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# Life Cycle Inventories of Electricity Mixes and Grid

## Version 1.3

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on behalf of the
**Paul Scherrer Institut (PSI)**

Uster, June 2014

# Imprint

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|---|---|
| Title | Life Cycle Inventories of Electricity Mixes and Grid |
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| Commissioner | Paul Scherrer Institut (PSI) |
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| Liability Statement |  |
| Version | itten-2012-electricity-mix-v1.3.docx, 25/06/2014 15:08:00 |

# Acknowledgement Update 2012

This study would not have been possible without the valuable information provided by:

Gerhard Emch (EWZ), Stefan Burri (ElCom) and Philippa Notten (The Green House ZA).

Furthermore, we would like to thank Karin Treyer (PSI) for her assistance in the preparation and completion of this study.

# Acknowledgement Update 2004

Ganz herzlich sei für die wertvollen Informationen zur Aktualisierung des Strommixes den nachfolgenden Personen gedankt:

Sandra Bornwasser (SBB, Infrastruktur Energie, Energiewirtschaft), Kiyotaka Tahara (National Institute of Advanced Industrial Science and Technology, Japan), Nadine Guthapfel (VUE naturemade) und Louis von Moos (Issuing Body IB RECS Schweiz) für den Anteil an zertifiziertem Strom in der Schweiz.

# Acknowledgement Update 2000

Für die wertvollen Informationen im Zuge der Aktualisierung 2000 sei an dieser Stelle den nachfolgenden Personen herzlich gedankt:

F. Martinez Casares, REE Spanien, N. Corovic, EPCG Montenegro, Hr. Fessler, EWZ (für die Informationen zu $SF_6$ in Schaltanlagen), A. Heikkinen, Fortum Finnland, R. Mattatia, RTE France, D. Novakovic, Elektro Slovenjia d.o.o. Slowenien, C. Setterval, Swedpower Schweden, R. Sigg, Bundesamt für Wasser und Geologie Schweiz, B. Stehle, VDEW Deutschland.

# Acknowledgement 1996

Für das Überlassen von Zahlenmaterial und/oder für die gegebenen Auskünfte zu den Strommixen europäischer Länder gilt den nachfolgenden Personen unser Dank:

H. Bur (Bundesamt für Energiewirtschaft BEW, Bern), Dipl.-Ing. J. Precht (Bundeslastverteiler, Bundesministerium für wirtschaftliche Angelegenheiten, Wien), F. Bruppacher (Elektrizitätsgesellschaft Laufenburg EGL, Laufenburg), A. Lupi (ENEL, Rom), H. Baumberger (Nordostschweizerische Kraftwerke AG, Baden), A. Forstbauer und H.Widrig (Union internationale des Producteurs et Distributeurs d'Energie Electrique UNIPEDE, Paris), O. Wunsch (Vereinigung Deutscher Elektrizitätswerke VDEW, Frankfurt a.M.), J. Mutzner (Verband Schweizerischer Elektrizitätswerke VSE, Zürich)

# Summary

*Itten R., Frischknecht R. and Stucki M. (2012) Life Cycle Inventories of Electricity Mixes and Grid. treeze Ltd., Uster, Switzerland, retrieved from: www.lc-inventories.ch*

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 $CO_2$-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 $CO_2$-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 $gCO_2$-eq/kWh and a total environmental impact of 680 eco-points/kWh according to the ecological scarcity method 2006.

$SF_6$ emissions of switchgear, $N_2O$ 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 $SF_6$ 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.

# Contents

# 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) | |
| NMVOC | 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 Transmission 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 statistic 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 $CO_2$ 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 ***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)<br>(Kaufmann et al. 1999:45) |
| M5 | Consumer mix | This study, applied on Swiss electricity mix only |

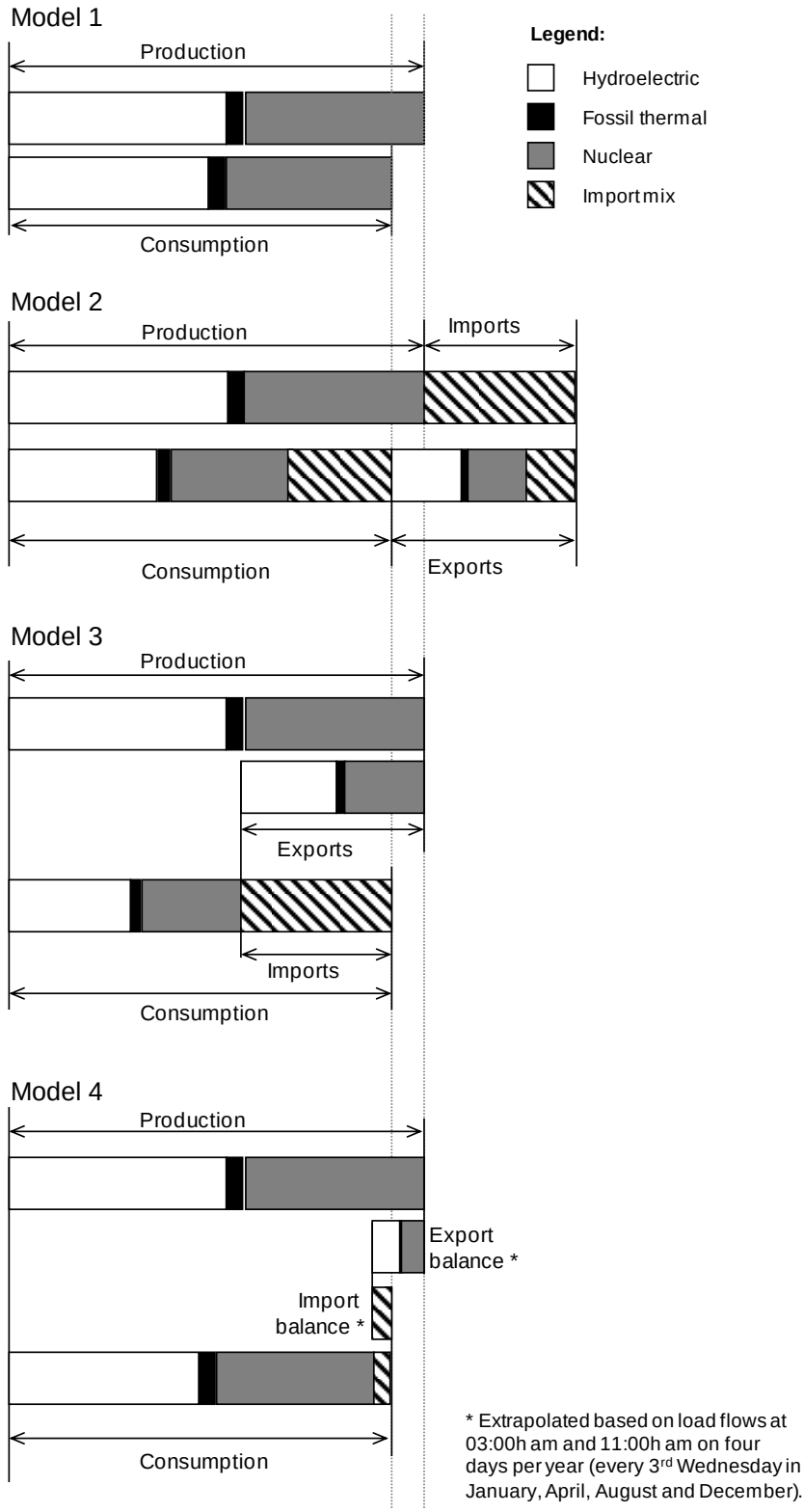


**Fig. 2.1: Model approaches for electricity mixes in LCA; graphs represent annual averages (Ménard *et al.* 1998, S. 10-11)**

A survey of the leading Swiss electricity suppliers (Alpiq, BKW, EGL, EOS, EWZ and Axpo) 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 report[4]. 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 other[5]. 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 issueing | 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 Zimbabwe[6]. 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **143** | **126** | **0.06** | **0.05** |
| *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** | **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** |
| *Photovoltaic* | *22* | *21* | *0.01* | *0.01* |
| *Solar thermal* | *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 6400kWth, 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 | Infrastructur | Unit | electricity mix | Uncertainty | 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 6400kWth, 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 | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | TZ | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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 | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | TZ | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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 hydropower 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **1'657** | **1'578** | **10.82** | **10.82** |
| *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** | **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** |
| *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** | **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**

| | Name | Location | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | TN | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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**

| | Name | Location | Unit | electricity mix | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | TN | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **17'554** | **16'857** | **3.70** | **3.38** |
| *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** | **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** |
| *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** | **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 | Uncertainty | 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 |

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 hydro-

power 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

**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 |
|---|---|---|---|---|---|---|---|
| | **Location** | | | CA | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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 6400kWth, 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 | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | CA | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | 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 6400kWth, 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 |

## 3.3.2 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **16'090** | **15'479** | **26.63** | **26.12** |
| *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** | **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** |
| *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** | **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 | StandardDeviation95 % | 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 6400kWth, 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 | Uncertainty | StandardDeviation95% | 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 6400kWth, 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 |

### 3.3.3 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 hydropower 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

**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** | | | MX | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | electricity mix, domestic production | MX | kWh | 1.00E+0 | | | |
| technosphere | electricity, hard coal, at power plant | US | 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, 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 | 1.86E-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, 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 | 1.58E-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 | 3.44E-5 | 1 | 1.05 | (1,1,1,3,1,1); assumption for solar power production in Mexico, value: IEA statistics 2008 |
| | electricity, at cogen 6400kWth, wood, 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 | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | MX | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | electricity mix | MX | kWh | 1.00E+0 | | | |
| 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 6400kWth, 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 |

### 3.3.4 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **2'921** | **2'873** | **8.97** | **8.97** |
| *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** | **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** |
| *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** | **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 | UncertaintyType | StandardDeviation95 % | 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 6400kWth, 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 | StandardDeviation95% | 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 6400kWth, 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 |

## 3.3.5 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

**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 |
|---|---|---|---|---|---|---|---|
| | **Location** | | | US | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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 | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | US | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *1'821* | *1'621* | *0.70* | *0.70* |
| **Petroleum products** | **2'756** | **2'453** | **1.06** | **1.06** |
| *Fuel oil* | *626* | *557* | *0.24* | *0.24* |
| *Diesel* | *2'130* | *1'896* | *0.82* | *0.82* |
| *other petroleum products* | *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** |
| *Photovoltaic* | *156* | *147* | *0.06* | *0.06* |
| *Solar thermal* | *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

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

| | Name | Location | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | AU | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | 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 6400kWth, 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 | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | AU | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | 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 6400kWth, 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 hydropower 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **34'148** | **31'906** | **4.07** | **4.03** |
| *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** | **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** |
| *Photovoltaic* | *20* | *19* | *0.00* | *0.00* |
| *Solar thermal* | *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

**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 | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | IN | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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**

| | Name | Location | Unit | electricity mix | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | IN | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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 6400kWth, 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **42'981** | **41'434** | **28.71** | **28.71** |
| *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** | **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** |
| *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** | **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**

| | Name | Location | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | ID | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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**

| | Name | Location | Unit | electricity mix | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | ID | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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 hydropower 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **35'543** | **33'854** | **16.55** | **16.55** |
| *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** | **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** |
| *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** | **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**

| | Name | Location | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | IR | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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**

| | Name | Location | Unit | electricity mix | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | IR | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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** |
| *Coke gases* | *8'215* | *7'720* | *0.76* | *0.76* |
| *Blast furnace gases* | *23'946* | *22'503* | *2.20* | *2.20* |
| **Petroleum products** | **131'593** | **123'663** | **12.11** | **12.11** |
| *Fuel oil* | *108'997* | *102'429* | *10.03* | *10.03* |
| *Diesel* | *3'199* | *3'006* | *0.29* | *0.29* |
| *other petroleum products* | *19'397* | *18'228* | *1.78* | *1.78* |
| **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** |
| *Photovoltaic* | *2'251* | *2'116* | *0.21* | *0.21* |
| *Solar thermal* | *0* | *0* | *0.00* | *0.00* |
| **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

**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 |
|---|---|---|---|---|---|---|---|
| | **Location** | | | JP | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | 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 6400kWth, 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 | StandardDeviation95% | 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); 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 6400kWth, 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 |

## 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 Malysia (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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **1'845** | **1'810** | **1.89** | **1.89** |
| *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** | **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** |
| *Photovoltaic* | *1* | *1* | *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** | **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 | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | MY | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | MY | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **23'411** | **20'632** | **0.66** | **0.66** |
| *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** | **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** |
| *Photovoltaic* | *172* | *162* | *0.01* | *0.01* |
| *Solar thermal* | *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 | StandardDeviation95 % | 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 6400kWth, 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 | Uncertainty | StandardDeviation95% | 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 6400kWth, 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**

| | Name | Location | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | SA | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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**

| | Name | Location | Unit | electricity mix | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | SA | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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** |
| *Coke gases* | *1'616* | *1'537* | *0.36* | *0.36* |
| *Blast furnace gases* | *13'449* | *12'789* | *3.02* | *3.02* |
| **Petroleum products** | **15'351** | **14'598** | **3.45** | **3.45** |
| *Fuel oil* | *11'506* | *10'942* | *2.59* | *2.59* |
| *Diesel* | *446* | *424* | *0.10* | *0.10* |
| *other petroleum products* | *3'399* | *3'232* | *0.76* | *0.76* |
| **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** |
| *Photovoltaic* | *285* | *268* | *0.06* | *0.06* |
| *Solar thermal* | *0* | *0* | *0.00* | *0.00* |
| **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

**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 |
|---|---|---|---|---|---|---|---|
| | **Location** | | | KR | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | 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 6400kWth, 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 | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | KR | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | 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 6400kWth, 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **14'252** | **13'074** | **5.94** | **5.94** |
| *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** | **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** |
| *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** | **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

**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 | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | TW | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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 | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | TW | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **1'662** | **1'610** | **1.13** | **1.13** |
| *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** | **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** |
| *Photovoltaic* | *3* | *3* | *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** | **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 | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | TH | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | 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 6400kWth, 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 | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | TH | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | 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 6400kWth, 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** |
| *Coke gases* | *228* | *198* | *0.31* | *0.24* |
| *Blast furnace gases* | *1'146* | *993* | *1.57* | *1.19* |
| **Petroleum products** | **1'243** | **1'077** | **1.70** | **1.29** |
| *Fuel oil* | *544* | *471* | *0.74* | *0.57* |
| *Diesel* | *9* | *8* | *0.01* | *0.01* |
| *other petroleum products* | *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** |
| *Photovoltaic* | *28* | *26* | *0.04* | *0.03* |
| *Solar thermal* | *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

**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 | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | AT | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | 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 6400kWth, 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**

| | Name | Location | Unit | electricity mix | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | AT | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | electricity mix | AT | kWh | 1.00E+0 | | | |
| technosphere | 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 6400kWth, 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** |
| *Coke gases* | *72* | *65* | *0.08* | *0.07* |
| *Blast furnace gases* | *1'616* | *1'455* | *1.85* | *1.52* |
| **Petroleum products** | **406** | **366** | **0.47** | **0.38** |
| *Fuel oil* | *352* | *317* | *0.40* | *0.33* |
| *Diesel* | *54* | *49* | *0.06* | *0.05* |
| *other petroleum products* | *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** |
| *Photovoltaic* | *42* | *39* | *0.05* | *0.04* |
| *Solar thermal* | *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

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

| | Name | Location | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | BE | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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 | StandardDeviation95% | 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 6400kWth, 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 Herzegowina (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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **173** | **154** | **1.25** | **0.98** |
| *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** | **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** |
| *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** | **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 | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | BA | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | BA | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **277** | **238** | **0.59** | **0.55** |
| *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** | **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** |
| *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** | **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 productionmix in Bulgaria 2008, at busbar**

| | Name | Location | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | BG | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | BG | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **1'985** | **1'814** | **15.57** | **9.15** |
| *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** | **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** |
| *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** | **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** | | | HR | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | HR | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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

**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 |
|---|---|---|---|---|---|---|---|
| | **Location** | | | CZ | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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 | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | CZ | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | 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 6400kWth, 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **1'131** | **1'066** | **3.07** | **2.24** |
| *Fuel oil* | *916* | *863* | *2.49* | *1.82* |
| *Diesel* | *78* | *74* | *0.21* | *0.15* |
| *other petroleum products* | *137* | *129* | *0.37* | *0.27* |
| **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** |
| *Photovoltaic* | *3* | *3* | *0.01* | *0.01* |
| *Solar thermal* | *0* | *0* | *0.00* | *0.00* |
| **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** | | | DK | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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 | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | DK | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **37** | **32** | **0.35** | **0.30** |
| *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** | **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** |
| *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** | **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**

| | Name | Location | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | EE | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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 6400kWth, 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**

| | Name | Location | Unit | electricity mix | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | EE | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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 6400kWth, 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 hydropower 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** |
| *Coke gases* | *45* | *43* | *0.06* | *0.05* |
| *Blast furnace gases* | *553* | *523* | *0.71* | *0.58* |
| **Petroleum products** | **425** | **402** | **0.54** | **0.45** |
| *Fuel oil* | *402* | *380* | *0.51* | *0.42* |
| *Diesel* | *18* | *17* | *0.02* | *0.02* |
| *other petroleum products* | *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** |
| *Photovoltaic* | *4* | *4* | *0.01* | *0.00* |
| *Solar thermal* | *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

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

| | Name | Location | Unit | electricity, production mix FI | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | FI | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | 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 6400kWth, 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 | UncertaintyT | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | FI | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 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 6400kWth, 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** |
| *Coke gases* | *933* | *835* | *0.15* | *0.15* |
| *Blast furnace gases* | *2'920* | *2'613* | *0.48* | *0.47* |
| **Petroleum products** | **5'825** | **5'212** | **0.96** | **0.94** |
| *Fuel oil* | *4'108* | *3'676* | *0.68* | *0.67* |
| *Diesel* | *407* | *364* | *0.07* | *0.07* |
| *other petroleum products* | *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** |
| *Photovoltaic* | *41* | *39* | *0.01* | *0.01* |
| *Solar thermal* | *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

**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 |
|---|---|---|---|---|---|---|---|
| | **Location** | | | FR | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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 | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | FR | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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

**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 | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | DE | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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 | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | DE | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | 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 6400kWth, 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **9'990** | **8'789** | **15.47** | **13.65** |
| *Fuel oil* | *7'447* | *6'552* | *11.53* | *10.18* |
| *Diesel* | *1'807* | *1'590* | *2.80* | *2.47* |
| *other petroleum products* | *736* | *648* | *1.14* | *1.01* |
| **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** |
| *Photovoltaic* | *5* | *5* | *0.01* | *0.01* |
| *Solar thermal* | *0* | *0* | *0.00* | *0.00* |
| **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

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

| | Name | Location | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | Location | | | GR | | | |
| | InfrastructureProcess | | | 0 | | | |
| | Unit | | | 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 | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | Location | | | GR | | | |
| | InfrastructureProcess | | | 0 | | | |
| | Unit | | | 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 hydropower 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** |
| *Coke gases* | *30* | *26* | *0.07* | *0.06* |
| *Blast furnace gases* | *89* | *76* | *0.21* | *0.19* |
| **Petroleum products** | **355** | **304** | **0.85** | **0.74** |
| *Fuel oil* | *242* | *207* | *0.58* | *0.51* |
| *Diesel* | *18* | *15* | *0.04* | *0.04* |
| *other petroleum products* | *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** |
| *Photovoltaic* | *1* | *1* | *0.00* | *0.00* |
| *Solar thermal* | *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

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

| | Name | Location | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | HU | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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 | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | HU | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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 hydropower 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **2** | **2** | **0.01** | **0.01** |
| *Fuel oil* | *0* | *0* | *0.00* | *0.00* |
| *Diesel* | *2* | *2* | *0.01* | *0.01* |
| *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** | **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** |
| *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** | **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**

| | Name | Location | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | IE | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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**

| | Name | Location | Unit | electricity mix | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | IE | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **1'731** | **1'615** | **5.78** | **5.78** |
| *Fuel oil* | *1'649* | *1'538* | *5.51* | *5.51* |
| *Diesel* | *50* | *47* | *0.17* | *0.17* |
| *other petroleum products* | *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** |
| *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** | **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 | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | IE | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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 | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | IE | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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 | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | IT | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | 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 6400kWth, 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 | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | IT | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **2** | **2** | **0.04** | **0.02** |
| *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** | **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** |
| *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** | **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 | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | LV | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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 6400kWth, 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 | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | LV | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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 6400kWth, 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 datasets 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **566** | **448** | **3.53** | **2.44** |
| *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** | **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** |
| *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** | **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 productionmix in Lithuania 2008, at busbar**

| | Name | Location | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | LT | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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 6400kWth, 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**

| | Name | Location | Unit | electricity mix | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | LT | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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 6400kWth, 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **0** | **0** | **0.00** | **0.00** |
| *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** | **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** |
| *Photovoltaic* | *20* | *19* | *0.70* | *0.20* |
| *Solar thermal* | *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**

| | Name | Location | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | LU | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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**

| | Name | Location | Unit | electricity mix | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | LU | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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**

| | Name | Location | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | MK | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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: 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**

| | Name | Location | Unit | electricity mix | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | MK | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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

**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** | | | NL | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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 | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | NL | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | 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 6400kWth, 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *94* | *90* | *0.06* | *0.06* |
| **Petroleum products** | **16** | **15** | **0.01** | **0.01** |
| *Fuel oil* | *0* | *0* | *0.00* | *0.00* |
| *Diesel* | *16* | *15* | *0.01* | *0.01* |
| *other petroleum products* | *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** |
| *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** | **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

**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** | | | NO | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | 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 6400kWth, 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 | UncertaintyT | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | NO | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | 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 6400kWth, 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

**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 |
|---|---|---|---|---|---|---|---|
| | **Location** | | | PL | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | 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 6400kWth, 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 | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | PL | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | 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 6400kWth, 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **4'148** | **3'890** | **8.87** | **7.12** |
| *Fuel oil* | *3'938* | *3'693* | *8.42* | *6.76* |
| *Diesel* | *75* | *70* | *0.16* | *0.13* |
| *other petroleum products* | *135* | *127* | *0.29* | *0.23* |
| **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** |
| *Photovoltaic* | *38* | *36* | *0.08* | *0.07* |
| *Solar thermal* | *0* | *0* | *0.00* | *0.00* |
| **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

**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 |
|---|---|---|---|---|---|---|---|
| | **Location** | | | PT | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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 | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | PT | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **700** | **582** | **1.00** | **0.99** |
| *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** | **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** |
| *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** | **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

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

| | Name | Location | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | Location | | | RO | | | |
| | InfrastructureProcess | | | 0 | | | |
| | Unit | | | kWh | | | |
| 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 6400kWth, 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 | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | Location | | | RO | | | |
| | InfrastructureProcess | | | 0 | | | |
| | Unit | | | kWh | | | |
| 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 6400kWth, 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 datasets 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **16'104** | **13'193** | **1.47** | **1.46** |
| *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** | **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** |
| *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** | **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

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

| | Name | Location | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | RU | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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 | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | RU | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **172** | **152** | **0.45** | **0.35** |
| *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** | **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** |
| *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** | **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**

| | Name | Location | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | CS | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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**

| | Name | Location | Unit | electricity mix | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | CS | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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 hydropower 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

**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** | | | SK | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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 | StandardDeviation95% | 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 6400kWth, 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** |

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

| | Name | Location | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | SI | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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 | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | SI | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 6400kWth, 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** |
| *Coke gases* | *285* | *264* | *0.09* | *0.09* |
| *Blast furnace gases* | *974* | *904* | *0.31* | *0.30* |
| **Petroleum products** | **18'002** | **16'706** | **5.65** | **5.54** |
| *Fuel oil* | *10'474* | *9'720* | *3.29* | *3.22* |
| *Diesel* | *4'700* | *4'362* | *1.47* | *1.45* |
| *other petroleum products* | *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** |
| *Photovoltaic* | *2'562* | *2'408* | *0.81* | *0.80* |
| *Solar thermal* | *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

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

| | Name | Location | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | ES | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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 6400kWth, 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 | StandardDeviation95% | 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 6400kWth, 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

**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 6400kWth, 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 | UncertaintyT | StandardDeviation95% | 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 6400kWth, 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 information[7]. It shows the provenance of the electricity sold to

[7] Personal communication: Ruedi Zurbrügg, 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 eletricity/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 2009[7]**

| | 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%** |
| *Solar* | *0.060%* | *0.054%* | *0.006%* |
| *Wind* | *0.156%* | *0.032%* | *0.124%* |
| *Biomass* | *0.181%* | *0.164%* | *0.017%* |
| *Geothermal* | *0.000%* | *0.000%* | *0.000%* |
| **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%** |
| *Fuel oil* | *0.074%* | *0.053%* | *0.021%* |
| *Natural gas* | *1.500%* | *0.200%* | *1.300%* |
| *Hard Coal* | *0.084%* | *0.003%* | *0.081%* |
| **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% |
| *Laufwasserkraft* | *12'710.0* | *19.115%* | *11.935%* | *33.468%* | *9.637%* |
| *Speicherwasserkraft* | *19'701.0* | *29.628%* | *17.375%* | *55.365%* | *13.322%* |
| *Kleinwasserkraft* | *3'400.0* | *5.113%* | *3.193%* | *8.953%* | *2.578%* |
| *Pumpspeicherkraft* | *1'325.0* | *1.993%* | *0.000%* | *0.000%* | *0.000%* |
| Andere erneuerbare Energien | 914.0 | 1.375% | 0.678% | 1.833% | 0.555% |
| *Sonne* | *114.5* | *0.172%* | *0.085%* | *0.655%* | *0.024%* |
| *Wind* | *57.8* | *0.087%* | *0.043%* | *0.445%* | *0.000%* |
| *Holz* | *515.2* | *0.775%* | *0.382%* | *0.509%* | *0.369%* |
| *Biogas Landwirtschaft* | *125.0* | *0.188%* | *0.093%* | *0.123%* | *0.089%* |
| *Biogas Industrie* | *101.6* | *0.153%* | *0.075%* | *0.100%* | *0.073%* |
| *Geothermie* | *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% |
| *Druckwasserreaktor* | *13'780.0* | *20.724%* | *16.941%* | *0.000%* | *18.743%* |
| *Siedewasserreaktor* | *12'339.0* | *18.557%* | *15.169%* | *0.000%* | *16.783%* |
| Fossile Energieträger | 359.0 | 0.540% | 0.266% | 0.000% | 0.295% |
| *Erdöl* | *74.3* | *0.112%* | *0.055%* | *0.000%* | *0.061%* |
| *Erdgas* | *280.5* | *0.422%* | *0.208%* | *0.000%* | *0.230%* |
| *Kohle* | *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% |
| *Laufwasserkraft* | *0.0* | *0.000%* | *4.436%* | *0.000%* | *4.908%* |
| *Speicherwasserkraft* | *0.0* | *0.000%* | *0.845%* | *0.000%* | *0.935%* |
| *Kleinwasserkraft* | *0.0* | *0.000%* | *0.000%* | *0.000%* | *0.000%* |
| Andere erneuerbare Energien | 0.0 | 0.000% | 0.153% | 0.381% | 0.129% |
| *Sonne* | *0.0* | *0.000%* | *0.006%* | *0.000%* | *0.007%* |
| *Wind* | *0.0* | *0.000%* | *0.129%* | *0.381%* | *0.102%* |
| *Holz* | *0.0* | *0.000%* | *0.012%* | *0.000%* | *0.014%* |
| *Biogas Landwirtschaft* | *0.0* | *0.000%* | *0.003%* | *0.000%* | *0.003%* |
| *Biogas Industrie* | *0.0* | *0.000%* | *0.002%* | *0.000%* | *0.003%* |
| *Geothermie* | *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% |
| *Druckwasserreaktor* | *0.0* | *0.000%* | *11.249%* | *0.000%* | *12.446%* |
| *Siedewasserreaktor* | *0.0* | *0.000%* | *0.000%* | *0.000%* | *0.000%* |
| Fossile Energieträger | 0.0 | 0.000% | 1.458% | 0.000% | 1.613% |
| *Erdöl* | *0.0* | *0.000%* | *0.022%* | *0.000%* | *0.024%* |
| *Erdgas* | *0.0* | *0.000%* | *1.353%* | *0.000%* | *1.497%* |
| *Kohle* | *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.

**Tab. 3.168: Unit process raw data of the electricity production mix in Switzerland 2009, at busbar**

| | Name | Location | Unit | electricity, production mix CH | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | CH | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | electricity, production mix CH | CH | kWh | 1.00E+0 | | | |
| technosphere | electricity, hydropower, at run-of-river power plant | CH | kWh | 1.91E-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, at reservoir power plant | CH | kWh | 2.96E-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 | 5.11E-2 | 1 | 1.07 | (1,1,1,1,1,3,BU:1.05); assumption for small hydropower production in , own calculations |
| | electricity, hydropower, at pumped storage power plant | CH | kWh | 1.99E-2 | 1 | 1.07 | (1,1,1,1,1,3,BU:1.05); assumption for small hydropower production in Nr., own calculations |
| | electricity, production mix photovoltaic, at plant | CH | kWh | 1.72E-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 | 8.69E-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 6400kWth, wood, emission control, allocation exergy | CH | kWh | 7.75E-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 | 1.88E-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 | 1.53E-3 | 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 | 2.07E-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 | 1.86E-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 | 1.12E-3 | 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 | 4.22E-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 | 6.33E-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 | 2.96E-2 | 1 | 1.07 | (1,1,1,1,1,3,BU:1.05); assumption electricity generation from waste in Switzerland, own calculations |

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

| | Name | Location | Unit | electricity, consumer mix | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | CH | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | electricity, consumer mix | CH | kWh | 1.00E+0 | | | |
| technosphere | 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 6400kWth, 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 6400kWth, 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 |

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

| | Name | Location | Unit | electricity, certified eletricity | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | CH | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | electricity, certified eletricity | 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 6400kWth, 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**

| | Name | Location | Unit | electricity mix | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | CH | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | 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 6400kWth, 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 6400kWth, 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** |
| *Coke gases* | *497* | *469* | *0.25* | *0.25* |
| *Blast furnace gases* | *844* | *796* | *0.42* | *0.42* |
| **Petroleum products** | **7'519** | **7'095** | **3.76** | **3.74** |
| *Fuel oil* | *7'209* | *6'803* | *3.60* | *3.59* |
| *Diesel* | *266* | *251* | *0.13* | *0.13* |
| *other petroleum products* | *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** |
| *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** | **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

**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 | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | TR | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | electricity mix, domestic production | TR | kWh | 1.00E+0 | | | |
| 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 6400kWth, 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 | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | TR | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | electricity mix | TR | kWh | 1.00E+0 | | | |
| 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 6400kWth, 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** |
| *Coke gases* | *0* | *0* | *0.00* | *0.00* |
| *Blast furnace gases* | *0* | *0* | *0.00* | *0.00* |
| **Petroleum products** | **687** | **585** | **0.34** | **0.33** |
| *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** | **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** |
| *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** | **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 | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | UA | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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 | Uncertainty | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | UA | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| 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** |
| *Coke gases* | *328* | *302* | *0.08* | *0.08* |
| *Blast furnace gases* | *1'055* | *972* | *0.27* | *0.26* |
| **Petroleum products** | **6'101** | **5'621** | **1.56** | **1.51** |
| *Fuel oil* | *4'397* | *4'051* | *1.12* | *1.09* |
| *Diesel* | *250* | *230* | *0.06* | *0.06* |
| *other petroleum products* | *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** |
| *Photovoltaic* | *17* | *16* | *0.00* | *0.00* |
| *Solar thermal* | *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

**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 |
|---|---|---|---|---|---|---|---|
| | **Location** | | | GB | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | 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 |
| | electricity, industrial gas, at power plant | UCTE | kWh | 3.53E-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 | 1.49E-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 | 6.38E-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 | 4.51E-1 | 1 | 1.05 | (1,1,1,1,1,1); assumption for natural gas power production in United Kingdom, value: IEA statistics |
| | electricity, hydropower, at run-of-river power plant | RER | kWh | 1.42E-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 | 1.12E-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 | 1.37E-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 | 1.97E-2 | 1 | 1.05 | (1,1,1,2,1,1); assumption for geothermal power production in United Kingdom, value: IEA statistics |
| | electricity, production mix photovoltaic, at plant | GB | kWh | 4.43E-5 | 1 | 1.05 | (1,1,1,1,1,1); assumption for solar power production in United Kingdom, value: IEA statistics 2008 |
| | electricity, at cogen 6400kWth, wood, allocation exergy | CH | kWh | 7.06E-3 | 1 | 1.05 | (1,1,1,3,1,1); assumption for cogeneration power production in United Kingdom, value: IEA statistics |
| | electricity, at cogen with biogas engine, allocation exergy | CH | kWh | 1.36E-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 | 7.33E-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 |

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

| | Name | Location | Unit | electricity mix | Uncertainty | StandardDeviation95% | 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 6400kWth, 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 Railways[8]**

| | | 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**

| | Name | Location | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95 % | GeneralComment |
|---|---|---|---|---|---|---|---|
| | **Location** | | | SBB | | | |
| | **InfrastructureProcess** | | | 0 | | | |
| | **Unit** | | | kWh | | | |
| product | 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 6400kWth, 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** |
| Netherland | 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%** |
| Netherland | 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. 3.188: Unit process raw data of the electricity production mix of the ENTSO-E network in 2008, at busbar**

| | Name | Location | InfrastructurePr | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | ENTSO | | | |
| | InfrastructureProcess | | | | 0 | | | |
| | Unit | | | | kWh | | | |
| product | electricity mix, domestic production | ENTSO | 0 | kWh | 1 | | | |
| | electricity mix, domestic production | AT | 0 | kWh | 1.86E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | BE | 0 | kWh | 2.31E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | BA | 0 | kWh | 3.59E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | BG | 0 | kWh | 1.19E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | HR | 0 | kWh | 3.42E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | CZ | 0 | kWh | 2.23E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | DK | 0 | kWh | 1.02E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | EE | 0 | kWh | 2.67E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | FI | 0 | kWh | 2.17E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | FR | 0 | kWh | 1.59E-1 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | DE | 0 | kWh | 1.73E-1 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | GR | 0 | kWh | 1.67E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | HU | 0 | kWh | 1.05E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | IE | 0 | kWh | 8.20E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | IS | 0 | kWh | 4.75E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | IT | 0 | kWh | 8.65E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | LV | 0 | kWh | 1.50E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | LT | 0 | kWh | 3.73E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | LU | 0 | kWh | 7.92E-4 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | MK | 0 | kWh | 1.67E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | NL | 0 | kWh | 2.89E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | NO | 0 | kWh | 4.15E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | PL | 0 | kWh | 3.89E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | PT | 0 | kWh | 1.29E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | RO | 0 | kWh | 1.70E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | CS | 0 | kWh | 1.00E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | SK | 0 | kWh | 7.90E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | SI | 0 | kWh | 4.56E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | ES | 0 | kWh | 8.69E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | SE | 0 | kWh | 4.25E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | CH | 0 | kWh | 1.96E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | GB | 0 | kWh | 1.06E-1 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |

### 3.6.4 Outdated networks (UCTE, CENTREL, NORDEL, RER)

The UCTE, NORDEL, CENTREL and RER networks have been replaced by the ENTSO-E network. However, the UCTE, NORDEL and CENTREL are still modelled for the use as regional electricity mixes for continental Europe, Scandinavia and central Europe. The RER network more or less corresponds to the ENTSO-E network. The only difference is that the Baltic States and Iceland are included in the ENTSO-E mix.

Tab. 3.189 shows the production volume of the countries in the different networks and their shares of the total production. The production volumes are taken from the IEA statistics for the year 2008 (IEA 2011, IEA 2010).

The annual production in the UCTE network is 2’577’860 GWh with Germany, France, Spain and Italy as the main producers. The annual production in the NORDEL network is 394’639 GWh with Sweden and Norway as main producers and the annual production in the CENTREL network is 270’588 GWh with Poland and Czech Republic as main producers. The annual production in the RER network corresponds to the production in the ENTSO-E network excluding the Baltic States and Island (see section 3.6.3 for more detailed information).

**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**

| County | UCTE | Shares UCTE | NORDEL | Shares NORDEL | CENTREL | Shares CENTREL | RER | Shares RER |
|---|---|---|---|---|---|---|---|---|
| | GWh | - | GWh | - | GWh | - | GWh | - |
| 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%** |
| Netherland | **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.

**Tab. 3.190: Unit process raw data of the electricity production in the outdated networks (UCTE, NORDEL, CENTREL, RER) in 2008, at busbar**

| Name | Location | InfrastructurePr | Unit | electricity, production mix UCTE | electricity, production mix NORDEL | electricity, production mix CENTREL | electricity, production mix RER | UncertaintyType | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|---|---|---|
| Location | | | | UCTE | NORDEL | CENTREL | RER | | | |
| InfrastructureProcess | | | | 0 | 0 | 0 | 0 | | | |
| Unit | | | | kWh | kWh | kWh | kWh | | | |
| electricity, production mix UCTE | UCTE | 0 | kWh | 1 | 0 | 0 | 0 | | | |
| electricity, production mix NORDEL | NORDEL | 0 | kWh | 0 | 1 | 0 | 0 | | | |
| electricity, production mix CENTREL | CENTREL | 0 | kWh | 0 | 0 | 1 | 0 | | | |
| electricity, production mix RER | RER | 0 | kWh | 0 | 0 | 0 | 1 | | | |
| electricity, production mix AT | AT | 0 | kWh | 2.46E-2 | 0 | 0 | 1.89E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix BE | BE | 0 | kWh | 3.05E-2 | 0 | 0 | 2.34E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix BA | BA | 0 | kWh | 4.75E-3 | 0 | 0 | 3.64E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix BG | BG | 0 | kWh | 1.57E-2 | 0 | 0 | 1.20E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix HR | HR | 0 | kWh | 4.52E-3 | 0 | 0 | 3.47E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix CZ | CZ | 0 | kWh | 2.94E-2 | 0 | 2.80E-1 | 2.26E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix DK | DK | 0 | kWh | 0 | 8.79E-2 | 0 | 1.03E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix EE | EE | 0 | kWh | 0 | 0 | 0 | 0 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix FI | FI | 0 | kWh | 0 | 1.87E-1 | 0 | 2.20E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix FR | FR | 0 | kWh | 2.10E-1 | 0 | 0 | 1.61E-1 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix DE | DE | 0 | kWh | 2.28E-1 | 0 | 0 | 1.75E-1 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix GR | GR | 0 | kWh | 2.20E-2 | 0 | 0 | 1.69E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix HU | HU | 0 | kWh | 1.38E-2 | 0 | 1.32E-1 | 1.06E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix IE | IE | 0 | kWh | 0 | 0 | 0 | 8.31E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix IS | IS | 0 | kWh | 0 | 0 | 0 | 0 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix IT | IT | 0 | kWh | 1.14E-1 | 0 | 0 | 8.76E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix LV | LV | 0 | kWh | 0 | 0 | 0 | 0 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix LT | LT | 0 | kWh | 0 | 0 | 0 | 0 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix LU | LU | 0 | kWh | 1.05E-3 | 0 | 0 | 8.03E-4 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix MK | MK | 0 | kWh | 2.21E-3 | 0 | 0 | 1.69E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix NL | NL | 0 | kWh | 3.82E-2 | 0 | 0 | 2.93E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix NO | NO | 0 | kWh | 0 | 3.58E-1 | 0 | 4.20E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix PL | PL | 0 | kWh | 5.13E-2 | 0 | 4.89E-1 | 3.94E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix PT | PT | 0 | kWh | 1.70E-2 | 0 | 0 | 1.30E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix RO | RO | 0 | kWh | 2.25E-2 | 0 | 0 | 1.72E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix CS | CS | 0 | kWh | 1.32E-2 | 0 | 0 | 1.01E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix SK | SK | 0 | kWh | 1.04E-2 | 0 | 9.94E-2 | 8.00E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix SI | SI | 0 | kWh | 6.03E-3 | 0 | 0 | 4.62E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix ES | ES | 0 | kWh | 1.15E-1 | 0 | 0 | 8.80E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix SE | SE | 0 | kWh | 0 | 3.67E-1 | 0 | 4.31E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix CH | CH | 0 | kWh | 2.59E-2 | 0 | 0 | 1.98E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| electricity, production mix GB | GB | 0 | kWh | 0 | 0 | 0 | 1.07E-1 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |

## 3.6.5 World Production (GLO)

All the 55 country specific electricity mixes documented in this report are combined to a global electricity mix. The production shares of the countries are calculated according to the net electricity production and a global average for the electricity production is calculated. The United States (24.0 %), China (18.4 %), Japan (6.0 %), India (4.6 %), Canada (3.7 %), Germany (3.5 %) and France (3.2 %) make up for about two third of the global electricity production. Tab. 3.191 shows the net electricity production of all countries described in this report.

The production volumes taken from the IEA statistics (IEA 2011, IEA 2010) differs slightly from the production volumes documented in the global statistics of the IEA (IEA 2010). The total electricity production in this report for the year 2008 leads to a global net electricity production of 16’971’097 GWh, which is comparable to the total net electricity production documented in the annual statistics of the IEA for the year 2008, which corresponds to 20’260’838 GWh.

**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** |
| Netherland | 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.

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%** |
| Netherland | 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.

**Tab. 3.193: Unit process raw data of the global electricity production mix in 2008, at busbar**

| | Name | Location | InfrastructurePr | Unit | electricity mix, domestic production | UncertaintyType | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|---|
| | Location | | | | GLO | | | |
| | InfrastructureProcess | | | | 0 | | | |
| | Unit | | | | kWh | | | |
| | electricity mix, domestic production | GLO | 0 | kWh | 1 | | | |
| technosphere | electricity mix, domestic production | AU | 0 | kWh | 1.36E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | AT | 0 | kWh | 3.74E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | BE | 0 | kWh | 4.63E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | BA | 0 | kWh | 7.21E-4 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | BR | 0 | kWh | 2.69E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | BG | 0 | kWh | 2.38E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | CA | 0 | kWh | 3.70E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | CL | 0 | kWh | 3.42E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | CN | 0 | kWh | 1.84E-1 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | HR | 0 | kWh | 6.87E-4 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | CZ | 0 | kWh | 4.47E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | DK | 0 | kWh | 2.04E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | EE | 0 | kWh | 5.36E-4 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | FI | 0 | kWh | 4.35E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | FR | 0 | kWh | 3.19E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | DE | 0 | kWh | 3.46E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | GR | 0 | kWh | 3.35E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | HU | 0 | kWh | 2.10E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | IN | 0 | kWh | 4.61E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | ID | 0 | kWh | 8.50E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | IR | 0 | kWh | 1.21E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | IE | 0 | kWh | 1.65E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | IS | 0 | kWh | 9.54E-4 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | IT | 0 | kWh | 1.73E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | JP | 0 | kWh | 6.02E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | LV | 0 | kWh | 3.00E-4 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | LT | 0 | kWh | 7.49E-4 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | LU | 0 | kWh | 1.59E-4 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | MK | 0 | kWh | 3.35E-4 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | MY | 0 | kWh | 5.63E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | MX | 0 | kWh | 1.45E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | NL | 0 | kWh | 5.80E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | NO | 0 | kWh | 8.32E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | PE | 0 | kWh | 1.89E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | PL | 0 | kWh | 7.79E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | PT | 0 | kWh | 2.58E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | RO | 0 | kWh | 3.42E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | RU | 0 | kWh | 5.31E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | SA | 0 | kWh | 1.11E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | CS | 0 | kWh | 2.01E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | SK | 0 | kWh | 1.58E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | SI | 0 | kWh | 9.16E-4 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | ZA | 0 | kWh | 1.35E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | KR | 0 | kWh | 2.49E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | ES | 0 | kWh | 1.74E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | SE | 0 | kWh | 8.53E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | CH | 0 | kWh | 3.93E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | TW | 0 | kWh | 1.30E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | TZ | 0 | kWh | 2.56E-4 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | TH | 0 | kWh | 8.42E-3 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | TN | 0 | kWh | 8.59E-4 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | TR | 0 | kWh | 1.11E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | UA | 0 | kWh | 1.02E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | GB | 0 | kWh | 2.13E-2 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |
| | electricity mix, domestic production | US | 0 | kWh | 2.40E-1 | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); IEA statistics 2008; |

# 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 EWZ[9].

[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.

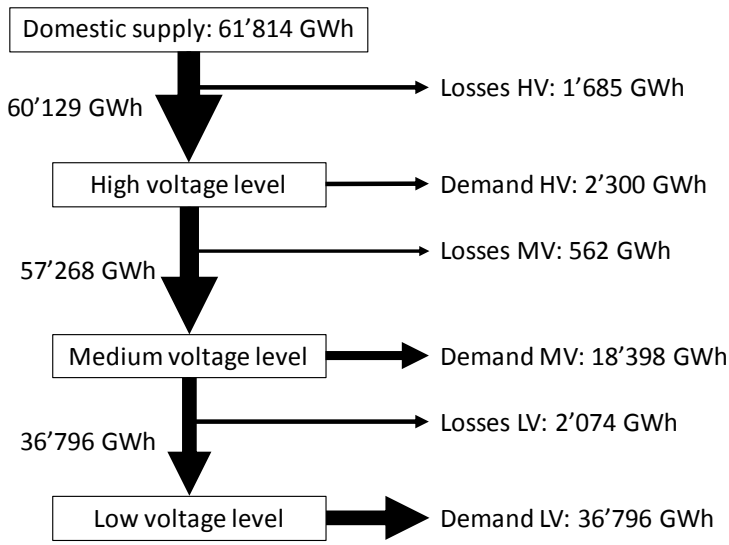


**Fig. 4.1 Model of the electricity distribution in Switzerland for the year 2009**

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 (ElCom 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 ElCom (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 m[10].

[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 EWZ[11] a share of 30 % of the medium and low voltage cables is built in a cable duct made of concrete. The EWZ[12] 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 $m^3$ of wood are needed for pressure-impregnated wood (Werner et al. 2003). According to Künniger et al. (1995) 17.8 kg/$m^3$ 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 at 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 at 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 |

$SF_6$ (sulphur hexafluoride) is used as quenching and insulation gas in gas-insulated switchgear. $SF_6$ has physically ideal properties for the use in high and medium voltage switchgear. Most of the $SF_6$ used in Switzerland is used in electrical equipment (Metz et al. 2001, S. 215).

According to Liechti (2002) the total amount of $SF_6$ used in switchgear in Switzerland is 235'700 kg. According to the Swiss greenhouse gas statistics of the year 2009 342'000 kg of $SF_6$ are used in Switzerland[13]. In this study the total value derived from the Swiss greenhouse gas statistics is used (see Tab. 4.13).

The $SF_6$ used in the high voltage switchgear account for 80-85 % of the total amount according to Klaus & Dinkel (1999) and 90 % according to the EWZ[14]. In this study we use a share of 90 % for the high voltage switchgear and 10 % for the medium voltage switchgear. The $SF_6$ 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 $SF_6$ 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 $SF_6$ during construction and disposal. The emission factors applied in this study are shown in Tab. 4.13.

**Tab. 4.13 Overall amount of $SF_6$ 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 | ElCom 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 $m^2$ per steel mast is assumed. 4 $m^2$ are occupied by the sockets of the mast and the unused area below the mast is 20 $m^2$. A land use 0.06 $m^2$ 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 a | % | $m^2$ | $m^2$ | $m^2$ |
| **Masts, steel** | | **24'370** | | | | | |
| Industrial area, built up | | | 4 | 90.00% | 0 | 9'748 | 87'733 |
| Industiral 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 $kg/m^3$ and 2200 $kg/m^3$, 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**

| | Name | Location | InfrastructurePr | Unit | distribution network, electricity, low voltage | transmission network, electricity, high voltage | transmission network, electricity, medium voltage | transmission network, long-distance | UncertaintyType | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Location | | | | CH | CH | CH | UCTE | | | |
| | InfrastructureProcess | | | | 1 | 1 | 1 | 1 | | | |
| | Unit | | | | km | km | km | km | | | |
| product | 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 |
| | bronze, 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 ecoinvent 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 ecoinvent report nr 1 |
| | excavation, hydraulic digger | RER | 0 | m3 | 4.87E+1 | 1.01E+2 | 3.75E+2 | 0 | 1 | 1.24 | (2,2,3,2,1,5,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 $m^3$/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.

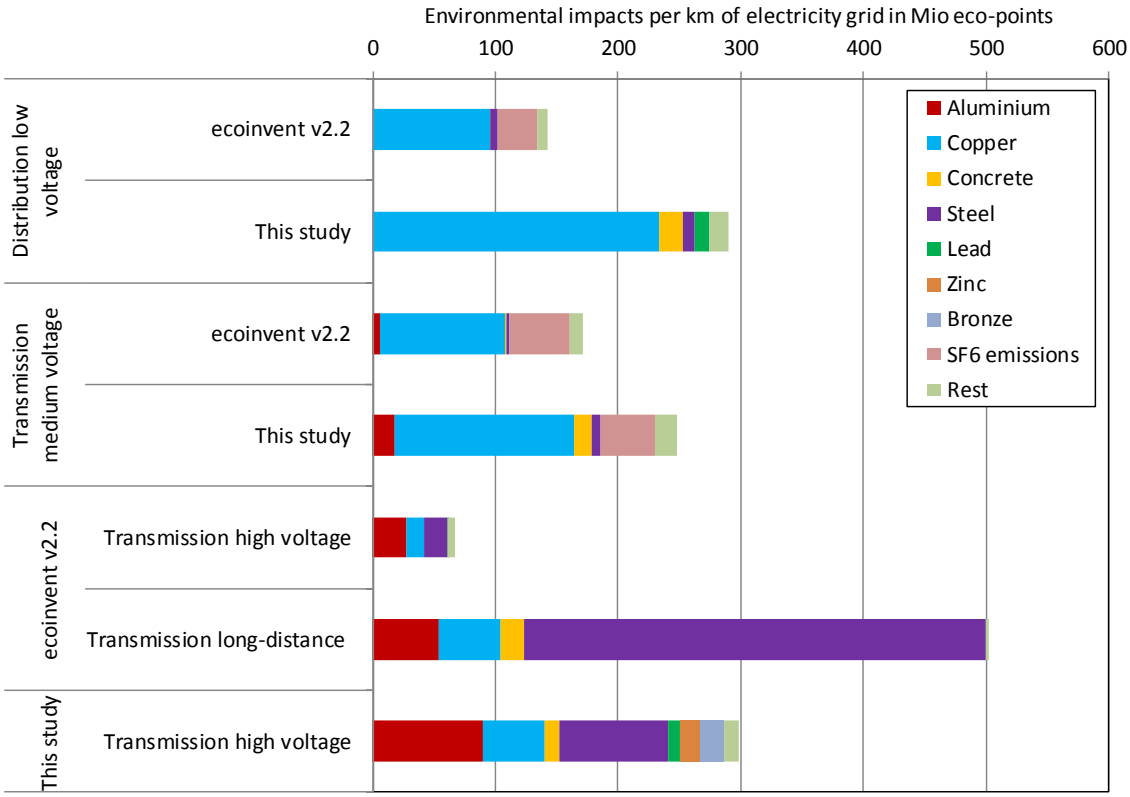


**Fig. 4.2: Comparison of the environmental impacts per km of the electricity grid on the different voltage levels described in this study and according to the ecoinvent data 2.2 using the ecological scarcity method 2006**

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 $CO_2$-eq compared to 12.6 tons $CO_2$-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 $CO_2$-eq compared to 18.4 tons $CO_2$-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 $CO_2$-eq compared to 43.1 tons $CO_2$-eq (high voltage transmission grid) and 336 tons $CO_2$-eq (long-distance transmission grid)

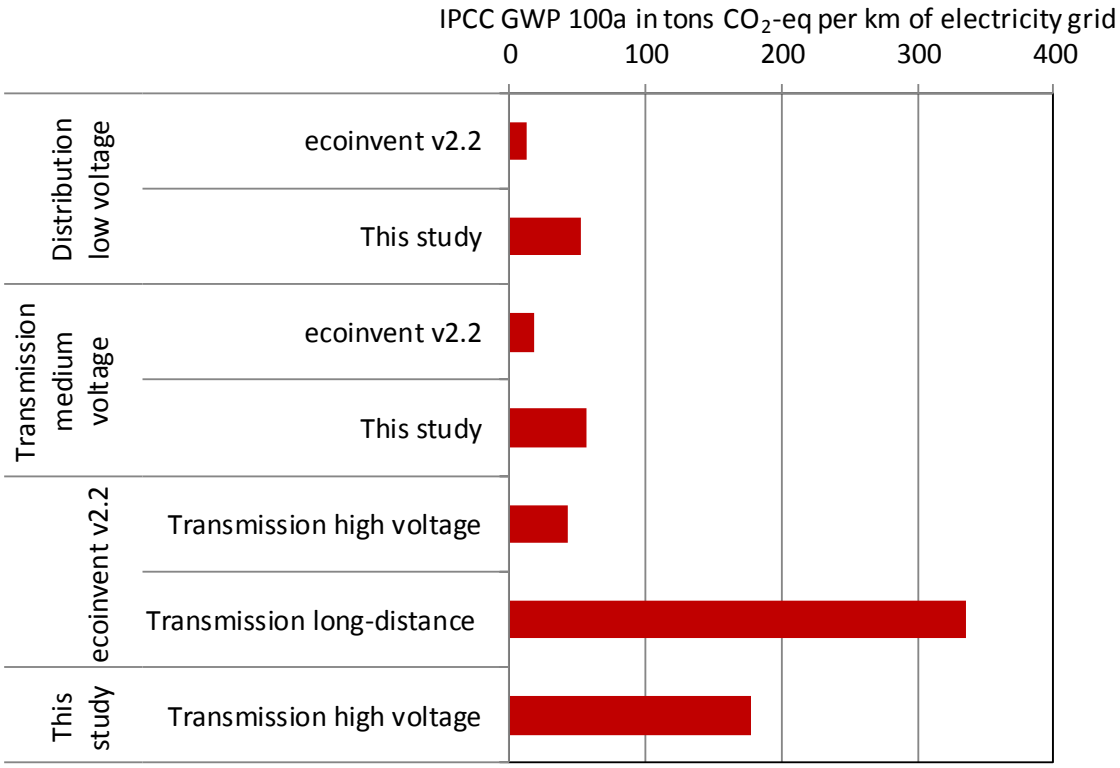


**Fig. 4.3: Comparison of the greenhouse gas emissions in tons of $CO_2$-eq (according to IPCC GWP 2007 100 a) per km of the electricity grid on the different voltage levels described in this study and in the datasets of ecoinvent data v2.2**

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

- $SF_6$ 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 $N_2O$-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.

#### $SF_6$-emissions

The $SF_6$-emissions are modelled for five different countries: Switzerland, Germany, Japan, Brazil, India and the USA. $SF_6$ is used as insulation gas for switchgear. Most of $SF_6$-emissions are caused by the high voltage level switchgear, which are allocated to the electricity demand on medium voltage. In Tab. 4.26 the $SF_6$-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 $SF_6$ filling capacity, emissions and emission factors for the high and medium voltage level of the Swiss electricity grid. The estimated emission rate of $SF_6$ 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 $SF_6$ 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 $SF_6$ used on the high voltage level corresponds to about 90 % of the overall amount[15] 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 level[15].

**Tab. 4.20 $SF_6$ filling capacity, emissions and emission factors of the operation of high and medium voltage switchgear according to the Swiss greenhouse gas statistics[16]**

| | 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 $SF_6$ 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 $SF_6$ 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 $SF_6$ filling capacity, emissions and emission factors for the high and medium voltage level of the Japanese electricity grid. The emission rates of $SF_6$ 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 $SF_6$ 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 $SF_6$ 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 $SF_6$ per year, this corresponds to 0.14 % of the filling capacity[17] (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 $SF_6$ 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 $SF_6$ filling capacity, emissions and emission factors of the operation of high and medium voltage switchgear 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 $SF_6$ 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, clsforum 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-grids[18], avoiding the need of high and highest voltage switchgear.

It is assumed that 95 % of the $SF_6$ 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 $SF_6$ filling capacity, emissions and emission factors of the operation of high and medium voltage switchgear 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 $SF_6$ filling capacity, emissions and emission factors on the high and medium voltage level of the US American electricity grid. The $SF_6$ 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 Report[19] reports a total emission of 540'000 kg of $SF_6$. 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 $SF_6$ filling capacity, emissions and emission factors of the operation of high and medium voltage switchgear 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 $SF_6$ Emission Reduction Partnership for Electric Power Systems reports an $SF_6$ emission rate of 9.4 % and a total emission of 188'000 kg of $SF_6$ in the year 2004. This partnership represents 42 % of the transmission and distribution sector[20]. 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 $SF_6$ filling capacity, emissions and emission factors on the high and medium voltage level of the Indian electricity grid. In 2005, 191.03 tons of $SF_6$ 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 $SF_6$ emissions from electrical equipment and the power supply, the total emissions of $SF_6$ 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 $SF_6$ filling capacity, emissions and emission factors of the operation of high and medium voltage switchgear 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 $SF_6$ emissions per handled electricity the value of the Swiss electricity grid is used to calculate the emission rates. This means that the German $SF_6$ 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 $SF_6$ 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.

**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 |
| Netherland | 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 $N_2O$, ozone and $SF_6$ 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 2009**[22]

| | Unit | Low voltage | Medium voltage | High voltage |
|---|---|---|---|---|
| | | kWh | kWh | 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 |
| $N_2O$ | 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 $SF_6$ 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.

**Tab. 4.28 Unit process raw data of "electricity, high/medium/low voltage, at grid, CH"**

| | Name | Location | InfrastructurePr | Unit | electricity, high voltage, at grid | electricity, medium voltage, at grid | electricity, low voltage, at grid | UncertaintyType | StandardDeviation95% | GeneralComment |
|---|---|---|---|---|---|---|---|---|---|---|
| | Location | | | | CH | CH | CH | | | |
| | InfrastructureProcess | | | | 0 | 0 | 0 | | | |
| | Unit | | | | kWh | kWh | kWh | | | |
| product | electricity, high voltage, at grid | CH | 0 | kWh | 1 | | | | | |
| | electricity, medium voltage, at grid | CH | 0 | kWh | | 1 | | | | |
| | electricity, low voltage, at grid | CH | 0 | kWh | | | 1 | | | |
| technosphere | electricity mix | CH | 0 | kWh | 1.03E+0 | | | 1 | 1.05 | (1,1,1,1,1,1,BU:1.05); specific losses of network estimated based on statistics |
| | electricity, high voltage, at grid | CH | 0 | kWh | | 1.01E+0 | | 1 | 1.05 | (1,2,1,1,1,1,BU:1.05); specific losses of network estimated based on statistics |
| | electricity, medium voltage, at grid | CH | 0 | kWh | | | 1.06E+0 | 1 | 1.31 | (2,3,1,1,3,5,BU:1.05); specific losses of network estimated based on statistics |
| | sulphur hexafluoride, liquid, at plant | RER | 0 | kg | | 5.06E-8 | 2.80E-9 | 1 | 1.31 | (2,3,1,1,3,5,BU:1.05); based on emission data |
| | transmission network, electricity, high voltage | CH | 1 | km | 6.82E-9 | | | 1 | 3.09 | (4,5,na,na,na,na,BU:3); based on consumption statistics |
| | transmission network, electricity, medium voltage | CH | 1 | km | | 1.86E-8 | | 1 | 3.09 | (4,5,na,na,na,na,BU:3); based on consumption statistics |
| | distribution network, electricity, low voltage | CH | 1 | km | | | 8.74E-8 | 1 | 3.06 | (2,4,1,1,1,5,BU:3); based on consumption statistics |
| emission soil, unspecified | Heat, waste | - | - | MJ | 5.94E-3 | 1.59E-2 | 1.63E-1 | 1 | 1.24 | (2,4,1,1,1,5,BU:1.05); estimations based on losses |
| emission air, unspecified | Heat, waste | - | - | MJ | 1.13E-1 | 1.94E-2 | 5.43E-2 | 1 | 1.24 | (2,4,1,1,1,5,BU:1.05); estimations based on losses |
| | Ozone | - | - | kg | 4.50E-6 | | | 1 | 5.00 | (2,4,1,1,1,5,BU:1.5); standard deviation based on variation reported in literature |
| | Dinitrogen monoxide | - | - | kg | 5.00E-6 | | | 1 | 4.60 | (2,3,1,1,3,5,BU:1.5); standard deviation based on variation reported in literature |
| | Sulfur hexafluoride | - | - | kg | | 5.06E-8 | 2.80E-9 | 1 | 1.62 | (2,3,1,1,3,5,BU:1.5); national statistics |

## 4.3.5 Data quality

The total electricity losses are based on national and IEA statistics. The distribution of the electricity demand and losses is based on actual Swiss data and are considered as reliable.

The infrastructure used for electricity distribution and transmissions is split in internally linked sub-grids, which underlie constant change. This fact makes the inventorying of the infrastructure rather difficult.

The material use for the construction is based on several recent data sources and scaled to the total Swiss electricity grid. A satisfying completeness was reached with regard to other material flows like direct emissions or operational material use.

The $SF_6$ emission rates for Switzerland are up to date. There is only little information available for Europe and other countries. European emission rates are approximated based on the Swiss emission rates using the available information.

The $SF_6$ emissions are analysed in detail for four non-European countries (Japan, Brazil, India and the USA). The emission rates for Japan and the USA are from recent data sources, whereas the Brazilian and Indian rates are extrapolated from older data.

The $N_2O$ and ozone emissions from high voltage aerial lines are based on only few sources published at the end of the nineties and show a high uncertainty.

The demand of infrastructure during operation is uncertain. It was assumed that the actual use corresponds to the average use. The electricity transmission and distribution on the different voltage levels is based on recent values for Switzerland and was adopted for all the remaining countries because no data was available, neither for European nor for non-European countries.

The Swiss datasets are used for the distribution network. The error introduced with this assumption is small for European and North American countries, because of the small difference in the technical structure and the electricity demand. But for the remaining countries a considerable uncertainty is introduced by the use of the Swiss infrastructure data sets, because of differences in the grid infrastructure and the length on the different voltage levels. This uncertainty is damped when analysing the environmental impacts of electricity supplied, due to the modest importance of the grid infrastructure on the environmental impact of electricity delivered to the customers,

# 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 $CO_2$-eq/kWh), followed by Estonia (1058 g $CO_2$-eq/kWh), Poland (1053 g $CO_2$-eq/kWh), Australia (1032 g $CO_2$-eq/kWh) and Macedonia (1029 g $CO_2$-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 $CO_2$-eq/kWh), followed by Icelandic electricity (15.4 g $CO_2$-eq/kWh), Norwegian electricity (24.0 g $CO_2$-eq/kWh), Swedish electricity (43.7 g $CO_2$-eq/kWh) and French electricity (90.3 g $CO_2$-eq/kWh). The greenhouse gas emissions are low for countries with a high share of hydroelectric 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 | 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 | 12.06 | 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 ($N_2O$, Ozone and $SF_6$) 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 | 262 |
| | 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 |
| Asia and Australia | Australia | AU | 12.67 | 12.19 | 0.10 | 0.38 | 1083.3 | 749 |
| | 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 | 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 | 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 $SF_6$ 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) .

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