CoM Default Emission Factors for the Member States of the European Union

Dataset Version 2017

Koffi, B., Cerutti, A., Duerr, M., Iancu, A., Kona, A.,
Janssens-Maenhout, G.

Developed by the Joint Research Centre of the European Commission
Published in 2017

How to cite: Koffi, Brigitte; Cerutti, Alessandro; Duerr, Marlene; Iancu, Andreea; Kona, Albana; Janssens-Maenhout, Greet (2017): CoM Default Emission Factors for the Member States of the European Union - Version 2017, European Commission, Joint Research Centre (JRC) [Dataset] PID: http://data.europa.eu/89h/jrc-com-ef-comw-ef-2017.

Download URL: http://data.europa.eu/89h/jrc-com-ef-comw-ef-2017

Definition and use of 2017 CoM default emission factors for EU countries

This document provides an update to the Covenant of Mayors (CoM) default emission factors initially published in the CoM 2010 guidebook (Bertoldi et al., 2010) and subsequently updated in the CoM reporting guidelines (CoM, 2014; CoM, 2016). They can be used by local authorities to estimate their CO_2 or Greenhouse Gas (GHG) emissions due to:

- Table 1: local consumption of fossil fuels and wastes (non-renewable)
- Table 2: local consumption of biofuels, biomass, solar thermal and geothermal Renewable energy sources (RES)
- Table 3: local electricity production from other RES (wind, hydroelectric, photovoltaics)
- Tables 4 to 6: local electricity consumption

The default emission factors in Tables 1 to 3 quantify the **CO_2** (in tCO_2/MWh) and **GHG** (in tCO_2-eq/MWh) emissions from the consumption of energy carriers and RES (Standard approach) and their corresponding supply chains (Life Cycle Assessment (LCA) approach). As with the previous versions, they are provided for the most commonly used energy carriers and RES in Europe. The CoM **Standard default emission factors** are the IPCC (2006) default factors for stationary combustion. The **LCA default emission factors** have been calculating by adding to the standard emission factors, emissions from the supply chain as estimated from the latest version (v3.2) of the European Life Cycle Database, as well as other databases and literature reviews. Because LCA values have a period of validity, both the previous (valid up to 2007) and present (valid from 2008) LCA factors are reported. The **GHG emission factors**, which include CO_2, CH_4 and N_2O have been updated using the Global Warming Potential values from the IPCC (2007) Fourth Assessment Report (instead of the IPCC (1995) values), as recommended for the national inventory reporting in Annex I countries of the United Nations Framework Convention on Climate Change. An update of the National and European Emission Factors for Electricity consumption (NEEFE) to estimate the emissions from the production of electricity elsewhere that is consumed locally is also provided. **Annual NEEFE values** for 1990 to 2013**,** as derived from an extended set of energy data (IEA, 2016), have been calculated for both the standard (Tables 4 and 5) and LCA (Table 6) approaches.

Detailed information on the methodologies, assumptions and data sources, as well as recommendations for using these factors are found in Koffi et al. (2017). Regular updates are foreseen for the future, so we recommend new CoM signatories to use the latest version available from the JRC COM-EF collection (http://data.jrc.ec.europa.eu/collection/id-0083). It is important not to update the CoM default emission factors during the monitoring phase, because it would affect the evaluation of the mitigation action plan. If local authorities prefer to use emission factors that better reflect the properties of the fuels used in their territory, they are welcome to do so.

More recent knowledge and technologies can give substantial changes in the CoM default emission factors. When selecting these factors, it is important not to update the ones used for the Baseline Emission Inventory during the monitoring phase, in order to identify the trends and changes in local emissions that are due to local energy production and consumption rather than changes in the emission factors used.

Table 1: Default Emission factors for fossil fuels and municipal wastes

Energy carriers[1]		Standard (IPCC, 2006)		LCA[2, 4] up to 2007	LCA[3, 4] 2008-2015 (current update)
SECAP Template	IPCC denomination	t CO_2 /MWh	t CO_2-eq /MWh	t CO_2-eq /MWh	t CO_2-eq /MWh
Natural gas	Natural gas	0.202	0.202	0.237	**0.240**
Liquid gas	Liquefied Petroleum Gases	0.227	0.227	n.a.	**0.281**[a]
	Natural Gas Liquids	0.231	0.231	n.a.	**0.272**[a]
Heating Oil	Gas/Diesel oil	0.267	0.268	0.305	**0.306**
Diesel	Gas/Diesel oil	0.267	0.268[b]	0.305	**0.306**
Gasoline	Motor gasoline	0.249	0.250[b]	0.307	**0.314**
Lignite	Lignite	0.364	0.365	0.375	0.375
Coal	Anthracite	0.354	0.356	0.393	**0.370**
	Other Bituminous Coal	0.341	0.342	0.380	**0.358**
	Sub-Bituminous Coal	0.346	0.348	0.385	**0.363**
Other non renewable fuels	Peat	0.382	0.383	0.392	**0.390**[a]
	Municipal Wastes (non-biomass fraction)	0.330	0.337	0.174	**0. 295**

[1]Default energy carriers of CoM SECAP on-line template. [2]ELCD (2009) and [3]ELCD v3.2 (ELCD, 2015) databases, except [a]Ecoinvent. [b]If choosing to report in CO_2-eq, please consider that the emission factors for the transport sector are up to 3% higher than the values provided here (e.g., for gasoline), which are characteristic for stationary sources. For municipal wastes, the LCA factor is lower than the IPCC (2006) factor because of the emission savings allowed by the waste treatment. [4]The validity range applies to the baseline year, i.e. to the year of the so-called Baseline Emission Inventory (BEI). For the subsequent monitoring emission inventories (MEIs), the same emission factors should be applied (see also Koffi et al. (2017) for details on the use of local versus CoM default emission factors).

Table 2: Default Emission factors for renewable energy sources

Renewable energy			Standard[2] (IPCC, 2006)		LCA[3] up to 2007[5]	LCA[4] 2008-2015[5] (current update)
Energy classes[1]	IPCC denomination *Carbon neutrality*		t CO_2 /MWh	t CO_2-eq /MWh	t CO_2-eq /MWh	t CO_2-eq /MWh
Plant oil	Other Liquid Biofuels	*cn*	0	0.001	0.182 [a]	0.182[a]
		ncn	0.287	0.302	0.484	0.484
Biofuel	Bio-gasoline	*cn*	0	0.001	0.207[a]	0.207[a]
		ncn	0.255	0.256	0.462	0.462
	Biodiesels	*cn*	0	0.001	0.156 [a]	0.156[a]
		ncn	0.255	0.256	0.411	0.411
Other biomass	Biogas	*ncn*	0.197	0.197	n.a.	**0.284** [b]
	Municipal wastes (biom. fraction)	*cn*	0	0.007	0.106	0.106[3]
	Wood *(/Wood waste)*	*cn*	0	0.007	0.013	**0.017**[c]
		ncn	0.403	0.410	0.416	**0.420**
	(Wood/) Wood waste	*ncn*	0.403	0.410	0.184[3]	0.184[3]
	Other primary solid biomass	*ncn*	0.360	0.367	n.a.	n.a.
Solar thermal			0	0	n.a.	**0.040**[d]
Geothermal			0	0	n.a.	**0.050**[d]

[1]Default energy carriers of CoM SECAP on-line template. [2] Standard emission factors should be reported zero if the biofuels/biomass meet CO_2 neutrality criteria (*cn*) in terms of CO_2 emissions versus CO_2 assimilation by plants; For fuels that do not meet carbon neutrality criteria (see Koffi et al., 2017), the *ncn* (not carbon neutral) IPCC (2006) default emission factors reflecting the carbon content, potentially further corrected for the carbon assimilation, should be used (excluding emissions from the supply chain, which are included in the LCA factor). The sources of LCA values are [3]ELCD (2009) and [4]ELCD v3.2 (ELCD, 2015) databases except [a)]Bertoldi et al. (2010), [b)] Ecoinvent world value for the year 2015, [c)] NEEDS database and [d)] Amponsah et al. (2014). [5]The validity range applies to the baseline year, i.e. to the year of the so-called Baseline Emission Inventory (BEI), whereas for the monitoring emission inventories (MEIs), the same emission factors should be applied. The LCA factors for emissions from plant oil, biogasoline (bioethanol) and biogas have been checked for consistency against the values reported in the EU Renewable Energy Directive. See also Koffi et al. (2017) on the use of local versus CoM default emission factors.

Table 3: Default Emission factors for local electricity production

	Standard (IPCC)		LCA[2] Up to 2007[4]	LCA[3] 2008-2015[4] (current **update**)
Electricity generation RES Technology[1]	t CO_2 /MWh	t CO_2-eq /MWh	t CO_2-eq /MWh	t CO_2-eq /MWh
Wind	0	0	0.020-0.050[a]	**0.010**
Hydroelectric	0	0	0.007	**0.006**
Photovoltaics	0	0	0.024[b]	**0.030[c]**

LCA data sources: [1]RES Technologies as defined in CoM SECAP on-line template; [2]ELCD (2009) and [3]ELCD v3.2 (ELCD, 2015) databases except: [a)]based on results from one plant, operated in coastal areas with good wind conditions, [b)] Vasilis et al. (2008) and [c)] Amponsah et al. (2014). [4]The validity range applies to the baseline emission inventory. For the subsequent monitoring emission inventories, the same emission factors should be applied (see also Koffi et al. 2017 on the use of local versus CoM default emission factors).

Tables 4 to 6: National and European Emission factors for electricity consumption

Table 4. National and European Emission factors for Electricity consumption: Standard approach, tCO_2/MWh – 1990 to 2001

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Austria	0.279	0.281	0.221	0.209	0.229	0.248	0.257	0.259	0.228	0.222	0.201	0.200
Belgium	0.433	0.416	0.407	0.409	0.424	0.409	0.378	0.349	0.365	0.331	0.329	0.313
Bulgaria	0.956	0.867	0.981	1.008	0.912	0.857	0.799	0.880	0.897	0.833	0.816	0.993
Croatia	0.252	0.180	0.332	0.359	0.204	0.237	0.255	0.274	0.337	0.330	0.286	0.363
Cyprus	0.933	0.925	0.959	0.938	0.936	0.933	0.955	0.973	0.974	0.981	0.952	0.897
Czech Republic	0.977	1.024	1.002	1.052	1.021	1.020	0.992	0.995	1.003	0.958	1.077	1.135
Denmark	0.627	0.876	0.695	0.718	0.843	0.706	1.049	0.782	0.668	0.580	0.498	0.557
Estonia	2.436	2.092	2.093	1.878	2.032	2.093	2.030	1.897	1.899	1.946	1.841	1.768
Finland	0.176	0.193	0.155	0.193	0.254	0.223	0.299	0.252	0.185	0.185	0.164	0.214
France	0.149	0.172	0.134	0.092	0.093	0.107	0.112	0.102	0.138	0.120	0.108	0.096
Germany	0.750	0.753	0.734	0.725	0.729	0.708	0.718	0.685	0.675	0.638	0.641	0.580
Greece	1.228	1.165	1.198	1.180	1.164	1.166	1.022	0.973	0.956	0.967	1.033	1.023
Hungary	0.452	0.518	0.599	0.644	0.636	0.635	0.622	0.645	0.659	0.644	0.564	0.561
Ireland	0.899	0.902	0.906	0.884	0.879	0.872	0.855	0.840	0.837	0.812	0.758	0.807
Italy	0.575	0.549	0.535	0.516	0.512	0.546	0.524	0.514	0.513	0.493	0.496	0.476
Latvia	0.095	0.102	0.085	0.109	0.129	0.117	0.140	0.130	0.125	0.125	0.120	0.123
Lithuania	0.377	0.413	0.200	0.162	0.166	0.139	0.234	0.141	0.283	0.236	0.178	0.194
Luxembourg	0.417	0.440	0.414	0.404	0.300	0.182	0.150	0.089	0.030	0.032	0.034	0.068
Malta	1.945	1.335	1.227	1.662	1.491	1.255	1.218	1.173	1.155	1.116	1.012	1.260
Netherlands	0.603	0.592	0.586	0.596	0.585	0.542	0.523	0.496	0.494	0.461	0.442	0.508
Poland	1.435	1.479	1.503	1.474	1.498	1.406	1.361	1.328	1.291	1.296	1.278	1.356
Portugal	0.635	0.636	0.733	0.664	0.618	0.673	0.503	0.505	0.555	0.656	0.557	0.562
Romania	1.070	1.105	1.161	1.265	1.280	1.221	1.176	0.954	0.781	0.823	0.893	0.939
Slovak Republic	0.431	0.458	0.445	0.470	0.412	0.449	0.400	0.428	0.447	0.422	0.350	0.386
Slovenia	0.588	0.509	0.601	0.608	0.523	0.538	0.491	0.508	0.537	0.446	0.453	0.501
Spain	0.524	0.518	0.580	0.504	0.492	0.543	0.429	0.475	0.455	0.526	0.517	0.490
Sweden	0.014	0.023	0.023	0.025	0.029	0.026	0.053	0.031	0.034	0.032	0.024	0.027
United-Kingdom	0.794	0.771	0.759	0.665	0.640	0.606	0.593	0.550	0.555	0.516	0.545	0.567
EU-28	0.602	0.595	0.582	0.554	0.550	0.544	0.537	0.511	0.506	0.488	0.486	0.482

Table 4 (*continued*): Standard approach, tCO_2/MWh – 2002 to 2013

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Austria	0.221	0.255	0.253	0.248	0.229	0.213	0.203	0.187	0.211	0.218	0.183	0.170
Belgium	0.304	0.297	0.290	0.302	0.275	0.274	0.260	0.252	0.247	0.221	0.220	0.198
Bulgaria	0.854	0.914	0.913	0.883	0.854	0.963	0.897	0.870	0.915	1.060	0.910	0.791
Croatia	0.374	0.408	0.305	0.287	0.278	0.335	0.282	0.241	0.208	0.231	0.214	0.204
Cyprus	0.854	0.936	0.875	0.880	0.855	0.854	0.840	0.827	0.769	0.773	0.785	0.707
Czech Republic	1.016	0.992	0.975	0.924	0.903	0.992	0.905	0.890	0.878	0.915	0.855	0.783
Denmark	0.531	0.686	0.501	0.405	0.628	0.506	0.446	0.467	0.430	0.351	0.254	0.331
Estonia	1.656	1.882	1.831	1.808	1.476	1.919	1.671	1.450	1.903	1.878	1.594	1.977
Finland	0.229	0.323	0.272	0.147	0.259	0.230	0.170	0.180	0.221	0.179	0.120	0.155
France	0.095	0.097	0.093	0.110	0.101	0.104	0.093	0.097	0.094	0.083	0.086	0.082
Germany	0.642	0.614	0.597	0.594	0.598	0.622	0.585	0.568	0.547	0.556	0.574	0.587
Greece	0.961	0.945	0.937	0.923	0.849	0.866	0.840	0.818	0.775	0.819	0.811	0.757
Hungary	0.521	0.551	0.475	0.412	0.395	0.437	0.411	0.341	0.346	0.331	0.334	0.254
Ireland	0.733	0.654	0.636	0.621	0.567	0.554	0.532	0.503	0.511	0.473	0.523	0.464
Italy	0.499	0.506	0.501	0.482	0.481	0.478	0.463	0.411	0.405	0.403	0.389	0.343
Latvia	0.101	0.096	0.080	0.072	0.086	0.075	0.087	0.085	0.128	0.126	0.078	0.121
Lithuania	0.174	0.166	0.165	0.181	0.143	0.134	0.124	0.147	0.192	0.134	0.138	0.096
Luxembourg	0.183	0.159	0.185	0.188	0.183	0.165	0.139	0.177	0.168	0.138	0.148	0.091
Malta	1.169	1.184	1.142	1.280	1.176	1.268	1.070	1.091	1.022	1.000	1.032	0.871
Netherlands	0.468	0.472	0.461	0.440	0.423	0.445	0.439	0.461	0.459	0.428	0.428	0.429
Poland	1.261	1.280	1.234	1.225	1.209	1.155	1.089	1.089	1.033	1.063	1.013	1.013
Portugal	0.584	0.461	0.472	0.525	0.443	0.383	0.375	0.396	0.274	0.329	0.363	0.314
Romania	0.863	0.940	0.764	0.751	0.799	0.817	0.795	0.725	0.604	0.724	0.666	0.502
Slovak Republic	0.290	0.351	0.300	0.309	0.287	0.255	0.245	0.240	0.224	0.231	0.234	0.199
Slovenia	0.483	0.440	0.428	0.421	0.423	0.433	0.432	0.471	0.441	0.435	0.418	0.399
Spain	0.519	0.455	0.466	0.480	0.449	0.472	0.402	0.364	0.289	0.354	0.378	0.297
Sweden	0.032	0.041	0.026	0.023	0.024	0.020	0.020	0.020	0.029	0.020	0.015	0.015
United-Kingdom	0.551	0.588	0.579	0.568	0.598	0.593	0.561	0.520	0.512	0.507	0.554	0.515
EU-28	0.486	0.489	0.472	0.466	0.466	0.473	0.443	0.423	0.406	0.416	0.414	0.391

Table 5. National and European Emission factors for Electricity consumption: Standard approach, tCO_2 eq/MWh – 1990 to 2001

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Austria	0.280	0.282	0.222	0.210	0.230	0.249	0.258	0.260	0.229	0.223	0.202	0.201
Belgium	0.435	0.417	0.409	0.410	0.426	0.411	0.379	0.350	0.367	0.332	0.330	0.314
Bulgaria	0.960	0.871	0.986	1.012	0.916	0.861	0.802	0.884	0.901	0.837	0.820	0.997
Croatia	0.253	0.181	0.333	0.360	0.205	0.238	0.256	0.275	0.338	0.331	0.287	0.365
Cyprus	0.936	0.928	0.962	0.942	0.939	0.936	0.958	0.977	0.978	0.984	0.955	0.900
Czech Republic	0.981	1.028	1.007	1.057	1.026	1.024	0.996	0.999	1.007	0.962	1.082	1.140
Denmark	0.630	0.881	0.698	0.722	0.847	0.710	1.054	0.785	0.671	0.583	0.500	0.560
Estonia	2.446	2.101	2.102	1.886	2.041	2.102	2.039	1.905	1.908	1.954	1.849	1.775
Finland	0.177	0.194	0.155	0.194	0.255	0.224	0.300	0.253	0.186	0.186	0.165	0.215
France	0.150	0.172	0.135	0.093	0.093	0.107	0.112	0.102	0.139	0.120	0.108	0.097
Germany	0.754	0.756	0.738	0.728	0.732	0.712	0.721	0.688	0.678	0.641	0.644	0.583
Greece	1.234	1.170	1.203	1.185	1.169	1.171	1.026	0.978	0.960	0.971	1.037	1.027
Hungary	0.454	0.519	0.602	0.647	0.638	0.637	0.624	0.647	0.662	0.646	0.567	0.563
Ireland	0.903	0.905	0.910	0.888	0.882	0.875	0.858	0.843	0.840	0.814	0.761	0.810
Italy	0.577	0.551	0.537	0.517	0.514	0.547	0.525	0.515	0.514	0.495	0.497	0.477
Latvia	0.095	0.102	0.085	0.110	0.129	0.117	0.140	0.130	0.125	0.125	0.120	0.124
Lithuania	0.378	0.414	0.200	0.163	0.166	0.139	0.234	0.142	0.283	0.237	0.178	0.195
Luxembourg	0.417	0.441	0.414	0.404	0.300	0.182	0.150	0.089	0.030	0.033	0.034	0.069
Malta	1.953	1.340	1.232	1.668	1.496	1.259	1.222	1.177	1.159	1.120	1.016	1.265
Netherlands	0.605	0.593	0.587	0.598	0.587	0.544	0.525	0.497	0.495	0.462	0.443	0.510
Poland	1.442	1.486	1.510	1.481	1.505	1.413	1.367	1.334	1.297	1.302	1.284	1.362
Portugal	0.638	0.638	0.736	0.666	0.620	0.676	0.505	0.507	0.557	0.659	0.559	0.564
Romania	1.073	1.109	1.165	1.269	1.284	1.225	1.180	0.957	0.784	0.826	0.897	0.943
Slovak Republic	0.432	0.460	0.447	0.472	0.414	0.451	0.401	0.430	0.449	0.424	0.351	0.388
Slovenia	0.591	0.512	0.603	0.610	0.525	0.540	0.493	0.510	0.539	0.448	0.455	0.504
Spain	0.526	0.520	0.582	0.507	0.494	0.546	0.431	0.477	0.457	0.528	0.519	0.492
Sweden	0.014	0.023	0.023	0.025	0.030	0.026	0.053	0.031	0.034	0.032	0.024	0.028
United-Kingdom	0.798	0.775	0.762	0.668	0.643	0.609	0.595	0.552	0.557	0.518	0.547	0.569
EU-28	0.604	0.597	0.584	0.557	0.552	0.546	0.539	0.513	0.508	0.489	0.488	0.484

Table 5. (continued): Standard approach, tCO_2 eq/MWh – 2002 to 2013

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Austria	0.222	0.255	0.254	0.248	0.229	0.214	0.204	0.188	0.212	0.219	0.184	0.170
Belgium	0.305	0.298	0.291	0.303	0.276	0.275	0.261	0.253	0.248	0.221	0.221	0.199
Bulgaria	0.858	0.918	0.917	0.887	0.858	0.967	0.901	0.874	0.920	1.065	0.914	0.795
Croatia	0.376	0.409	0.306	0.288	0.279	0.336	0.283	0.241	0.209	0.231	0.214	0.205
Cyprus	0.857	0.939	0.877	0.883	0.858	0.856	0.843	0.830	0.771	0.775	0.788	0.709
Czech Republic	1.020	0.996	0.980	0.928	0.907	0.997	0.909	0.894	0.883	0.920	0.859	0.787
Denmark	0.533	0.689	0.504	0.407	0.631	0.509	0.448	0.469	0.433	0.353	0.255	0.333
Estonia	1.663	1.890	1.839	1.816	1.483	1.927	1.678	1.456	1.912	1.887	1.601	1.986
Finland	0.230	0.324	0.273	0.147	0.260	0.231	0.171	0.181	0.223	0.179	0.120	0.156
France	0.095	0.098	0.093	0.110	0.101	0.104	0.093	0.098	0.095	0.084	0.087	0.083
Germany	0.645	0.616	0.599	0.597	0.601	0.625	0.588	0.570	0.550	0.559	0.576	0.589
Greece	0.965	0.949	0.941	0.927	0.852	0.870	0.844	0.821	0.779	0.822	0.814	0.760
Hungary	0.522	0.553	0.477	0.414	0.397	0.438	0.412	0.342	0.348	0.332	0.335	0.255
Ireland	0.736	0.656	0.638	0.623	0.569	0.556	0.534	0.505	0.512	0.475	0.524	0.465
Italy	0.500	0.507	0.503	0.484	0.482	0.479	0.464	0.413	0.407	0.405	0.391	0.344
Latvia	0.101	0.096	0.080	0.072	0.086	0.075	0.087	0.085	0.128	0.126	0.078	0.121
Lithuania	0.175	0.166	0.166	0.181	0.143	0.134	0.124	0.148	0.193	0.134	0.138	0.096
Luxembourg	0.184	0.159	0.185	0.188	0.184	0.165	0.139	0.178	0.168	0.138	0.149	0.091
Malta	1.173	1.188	1.146	1.284	1.180	1.272	1.073	1.094	1.026	1.003	1.035	0.874
Netherlands	0.469	0.473	0.463	0.441	0.425	0.447	0.441	0.463	0.460	0.430	0.430	0.430
Poland	1.267	1.286	1.240	1.231	1.214	1.160	1.095	1.094	1.038	1.068	1.018	1.017
Portugal	0.587	0.463	0.474	0.528	0.445	0.384	0.376	0.398	0.275	0.330	0.365	0.316
Romania	0.866	0.944	0.767	0.754	0.802	0.820	0.798	0.728	0.607	0.727	0.668	0.504
Slovak Republic	0.291	0.352	0.301	0.310	0.289	0.256	0.246	0.241	0.225	0.232	0.235	0.199
Slovenia	0.485	0.442	0.430	0.423	0.425	0.435	0.434	0.473	0.444	0.437	0.420	0.401
Spain	0.521	0.457	0.468	0.482	0.450	0.474	0.404	0.366	0.290	0.355	0.380	0.298
Sweden	0.033	0.041	0.026	0.023	0.025	0.020	0.021	0.020	0.030	0.020	0.015	0.016
United-Kingdom	0.553	0.590	0.582	0.570	0.600	0.595	0.562	0.521	0.514	0.509	0.556	0.517
EU-28	0.488	0.491	0.474	0.468	0.468	0.475	0.445	0.425	0.407	0.418	0.416	0.393

Table 6. National and European Emission factors for Electricity consumption: LCA approach, $tCO_{2\text{-}eq}$/MWh – 1990 to 2001

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Austria	0.314	0.317	0.254	0.248	0.274	0.293	0.300	0.298	0.267	0.262	0.232	0.238
Belgium	0.459	0.441	0.414	0.419	0.430	0.424	0.404	0.373	0.394	0.352	0.343	0.327
Bulgaria	0.938	0.855	0.973	1.023	0.910	0.852	0.809	0.913	0.933	0.869	0.852	1.040
Croatia	0.287	0.204	0.377	0.413	0.238	0.272	0.295	0.312	0.385	0.377	0.320	0.408
Cyprus	1.072	1.063	1.101	1.078	1.074	1.072	1.096	1.118	1.119	1.127	1.093	1.030
Czech Republic	1.011	1.060	1.038	1.091	1.061	1.060	1.031	1.036	1.044	1.001	1.123	1.190
Denmark	0.660	0.927	0.737	0.763	0.898	0.757	1.124	0.845	0.727	0.637	0.547	0.618
Estonia	2.452	2.104	2.107	1.888	2.040	2.105	2.042	1.909	1.915	1.963	1.858	1.787
Finland	0.220	0.234	0.189	0.233	0.299	0.267	0.340	0.295	0.225	0.224	0.205	0.280
France	0.159	0.184	0.144	0.099	0.100	0.114	0.120	0.109	0.148	0.128	0.107	0.096
Germany	0.782	0.781	0.762	0.747	0.756	0.735	0.745	0.713	0.703	0.665	0.672	0.607
Greece	1.291	1.227	1.261	1.242	1.223	1.225	1.075	1.025	1.007	1.023	1.094	1.085
Hungary	0.468	0.534	0.613	0.659	0.656	0.664	0.651	0.679	0.694	0.679	0.599	0.599
Ireland	0.971	0.976	0.979	0.960	0.954	0.948	0.934	0.925	0.924	0.902	0.842	0.897
Italy	0.654	0.626	0.614	0.594	0.589	0.626	0.603	0.593	0.592	0.571	0.575	0.549
Latvia	0.111	0.119	0.099	0.125	0.146	0.132	0.158	0.149	0.143	0.144	0.138	0.145
Lithuania	0.441	0.481	0.232	0.188	0.192	0.161	0.272	0.164	0.327	0.275	0.210	0.233
Luxembourg	0.425	0.449	0.423	0.412	0.305	0.187	0.156	0.094	0.032	0.035	0.037	0.078
Malta	2.156	1.485	1.371	1.852	1.672	1.431	1.398	1.347	1.327	1.282	1.162	1.447
Netherlands	0.665	0.656	0.651	0.661	0.646	0.595	0.576	0.547	0.540	0.511	0.488	0.569
Poland	1.498	1.545	1.570	1.539	1.564	1.468	1.421	1.387	1.349	1.354	1.336	1.422
Portugal	0.708	0.712	0.819	0.737	0.680	0.745	0.553	0.557	0.618	0.733	0.618	0.640
Romania	1.097	1.154	1.105	1.167	1.223	1.145	1.120	0.855	0.722	0.762	0.850	0.876
Slovak Republic	0.460	0.489	0.473	0.506	0.445	0.482	0.430	0.459	0.479	0.454	0.375	0.418
Slovenia	0.613	0.529	0.624	0.632	0.545	0.560	0.512	0.526	0.557	0.463	0.472	0.529
Spain	0.555	0.549	0.617	0.535	0.523	0.581	0.460	0.512	0.490	0.569	0.559	0.536
Sweden	0.018	0.028	0.030	0.031	0.037	0.033	0.063	0.039	0.042	0.039	0.034	0.050
United-Kingdom	0.845	0.820	0.810	0.716	0.692	0.657	0.646	0.605	0.611	0.574	0.606	0.625
EU-28	0.639	0.632	0.617	0.589	0.586	0.580	0.572	0.548	0.544	0.526	0.525	0.523

Table 6. (continued): LCA approach, $tCO_{2\text{-eq}}$/MWh – 2002 to 2013

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Austria	0.252	0.289	0.287	0.289	0.271	0.257	0.250	0.235	0.280	0.267	0.235	0.211
Belgium	0.315	0.327	0.321	0.338	0.310	0.313	0.300	0.299	0.298	0.263	0.265	0.239
Bulgaria	0.892	0.952	0.950	0.920	0.890	1.005	0.935	0.905	0.967	1.101	0.946	0.824
Croatia	0.419	0.455	0.340	0.318	0.310	0.376	0.314	0.270	0.238	0.257	0.240	0.228
Cyprus	0.981	1.075	1.004	1.011	0.982	0.981	0.966	0.952	0.886	0.891	0.906	0.817
Czech Republic	1.059	1.031	1.016	0.964	0.943	1.037	0.949	0.938	0.940	0.972	0.917	0.850
Denmark	0.588	0.753	0.562	0.457	0.693	0.562	0.497	0.523	0.549	0.405	0.301	0.380
Estonia	1.672	1.900	1.847	1.825	1.491	1.935	1.685	1.471	1.978	1.922	1.643	2.017
Finland	0.276	0.377	0.325	0.191	0.312	0.274	0.216	0.221	0.310	0.230	0.165	0.206
France	0.096	0.100	0.096	0.121	0.111	0.116	0.105	0.110	0.114	0.098	0.098	0.093
Germany	0.675	0.652	0.636	0.636	0.644	0.676	0.641	0.626	0.611	0.618	0.643	0.658
Greece	1.021	1.004	0.995	0.981	0.905	0.927	0.901	0.872	0.828	0.876	0.867	0.810
Hungary	0.554	0.593	0.529	0.481	0.455	0.506	0.487	0.411	0.431	0.389	0.388	0.297
Ireland	0.814	0.728	0.712	0.691	0.636	0.625	0.601	0.571	0.583	0.537	0.587	0.523
Italy	0.576	0.587	0.581	0.560	0.559	0.556	0.540	0.485	0.489	0.480	0.467	0.424
Latvia	0.120	0.116	0.100	0.090	0.107	0.093	0.109	0.107	0.194	0.160	0.115	0.183
Lithuania	0.208	0.197	0.196	0.214	0.170	0.161	0.149	0.178	0.276	0.166	0.172	0.128
Luxembourg	0.215	0.186	0.217	0.221	0.216	0.194	0.164	0.210	0.205	0.163	0.176	0.108
Malta	1.343	1.359	1.312	1.470	1.351	1.456	1.229	1.253	1.174	1.149	1.187	1.002
Netherlands	0.521	0.524	0.517	0.500	0.484	0.501	0.502	0.533	0.548	0.496	0.490	0.486
Poland	1.320	1.340	1.295	1.289	1.274	1.219	1.155	1.160	1.120	1.140	1.097	1.090
Portugal	0.652	0.512	0.527	0.589	0.495	0.434	0.427	0.452	0.333	0.388	0.423	0.368
Romania	0.834	0.937	0.812	0.796	0.846	0.864	0.839	0.762	0.652	0.760	0.702	0.532
Slovak Republic	0.310	0.373	0.319	0.327	0.308	0.273	0.266	0.266	0.270	0.269	0.279	0.241
Slovenia	0.505	0.461	0.449	0.441	0.443	0.453	0.461	0.499	0.476	0.462	0.444	0.424
Spain	0.567	0.503	0.517	0.535	0.500	0.524	0.456	0.416	0.336	0.403	0.429	0.343
Sweden	0.043	0.056	0.042	0.039	0.041	0.037	0.038	0.044	0.089	0.039	0.038	0.038
United-Kingdom	0.615	0.655	0.650	0.640	0.671	0.669	0.637	0.597	0.592	0.584	0.627	0.589
EU-28	0.527	0.532	0.517	0.513	0.514	0.523	0.494	0.475	0.467	0.469	0.468	0.444

Main reference

Koffi B, Cerutti A.K., Duerr M., Iancu A., Kona A., Janssens-Maenhout G., Covenant of Mayors for Climate and Energy: Default emission factors for local emission inventories– Version 2017, EUR 28718 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-71479-5, doi:10.2760/290197, JRC107518.

Other references

Amponsah et al. (2014), Greenhouse gas emissions from renewable energy sources: A review of lifecycle considerations. Renewable and Sustainable Energy Review, 39, 461-475.

Bertoldi, P., Cayuela, D. B., Monni, S., & de Raveschoot, R. P. (2010). How to develop a Sustainable Energy Action Plan (SEAP). Joint Research Centre Scientific and Technical reports, EUR 24360 EN, ISBN 978-92-79-15782-0.

CoM (2014), Reporting Guidelines on Sustainable Energy Action Plan and Monitoring (http://www.covenantofmayors.eu/IMG/pdf/Reporting_Guidelines_SEAP_and_Monitoring.pdf).

CoM (2016), The Covenant of Mayors for Climate and Energy Reporting Guidelines (http://www.covenantofmayors.eu/IMG/pdf/Covenant_ReportingGuidelines.pdf)

Ecoinvent, http://www.ecoinvent.org/database/ecoinvent-33/ecoinvent-33.html.

ELCD (2009). European Reference Life Cycle Database (ELCD). LCA data sets of key energy carriers, materials, waste and transport services of European scope. Previously available at http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm.

ELCD (2015). European Reference Life Cycle Database (ELCD) Release 3.2. LCA data sets of key energy carriers, materials, waste and transport services of European scope. Available at http://eplca.jrc.ec.europa.eu/ELCD3/index.xhtml.

IEA (2016), "Extended World Energy Balances, Edition 2015", *IEA World Energy Statistics and Balances* (database). http://dx.doi.org/10.1787/95e22f23-en.

IPCC, 1995. Contribution of Working Group I to the Second Assessment of the Intergovernmental Panel on Climate Change. Houghton, J.T., Meira Filho, L.G., Callender, B.A., Harris, N., Kattenberg, A. and K Maskell (Eds). Cambridge University Press, UK. pp 572.

IPCC (2006), 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme. Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan. Available at http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.htm.

IPCC (2007), Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change**,** Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp.

Koffi B, Cerutti A.K., Duerr M., Iancu A., Kona A., Janssens-Maenhout G., Covenant of Mayors for Climate and Energy: Default emission factors for local emission inventories– Version 2017, EUR 28718 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-71479-5, doi:10.2760/290197, JRC107518.

NEED Database, http://www.needs-project.org/needswebdb/index.php.

Vasilis et al. (2008), Emissions from Photovoltaic Life Cycles, Environmental Science & Technology, Vol. 42, No. 6, p. 2168-2174.