

## Annex 2.1 Detailed discussion of methodology and data for estimating CO<sub>2</sub> emissions from fossil fuel combustion – stationary combustion

### Correspondence between Energy Balance and the CRF categories

The following sector allocation was applied in the calculation worksheets:

**Table 2. 1 Correspondence between the IEA/EUROSTAT format Energy Balances and the CRF categories**

IEA/EUROSTAT Energy Balance category	CRF category
<b>Transformation Sector</b>	
Main Activity Producer Electricity Plants	1A1a
Main Activity Producer CHP Plants	1A1a
Main Activity Producer Heat Plants	1A1a
Autoproducer Electricity Plants	1A2f
Autoproducer CHP Plants	1A2f
Autoproducer Heat Plants	1A2f
Patent Fuel Plants (Transformation)	
Coke Ovens (Transformation)	
BKB Plants (Transformation)	
Gas Works (Transformation)	
Blast Furnaces (Transformation)	
Coal Liquefaction Plants (Transformation)	
For Blended Natural Gas	
Non-specified (Transformation)	
<b>Energy Sector</b>	
Own Use in Electricity, CHP and Heat Plants	1A1a
Coal Mines	1A1c
Patent Fuel Plants (Energy)	1A1c
Coke Ovens (Energy)	1A1c
BKB Plants (Energy)	1A1c
Gas Works (Energy)	
Blast Furnaces (Energy)	1A2a
Petroleum Refineries	1A1b
Coal Liquefaction Plants (Energy)	
Non-specified (Energy)	1A1c
<b>Industry Sector</b>	
Iron and Steel	1A2a

Chemical (including Petrochemical)	1A2c
Non-Ferrous Metals	1A2b
Non-Metallic Minerals	1A2f
Transport Equipment	1A2f
Machinery	1A2f
Mining and Quarrying	1A2f
Food, Beverages and Tobacco	1A2e
Paper, Pulp and Printing	1A2d
Wood and Wood Products	1A2f
Construction	1A2f
Textiles and Leather	1A2f
Non-specified (Industry)	1A2f
<b>Other Sectors</b>	
Commercial and Public Services	1A4a
Residential	1A4b
Agriculture/Forestry	1A4c
Fishing	1A4c
Non-specified (Other)	1A5a
<b>LIQUID FUELS</b>	<b>CRF category</b>
Refinery Fuel	1A1b
Energy Use in Petrochemical Sector	1A2c
<b>Transformation Sector</b>	
Main Activity Producer Electricity Plants	1A1a
Autoproducer Electricity Plants	1A2f
Main Activity Producer CHP Plants	1A1a
Autoproducer CHP Plants	1A2f
Main Activity Producer Heat Plants	1A1a
Autoproducer Heat Plants	1A2f
Gas Works (Transformation)	
For Blended Natural Gas	
Coke Ovens (Transformation)	
Blast Furnaces (Transformation)	
Petrochemical Industry	
Patent Fuel Plants (Transformation)	
Non-specified (Transformation)	
<b>Energy Sector</b>	
Coal Mines	1A1c
Oil and Gas Extraction	1A1c
Coke Ovens (Energy)	1A1c

Blast Furnaces (Energy)	1A2a
Gas Works (Energy)	
Own Use in Electricity, CHP and Heat Plants	1A1a
Non-specified (Energy)	1A1c
<b>Industry Sector</b>	
Iron and Steel	1A2a
Chemical (including Petrochemical)	1A2c
Non-Ferrous Metals	1A2b
Non-Metallic Minerals	1A2f
Transport Equipment	1A2f
Machinery	1A2f
Mining and Quarrying	1A2f
Food, Beverages and Tobacco	1A2e
Paper, Pulp and Printing	1A2d
Wood and Wood Products	1A2f
Construction	1A2f
Textiles and Leather	1A2f
Non-specified (Industry)	1A2f
<b>Other Sectors</b>	
Commercial and Public Services	1A4a
Residential	1A4b
Agriculture/Forestry	1A4c
Fishing	1A4c
Non-specified (Other)	1A5a
<b>GASEOUS FUELS</b>	<b>CRF category</b>
<b>Transformation Sector</b>	
Main Activity Producer Electricity Plants	1A1a
Autoproducer Electricity Plants	1A2f
Main Activity Producer CHP Plants	1A1a
Autoproducer CHP Plants	1A2f
Main Activity Producer Heat Plants	1A1a
Autoproducer Heat Plants	1A2f
Gas Works (Transformation)	
Coke Ovens (Transformation)	
Blast Furnaces (Transformation)	
Gas-to-Liquids (GTL) Plants (Transformation)	
Non-specified (Transformation)	
<b>Energy Sector</b>	
Coal Mines	1A1c

Oil and Gas Extraction	1A1c
Petroleum Refineries	1A1b
Coke Ovens (Energy)	1A1c
Blast Furnaces (Energy)	1A2a
Gas Works (Energy)	
Own Use in Electricity, CHP and Heat Plants	1A1a
Liquefaction (LNG) / Regasification Plants	
Gas-to-Liquids (GTL) Plants (Energy)	
Non-specified (Energy)	1A1c
<b>Industry Sector</b>	
Iron and Steel	1A2a
Chemical (including Petrochemical)	1A2c
Non-Ferrous Metals	1A2b
Non-Metallic Minerals	1A2f
Transport Equipment	1A2f
Machinery	1A2f
Mining and Quarrying	1A2f
Food, Beverages and Tobacco	1A2e
Paper, Pulp and Printing	1A2d
Wood and Wood Products	1A2f
Construction	1A2f
Textiles and Leather	1A2f
Non-specified (Industry)	1A2f
<b>Other Sectors</b>	
Commercial and Public Services	1A4a
Residential	1A4b
Agriculture/Forestry	1A4c
Fishing	1A4c
Non-specified (Other)	1A4c
Total Final Consumption (Non-Energy Use)	

<b>Biomass and Other Fuels</b>	<b>CRF category</b>
<b>Transformation</b>	
Main activity producer electricity plants	1A1a
Autoproducer electricity plants	1A2f
Main activity producer CHP plants	1A1a
Autoproducer CHP plants	1A2f

Main activity producer heat plants	1A1a
Autoproducer heat plants	1A2f
Heat pumps	
Electric boilers	
Chemical heat for electricity production	
Patent fuel plants	1A1c
Coke ovens	
Gas works	
Blast furnaces	1A2a
Petrochemical plants	
BKB plants	
Oil refineries	
Coal liquefaction plants	
Gas-to-liquids (GTL) plants	
For blended natural gas	
Charcoal production plants	
Non-specified (transformation)	
<b>Energy industry own use</b>	
Coal mines	1A1c
Oil and gas extraction	
Patent fuel plants	1A1c
Coke ovens	1A1c
Gas works	
Gasification plants for biogas	
Blast furnaces	1A2a
BKB plants	1A1c
Oil refineries	
Coal liquefaction plants	
Liquefaction (LNG) / regasification plants	
Gas-to-liquids (GTL) plants	

Own use in electricity, CHP and heat plants	1A1a
Used for pumped storage	
Nuclear industry	
Charcoal production plants	
Non-specified (energy)	
<b>Industry</b>	
Iron and steel	1A2a
Chemical and petrochemical	1A2c
Non-ferrous metals	1A2b
Non-metallic minerals	1A2f
Transport equipment	1A2f
Machinery	1A2f
Mining and quarrying	1A2f
Food and tobacco	1A2e
Paper, pulp and print	1A2d
Wood and wood products	1A2f
Construction	1A2f
Textile and leather	1A2f
Non-specified (industry)	1A2f
<b>Other</b>	
Residential	1A4b
Commercial and public services	1A4a
Agriculture/forestry	1A4c
Fishing	1A4c
Non-specified (other)	1A5a

For the sectoral approach all fuels for which there was reported energy consumption were considered. These fuels are:

**Solid fuels:**

- Anthracite,
- Coking Coal,
- Other Bituminous Coal,
- Sub-bituminous Coal,
- Lignite/Brown Coal,
- Coke Oven Coke,
- Patent Fuel,
- BKB/PB,
- Coke Oven Gas,
- Blast Furnace Gas,
- Peat.

**Liquid fuels:**

- Crude Oil,
- Refinery Gas,
- LPG,
- Motor Gasoline,
- Aviation Gasoline,
- Kerosene Type Jet Fuel,
- Transport Diesel,
- Residual Fuel Oil,
- Petroleum Coke,
- Other Products,
- Natural Gas Liquids,
- Naphtha,
- Other Kerosene,
- Heating and Other Gasoil,

- White Spirit & SBP.

**Gaseous fuels:**

- Natural Gas Dry

**Other Fuels:**

- Industrial Wastes

**Biomass:**

- Solid biomass,
- Gas biomass.

The Net Calorific Values (NCVs) were provided in the Energy Balances (see the Annex 4.2).

For the solid fuels, the NCVs were applied to the appropriate sectors, according to the following allocation:

<b>IEA/EUROSTAT Energy Balance category</b>	<b>NCVs</b>
Indigenous Production	
Underground Production	
Surface Production	
From Other Sources	
From Other Sources - Oil	
From Other Sources - Natural Gas	
From Other Sources - Renewables	
Total Imports (Balance)	
Total Exports (Balance)	
International Marine Bunkers	
Stock Changes (National Territory)	
Inland Consumption (Calculated)	
Statistical Differences	
<b>Transformation Sector</b>	
Main Activity Producer Electricity Plants	Used in Main Activity Plants (net)
Main Activity Producer CHP Plants	Used in Main Activity Plants (net)
Main Activity Producer Heat Plants	Used in Main Activity Plants (net)



Autoproducer Electricity Plants	Used in industry (net)
Autoproducer CHP Plants	Used in industry (net)
Autoproducer Heat Plants	Used in industry (net)
Patent Fuel Plants (Transformation)	
Coke Ovens (Transformation)	
BKB Plants (Transformation)	
Gas Works (Transformation)	
Blast Furnaces (Transformation)	
Coal Liquefaction Plants (Transformation)	
For Blended Natural Gas	
Non-specified (Transformation)	
<b>Energy Sector</b>	
Own Use in Electricity, CHP and Heat Plants	Used in Main Activity Plants (net)
Coal Mines	Production (net)
Patent Fuel Plants (Energy)	Production (net)
Coke Ovens (Energy)	Used in coke ovens (gross)
BKB Plants (Energy)	Production (net)
Gas Works (Energy)	
Blast Furnaces (Energy)	Used in blast furnaces (net)
Petroleum Refineries	Used in industry (net)
Coal Liquefaction Plants (Energy)	
Non-specified (Energy)	For Other Uses (net)
Distribution Losses	
Total Final Consumption	
Total Non-Energy Use	
Non-Energy Use	
Industry/Transformation/Energy	
Of which: Non-Energy Use- Chemical/Petrochem	
Non-Energy Use in Transport	
Non-Energy Use in Other Sectors	
Final Energy Consumption	
<b>Industry Sector</b>	
Iron and Steel	Used in industry (net)
Chemical (including Petrochemical)	Used in industry (net)
Non-Ferrous Metals	Used in industry (net)
Non-Metallic Minerals	Used in industry (net)
Transport Equipment	Used in industry (net)
Machinery	Used in industry (net)
Mining and Quarrying	Used in industry (net)
Food, Beverages and Tobacco	Used in industry (net)
Paper, Pulp and Printing	Used in industry (net)
Wood and Wood Products	Used in industry (net)

Construction	Used in industry (net)
Textiles and Leather	Used in industry (net)
Non-specified (Industry)	Used in industry (net)
<b>Other Sectors</b>	
Commercial and Public Services	For Other Uses (net)
Residential	For Other Uses (net)
Agriculture/Forestry	For Other Uses (net)
Fishing	For Other Uses (net)
Non-specified (Other)	For Other Uses (net)

The emission factors for the analyzed fuels were applied as default, using Tier 1 approach, according with the IPCC provision (IPCC 1996 Guidelines, Vol. II, Ch. 1, Table 1-2).

For the following fuels were applied country specific emission factors, in order to have Tier 2 of approach:

- Lignite,
- Natural gas,
- Refinery gas,
- Other bituminous coal,
- Coking coal,
- Transport diesel,
- Residual fuel oil,
- Heating and other gasoil,
- Petroleum Coke,
- Motor gasoline<sup>\*</sup>.

\* For the motor gasoline fuel the country specific emission factor was calculated based on the carbon content provided by the Romanian Ministry of Economy.

Based on European Union Emission Trading Scheme (EU-ETS) reporting of the fuel consumption, estimated emissions and plant specific emission factors, the Study “Elaboration/documentation of national emission factors/other parameters relevant to National Greenhouse Gas Inventory (NGHGI) Sectors Energy, Industrial Processes, Agriculture and

Waste, values to allow for the higher tier calculation methods implementation” calculated the country specific emission factors (EFs), as they are presented in the following table:

**Table 2. 2 The determination of the country-specific CO<sub>2</sub> emission factors for Stationary Combustion, based on EU-ETS reporting**

Lignite														
Year	2007			2008			2009			2010			2007-2010	
Activity category	Cons. [TJ]	EF Ox [t/TJ]	EF [t/TJ]	Consum. [TJ]	EF Ox [t/TJ]	EF [t/TJ]	Consum. [TJ]	EF Ox [t/TJ]	EF [t/TJ]	Consum. [TJ]	EF Ox [t/TJ]	EF [t/TJ]	EF Ox [t/TJ]	EF [t/TJ]
1A1a	287953.48	97.80	102.14	246127.88	94.23	98.87	257449.45	91.65	97.70	238482.43	89.04	96.55	93.38	98.96
Total consum./ WA EF	287953.48	97.80	102.14	246127.88	94.23	98.87	257449.45	91.65	97.70	238482.43	89.04	96.55	93.38	98.96
Carbon content [t/TJ]			27.86			26.96			26.65			26.33		26.99
Natural gas														
1A1a	130182.27	54.56	55.21	122442.29	55.99	55.99	106474.52	55.65	55.66	87758.47	55.46	55.52	55.39	55.59
1A1b	24917.25	54.16	54.64	23505.77	55.74	54.67	8911.51	56.61	56.60	13482.61	55.38	57.68	55.23	55.48
1A1c	8802.84	56.74	57.02	6970.53	56.33	56.33	5908.98	56.56	56.57	8157.29	56.34	56.34	56.50	56.58
1A2a	9495.49	55.13	55.40	8865.92	55.34	55.34	12566.23	52.57	55.17	7975.65	55.34	55.39	54.39	55.31
1A2b	2296.33	55.05	55.33	1688.23	55.23	55.22	1427.02	56.10	56.14	7625.33	53.63	56.11	54.36	55.86
1A2c	48829.94	54.95	55.08	62007.09	55.05	55.19	49497.72	54.82	54.86	14811.14	55.71	55.71	55.01	55.11
1A2d	2227.36	54.81	55.08	2450.66	55.44	55.29	1564.17	55.31	55.31	1948.09	55.26	55.27	55.20	55.23
1A2e	755.64	54.75	54.44	1677.58	55.29	55.29	1910.85	55.49	55.50	1613.42	55.19	55.19	55.26	55.22
1A2f	8111.37	54.98	55.40	16184.36	55.15	55.16	12422.24	55.40	55.41	13586.45	55.53	55.47	55.29	55.35
Total consum./ WA EF	235618.49	54.73	55.20	245792.42	55.65	55.58	200683.24	55.31	55.49	156958.46	55.43	55.78	55.27	55.49
Carbon content [t/TJ]			15.05			15.16			15.13			15.21		15.13

Refinery gas														
Year	2007			2008			2009			2010			2007-2010	
Activity category	Consum. [TJ]	EF Ox [t/TJ]	EF [t/TJ]	Consum. [TJ]	EF Ox [t/TJ]	EF [t/TJ]	Consum. [TJ]	EF Ox [t/TJ]	EF [t/TJ]	Consum. [TJ]	EF Ox [t/TJ]	EF [t/TJ]	EF Ox [t/TJ]	EF [t/TJ]
1A1a	-	-	-	-	-	-	-	-	-	3452.43	55.33	55.33	55.33	55.33
1A1b	15757.70	54.89	55.12	8546.89	56.92	54.05	6820.88	58.00	57.99	11788.05	57.59	58.03	56.53	56.16
Total consum./ WA EF	15757.70	54.89	55.12	8546.89	56.92	54.05	6820.88	58.00	57.99	15240.48	57.08	57.42	56.44	56.10
Carbon content [t/TJ]			15.03			14.74			15.82			15.66		15.30
Other bituminous coal														
1A1a	3725.63	92.00	92.44	9287.90	89.22	91.12	3747.13	94.81	94.81	2538.18	97.44	97.83	91.92	92.97
1A2f	2344.60	94.51	94.50	10185.64	97.28	97.28	9211.78	95.34	95.37	8506.84	96.92	94.00	96.37	95.56
Total consum./ WA EF	6070.23	92.97	93.24	19473.54	93.43	94.34	12958.91	95.19	95.20	11045.02	97.04	94.88	94.64	94.55
Carbon content [t/TJ]			25.43			25.73			25.96			25.88		25.79

Coking coal														
Year	2007			2008			2009			2010			2007-2010	
Activity category	Consum. [TJ]	EF Ox [t/TJ]	EF [t/TJ]	Consum. [TJ]	EF Ox [t/TJ]	EF [t/TJ]	Consum. [TJ]	EF Ox [t/TJ]	EF [t/TJ]	Consum. [TJ]	EF Ox [t/TJ]	EF [t/TJ]	EF Ox [t/TJ]	EF [t/TJ]
1A2e	62.54	92.06	92.92	59.75	84.46	84.33	114.67	92.97	92.89	80.36	92.65	92.65	91.11	91.22
Total consum./ WA EF	62.54	92.06	92.92	59.75	84.46	84.33	114.67	92.97	92.89	80.36	92.65	92.65	91.11	91.22
Carbon content [t/TJ]			25.34			23.00			25.33			25.27		24.88
Transport diesel														
1A1a	0.14	73.25	74.00	13.98	77.53	72.07	21.16	74.22	74.04	12.79	73.29	72.75	74.93	73.12
1A1b	79.84	73.95	74.00	56.85	72.42	72.42	0.00	0.00	0.00	0.00	0.00	0.00	73.31	73.34
Total consum./ WA EF	79.97	73.95	74.00	70.83	73.43	72.35	21.16	74.22	74.04	12.79	73.29	72.75	73.74	73.29
Carbon content [t/TJ]			20.18			19.73			20.19			19.84		19.99
Residual fuel oil														
1A1a	10436.38	77.73	78.42	7907.01	77.68	77.67	13350.49	77.73	77.69	6322.92	79.07	79.07	77.94	78.12
1A1b	10467.17	78.15	78.45	8795.24	75.87	75.76	5931.30	78.46	78.42	4923.55	80.75	80.71	77.97	78.03
1A2b	441.36	79.71	80.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	79.71	80.10
1A2d	126.83	85.98	86.40	240.45	84.59	84.86	0.00	0.00	0.00	0.00	0.00	0.00	85.07	85.39
1A2e	1813.26	78.95	79.29	491.29	78.54	78.54	378.97	80.42	80.38	226.07	75.07	75.07	78.77	78.98
1A2f	-	-	-	297.72	75.24	75.74	20.44	78.31	78.31	39.62	78.31	78.31	75.76	76.17
Total consum./ WA EF	23285.01	78.09	78.58	17731.71	76.86	76.81	19681.21	78.00	77.97	11512.17	79.71	79.69	78.02	78.15
Carbon content [t/TJ]			21.43			20.95			21.26			21.73		21.31

Heating and other gasoil														
Year	2007			2008			2009			2010			2007-2010	
Activity category	Consum. [TJ]	EF Ox [t/TJ]	EF [t/TJ]	Consum. [TJ]	EF Ox [t/TJ]	EF [t/TJ]	Consum. [TJ]	EF Ox [t/TJ]	EF [t/TJ]	Consum. [TJ]	EF Ox [t/TJ]	EF [t/TJ]	EF Ox [t/TJ]	EF [t/TJ]
1A1a	5.41	74.96	74.95	6.33	79.97	79.12	103.42	74.65	74.45	110.68	73.67	73.66	74.32	74.20
1A2e	3.59	73.46	73.73	1.74	73.17	73.30	0.00	0.00	0.00	0.87	73.71	73.30	73.41	73.55
Total consum./ WA EF	9.00	74.36	74.46	8.06	78.50	77.87	103.42	74.65	74.45	111.55	73.67	73.66	74.30	74.19
Carbon content [t/TJ]			20.31			21.24			20.30			20.09		20.23
Petroleum Coke														
1A2f	-	-	-	12515.24	94.52	94.34	5935.62	91.85	91.85	4548.26	94.02	94.02	93.73	93.63
Total consum./ WA EF	-	-	-	12515.24	94.52	94.34	5935.62	91.85	91.85	4548.26	94.02	94.02	93.73	93.63
Carbon content [t/TJ]			-			25.73			25.05			25.64		25.54

where:

EF Ox - emission factor with oxidation included

EF - emission factor without oxidation

WA EF - weighted average of the emission factors