CoM Default Emission Factors for the Southern Mediterranean Partner countries

Dataset Version 2017

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Definition and use of 2017 CoM East default emission factors and BAU coefficients

This document provides an update to the Covenant of Mayors (CoM) default emission factors and an extension of the Business-As-usual Scenario coefficients initially published in Cerutti and Janssens-Maenhout (2013) and Cerutti et al. (2014) Joint Research Centre (JRC) technical reports.

The CoM default emission factors can be used by local authorities in the Southern Mediterranean Partner countries (Algeria, Egypt, Israel, Jordan, Lebanon, Morocco, Palestine, Tunisia) of Covenant of Mayors for Climate and Energy (CoMCE) initiative to estimate their CO_2 or Greenhouse Gas (GHG) emissions due to:

a) local consumption of fossil fuels and non-renewable wastes
b) local consumption of biofuels, biomass, solar thermal and geothermal Renewable energy sources (RES)
c) local electricity production from other RES (wind, hydroelectric, photovoltaics)
d) local electricity consumption

The a) and b) factors 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 (Tables 1 and 2) for the <u>most commonly used energy carriers and RES in Europe.</u> The CoM **Standard default emission factors** are the IPCC (2006) default factors for stationary combustion as in Cerutti et al. (2014). The **LCA default emission factors** have been calculated 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 (Koffi et al., 2017a). 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** (in CO_2 eq), which include CO_2, CH_4 and N_2O have been updated using the 100-year time horizon Global Warming Potential factors from the IPCC four assessment report (IPCC, 2007).

An update of the **National Emission Factors for Electricity consumption (NEFE) to** estimate the emissions from the production of electricity elsewhere that is consumed locally is also provided (Table 3). Annual NEFE values for 1990 to 2013**,** as derived from an extended set of energy data (IEA, 2016), have been calculated for both the standard and LCA approaches (Koffi et al., 2017a). In case of local electricity production (Table 4) and/or purchase of certified green electricity by the local authority, a local emission factor for electricity consumption has to be further assessed from the NEFE by also accounting for the local production and purchase of electricity and the related emissions. The NEFEs using the IPCC approach and accounting for CO_2 emissions (tCO_2/MWh) are provided in Table 3.1, whereas the GHG factors (in tCO_2 eq/MWh), which include CO_2, CH_4 and N_2O emissions, are provided in Table 3.2. The NEFEs using the LCA approach (Table 3.3) were obtained applying the LCA emission factors of Table 1 to the IEA input energy carriers (see Koffi et al., 2017 for details).

The **2030 BAU coefficients** provided in Table 5 (Koffi et al., 2017b), which account for the urbanisation level of the country, can be used by local authorities in the Southern Mediterranean Partner countries of CoMCE to estimate their total CO_2 or Greenhouse Gas (GHG) emissions by 2030. They are estimated from historical EDGAR-CIRCE emission data (Doering et al., 2010) and a BAU forecast scenario from the POLES model (Russ et al., 2007), as explained in Koffi et al. (2017b). These coefficients have to be applied by CoMCE local authorities to their BEI inventory in order to estimate their 2030 CO_2 or GHG emissions.

Further information on the methodology, assumptions, data sources and use of these default emission factors and BAU coefficients is found in Koffi et al. (2017a) and Koffi et al. (2017b) JRC Technical reports, respectively. **Regular updates** of the CoM default emission factors are foreseen, so we recommend checking for the latest version from the JRC COM-EF collection (http://data.jrc.ec.europa.eu/collection/id-0083). It is important not to update these factors during the monitoring phase, because it would affect the evaluation of the mitigation action plan. If local authorities prefer to use and update 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. (2017a) 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 (Koffi et al., 2017a), 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. (2017a) on the use of local versus CoM default emission factors.

Table 3. National Emission factors for electricity consumption for CoM South Mediterranean countries

Table 3.1: CO_2 emissions from Electricity consumption (IPCC approach, tCO_2/MWh) in CoM-South Mediterranean countries

BEI year >	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Algeria	0.851	0.830	0.846	0.827	0.840	0.775	0.831	0.797	0.805	0.884	0.749	0.798	0.777	0.718
Egypt	0.419	0.461	0.475	0.478	0.587	0.565	0.554	0.519	0.546	0.549	0.500	0.483	0.523	0.517
Israel	0.861	0.885	0.978	0.964	0.950	0.903	0.906	0.909	0.864	0.855	0.839	0.899	0.948	0.829
Jordan	0.873	0.790	0.868	0.744	0.760	0.728	0.721	0.718	0.707	0.690	0.667	0.698	0.748	0.763
Lebanon	0.744	0.624	0.802	0.779	0.678	0.656	0.753	0.705	0.789	0.759	0.746	0.762	0.876	0.754
Morocco	0.847	0.880	0.975	0.939	0.950	0.923	0.859	0.790	0.757	0.670	0.693	0.720	0.702	0.632
Palestine	NaN	0.011	0.034	0.095	0.114	0.112	0.074	0.086	0.068	0.075	0.069	0.078	0.063	0.067
Tunisia	0.682	0.605	0.674	0.532	0.517	0.531	0.546	0.573	0.559	0.588	0.583	NaN	0.581	NaN

Table 3.2: GHG emissions from Electricity consumption (IPCC approach, $tCO_{2\text{-eq}}/MWh$) in CoM-South Mediterranean countries

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Algeria	0.852	0.831	0.847	0.828	0.841	0.775	0.832	0.798	0.806	0.885	0.750	0.799	0.778	0.719
Egypt	0.419	0.461	0.476	0.479	0.588	0.565	0.555	0.519	0.547	0.550	0.501	0.484	0.524	0.518
Israel	0.865	0.889	0.982	0.969	0.955	0.907	0.910	0.913	0.868	0.858	0.843	0.903	0.952	0.832
Jordan	0.876	0.792	0.871	0.746	0.762	0.730	0.722	0.719	0.708	0.691	0.668	0.700	0.750	0.765
Lebanon	0.746	0.626	0.805	0.781	0.680	0.659	0.756	0.707	0.791	0.762	0.748	0.765	0.879	0.757
Morocco	0.851	0.885	0.979	0.943	0.955	0.927	0.863	0.794	0.760	0.673	0.696	0.723	0.705	0.635
Palestine	NaN	0.011	0.035	0.095	0.114	0.113	0.074	0.086	0.069	0.075	0.069	0.078	0.063	0.067
Tunisia	0.683	0.606	0.675	0.533	0.518	0.531	0.547	0.574	0.559	0.589	0.583	NaN	0.582	NaN

Table 3.3: GHG emissions from Electricity consumption (LCA approach, $tCO_{2\text{-eq}}/MWh$) in CoM-South Mediterranean countries

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Algeria	1.010	0.986	1.004	0.982	0.997	0.919	0.987	0.947	0.956	1.049	0.889	0.945	0.920	0.849
Egypt	0.494	0.545	0.562	0.566	0.692	0.666	0.653	0.611	0.643	0.646	0.589	0.570	0.616	0.609
Israel	0.925	0.942	1.047	1.032	1.020	0.973	0.976	0.982	0.937	0.926	0.914	0.981	1.030	0.908
Jordan	1.006	0.911	1.000	0.858	0.887	0.852	0.847	0.847	0.835	0.816	0.783	0.808	0.863	0.882
Lebanon	0.854	0.717	0.921	0.894	0.778	0.753	0.864	0.809	0.905	0.871	0.857	0.875	1.005	0.865
Morocco	0.909	0.932	1.041	1.005	1.019	0.992	0.923	0.851	0.820	0.726	0.753	0.784	0.767	0.689
Palestine	NaN	0.012	0.037	0.101	0.122	0.121	0.080	0.093	0.074	0.081	0.075	0.085	0.069	0.073
Tunisia	0.805	0.719	0.796	0.632	0.614	0.630	0.647	0.678	0.662	0.697	0.693	NaN	0.691	NaN

Table 4: Emission factors for local renewable 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. 2017a on the use of local versus CoM default emission factors).

Table 5. 2030 BAU coefficients for CoM South Mediterranean countries

Table 5.1. BAU coefficients to apply to BEI CO_2 emissions (CO_2/yr) in order to assess 2030 emissions in CoM-South Mediterranean countries

	BEI year													
Country	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Algeria	1.97	1.80	1.63	1.46	1.40	1.34	1.29	1.23	1.17	1.16	1.14	1.13	1.11	1.10
Egypt	2.76	2.58	2.41	2.23	2.12	2.01	1.90	1.79	1.68	1.60	1.52	1.44	1.36	1.29
Israel	1.90	1.77	1.73	1.89	1.75	1.67	1.69	1.69	1.69	1.66	1.62	1.58	1.54	1.51
Jordan	2.25	2.13	2.01	1.89	1.89	1.90	1.90	1.91	1.91	1.85	1.79	1.73	1.68	1.62
Lebanon	1.73	1.72	1.71	1.71	1.74	1.77	1.80	1.83	1.86	1.81	1.75	1.69	1.64	1.59
Morocco	2.79	2.67	2.56	2.45	2.36	2.27	2.18	2.09	2.00	1.92	1.84	1.76	1.68	1.61
Palestine*	2.34	2.25	2.17	2.09	2.07	2.05	2.03	2.01	1.99	1.92	1.86	1.80	1.74	1.69
Tunisia	2.42	2.34	2.26	2.17	2.13	2.08	2.03	1.99	1.94	1.86	1.78	1.71	1.64	1.57

	BEI year													
Country	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
Algeria	1.08	1.06	1.05	1.03	1.01	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1.01
Egypt	1.22	1.15	1.08	1.02	0.96	0.97	0.97	0.98	0.98	0.99	0.99	0.99	1.00	1.00
Israel	1.47	1.43	1.40	1.36	1.33	1.29	1.26	1.23	1.20	1.16	1.13	1.09	1.06	1.02
Jordan	1.57	1.51	1.46	1.41	1.36	1.33	1.29	1.26	1.22	1.18	1.14	1.10	1.07	1.03
Lebanon	1.53	1.48	1.43	1.39	1.34	1.30	1.27	1.24	1.20	1.17	1.13	1.10	1.06	1.02
Morocco	1.54	1.47	1.40	1.34	1.28	1.25	1.22	1.19	1.16	1.13	1.10	1.07	1.05	1.02
Palestine*	1.63	1.57	1.52	1.46	1.41	1.37	1.33	1.29	1.25	1.20	1.16	1.12	1.08	1.03
Tunisia	1.50	1.43	1.37	1.31	1.25	1.23	1.19	1.17	1.14	1.12	1.09	1.07	1.05	1.02

* Because activity data from international statistics are scarce for this country, the national BAU factors are based on annual emission shares per sector in the neighbouring countries (see Koffi et al., 2017b for details), whereas the correction for the urban dimension applied to the BAU factors is based on Palestine population statistics.

Table 5.2. BAU coefficients to apply to BEI GHG emissions (CO_2eq/yr) in order to assess 2030 emissions in CoM-South Mediterranean countries

	BEI year													
Country	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Algeria	2.14	1.97	1.81	1.64	1.58	1.51	1.45	1.38	1.32	1.30	1.27	1.25	1.23	1.20
Egypt	2.85	2.68	2.51	2.34	2.24	2.14	2.04	1.94	1.84	1.76	1.67	1.59	1.51	1.43
Israel	1.93	1.81	1.77	1.92	1.79	1.71	1.73	1.72	1.72	1.67	1.63	1.59	1.55	1.51
Jordan	2.30	2.18	2.06	1.94	1.94	1.93	1.93	1.92	1.92	1.85	1.79	1.73	1.67	1.61
Lebanon	1.80	1.79	1.78	1.77	1.79	1.81	1.83	1.85	1.87	1.81	1.75	1.69	1.64	1.58
Morocco	2.84	2.73	2.62	2.51	2.42	2.33	2.24	2.15	2.07	1.98	1.89	1.81	1.73	1.66
Palestine*	2.40	2.31	2.22	2.13	2.10	2.08	2.05	2.03	2.00	1.93	1.87	1.80	1.74	1.68
Tunisia	2.12	2.05	1.98	1.91	1.90	1.89	1.89	1.88	1.87	1.80	1.73	1.66	1.60	1.53

	BEI year													
Country	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
Algeria	1.18	1.16	1.13	1.11	1.08	1.08	1.07	1.07	1.06	1.05	1.04	1.03	1.02	1.01
Egypt	1.36	1.28	1.21	1.14	1.08	1.07	1.07	1.06	1.05	1.05	1.04	1.03	1.02	1.01
Israel	1.47	1.43	1.40	1.36	1.32	1.29	1.26	1.22	1.19	1.16	1.12	1.09	1.06	1.02
Jordan	1.56	1.51	1.45	1.40	1.36	1.32	1.28	1.25	1.20	1.18	1.14	1.10	1.07	1.03
Lebanon	1.53	1.48	1.43	1.38	1.33	1.30	1.27	1.23	1.20	1.16	1.12	1.10	1.06	1.02
Morocco	1.59	1.51	1.45	1.38	1.32	1.28	1.24	1.21	1.17	1.14	1.11	1.08	1.05	1.02
Palestine*	1.62	1.57	1.51	1.46	1.40	1.36	1.32	1.28	1.23	1.20	1.15	1.11	1.07	1.03
Tunisia	1.47	1.41	1.35	1.29	1.24	1.21	1.19	1.16	1.14	1.11	1.09	1.06	1.04	1.02

* Because activity data from international statistics are scarce for this country, the national BAU factors are based on annual emission shares per sector in the neighbouring countries, whereas the correction for the urban dimension applied to the BAU factors is based on Palestine population statistics.

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