



**Alleanza
per il Clima**
Italia onlus

Emission factors for
Electric Energy in
ECORegion

Alleanza per il Clima Italia onlus
Via G. Marconi 8 | I-06012 Città di Castello
Tel. +39.075.8554321 | coordinamento@climatealliance.it

The Emission Factors in ECORegion

ECORegion uses its own CO₂ emission factors for calculating the CO₂ emission inventory on the basis of the energy inventory, be it for the direct emissions be it for the LCA emissions. The software permits, however, to use other factors overwriting simply the default ones. In some cases, as we will see, there are some marked differences between the factors that have been adopted by ECORegion as opposed to the ones that are being proposed in the Guidelines of the Covenant of Mayors for the elaboration of SEAPs.

As indicated in the Guidelines it is possible to choose between two approaches as far as emission factors are concerned, both of which are supported by ECORegion:

1. **Direct emission factors**, that is to say standard emissions calculated according to the approach of the IPCC that comprise all the CO₂ emissions that refer to the energy consumed in the municipal territory, be it directly through combustion be it indirectly through combustion that takes place elsewhere related to the use of electricity and heat/cooling. The direct emission factors are based on the carbon content of each fuel, as in the National Inventories of GHG emissions that are being elaborated in the context of the Framework Convention on Climate Change of the UN (UNFCCC) and the Kyoto Protocol. In case of the biomasses, as with the production of electricity from renewables the emissions usually are set at zero.

For the direct emission factors the principal source of ECORegion are the data from the NIR (National Inventory Report) that Italy presents annually to the UN. The NIR is being elaborated every year by ISPRA (Istituto Superiore per la Protezione e la Ricerca Ambientale, ex APAT). As can be seen from the following table, the emission factors calculated in this way do not differ significantly from the ones proposed by the Covenant of Mayors.

Type of fuel	CO ₂ emission factors - CoM [t/MWh]	CO ₂ emission factors - ECORegion [t/MWh]
Petrolio greggio	0,264	0,263
Orimulsion	0,277	0,263
Liquidi da gas naturale	0,231	0,205
Benzina per motori	0,249	0,256
Benzina avio	0,252	0,256
Benzina per aeromobili	0,252	0,256
Kerosene per aeromobili	0,257	0,257
Altro kerosene	0,259	0,257
Olio di scisto	0,264	0,263
Gasolio/olio diesel	0,267	0,263
Olio combustibile residuo	0,279	0,263
GPL	0,227	0,234
Etano	0,222	nd
Nafta	0,264	0,263
Bitume	0,291	0,263
Lubrificanti	0,264	0,263
Coke di petrolio	0,351	0,345
Prodotti base di raffineria	0,264	0,263
Gas di raffineria	0,207	0,205
Cere Paraffiniche	0,264	0,263
Acqua ragia e benzine speciali	0,264	0,263
Altri prodotti petroliferi	0,264	0,263
Antracite	0,354	0,345
Carbone da coke	0,341	0,345
Altro carbone bituminoso	0,341	0,345
Altro carbone sub-bituminoso	0,346	0,345
Lignite	0,364	0,404
Scisti e sabbie bituminose	0,385	0,345
Mattonelle di lignite	0,351	0,404
Agglomerati	0,351	0,345
Coke da cokeria e coke di lignite	0,385	0,345
Coke da gas	0,385	0,345
Catrame di carbone	0,291	0,345
Gas di officina	0,16	0,205
Gas di cokeria	0,16	0,205
Gas di altoforno	0,936	nd
Gas da convertitore	0,655	nd
Gas naturale - METANO	0,202	0,205
Rifiuti urbani (frazione secca)	0,33	0,334
Rifiuti industriali	0,515	nd
Oli usati	0,264	0,263
Torba	0,382	0,345

*nd = not available

Tab. 1 - Direct emission factors Covenant of Mayors Guidelines and ECORegion

2. The alternative approach for calculating the emissions is based on the **LCA methodology**¹, which takes into consideration the whole life cycle and in this sense is a more comprehensive approach.

Here too the LCA emission factors used by ECORegion and elaborated from the database of EcoInvent and the German software GEMIS of the Öko-Institut in Freiburg do not differ very much from those used in the Guidelines of the Covenant of Mayors.

Type of fuel	CO ₂ -LCA energy emission factors CoM [t/MWh]	CO ₂ -LCA energy emission factors ECORegion [t/MWh]
Olio combustibile EL	0,310	0,320
Benzina	0,299	0,302
Diesel	0,305	0,292
Cherosene	nd	0,284
Metano	0,237	0,228
Teleriscaldamento	nd	0,229
Biomassa	0,020	0,024
Carbone	0,393	0,371
Geotermia	Nd	0,164
Collettori solari	Nd	0,025
Biogas	Nd	0,015
Rifiuti	0,330	0,250
GPL	Nd	0,241
Olio vegetale	0,182	0,036
Biodiesel	0,156	0,087
Lignite	0,385	0,438
Carbone fossile	0,380	0,365

*nd = not available

Tab. 2 - LCA emission factors Covenant of Mayors Guidelines and ECORegion

¹ SEAP Guidelines: LCA is an internationally standardised method (ISO 14040 series) and used by a large number of companies and governments, including for Carbon footprinting. LCA is the scientific basis used typically behind e.g. the Thematic Strategies on Natural Resources and Waste, the Ecodesign Directive, and Ecolabel Regulation. On EU level a series of technical guidance documents building on the ISO 14040 series is currently being developed, coordinated by the European Commission's Joint Research Centre (JRC): International Reference Life Cycle Data System (ILCD) Handbook is consulted and coordinated within the EU and also with national LCA projects outside the EU (including China, Japan and Brazil), as well as a range of European business associations. A related ILCD Data Network (JRC et al., 2009) is currently being established (launch foreseen for end of 2009), that would be open for all data providers to give access to consistent and quality assured LCA data. The network can host cost-free data, licensed data, members-only data, etc. The LCA emission factors given in these guidelines are based on a European Reference Life Cycle Database (ELCD) (JRC, 2009). The ELCD provides LCA data for most of the fuels and also Member State specific electricity mix data. Both the ELCD and the ILCD data sets work with the IPCC global warming factors for the individual gases.

Emission factors CO₂ - LCA for electric energy

The emission factors associated with electricity consumption merit a separate discourse. They are calculated on the basis of a specific energy mix and influenced by the efficiency of the production-transport-distribution system for electric energy.

Below a scheme of what the LCA approach tries to evaluate using the energy carriers of electricity:

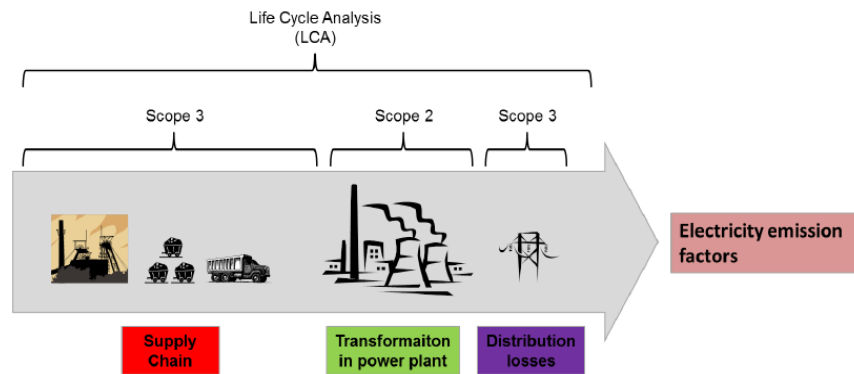


Fig. 1 - LCA applied to the energy product electricity

To calculate the medium LCA emission factors ECORegion applies the single factors of the specific emissions of each energy carrier that contributes to the electric energy mix using the data from the German software GEMIS.

ECORegion is able to elaborate different national and local LCA emission factors. The latter are calculated departing from the national values and applying the criteria of the CoM Guidelines takes into account the contributions of local electric energy production.

As was said above, ECORegion presently uses the factors of the Öko-Institut Freiburg that were developed predominantly for Germany. Further the software ECORegion does not use the production mix of electric energy but the supply mix. The difference lies in the 10% electric energy consumption that is being imported from abroad and mainly originates in French nuclear power plants. These reasons lead to partly significant differences in the LCA emission factors used in ECORegion compared to those in the CoM Guidelines. In the specific case of Italy this translates into ECORegion emission factors that are considerably lower than those in the Guidelines.

This, however, does not produce any systematic advantages or disadvantages in the phase of planning, because the same factors are being used, in this case the ECORegion LCA factors, be it for the CO₂ emission inventory be it for the quantification of the avoided emissions of the actions in the SEAP.

COUNTRY	STANDARD EMISSION FACTOR (t CO ₂ /MWh _e)	LCA EMISSION FACTOR (t CO ₂ -eq/MWh _e)
Austria	0.209	0.310
Belgium	0.285	0.402
Germany	0.624	0.706
Denmark	0.461	0.760
Spain	0.440	0.639
Finland	0.216	0.418
France	0.056	0.146
United Kingdom	0.543	0.658
Greece	1.149	1.167
Ireland	0.732	0.870
Italy	0.483	0.708
Netherlands	0.435	0.716
Portugal	0.369	0.750
Sweden	0.023	0.079
Bulgaria	0.819	0.906
Cyprus	0.874	1.019
Czech Republic	0.950	0.802
Estonia	0.908	1.593
Hungary	0.566	0.678
Lithuania	0.153	0.174
Latvia	0.109	0.563
Poland	1.191	1.185
Romania	0.701	1.084
Slovenia	0.557	0.602
Slovakia	0.252	0.353
EU-27	0.460	0.578

Note that the year which the data represents varies between countries and between standard and LCA approach (6).

Tab. 3 - National and European emission factors for consumed electricity

In respect to the value proposed by the Guidelines of the JRC, the values elaborated on the basis of GEMIS and used in ECORegion are one third lower. As can be seen in table 5 the LCA-CO₂ emission factor in ECORegion is approximately 450 gCO₂-eq/KWh as opposed to 708 gCO₂-eq/KWh in the CoM Guidelines.

Electricity Mix ECORegion Italy (%)											
Power products	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Water	15.67	16.03	13.67	12.43	13.77	11.72	11.64	10.71	12.97	14.50	15.46
Nuclear power	13.65	14.38	14.63	14.31	12.59	13.42	12.06	12.89	10.99	12.20	12.55
Natural gas	30.04	28.51	28.75	32.93	35.79	40.75	42.37	48.07	47.42	46.85	43.41
Solar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.18	0.54
Biogas	0.16	0.18	0.23	0.24	0.27	0.26	0.29	0.40	0.44	0.45	0.58
Waste	0.08	0.09	0.12	0.17	0.20	0.23	0.29	0.84	0.43	0.44	0.58
Wind	0.18	0.35	0.41	0.41	0.51	0.84	0.80	1.12	1.33	1.78	2.59
Wood	0.04	0.05	0.20	0.29	0.28	0.29	0.41	0.69	0.75	0.77	0.64
Crude oil	29.34	28.13	28.94	25.33	21.07	17.72	17.14	9.85	10.74	9.59	9.46
Lignite	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coal	9.39	10.93	11.70	12.39	14.04	13.50	13.52	13.85	13.35	11.79	12.64
Geothermal	1.45	1.34	1.35	1.50	1.50	1.45	1.48	1.55	1.52	1.45	1.53
Sum	100	100	100	100	100	100	100	100	100	100	100

Tab. 4 - Electricity Mix ECORegion Italy

LCA Emission Factors Italy (g/kWh)											
Power products	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Water	10	10	10	10	10	10	10	10	10	10	10
Nuclear power	8	8	8	8	8	8	8	8	8	8	8
Natural gas	457	457	457	457	457	457	457	457	457	457	457
Solar	109	109	109	109	109	109	109	109	109	109	109
Biogas	25	25	25	25	25	25	25	25	25	25	25
Waste	889	889	889	889	889	889	889	889	889	889	889
Wind	19	19	19	19	19	19	19	19	19	19	19
Wood	29	29	29	29	29	29	29	29	29	29	29
Crude oil	697	697	697	697	697	697	697	697	809	809	809
Lignite	1,142	1,142	1,142	1,142	1,142	1,142	1,142	1,142	1,142	1,142	1,142
Coal	1,081	1,081	1,081	1,081	1,081	1,081	1,081	1,081	1,081	1,081	1,081
Geothermal	131	131	131	131	131	131	131	131	131	131	131
Resulting Emission Factor ECORegion	449	450	465	467	469	462	466	450	457	428	423

Formula in ECORegion:
Emission factor electricity = [electricity mix] x [LCA emission factors]

Tab. 5 - LCA Emission Factors Italy

Recently an Italian LCA study group has elaborated a document that sums up several studies and analyses on the subject of LCA factors connected with the production of electricity and considering the main databases and the existing factors as well as the most suitable methodology for the national situation it comes up with a figure of 600 gCO₂eq/kWh.

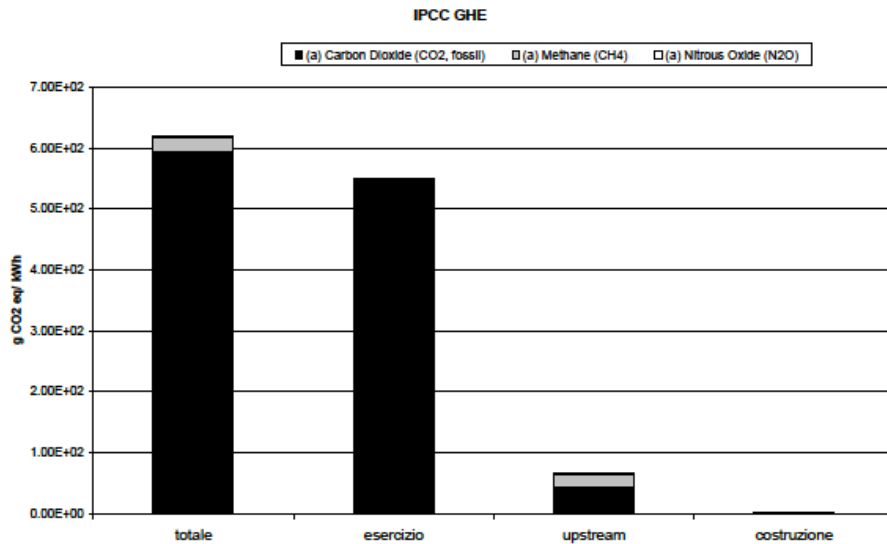


Fig. 2 - Contribution of the single phases of the Life Cycle of electrical energy to the impact of the "green house effect"

Notes

Daniel, W. (2007), "A guide to life-cycle greenhouse gas (GHG) emissions from electric supply technologies." *Energy* **32**(9): 1543-1559

Ecoinvent (2007). ecoinvent report No. 6 / Teil XVI "Strommix und Stromnetz". Uster.

IEA (2011). CO2 EMISSIONS FROM FUEL COMBUSTION - HIGHLIGHTS, International Energy Agency.

JRC (2009). "European Reference Life Cycle Database (ELCD)." from <http://lca.jrc.ec.europa.eu/lcaifohub/datasetCategories.vm>

Öko-Institut (2006). "Global Emission Model for Integrated Systems (GEMIS) Version 4.2."

Öko-Institut (2011). "Global Emission Model for Integrated Systems (GEMIS) Version 4.7." from <http://www.oeko.de/service/gemis/en/index.htm>

Scalbi, Simona (a cura di), Dall'Analisi del Ciclo di Vita all'impronta Ambientale, Atti del VI convegno della rete italiana LCA, Edizioni ENEA, Giugno 2012, download at <http://www.enea.it/it/produzione-scientifica/edizioni-enea/2012/vi-convegno-lca>

SEAP Guidebook, download at: http://www.eumayors.eu/support/library_en.html