6.01	3.63	1.00	479.6	455
	NORDEL Network	NORDEL	7.20	1.52	2.73	2.96	130.9	201
	RER Network	RER	10.66	6.04	3.65	0.98	481.4	457
	UCTE Network	UCTE	11.15	6.30	4.07	0.79	509.3	496
Companies	European Aluminium Association	EAA	7.68	3.33	2.00	2.35	264.0	254
	Swiss Railways	SBB	6.62	0.07	3.70	2.86	8.4	184
World	World	GLO	11.59	8.49	2.27	0.82	751.2	709

1) The Indian electricity production of hard coal power plants is modelled with preliminary data

5.2.2 Medium voltage level

Tab. 5.3 Selected LCA results of the electricity mixes 2008 described in this study, on the level „electricity, medium voltage, at grid“

Region / Company	Country	Country Code	CED total	CED fossil	CED nuclear	CED renewable	GWP	Ecological scarcity 2006	
			MJ-oil-eq	MJ-oil-eq	MJ-oil-eq	MJ-oil-eq	g CO ₂ -eq	eco-points	
Africa	South Africa	ZA	12.79	11.64	0.85	0.30	1036.0	675	
	Tanzania	TZ	7.52	4.88	0.04	2.60	334.0	168	
	Tunisia	TN	11.91	11.78	0.08	0.05	717.0	382	
Americas	Brazil	BR	5.58	1.68	0.38	3.52	170.4	127	
	Canada	CA	8.45	3.44	2.52	2.50	295.8	268	
	Chile	CL	9.31	6.96	0.09	2.26	546.5	416	
	Mexico	MX	11.74	10.21	0.69	0.84	680.7	625	
	Peru	PE	7.29	4.70	0.04	2.55	331.8	202	
	United States of America	US	12.87	9.06	3.30	0.50	765.2	626	
	Australia	AU	12.67	12.19	0.10	0.38	1083.3	749	
Asia and Australia	China	CN	11.08	9.89	0.34	0.85	1163.9	1009	
	Chinese Taipei	TW	12.43	9.69	2.48	0.26	959.7	841	
	India ¹⁾	IN	14.82	13.65	0.41	0.76	1122.0	2694	
	Indonesia	ID	12.32	11.64	0.11	0.58	935.2	664	
	Iran	IR	12.22	11.99	0.08	0.14	749.3	422	
	Japan	JP	11.91	8.07	3.30	0.55	643.5	565	
	Malaysia	MY	11.02	10.58	0.09	0.34	737.1	399	
	Saudia Arabia	SA	12.35	12.22	0.11	0.03	829.1	610	
	South Korea	KR	12.46	7.85	4.51	0.10	681.5	647	
	Thailand	TH	11.57	10.86	0.09	0.62	741.4	410	
	Europe	Austria	AT	8.01	4.57	0.91	2.54	358.3	269
		Belgium	BE	12.13	4.43	7.25	0.46	326.8	561
		Bosnia and Herzegovina	BA	11.45	9.72	0.15	1.59	900.8	841
		Bulgaria	BG	12.64	7.33	4.87	0.44	681.4	638
Croatia		HR	11.22	7.63	2.22	1.38	580.0	539	
Czech Republic		CZ	11.76	7.40	4.03	0.33	811.0	614	
Denmark		DK	8.83	6.06	0.92	1.85	484.9	296	
Estonia		EE	12.66	12.03	0.40	0.22	1145.8	684	
Finland		FI	10.17	4.37	3.58	2.22	349.9	367	
France		FR	12.29	1.09	10.63	0.57	98.7	618	
Germany		DE	10.95	7.22	3.03	0.70	637.7	422	
Greece		GR	15.61	14.68	0.48	0.45	983.3	711	
Hungary		HU	13.28	7.46	5.19	0.63	544.6	529	
Iceland		IS	4.02	0.09	0.02	3.91	22.1	24	
Ireland		IE	10.96	10.32	0.09	0.55	735.1	417	
Italy		IT	10.06	8.12	0.97	0.97	586.1	387	
Latvia		LV	10.18	7.36	1.12	1.69	491.1	310	
Lithuania		LT	12.51	4.52	7.43	0.56	308.8	530	
Luxembourg		LU	12.24	8.47	3.19	0.58	646.7	452	
Macedonia		MK	14.40	13.46	0.13	0.81	1138.1	1386	
Netherlands		NL	10.57	8.88	1.09	0.60	656.6	372	
Norway		NO	4.23	0.17	0.11	3.95	31.5	31	
Poland		PL	13.49	12.63	0.39	0.47	1116.8	760	
Portugal		PT	9.67	7.61	0.59	1.47	550.6	424	
Romania		RO	10.74	6.97	2.57	1.21	617.7	479	
Russia		RU	12.46	9.32	2.36	0.78	654.4	466	
Serbia and Montenegro		CS	13.46	11.32	1.03	1.11	979.6	1062	
Slovakia		SK	11.67	4.52	6.48	0.68	456.0	637	
Slovenia		SI	10.71	5.55	3.60	1.56	454.7	608	
Spain		ES	10.12	6.54	2.68	0.90	470.2	435	
Sweden		SE	8.32	0.47	5.16	2.70	52.2	273	
Switzerland		CH	10.21	1.54	7.18	1.49	122.9	365	
Turkey		TR	13.36	12.49	0.08	0.78	973.6	725	
Ukraine		UA	13.47	6.53	6.61	0.33	549.3	653	
United Kingdom		GB	11.13	8.64	2.22	0.28	639.0	475	
Networks		CENTREL Network	CENTREL	12.86	9.63	2.78	0.45	887.2	684
		ENTSO Network	ENTSO	10.75	6.08	3.67	1.01	487.7	465
		NORDEL Network	NORDEL	7.29	1.54	2.76	2.99	135.8	208
		RER Network	RER	10.78	6.10	3.68	0.99	489.6	467
		UCTE Network	UCTE	11.27	6.37	4.11	0.80	517.7	506
Companies		European Aluminium Association	EAA	7.79	3.38	2.03	2.38	270.9	263
		Swiss Railways	SBB	6.70	0.08	3.74	2.89	10.8	191
World		World	GLO	11.73	8.60	2.30	0.83	763.5	722

1) The Indian electricity production of hard coal power plants is modelled with preliminary data

5.2.3 Low voltage level

Tab. 5.4 Selected LCA results of the electricity mixes 2008 described in this study, on the level „electricity, low voltage, at grid“

Region / Company	Country	Country Code	CED total	CED fossil	CED nuclear	CED renewable	GWP g CO ₂ -eq	Ecological scarcity 2006 eco-points
			MJ-oil-eq	MJ-oil-eq	MJ-oil-eq	MJ-oil-eq		
Africa	South Africa	ZA	13.91	12.65	0.93	0.33	1126.8	757
	Tanzania	TZ	9.06	5.88	0.05	3.12	404.5	227
	Tunisia	TN	13.35	13.19	0.10	0.07	805.1	452
Americas	Brazil	BR	6.44	1.97	0.44	4.03	199.7	171
	Canada	CA	9.13	3.73	2.72	2.68	322.1	314
	Chile	CL	10.06	7.52	0.10	2.43	591.8	473
	Mexico	MX	13.66	11.88	0.81	0.98	793.9	750
	Peru	PE	7.88	5.09	0.05	2.74	360.7	242
	United States of America	US	13.57	9.56	3.48	0.53	808.4	690
Asia and Australia	Australia	AU	13.49	12.97	0.12	0.40	1153.6	819
	China	CN	11.71	10.44	0.36	0.90	1229.6	1087
	Chinese Taipei	TW	12.90	10.06	2.57	0.27	997.4	895
	India ¹⁾	IN	16.79	15.46	0.47	0.86	1272.2	3068
	Indonesia	ID	13.50	12.74	0.12	0.63	1025.4	750
	Iran	IR	14.42	14.14	0.11	0.17	885.9	522
	Japan	JP	12.49	8.46	3.45	0.57	675.9	615
	Malaysia	MY	11.32	10.86	0.11	0.36	758.7	434
	Saudia Arabia	SA	13.35	13.19	0.12	0.04	897.4	682
	South Korea	KR	12.93	8.15	4.67	0.11	708.9	694
	Thailand	TH	12.25	11.49	0.10	0.66	786.3	458
Europe	Austria	AT	8.44	4.82	0.96	2.66	379.4	307
	Belgium	BE	12.69	4.65	7.56	0.48	345.0	609
	Bosnia and Herzegovina	BA	14.09	11.95	0.19	1.95	1108.3	1056
	Bulgaria	BG	14.24	8.27	5.47	0.50	769.2	741
	Croatia	HR	12.19	8.29	2.41	1.50	631.8	608
	Czech Republic	CZ	12.55	7.90	4.29	0.36	866.3	678
	Denmark	DK	9.38	6.45	0.98	1.96	517.0	338
	Estonia	EE	14.15	13.44	0.46	0.25	1281.1	788
	Finland	FI	10.57	4.56	3.71	2.30	366.3	405
	France	FR	13.05	1.19	11.25	0.61	109.0	679
	Germany	DE	11.51	7.60	3.17	0.74	671.5	466
	Greece	GR	16.74	15.74	0.52	0.48	1056.0	786
	Hungary	HU	14.43	8.11	5.63	0.69	594.0	598
	Iceland	IS	4.21	0.14	0.03	4.05	27.5	50
	Ireland	IE	11.75	11.05	0.11	0.59	789.2	470
	Italy	IT	10.64	8.59	1.03	1.02	621.2	433
	Latvia	LV	11.17	8.09	1.23	1.85	541.1	364
	Lithuania	LT	13.56	4.92	8.02	0.61	337.9	598
	Luxembourg	LU	12.48	8.64	3.24	0.60	661.4	484
	Macedonia	MK	16.64	15.55	0.15	0.94	1315.7	1622
	Netherlands	NL	10.99	9.23	1.14	0.63	684.2	410
	Norway	NO	4.58	0.22	0.13	4.23	38.5	59
	Poland	PL	14.60	13.66	0.43	0.51	1209.3	845
	Portugal	PT	10.38	8.17	0.64	1.57	592.7	478
	Romania	RO	12.03	7.81	2.87	1.36	693.4	559
	Russia	RU	13.77	10.30	2.60	0.87	725.2	539
	Serbia and Montenegro	CS	15.70	13.20	1.20	1.30	1143.0	1260
	Slovakia	SK	12.11	4.71	6.70	0.71	475.7	684
	Slovenia	SI	11.30	5.87	3.79	1.64	482.2	664
	Spain	ES	10.63	6.88	2.81	0.95	496.3	480
	Sweden	SE	8.94	0.54	5.51	2.88	60.4	316
	Switzerland	CH	10.89	1.68	7.62	1.58	135.0	413
Turkey	TR	15.17	14.17	0.10	0.89	1106.2	846	
Ukraine	UA	15.11	7.34	7.40	0.37	618.5	755	
United Kingdom	GB	11.90	9.23	2.37	0.30	684.7	531	
Networks	CENTREL Network	CENTREL	13.82	10.35	2.98	0.49	954.4	758
	ENTSO Network	ENTSO	11.43	6.47	3.89	1.07	520.7	517
	NORDEL Network	NORDEL	7.77	1.68	2.93	3.17	148.5	246
	RER Network	RER	11.46	6.50	3.90	1.06	522.6	519
	UCTE Network	UCTE	11.96	6.77	4.35	0.85	551.7	560
Companies	European Aluminium Association	EAA	8.43	3.68	2.19	2.56	296.0	308
	Swiss Railways	SBB	7.16	0.12	3.97	3.07	16.1	228
World	World	GLO	12.62	9.25	2.47	0.90	822.2	799

1) The Indian electricity production of hard coal power plants is modelled with preliminary data

6 Conclusions

The level of detail of the used data is good. The life cycle inventories of the electricity generation technologies is shown in more detail in various reports (Burger & Bauer 2007; Flury & Frischknecht 2012; Jungbluth 2007; Jungbluth et al. 2012; Röder et al. 2007; Schori et al. 2012).

Electricity trade is described with the physical electricity imports and exports because more detailed information is not available (except for Switzerland). Trade with Renewable or Electric Energy Certificates (RECS, or EECS) is disregarded.

The inventory of the electricity grid is based on recent data of the Swiss electricity grid and applied to the electricity grid of all countries covered in this study. Electricity losses are country-specific and SF₆ emissions are taken into account.

The data used to quantify the electricity production volumes of the different countries refer to IEA statistics for the year 2008. Daily, seasonal or annual fluctuations of the production volumes of hydro power, wind power or photovoltaic power are not considered. The averaging of multiple years is not applied because the yearly change in the production technologies (increase in installed wind power and natural gas power plants) is expected to outweigh the fluctuation in hydro, wind or photovoltaic power production.

It is suggested to add life cycle inventories of electricity supplied by electric utilities due to the increasing deregulation of the electricity markets. Furthermore, marginal electricity mixes may be developed based on official electricity production forecasts. Such electricity mixes are suitable for decisional LCAs as described in Frischknecht & Stucki (2010) .

References 1996

- Ammann 1993 Persönliche Mitteilung Hr. Ammann, EWZ, 13. Jan. 1993
- Bohlin et al. 1991 S. Bohlin, K. Eriksson, G. Flisberg, "Electrical transmission", World Clean Energy Conf., Geneva, Nov. 1991
- Böhringer et al. 1988 A. Böhringer et al., "Ozonbildung an Hochspannungsfreileitungen", Elektrizitätswirtschaft 87(1988) Nr. 21, S. 1017-1022
- Brugg 1993 Kabelwerke Brugg, "Katalog Elektrische Kabel", Stand Jan. 1993
- BUS 1988 Bundesamt für Umweltschutz, "Schutz vor umweltschäden durch PCB-haltige Kondensatoren und Transformatoren", Schriftenreihe Umweltschutz Nr. 90, Bern 1988
- BUWAL 1991 Habersatter K., Widmer F., "Ökobilanz für Packstoffe; Stand 1990", Schriftenreihe Umwelt 132, Bern 1991.
- DOE 1983 U.S. Department of Energy, "Energy technology characterizations handbook: Environmental pollution and control factors", 3rd ed., DOE/EP-0093, Washington, März 1983
- Fritsche et al. 1989 Fritsche U., Rausch L., Simon K.-H., "Gesamt-Emissions-Modell Integrierter Systeme (GEMIS); Umweltwirkungsanalyse von Energiesystemen", Darmstadt/Kassel 1989
- Gaille et al. 1992 F. Gaille, J. van Gilst, "Evaluation du potentiel de récupération de chaleur par refroidissement des câbles électriques", Bulletin SEV/VSE 83(1992) Nr. 15, S. 25-30
- Glavitsch 1993 Prof. Glavitsch (ETHZ), Persönliche Mitteilung, 28.6.93
- Graf 1988 E. Graf, "Oekologische Aspekte des Holzschutzes", in "Aktuelle Entwicklungen des technischen Holzschutzes", Seminarunterlagen, IP Holz, Regensdorf, Dez. 1988
- Heinrich 1993 Persönliche Mitteilung Hr. Heinrich, CKW, 13. Jan. 1993
- Hill et al. 1984 R.D. Hill, R.G. Rinker, A. Coucouvinos, "Nitrous Oxide Production by Lightning", Journal of Geophysical Research 89(1984) D1: 1411-1421
- Kieser 1993 Persönliche Mitteilung Hr. Kieser, EKZ, 20. Jan. 1993
- Lienhard 1993 Persönliche Mitteilung B. Lienhard, EKZ, 18. Jan. 1993
- Radlgruber 1993 Persönliche Mitteilung Hr. Radlgruber, ABB Sécheron, 19. Jan. 1993
- Rüegg 1993 Persönliche Mitteilung S. Rüegg, BKW, 20. Jan. 1993
- Schwab 1991 F. Schwab, "Das Energiesparen der Elektrizitätswirtschaft am Beispiel der Transformatorenverluste", Bulletin SEV/VSE 82(1991) Nr. 22, S. 19-21
- Schwab 1993 Persönliche Mitteilung F. Schwab, ATEL, 12. Jan. 1993
- van Oeteren 1988 K.-A. van Oeteren, "Feuerverzinkung", expert-Verlag, Ehningen 1988
- VSE 1988 Verband Schweizerischer Elektrizitätswerke, "Netzdatenblatt", Zürich 1988
- VSE 1989 Verband Schweizerischer Elektrizitätswerke, "Richtlinien über den Schutz der Gewässer beim Bau und Betrieb von Anlagen mit Isolier- und Hydraulikoel...", Zürich, Dez. 1989
- VSE 1993 Verband Schweizerischer Elektrizitätswerke et al., "Entschädigungsansätze für Schächte und erdverlegte Leitungen in landwirtschaftlichem Kulturland", Ausgabe 1993, Zürich 1993
- VSE/PTT 1989 Verband Schweizerischer Elektrizitätswerke, Generaldirektion PTT, "Empfehlungen über die Handhabung, die Wiederverwertung und die Entsorgung der imprägnierten Leitungsmasten aus Holz", Zürich, Apr. 1989
- Zantop 1993 Persönliche Mitteilung Hr. Zantop, EWZ, 19. Jan. 1993

References Update 2000 and 2004

- AEE 2006 AEE (2006) Ökostrom in der Schweiz - der Marktanteil erneuerbarer Stromprodukte im Jahr 2005, Ergebnisse einer Umfrage bei Schweizer Energieversorgungsunternehmen. Agentur für erneuerbare Energien und Energieeffizienz, Zürich.
- AGEB 2005 AGEB (2005) Arbeitsgruppe Energiebilanzen: Auswertungstabellen zu Energiebilanzen. Retrieved 13.3.2007 retrieved from: <http://www.ag-energiebilanzen.de/>.
- AIB 2007 AIB (2007) Revised certificate activity figures for the period to January 2007. Association of Issuing Bodies, 2007, Brussels.
- ANEEL 2006 ANEEL (2006) Matriz de Energia Eléctrica. Retrieved 28.8. retrieved from: www.aneel.gov.br/aplicacoes/capacidadebrasil/capacidadebrasil.asp.
- ATEL 1999 ATEL (1999) 104. Geschäftsbericht 1998. Aare-Tessin AG für Elektrizität, Olten.
- Bauer 2007 Bauer C. (2007) Holzenergie. In: *Sachbilanzen von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz*, Vol. ecoinvent report No. 6-IX, v2.0 (Ed. Dones R.). Paul Scherrer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH retrieved from: www.ecoinvent.org.
- BFE 2001 BFE (2001) Schweizerische Elektrizitätsstatistik 2000. Bundesamt für Energie, Bern, CH, retrieved from: <http://www.energieschweiz.ch/bfe/de/statistik/elektrizitaet/>.
- BFE 2005a BFE (2005a) Schweizerische Elektrizitätsstatistik 2004. Bundesamt für Energie, Bern.
- BFE 2005b BFE (2005b) Schweizerische Elektrizitätsstatistik 2004. Bundesamt für Energie, Bern, CH, retrieved from: <http://www.energieschweiz.ch/bfe/de/statistik/elektrizitaet/>.
- BMU 2005 BMU (2005) Erneuerbare Energien und Umwelt in Zahlen - Stand: Januar 2007 Internet-update. Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Berlin.
- Bolliger & Bauer 2007 Bolliger R. and Bauer C. (2007) Wasserkraft. In: *Sachbilanzen von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz*, Vol. ecoinvent report No. 6-VIII, v2.0 (Ed. Dones R.). Paul Scherrer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH retrieved from: www.ecoinvent.org.
- Bosi 2000 Bosi M. (2000) An Initial View on Methodologies for Emission Baselines: Electricity Generation Case Study. International Energy Agency, Paris.
- Burger & Bauer 2007 Burger B. and Bauer C. (2007) Windkraft. In: *Sachbilanzen von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz*, Vol. ecoinvent report No. 6-XIII, v2.0 (Ed. Dones R.). Paul Scherrer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH retrieved from: www.ecoinvent.org.
- CENTREL 2005 CENTREL (2005) CENTREL Annual Report 2004, retrieved from: www.centrel.org.
- clsforum 2006 clsforum (2006) Electricity generation and consumption in Brazil, 1993-2003. Retrieved 5.09. retrieved from: <http://www.clsforum.org/brazil.htm>.

- Doka 2007 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, retrieved from: www.ecoinvent.org.
- Dones 2007 Dones R. (2007) Kernenergie. In: *Sachbilanzen von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz*, Vol. ecoinvent report No. 6-VII, v2.0 (Ed. Dones R.). Paul Scherrer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH retrieved from: www.ecoinvent.org.
- Dones et al. 2007 Dones R., Bauer C., Bolliger R., Burger B., Faist Emmenegger M., Frischknecht R., Heck T., Jungbluth N. and Röder A. (2007) Sachbilanzen von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz. ecoinvent report No. 6, v2.0. Paul Scherrer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, retrieved from: www.ecoinvent.org.
- DTI 2004 DTI (2004) Digest of United Kingdom Energy Statistics 2004. Department of Trade and Industry (DTI), London, retrieved from: <http://www.dti.gov.uk/energy/inform/dukes/dukes2004/index.shtml>.
- EAA 2005 EAA (2005) Environmental profile report - Primary aluminium industry update year 2002. European Aluminium Association, Brussels.
- e-control 2005 e-control (2005) Erzeugung elektrischer Energie in Österreich nach Energieträgern: Gesamte Elektrizitätsversorgung Kalenderjahr 2005. Energie-Control GmbH, Wien, retrieved from: http://www.e-control.at/portal/page/portal/ECONTROL_HOME/STROM/ZAHLENDATENFAKTEN/ENERGIESTATISTIK/BERICHTSJAHR2005/FILES/2005GESERZ_12.XLS.
- Elkraft System 2001 Elkraft System (2001) Miljøberetning 2001. Elkraft System, Ballerup.
- EPE & MME 2005 EPE and MME (2005) Brazilian energy balance 2005 - year 2004. Ministério e Minas e Energia (MME), Empresa de Pesquisa Energética (EPE), Brasília.
- EPE & MME 2006 EPE and MME (2006) Balanço energético nacional - Resultados Preliminares ano base 2005. Ministério e Minas e Energia (MME), Empresa de Pesquisa Energética (EPE), Rio de Janeiro.
- EPS 2005 EPS (2005) Electric Power Industry of Serbia in 2004. Electric Power Industry of Serbia (EPS), Belgrad, retrieved from: www.eps.co.yu.
- EURELECTRIC 2001 EURELECTRIC (2001) Statistics and prospects for the European electricity sector (1980-1999, 2000-2020) (Eurprog 2001). Union of the Electricity Industry - EURELECTRIC, Brussels, retrieved from: www.eurelectric.org.
- EURELECTRIC & UCTE 2002 EURELECTRIC and UCTE (2002) European Interconnection: State of the Art 2002 (SYSTINT Annual Report). Union of the Electricity Industry - Eurelectric, Union for the Co-ordination of Transmission of Electricity, Brussels, retrieved from: www.ucte.org.
- EURELECTRIC 2004 EURELECTRIC (2004) Latest Industry Statistics as at 31 December 2004. Union of the Electricity Industry - EURELECTRIC, Brussels, retrieved from: www.eurelectric.org.
- European Aluminium Association 2000 European Aluminium Association (2000) Environmental Profile Report for the European Aluminium Industry. EAA, Brussels.
- EWZ 2001 EWZ (2001) Geschäftsbericht 2000; EWZ präsentiert den Überblick. Elektrizitätswerk der Stadt Zürich, Zürich.

- Faist Emmenegger et al. 2007 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 für die Schweiz*, Vol. ecoinvent report No. 6-V, v2.0 (Ed. Dones R.). Paul Scherrer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH retrieved from: www.ecoinvent.org.
- FEPC 2006a FEPC (2006a) Electricity review Japan 2005->2006. Federation of Electric Power Companies of Japan, Tokyo, retrieved from: www.fepec.or.jp.
- FEPC 2006b FEPC (2006b) Energy and environment 2005-2006. The Federation of Electric Power Companies, Tokyo.
- Frischknecht et al. 1996 Frischknecht R., Bollens U., Bosshart S., Ciot M., Ciseri L., Doka G., Dones R., Gantner U., Hischier R. and Martin A. (1996) Ökoinventare von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz. 3. Gruppe Energie - Stoffe - Umwelt (ESU), Eidgenössische Technische Hochschule Zürich und Sektion Ganzheitliche Systemanalysen, Paul Scherrer Institut, Villigen, Bundesamt für Energie (Hrsg.), Bern, CH, retrieved from: www.energieforschung.ch.
- Frischknecht & Jungbluth 2000 Frischknecht R. and Jungbluth N. (2000) Graue Treibhausgas-Emissionen des Energie- und des Ernährungssektors der Schweiz: 1990 und 1998. Umwelt-Materialien No. 128. ESU-services, Uster, im Auftrag des Bundesamtes für Umwelt, Wald und Landschaft (BUWAL), Bern, CH, retrieved from: <http://www.umwelt-schweiz.ch>.
- Frischknecht 2002 Frischknecht R. (2002) An Introduction to Attributional and Consequential LCI Models – Properties and Differences. 17. Diskussionsforum Ökobilanzen, Zürich, retrieved from: <http://www.texma.org/LCA-Forum/Documentation/AbstractsDF17.htm>.
- Frischknecht et al. 2007a 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, retrieved from: www.ecoinvent.org.
- Frischknecht et al. 2007b 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, retrieved from: www.ecoinvent.org.
- Habersatter et al. 1996 Habersatter K., Fecker I., Dall'Acqua S., Fawer M., Fallscheer F., Förster R., Maillefer C., Ménard M., Reusser L. and Som C. (1996) Ökoinventare für Verpackungen. 250. Bundesamt für Umwelt, Wald und Landschaft, Bern, Schweiz.
- Hrvatska 2004 Hrvatska (2004) Hrvatska Elektroprivreda D.D. 2001 basic data, Zagreb, retrieved from: www.hep.hr.
- ICOLD 2003 ICOLD (2003) World Register of Dams. International Commission on Large Dams, Paris.
- JEPIC 2006 JEPIC (2006) Japan data: Operating and financial data. Retrieved 24.07. retrieved from: www.jepic.or.jp/english.
- Jungbluth & Tuchschnid 2007 Jungbluth N. and Tuchschnid M. (2007) Photovoltaics. In: *Sachbilanzen von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz*, Vol. ecoinvent report No. 6-XII, v2.0 (Ed. Dones R.). pp. 180. Paul Scherrer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH retrieved from: www.ecoinvent.org.

- Jungbluth 2007 Jungbluth N. (2007) Erdöl. In: *Sachbilanzen von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz*, Vol. ecoinvent report No. 6-IV, v2.0 (Ed. Dones R.). Paul Scherrer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH retrieved from: www.ecoinvent.org.
- Kaufmann et al. 1999 Kaufmann U., Moser M. and Beck M. (1999) Schweizerische Statistik der erneuerbaren Energien - Schlussbericht: Grundlagen, Methodik und Auswertungen 1990-1998. Bundesamt für Energie, Bern.
- Kaufmann & Gutzwiller 2005 Kaufmann U. and Gutzwiller S. (2005) Thermische Stromproduktion inklusive Wärmekraftkopplung (WKK) in der Schweiz 1990 bis 2004. Bundesamt für Energie, Bern.
- Kaufmann & Rigassi 2005 Kaufmann U. and Rigassi R. (2005) Schweizerische Statistik der erneuerbaren Energien 2004. Bundesamt für Energie, Bern.
- Klaus & Dinkel 1999 Klaus T. and Dinkel F. (1999) Stoffflussanalyse Schweiz: Fluorkohlenwasserstoffe und Schwefelhexafluorid. Carbotech, Basel.
- Knoepfel 1995 Knoepfel I. (1995) Indikatorensystem für die ökologische Bewertung des Transports von Energie. Dissertation. Institut für Energietechnik (IET), Eidgenössische Technische Hochschule Zürich, Zürich.
- Künniger & Richter 1995 Künniger T. and Richter K. (1995) Ökologischer Vergleich von Freileitungsmasten aus imprägniertem Holz, armiertem Beton und korrosionsgeschütztem Stahl. EMPA, Dübendorf.
- Liechti 2002 Liechti A. (2002) Swiss Greenhouse Gas Inventory 2000. Bundesamt für Umwelt, Wald und Landschaft, Bern, CH.
- Ménard et al. 1998 Ménard M., Dones R. and Gantner U. (1998) Strommix in Ökobilanzen: Auswirkungen der Strommodellwahl für Produkt- und Betriebs-Ökobilanzen. PSI-Bericht No. 98-17. Paul Scherrer Institut, Villigen, CH.
- Metz et al. 2001 Metz B., Davidson O., Swart R. and Pan J. (ed.) (2001) *Climate Change 2001: Mitigation. Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel of Climate Change*. Cambridge University Press, Cambridge.
- Ministry of Science and Technology 2004 Ministry of Science and Technology (2004) Brazil's initial national communication to the United Nations framework convention on climate change. Ministry of Science and Technology, Brasilia, retrieved from: http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php.
- Ministry of the Environment 2006 Ministry of the Environment (2006) National Greenhouse Gas Inventory: Report of Japan. Ministry of the Environment, Japan.
- Ni 2006 Ni C. C. (2006) China's Electric Power Demand and Supply in 2005 retrieved from: <http://eneken.ieej.or.jp/en/data/pdf/315.pdf>.
- NISV 1999 NISV (1999) Verordnung über den Schutz vor nichtionisierender Strahlung (NISV), (Stand am 1. Februar 2000). Schweizerischer Bundesrat, Bern.
- NORDEL 2005 NORDEL (2005) Nordel annual report 2004. NORDEL, Oslo, retrieved from: www.nordel.org.
- OECD 2005 OECD (2005) OECD economic survey of Brazil 2005: regulation of the electricity sector. Organisation for Economic Co-operation and Development, Paris.
- OECD/IEA 2006 OECD/IEA (2006) Electricity information 2005. International Energy Agency (IEA), Paris Cedex.
- Pan J. et al. 2006 Pan J., Peng W., Li M., Wu X., L. W., Zerriffi H., Victor D., Elias B. and C. Z. (2006) Rural Electrification in China 1950-2004. Historical processes and key

- driving forces - Working Paper #60. December 2006. Program on Energy and Sustainable Development at the Center for Environmental Science and Policy, Stanford University, Stanford, CA. retrieved from: http://pesd.stanford.edu/publications/rural_elec_china/.
- Röder et al. 2004 Röder A., Bauer C. and Dones R. (2004) Kohle. 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 retrieved from: www.ecoinvent.org.
- Röder et al. 2007 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 für die Schweiz*, Vol. ecoinvent report No. 6-VI, v2.0 (Ed. Dones R.). Paul Scherrer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH retrieved from: www.ecoinvent.org.
- SBB 2005 SBB (2005) Geschäftsbericht 2005 der Schweizerischen Bundesbahnen SBB. SBB AG, retrieved from: www.sbb.ch.
- StoV 1986 StoV (1986) Verordnung über umweltgefährdende Stoffe (Stoffverordnung, StoV) (Stand am 28. Dezember 2001). Schweizerischer Bundesrat, Bern.
- Sugimura & Aoyama 2004 Sugimura E. and Aoyama T. (2004) The Situation of Reduction in SF₆ Emission from Gas-Insulated Electrical Equipment in Japan. In *proceedings from: Conference on SF₆ and the Environment*, EPA, Scottsdale, Arizona.
- Tecova 1992 Tecova (1992) CO₂-Bilanzierung der Elektrizität unter Berücksichtigung des Aussenhandels. Bundesamt für Energiewirtschaft (Hrsg.), Bern.
- TERNA 2005 TERNA (2005) Statistical Data on electricity in Italy - Synthesis 2004. Gestore Rete Trasmissione Nazionale, retrieved from: <http://www.terna.it/eng/statistiche/datistatistici04.asp>.
- UBA 1999 UBA (1999) Schwefelhexafluorid. Retrieved 14.8.2002 retrieved from: <http://www.ubavie.gv.at/publikationen/uba-aktuell/archiv/1999/08/SF6.html>.
- UCTE 2001 UCTE (2001) Statistical Yearbook 2000. Union for the Co-ordination of the Transmission of Electricity, Berlin, retrieved from: www.ucte.org.
- UCTE 2005 UCTE (2005) Statistical Yearbook 2004. Union for the Co-ordination of the Transmission of Electricity, Berlin, retrieved from: www.ucte.org.
- UNSCEAR 2000 UNSCEAR (2000) Sources and Effects of Ionizing Radiation; United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) 2000 Report to the General Assembly. UNSCEAR, Vienna, retrieved from: www.unscear.org.
- VSE (Verband Schweizerischer Elektrizitätsunternehmen) 2002 VSE (Verband Schweizerischer Elektrizitätsunternehmen) (2002) Mitglieder des VSE. Retrieved 23.08.2002 retrieved from: <http://www.strom.ch/deutsch/vse-mitglieder/mitglieder.asp>.
- Wang 1999 Wang H. H. (1999) China's Oil Industry and Market. Elsevier, The Netherlands.
- Werner et al. 2003 Werner F., Althaus H.-J., Künniger T., Richter K. and Jungbluth N. (2003) Life Cycle Inventories of Wood as Fuel and Construction Material. Final report ecoinvent 2000 No. 9. EMPA Dübendorf, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, retrieved from: www.ecoinvent.org.
- Wild 2000 Wild J. (2000) Perspektiven der schweizerischen Elektrizitätswirtschaft. Kundentagung der Städtischen Werke Winterthur, Winterthur, 9. November 2000. Retrieved 24.07.2002 retrieved from: <http://www.cepe.ethz.ch/download/staff/joerg/winterthur.pdf>.

References Update 2012

- AIB 2011 AIB (2011) Market activity, including issue, transfer and redemption of renewable energy certificates (RECS) by country and by technology. Association of Issuing Bodies, Brussels, retrieved from: http://www.aib-net.org/portal/page/portal/AIB_HOME/AIB_OPE.
- BFE 2009 BFE (2009) Schweizerische Statistik der erneuerbaren Energien 2008. Bundesamt für Energie, Bern, CH.
- BFE 2010 BFE (2010) Schweizerische Elektrizitätsstatistik 2009. Bundesamt für Energie, Bern, CH, retrieved from: http://www.bfe.admin.ch/themen/00526/00541/00542/00630/index.html?lang=de&dossier_id=04840.
- BFE 2012 BFE (2012) Umfrage Stromkennzeichnung 2009. Bundesamt für Energie, Bern, CH.
- Bumby et al. 2010 Bumby S., Druzhinina E., Feraldi R., Werthmann D., Geyer R. and Sahl J. (2010) Life Cycle Assessment of Overhead and Underground Primary Power Distribution. In: Environ. Sci. Technol.(44), pp. 5587-5593, 10.1021/es9037879.
- Burger & Bauer 2007 Burger B. and Bauer C. (2007) Windkraft. In: Sachbilanzen von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz, Vol. ecoinvent report No. 6-XIII, v2.0 (Ed. Dones R.). Paul Scherrer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH retrieved from: www.ecoinvent.org.
- CEA 2008 CEA (2008) Hydro Performance Review 2007-2008. Central Electricity Authority, Ministry of Power, Government of India, New Delhi, India, retrieved from: http://www.cea.nic.in/god/opm/Thermal_Performance_Review/0708Final/0_Coverpage.pdf.
- Central Statistics Office 2011 Central Statistics Office (2011) Statistical Year Book India, 2011. Ministry of Statistics and Programme Implementation, Government of India, New Delhi, India, retrieved from: http://mospi.nic.in/Mospi_New/upload/statistical_year_book_2011.htm.
- clsforum 2006 clsforum (2006) Electricity generation and consumption in Brazil, 1993-2003. Retrieved 5.09. retrieved from: www.clsforum.org/brazil.htm.
- CSO 2011 CSO (2011) Statistical Year Book India, 2011. Central Statistics Office, Ministry of Statistics and Programme Implementation, Government India, New Delhi, India, retrieved from: http://mospi.nic.in/Mospi_New/upload/statistical_year_book_2011.htm.
- EAA 2008 EAA (2008) Environmental Profile Report for the European Aluminium Industry. European Aluminium Association, Brussels.
- ElCom 2011 ElCom (2011) Tätigkeitsbericht des ElCom 2010. Eidgenössische Elektrizitätskommission ElCom, Bern, CH, retrieved from: www.elcom.admin.ch.
- Elkraft System 2001 Elkraft System (2001) Miljøberetning 2001. Elkraft System, Ballerup.
- ENTSO-E 2009 ENTSO-E (2009) Statistical Yearbook 2009. European Network of Transmission System Operators for Electricity ENTSO-E, retrieved from: <https://www.entsoe.eu/resources/publications/general-reports/statistical-yearbooks/>.
- Eskom 2010 Eskom (2010) Integrated Report. Eskom Holdings Limited, Johannesburg, ZA, retrieved from: <http://www.eskom.co.za/c/84/annual-report/>.

- EWZ 2001 EWZ (2001) Geschäftsbericht 2000; ewz präsentiert den Überblick. Elektrizitätswerk der Stadt Zürich, Zürich.
- Flury & Frischknecht 2012 Flury K. and Frischknecht R. (2012) Life Cycle Inventories of Hydroelectric Power Production. ESU-services Ltd., Uster.
- Frischknecht et al. 1996 Frischknecht R., Bollens U., Bosshart S., Ciot M., Ciseri L., Doka G., Dones R., Gantner U., Hischier R. and Martin A. (1996) Ökoinventare von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz. 3. Gruppe Energie - Stoffe - Umwelt (ESU), Eidgenössische Technische Hochschule Zürich und Sektion Ganzheitliche Systemanalysen, Paul Scherrer Institut, Villigen, Bundesamt für Energie (Hrsg.), Bern, CH, retrieved from: www.energieforschung.ch.
- Frischknecht & Jungbluth 2000 Frischknecht R. and Jungbluth N. (2000) Graue Treibhausgas-Emissionen des Energie- und des Ernährungssektors der Schweiz: 1990 und 1998. Umwelt-Materialien No. 128. ESU-services, Uster, im Auftrag des Bundesamtes für Umwelt, Wald und Landschaft (BUWAL), Bern, CH, retrieved from: www.umwelt-schweiz.ch.
- Frischknecht & Faist Emmenegger 2003 Frischknecht R. and Faist Emmenegger M. (2003) Strommix und Stromnetz. 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 retrieved from: www.ecoinvent.org.
- Frischknecht et al. 2007a Frischknecht R., Tuchs Schmid M., Faist Emmenegger M., Bauer C. and Dones R. (2007a) Strommix und Stromnetz. In: Sachbilanzen von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz, Vol. ecoinvent report No. 6-XVI, v2.0 (Ed. Dones R.). Paul Scherrer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH retrieved from: www.ecoinvent.org.
- Frischknecht et al. 2007b Frischknecht R., Jungbluth N., Althaus H.-J., Doka G., Dones R., Heck T., Hellweg S., Hischier R., Nemecek T., Rebitzer G. and Spielmann M. (2007b) Overview and Methodology. ecoinvent report No. 1, v2.0. Swiss Centre for Life Cycle Inventories, Dübendorf, CH, retrieved from: www.ecoinvent.org.
- Frischknecht & Stucki 2010 Frischknecht R. and Stucki M. (2010) Scope-dependent modelling of electricity supply in life cycle assessments. In: *Int J LCA*, 15(8), pp. 806-816, retrieved from: DOI: 10.1007/s11367-010-0200-7.
- Habersatter et al. 1996 Habersatter K., Fecker I., Dall'Acqua S., Fawer M., Fallscheer F., Förster R., Maillefer C., Ménard M., Reusser L. and Som C. (1996) Ökoinventare für Verpackungen. 250. Bundesamt für Umwelt, Wald und Landschaft, Bern, Schweiz.
- IEA 2010 IEA (2010) Energy Statistics for different countries. Electricity/Heat Data. Retrieved June 2011 retrieved from: <http://www.iea.org/stats/prodresult.asp?PRODUCT=Electricity/Heat>.
- IEA 2011 IEA (2011) OECD - Electricity and heat generation. International Energy Agency (IEA) Electricity information statistics (database), retrieved from: <http://www.oecd-ilibrary.org/energy/>.
- International Organization for Standardization (ISO) 2006 International Organization for Standardization (ISO) (2006) Environmental management - Life cycle assessment - Requirements and guidelines. ISO 14044:2006; First edition 2006-07-01, Geneva.

- International Organization for Standardization (ISO) 2011 International Organization for Standardization (ISO) (2011) Life cycle assessment - Water Footprint - Requirements and guidelines. ISO14046.3:2011; Working Draft, Geneva.
- Jones & McManus 2010 Jones C. I. and McManus M. C. (2010) Life-cycle assessment of 11 kV electrical overhead lines and underground cables. In: *Journal of Cleaner Production*(18), pp. 1464-1477, 10.1016/j.jclepro.2010.05.008.
- Jorge et al. 2011a Jorge R. S., Hawkins T. R. and Hertwich E. G. (2011a) Life cycle assessment of electricity transmission and distribution part 1: power lines and cables. In: *International Journal of Life Cycle Assessment*, pp., 10.1007/s11367-011-0335-1.
- Jorge et al. 2011b Jorge R. S., Hawkins T. R. and Hertwich E. G. (2011b) Life cycle assessment of electricity transmission and distribution part 2: transformers and substation equipment. In: *International Journal of Life Cycle Assessment*, pp., 10.1007/s11367-011-0336-0.
- Jungbluth 2007 Jungbluth N. (2007) Erdöl. In: *Sachbilanzen von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz*, Vol. ecoinvent report No. 6-IV, v2.0 (Ed. Dones R.). Paul Scherrer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH retrieved from: www.ecoinvent.org.
- Jungbluth et al. 2009 Jungbluth N., Stucki M. and Frischknecht R. (2009) Photovoltaics. In: *Sachbilanzen von Energiesystemen: Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von Energiesystemen in Ökobilanzen für die Schweiz*, Vol. ecoinvent report No. 6-XII, v2.1 (Ed. Bauer C. and Dones R.). pp. 171. Swiss Centre for Life Cycle Inventories, Dübendorf, CH retrieved from: www.ecoinvent.org.
- Jungbluth et al. 2012 Jungbluth N., Stucki M., Flury K., Frischknecht R. and Buesser S. (2012) Life Cycle Inventories of Photovoltaics. ESU-services Ltd., Uster, CH, retrieved from: www.esu-services.ch.
- Kaufmann et al. 1999 Kaufmann U., Moser M. and Beck M. (1999) Schweizerische Statistik der erneuerbaren Energien - Schlussbericht: Grundlagen, Methodik und Auswertungen 1990-1998. Bundesamt für Energie, Bern.
- KEV 2009 KEV (2009) Geschäftsbericht Stiftung kostendeckende Einspeisevergütung (KEV). Stiftung kostendeckende Einspeisevergütung (KEV), Frick, CH, retrieved from: <http://www.stiftung-kev.ch/berichte/jahresberichte.html>.
- Klaus & Dinkel 1999 Klaus T. and Dinkel F. (1999) Stoffflussanalyse Schweiz: Fluorkohlenwasserstoffe und Schwefelhexafluorid. Carbotech, Basel.
- Knoepfel 1995 Knoepfel I. (1995) Indikatorensystem für die ökologische Bewertung des Transports von Energie. Dissertation. Institut für Energietechnik (IET), Eidgenössische Technische Hochschule Zürich, Zürich.
- Kumar 2008 Kumar A. (2008) A Comprehensive Study to Aggregated Technical & Commercial Losses, retrieved from: <http://www.scribd.com/doc/52389411/AT-C>.
- Künniger & Richter 1995 Künniger T. and Richter K. (1995) Ökologischer Vergleich von Freileitungsmasten aus imprägniertem Holz, armiertem Beton und korrosionsgeschütztem Stahl. EMPA, Dübendorf.
- Liechti 2002 Liechti A. (2002) Swiss Greenhouse Gas Inventory 2000. Bundesamt für Umwelt, Wald und Landschaft, Bern, CH.
- Ménard et al. 1998 Ménard M., Dones R. and Gantner U. (1998) Strommix in Ökobilanzen: Auswirkungen der Strommodellwahl für Produkt- und Betriebs-Ökobilanzen. PSI-Bericht No. 98-17. Paul Scherrer Institut, Villigen, CH.

- Metz et al. 2001 Metz B., Davidson O., Swart R. and Pan J. (ed.) (2001) *Climate Change 2001: Mitigation. Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel of Climate Change*. Cambridge University Press, Cambridge.
- Ministry of Science and Technology 2004 Ministry of Science and Technology (2004) *Brazil's initial national communication to the United Nations framework convention on climate change*. Ministry of Science and Technology, Brasilia, retrieved from: unfccc.int/national_reports/non-annex_i_natcom/items/2979.php.
- Ministry of the Environment 2006 Ministry of the Environment (2006) *National Greenhouse Gas Inventory: Report of Japan*. Ministry of the Environment, Japan.
- NISV 1999 NISV (1999) *Verordnung über den Schutz vor nichtionisierender Strahlung (NISV), (Stand am 1. Februar 2000)*. Schweizerischer Bundesrat, Bern.
- OECD/IEA 2006 OECD/IEA (2006) *Electricity information 2005*. International Energy Agency (IEA), Paris Cedex.
- PRIS 2011 PRIS (2011) *Power Reactor Information System - PRIS International Atomic Energy Agency (IAEA) Power Reactor Information System - PRIS (database)*, retrieved from: <http://www.iaea.org/cgi-bin/db.page.pl/pris.db57.htm>.
- Röder et al. 2007 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 für die Schweiz, Vol. ecoinvent report No. 6-VI, v2.0 (Ed. Dones R.)*. Paul Scherrer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH retrieved from: www.ecoinvent.org.
- Schori et al. 2012 Schori S., Bauer C. and Frischknecht R. (2012) *Life Cycle Inventory of Natural Gas Supply*. Paul Scherrer Institut Villigen, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, retrieved from: www.ecoinvent.org.
- Sugimura & Aoyama 2004 Sugimura E. and Aoyama T. (2004) *The Situation of Reduction in SF6 Emission from Gas-Insulated Electrical Equipment in Japan*. In *proceedings from: Conference on SF6 and the Environment*, EPA, Scottsdale, Arizona.
- Svensson et al. 2008 Svensson B., Plummer J. K. and Mittal R. (2008) *Review of Greenhouse Gas Emissions from Creation of Hydropower Reservoirs in India*. The World Bank, retrieved from: <http://moef.nic.in/downloads/public-information/LCGEmissionsHydroJune2008.pdf>.
- Tecova 1992 Tecova (1992) *CO2-Bilanzierung der Elektrizität unter Berücksichtigung des Aussenhandels*. Bundesamt für Energiewirtschaft (Hrsg.), Bern.
- UBA 1999 UBA (1999) *Schwefelhexafluorid*. Retrieved 14.8.2002 retrieved from: www.ubavie.gv.at/publikationen/uba-aktuell/archiv/1999/08/SF6.html.
- UCTE 2005 UCTE (2005) *Statistical Yearbook 2004*. Union for the Co-ordination of the Transmission of Electricity, Berlin, retrieved from: www.ucte.org.
- UNFCCC-DE n.d. UNFCCC-DE (n.d.) *Third Report by the Government of the Federal Republic of Germany in accordance with the Framework Convention of the United Nations*, Berlin, retrieved from: unfccc.int/resource/natcom/nctable.html.
- UNFCCC-FR 2001 UNFCCC-FR (2001) *France Troisième communication nationale à la Convention cadre des Nations unies sur les changements climatiques. Mission Interministérielle de l'Effet de Serre*, Paris, retrieved from: unfccc.int/resource/natcom/nctable.html.
- VSE (Verband Schweizerischer Elektrizitätsunternehmen) 2002 VSE (Verband Schweizerischer Elektrizitätsunternehmen) (2002) *Mitglieder des VSE*. Retrieved 23.08.2002 retrieved from: www.strom.ch/deutsch/vse-mitglieder/mitglieder.asp.

- VUE 2011 VUE (2011) Der Marktanteil von Stromprodukten aus erneuerbaren Energien im Jahr 2009. Verein für umweltgerecht Energie (VUE), Zürich, CH.
- Werner et al. 2003 Werner F., Althaus H.-J., Künniger T., Richter K. and Jungbluth N. (2003) Life Cycle Inventories of Wood as Fuel and Construction Material. Final report ecoinvent 2000 No. 9. EMPA Dübendorf, Swiss Centre for Life Cycle Inventories, Dübendorf, CH, retrieved from: www.ecoinvent.org.
- Wild 2000 Wild J. (2000) Perspektiven der schweizerischen Elektrizitätswirtschaft. Kundentagung der Städtischen Werke Winterthur, Winterthur, 9. November 2000. Retrieved 24.07.2002 from: www.cepe.ethz.ch/download/staff/joerg/winterthur.pdf.