10. ΠΑΡΑΡΤΗΜΑ

ANNEX I

Conversion factor and IPCC emission factor tables

TABLE A. BASIC CONVERSION FACTORS				
FROM (MULTIPLY BY)	TO			
	TJ	Mtoe	GWh	MWh
TJ	1	2.388×10^{-5}	0.2778	277.8
Mtoe	4.1868×10^{4}	1	11 630	11 630 000
GWh	3.6	8.6×10^{-5}	1	1 000
MWh	0.0036	8.6×10^{-8}	0.001	1

A unit converter is available at the website of the International Energy Agency (IEA): **http://www.iea.org/stats/unit.asp**

TABLE B. CONVERSION OF FUELS FROM MASS TO ENERGY UNITS (IPCC, 2006)		
FUEL TYPE	NET CALORIFIC VALUE (TJ/Gg)	NET CALORIFIC VALUE (MWh/t)
Crude Oil	42.3	11.8
Orimulsion	27.5	7.6
Natural Gas Liquids	44.2	12.3
Motor Gasoline	44.3	12.3
Aviation Gasoline	44.3	12.3
Jet Gasoline	44.3	12.3
Jet Kerosene	44.1	12.3
Other Kerosene	43.8	12.2
Shale Oil	38.1	10.6
Gas/Diesel Oil	43.0	11.9
Residual Fuel Oil	40.4	11.2
Liquefied Petroleum Gases	47.3	13.1
Ethane	46.4	12.9
Naphtha	44.5	12.4
Bitumen	40.2	11.2
Lubricants	40.2	11.2
Petroleum Coke	32.5	9.0
Refinery Feedstocks	43.0	11.9
Refinery Gas 2	49.5	13.8
Paraffin Waxes	40.2	11.2
White Spirit and SBP	40.2	11.2
Other Petroleum Products	40.2	11.2
Anthracite	26.7	7.4
Coking Coal	28.2	7.8
Other Bituminous Coal	25.8	7.2
Sub-Bituminous Coal	18.9	5.3
Lignite	11.9	3.3
Oil Shale and Tar Sands	8.9	2.5
Brown Coal Briquettes	20.7	5.8
Patent Fuel	20.7	5.8
Coke Oven Coke and Lignite Coke	28.2	7.8
Gas Coke	28.2	7.8
Coal Tar	28.0	7.8
Gas Works Gas	38.7	10.8
Coke Oven Gas	38.7	10.8
Blast Furnace Gas	2.47	0.7
Oxygen Steel Furnace Gas	7.06	2.0
Natural Gas	48.0	13.3
Municipal Wastes (non-biomass fraction)	10.0	2.8
Waste Oil	40.2	11.2
Peat	9.76	2.7

TABLE C. CO_2 EMISSION FACTORS FOR FUELS (IPCC, 2006)

FUEL TYPE	CO_2 EMISSION FACTOR (Kg/ TJ)	CO_2 EMISSION FACTOR (t/MWh)
Crude Oil	73300	0.264
Orimulsion	77000	0.277
Natural Gas Liquids	64200	0.231
Motor Gasoline	69300	0.249
Aviation Gasoline	70000	0.252
Jet Gasoline	70000	0.252
Jet Kerosene	71500	0.257
Other Kerosene	71900	0.259
Shale Oil	73300	0.264
Gas oil/diesel	74100	0.267
Residual Fuel Oil	77400	0.279
Liquefied Petroleum Gases	63100	0.227
Ethane	61600	0.222
Naphtha	73300	0.264
Bitumen	80700	0.291
Lubricants	73300	0.264
Petroleum Coke	97500	0.351
Refinery Feedstocks	73300	0.264
Refinery Gas	57600	0.207
Paraffin Waxes	73300	0.264
White Spirit & SBP	73300	0.264
Other Petroleum Products	73300	0.264
Anthracite	98300	0.354
Coking Coal	94600	0.341
Other Bituminous Coal	94600	0.341
Sub-Bituminous Coal	96100	0.346
Lignite	101000	0.364
Oil Shale and Tar Sands	107000	0.385
Brown Coal Briquettes	97500	0.351
Patent Fuel	97500	0.351
Coke oven coke and lignite Coke	107000	0.385
Gas Coke	107000	0.385
Coal Tar	80700	0.291
Gas Works Gas	44400	0.160
Coke Oven Gas	44400	0.160
Blast Furnace Gas	260000	0.936
Oxygen Steel Furnace Gas	182000	0.655
Natural Gas	56100	0.202
Municipal Wastes (non-biomass fraction)	91700	0.330
Industrial Wastes	143000	0.515
Waste Oil	73300	0.264
Peat	106000	0.382

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Coke oven coke and lignite Coke	107000	0.385
Gas Coke	107000	0.385
Coal Tar	80700	0.291
Gas Works Gas	44400	0.160
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3.4 Electricity

In order to calculate the CO_2 emissions to be attributed to electricity consumption, it is necessary to determine which emission factor is to be used. The same emission factor will be used for all electricity consumption in the territory, including that in rail transportation. The local emission factor for electricity may take the following components into consideration. The contribution of each of them in the estimation of the local emission factor is explained in more detail in the Sections below:

1. National/European emission factor.
2. Local electricity production.
3. Purchases of certified green electricity by the local authority.

Because the estimation of emissions from electricity is based on electricity consumption, the emission factors are expressed as t/MWhe. Therefore, the corresponding activity data to be used has also to be in the form of MWhe, i.e. in MWh of electricity consumed.

3.4.1 National or European emission factor

Electricity is consumed in the territory of each local authority, but the main units that produce it are only concentrated on the territory of a few of them. These major production units are often large CO_2 emitters (in the case of fossil fuel thermal plants), but their electricity production is not meant to cover only the electricity needs of the municipality on which they are built, but the needs of a larger area. In other words, the electricity that is consumed in a particular municipality generally comes from different plants either inside or outside the municipality. As a consequence, the CO_2 that is emitted due to this electricity consumption actually comes from those various plants. To quantify this for each individual municipality would be a challenging task, as the physical flows of electricity cross the borders and vary depending on several factors. In addition, the municipalities in question usually have no control on the emissions of such plants. For these reasons, and keeping in mind that the focus of the Covenant of Mayors is on the demand (consumption) side, it is recommended to use a national or European emission factor as a starting point to determine the local emission factor. This emission factor reflects the average CO_2 emissions related to the national or European electricity production.

The national and European emission factors fluctuate from year to year due to energy mix used in electricity generation. These fluctuations are caused by the heating/cooling demand, availability of renewable energies, energy market situation, import/export of energy and so on. These fluctuations occur independently of the actions taken by the local authority. Therefore, it is recommended to use the same emission factor in the BEI and in the MEI, because otherwise the result of the emission inventory could be very sensitive to factors on which the local authority has no influence.

The local authority may decide to use either a national or European emission factor. The emission factors for standard and LCA approaches are presented in Table 5 for all the Member States (except Malta and Luxembourg for which the data were not available) and the EU as a whole. The local authority is welcome to search for more up-to-date data. Note that LCA emission factors should in all the cases be higher than standard emission factors. However, due to different data sources used and different years covered by the two sets of emission factors, the standard and LCA emission factors are not necessarily comparable, which is especially visible in the cases of Poland and the Czech Republic.

TABLE 5: NATIONAL AND EUROPEAN EMISSION FACTORS FOR CONSUMED ELECTRICITY

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 (8).

(8) *Sources for standard emission factors: Germany: http://www.umweltbundesamt.de/energie/archiv/co2-strommix.pdf (year 2007); Denmark: Average of emission factors for Eastern and Western Denmark including distribution loss of 5%. http://www.energinet.dk/en/menu/Climate+and+the+environment/Environmental+impact+statements+for+electricity/Environmental+impact+statements+for+electricity.htm (year 2008); Estonia: personal communication with Estonian Environment Information Centre (year 2007); Portugal: personal communication with Portuguese Agency for the Environment (year 2007); Slovenia: Personal communication with Environmental Agency of the Republic of Slovenia (year 2007); Slovakia: Personal communication with Slovak Hydrometeorological Institute (year 2007); Spain: personal communication with Ministry of Environment, Spain (year 2007); United Kindom: personal communication with Department of Energy and Climate Change (year 2007); other countries and European average: Eurelectric (2005), (available years 2000-2002). Source for LCA emission factors: European Reference Life Cycle Database (ELCD), http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm (year 2002).*

TABLE 4. STANDARD CO_2 EMISSION FACTORS (FROM IPCC, 2006) AND CO_2-EQUIVALENT LCA EMISSION FACTORS (FROM ELCD) FOR MOST COMMON FUEL TYPES

TYPE	STANDARD EMISSION FACTOR [t CO_2/MWh]	LCA EMISSION FACTOR [t CO_2-eq/MWh]
Motor Gasoline	0.249	0.299
Gas oil, diesel	0.267	0.305
Residual Fuel Oil	0.279	0.310
Anthracite	0.354	0.393
Other Bituminous Coal	0.341	0.380
Sub-Bituminous Coal	0.346	0.385
Lignite	0.364	0.375
Natural Gas	0.202	0.237
Municipal Wastes (non-biomass fraction)	0.330	0.330
Wood (a)	0 – 0.403	0.002 (b) – 0.405
Plant oil	0 (c)	0.182 (d)
Biodiesel	0 (c)	0.156 (e)
Bioethanol	0 (c)	0.206 (f)
Solar thermal	0	- (g)
Geothermal	0	- (g)

If local authorities prefer to use or develop emission factors that better reflect the properties of the fuels used in the territory, they are welcomed to do so. The choice of emission factor used in the BEI has to be consistent with the choice of the emission factor in the MEI.

BOX 2. HOW TO CALCULATE AN EMISSION FACTOR OF A BIOFUEL BLEND?

A biodiesel blend is used in the city, including 5 % of sustainable biodiesel, and the rest conventional diesel oil. Using the standard emission factors, the emission factor for this blend is calculated as

95%*0.267 t CO_2/MWh + 5%*0 t CO_2/MWh = 0.254 t CO_2/MWh

(a) *Lower value if wood is harvested in a sustainable manner, higher if harvesting is unsustainable.*

(b) *The figure reflects the production and local/regional transport of wood, representative for Germany, assuming: spruce log with bark; reforested managed forest; production mix entry to saw mill, at plant; and 44 % water content. The local authority using this emission factor is recommended to check that it is representative for the local circumstances and to develop an own emission factor if the circumstances are different.*

(c) *Zero if the biofuels meet sustainability criteria; fossil fuel emission factors to be used if biofuels are unsustainable.*

(d) *Conservative figure regarding pure plant oil from palm oil. Note that this figure represents the worst ethanol plant oil pathway and does not necessarily represent a typical pathway. This figure does not include the impacts of direct and indirect land use change. Had these been considered, the default value could be as high as 9 t CO_2-eq/MWh, in the case of conversion of forest land in the tropics.*

(e) *Conservative figure regarding biodiesel from palm oil. Note that this figure represents the worst biodiesel pathway and does not necessarily represent a typical pathway. This figure does not include the impacts of direct and indirect land use change. Had these been considered, the default value could be as high as 9 t CO_2-eq/MWh, in the case of conversion of forest land in the tropics.*

(f) *Conservative figure regarding ethanol from wheat. Note that this figure represents the worst ethanol pathway and does not necessarily represent a typical pathway. This figure does not include the impacts of direct and indirect land use change. Had these been considered, the default value could be as high as 9 t CO_2-eq/MWh, in the case of conversion of forest land in the tropics.*

(g) *Data not available, but emissions are assumed to be low (however the emissions from electricity consumption of heat pumps is to be estimated using the emission factors for electricity). Local authorities using these technologies are encouraged to try to obtain such data.*