Summary Report

The Study of emission factor for an electricity system in Thailand 2009

Rationale

Thailand realizes the seriousness of climate change as a global threat and it has been contributing to international efforts to address climate change issues. Thailand ratified the United Nations Framework Convention on Climate Change (UNFCCC) on 28th December 1994 and the Kyoto Protocol on 28th August 2002. As a Non-Annex I country, Thailand promotes the implementation of the **Clean Development Mechanisms (CDM)** under the Kyoto Protocol in order to encourage clean and environmental friendly technologies for greenhouse gas reduction in the country, as well as to promote the country's capability by developing sustainable business practices.

Thailand Greenhouse Gas Management Organization (TGO) (Public Organization) was established by Royal Decree on Establishment of Thailand Greenhouse Gas Management Organization (Public Organization) BE 2550 (2007). It is presently a public organization under the Ministry of Natural Resources and Environment (MNRE). Besides being the Designated National Authority for CDM (DNA-CDM) in Thailand, which is responsible for reviewing CDM projects for approval, TGO also has other roles including as an implementing agency on greenhouse gas (GHG) emission reduction in Thailand, promoting: low carbon activities; investment and marketing on GHG emission reductions; establishing GHG information centre; providing capacity development and outreach for CDM stakeholders and promote low carbon activities.

Calculations of emission reductions of CDM projects that produce electricity and export to the national grid must use an Emission Factor that represents the quantity of CO2 emitted by the electricity system. Project developers can choose the calculation method and calculate the Emission Factor on their own. However, the self-calculated Emission Factor sometimes causes problems in the validation process. In order to facilitate the project development and get the accurate amount of emission reduction, TGO set up a working group to study the Emission Factor for an electricity system in Thailand in 2009. The results of the study are as following:

Calculation of the Emission Factor for an electricity system

The Emission Factor can be calculated by using **Annex 14 Methodological Tool (Version 02) "Tool to calculate the emission factor for an electricity system"** which had been approved by the CDM Executive Board on October 16, 2009 (EB 50). Parameters of this method are listed below.

Parameter	SI Unit	Description
$EF_{grid,CM,y}$	tCO_2/MWh	Combined margin CO_2 emission factor for the project electricity system in year *y*
$EF_{grid,OM,y}$	tCO_2/MWh	Operating margin CO_2 emission factor for the project electricity system in year *y*
$EF_{grid,BM,y}$	tCO_2/MWh	Build margin CO_2 emission factor for the project electricity system in year *y*

The calculated Emission Factor can be used for the calculation of emission reductions of CDM projects that produce electricity and export to the national grid.

Delineation of connected electricity system

The electricity transmission system of Thailand is considered as a single system since the transmission lines are networked throughout the country and owned by the Electricity Generating Authority of Thailand (EGAT). EGAT is the authority that controls electricity generation and distribution in Thailand, whereas the Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA) are the authorities that supply the electricity to the users in Bangkok and provinces, respectively.

Method to determine the operating margin (OM)

The calculation of the operating margin emission factor (*EFgrid,OM,y*) is based on one of the following methods:

1) Simple OM
2) Simple Adjusted OM
3) Dispatch Data Analysis OM
4) Average OM

According to Thailand's data, the simple OM method (Ex ante Option) is the most appropriate method. This method requires the latest 3 years data including quantity of electricity generated, fuel types used and fuel consumption of each fuel type. This study used data obtained in the years 2007 – 2009 due to the following reasons:

1. In Thailand, the generated electricity that is transferred to the national grid is the only available data. Thus, it is not possible to obtain off-grid electricity generation data.

2. Low-cost/must-run (LC/MR) power plants include hydro and renewable power plants. The quantity of electricity generated by these power plants is not included in the calculation because it is less than 50% of total grid generation.

The Operating margin emission factor can be calculated by using Simple OM Option B as the following equation 1:

$$EF_{grid,OMsimple,y} = \frac{\sum_i \left(FC_{i,y} \times NCV_{i,y} \times EF_{CO_2,i,y}\right)}{EG_y} \qquad (1)$$

$EF_{grid,OMsimple,y}$	=	Simple operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
$FC_{i,y}$	=	Amount of fossil fuel type *i* consumed in the project electricity system in year *y* (mass or volume unit)
$NCV_{i,y}$	=	Net Calorific value (energy content) of fossil fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{CO_2,i,y}$	=	CO_2 emission factor of fossil fuel type *i* in year *y* (tCO_2/GJ)
EG_y	=	Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost/must run power plants/units, in year *y* (MWh)
i	=	All fossil fuel types combusted in power sources in the project electricity system in year *y*
y	=	The relevant year as per the data vintage chosen

The values of CO_2 emission from combustion of fossil fuel (per unit of fossil fuel) are shown in Table 1. Net Calorific Value (NCV) is obtained from data provided by the Department of Alternative Energy Development and Efficiency, Ministry of Energy. The CO_2 Emission Factor of fossil fuel follows IPCC default values as specified in the *2006 IPCC Guidelines for National Greenhouse Gas Inventories*.

Table 1 Net Calorific Value and CO_2 emission per unit of each type of fossil fuel

Fuel type [A]	Unit	Net Calorific Value [1] (MJ/Unit)	CO_2 Emission [2] (tCO_2/TJ)	CO_2 Emission ($kgCO_2/Unit$)
Natural Gas	scf.	1.02	54.30	0.0554
Lignite	ton	10,470.00	90.90	951.7230
Bituminous	ton	26,370.00	89.50	2,360.1150
Bunker	liter	39.77	75.50	3.0026
Diesel	liter	36.42	72.60	2.6441

[1] Electric Power in Thailand 2008/ Department of Alternative Energy Development and Efficiency, Ministry of Energy

[2] IPCC default values at the lower limit as provide in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

[A] See Table: Comparison of name of fuel type

The quantity of electricity generated and delivered to the national grid can be obtained from the Electricity Report 2007 – 2009 published by the Electricity Generating Authority of Thailand as shown in Table 2. Data are categorized by electricity generation system, type of power plant and quantity of electricity generated by LC/MR and Non LC/MR power plants. Type of power plant includes the power plant of the Electricity Generating Authority of Thailand, Independent Power Producers (IPPs) and Small Power Producers (SPPs).

Quantity and type of fossil fuel consumed in electricity generation are also obtained from the Electricity Report 2007 – 2009 published by the Electricity Generating Authority of Thailand as shown in Table 3.

VSPP power plants use renewable energy including biogas, biomass, hydro, wind and solar energy and are considered as low-cost/must-run power plants. However, a VSPP power plant is non-firm and can supply only a small quantity of electricity to the grid compared to other power plants. In 2009, the amount of electricity that VSPP power plants sold to the Provincial Electricity Authority was 974.47 GWh [3] (0.67% of the total electricity generated in 2009). Thus, this study does not include electricity generated by VSPP in the calculation of total electricity in the national grid. The total amount of electricity exported to the national grid (only Non LC/MR) in the years 2007 – 2009 was 406,291.70 GWh.

[3] Provincial Electricity Authority: PEA

Table 2 Quantity of electricity generated and delivered to the national grid [4]

Generation System	Grid Generation (GWh)				
	EGAT	IPP	SPP	Total	%
2009					
Summary	66,488.10	64,840.72	13,971.37	145,300.19	100.00
Non LC/MR	59,541.66	64,840.72	11,811.42	136,193.80	93.73
LC/MR [5]	6,946.44	—	2,159.95	9,106.39	6.27
Thermal	23,463.69	12,388.03	2,225.63	38,077.35	
Combined-Cycle	33,164.46	52,452.69	8,752.19	94,369.35	
Gas Turbine	309.63	—	833.60	1,143.23	
Diesel Engine	1.44	—	—	1.44	
Hydropower	6,941.74	—	23.97	6,965.71	
Renewable Energy	4.70	—	2,135.98	2,140.68	
Electricity Import	2,602.43	—	—	2,602.43	
2008					
Summary	63,719.02	67,420.14	14,092.83	145,232.00	100.00
Non LC/MR	56,791.19	67,420.14	11,904.81	136,116.14	93.72
LC/MR	6,927.83	—	2,188.03	9,115.86	6.28
Thermal	26,778.89	14,398.34	1,996.83	43,174.06	
Combined-Cycle	26,449.20	53,021.80	9,029.90	88,500.90	
Gas Turbine	659.33	—	878.07	1,537.41	
Diesel Engine	2.30	—	—	2.30	
Hydropower	6,926.02	—	28.77	6,954.79	
Renewable Energy	1.81	—	2,159.26	2,161.07	
Electricity Import	2,901.47	—	—	2,901.47	
2007					
Summary	67,704.95	62,233.44	14,426.00	144,364.39	100.00
Non LC/MR	59,765.33	62,233.44	11,982.99	133,981.76	92.81
LC/MR	7,939.62	—	2,443.02	10,382.64	7.19
Thermal	30,265.00	17,453.59	2,168.76	49,887.35	
Combined-Cycle	24,124.09	44,779.85	8,935.60	77,839.54	
Gas Turbine	884.20	—	878.63	1,762.83	
Diesel Engine	1.17	—	—	1.17	
Hydropower	7,937.20	—	21.70	7,958.90	
Renewable Energy	2.42	—	2,421.32	2,423.73	
Electricity Import	4,490.87	—	—	4,490.87	

[4] Electricity report 2007 – 2009/ Electricity Generating Authority of Thailand

[5] LC/MR power plants include hydropower and renewable energy (including biomass, solar and geothermal power)

Table 3 Amount of fossil fuel consumed by power plants[6]

Fuel type	Unit	Fuel Consumption			
		EGAT	IPP	SPP	Total
2009					
Natural Gas	scf.	369,146,214,392	459,228,417,361	140,550,086,056	968,924,717,809
Lignite	ton	15,818,265	—	—	15,818,265
Bituminous	ton	—	3,645,721	1,840,527	5,486,248
Bunker	liter	111,039,065	38,180,874	8,797,506	158,017,445
Diesel	liter	12,140,891	—	1,685,046	13,825,937
2008					
Natural Gas	scf.	340,739,529,461	490,866,999,785	145,410,364,035	977,016,893,281
Lignite	ton	16,407,465	—	—	16,407,465
Bituminous	ton	—	3,711,791	1,866,776	5,578,567
Bunker	liter	247,441,682	93,212,260	9,555,452	350,209,394
Diesel	liter	6,792,039	43,698,832	1,451,087	51,941,958
2007					
Natural Gas	scf.	342,335,310,261	454,590,745,280	145,512,075,117	942,438,130,658
Lignite	ton	16,060,766	—	—	16,060,766
Bituminous	ton	—	3,692,979	1,889,868	5,582,847
Bunker	liter	785,979,152	144,198,973	6,042,880	936,221,005
Diesel	liter	7,381,996	2,688,851	1,266,337	11,337,184

[6] Electricity report 2007 – 2009/ Electricity Generating Authority of Thailand

Table 4 shows the calculated CO_2 emission from electricity generation in the years 2007 - 2009 categorized by fuel types. The total emissions during the 3-years period (2007-2009) were 249,762,588 tCO_2.

The Operating Margin Emission Factor (Ex ante option) calculated by using equation 1 is shown in Table 5. The value is 0.6147 tCO_2/MWh (614.70 gCO_2/kWh).

Table 4 CO_2 emission from electricity generation in the years 2007 - 2009

Fuel type	Fuel Consumption		CO_2 Emission ($kgCO_2$/Unit)	CO_2 Emission ($kgCO_2$)
	Unit	Volume		
2009				
Total				82,178,673
Natural Gas	scf.	968,924,717,809	0.0554	53,664,864
Lignite	ton	15,818,265	951.7230	15,054,607
Bituminous	ton	5,486,248	2,360.1150	12,948,176
Bunker	liter	158,017,445	3.0026	474,469
Diesel	liter	13,825,937	2.6441	36,557
2008				
Total				84,083,369
Natural Gas	scf.	977,016,893,281	0.0554	54,113,058
Lignite	ton	16,407,465	951.7230	15,615,362
Bituminous	ton	5,578,567	2,360.1150	13,166,060
Bunker	liter	350,209,394	3.0026	1,051,551
Diesel	liter	51,941,958	2.6441	137,339
2007				
Total				83,500,546
Natural Gas	scf.	942,438,130,658	0.0554	52,197,878
Lignite	ton	16,060,766	951.7230	15,285,400
Bituminous	ton	5,582,847	2,360.1150	13,176,161
Bunker	liter	936,221,005	3.0026	2,811,130
Diesel	liter	11,337,184	2.6441	29,977

Table 5 Operating Margin Emission Factor (Ex ante option)

Year	CO_2 Emission (tCO_2)	Grid Consumption (GWh)	OM Emission Factor (tCO_2/MWh)
2009	82,178,673	136,193.80	0.6034
2008	84,083,369	136,116.14	0.6177
2007	83,500,546	133,981.76	0.6232
Summary	249,762,588	406,291.70	0.6147

Method to determine the Build Margin (BM)

Group of power units that are included in the build margin must be identified. The sample group of power units used to calculate the build margin consists of either:

1) The set of five power units that have been built most recently; or

2) The set of power capacity additions in the electricity system that comprise 20% of the system generation and that have been built most recently sorted by Commercial Operation Date (COD) which is the date when the power plant starts to supply electricity to the grid.

The set of power units that comprises the larger annual generation must be used. According to Thailand's data, the first option can generate less electricity than the second option, thus this study uses the quantity of electricity generation of the second option as listed in Table 6. Fuel consumptions of these power plants are shown in Table 7.

Table 6 Electricity generation by the most recently built power plants [7]

Power Unit	Grid Generation [7] (GWh)	COD
1. Bangpakong Power Plant (Unit 05)	1,918.11	16-Sep-09
2. South Bangkok Power Plant (Unit 03)	4,745.32	1-Mar-09
3. Chana Power Plant (Unit 01)	4,150.26	15-Jul-08
4. Ratchaburi Power Company Limited (RPCL) (Unit 1&2)	8,153.26	1-Jun-08
5. Gulf Power Generation Co., Ltd. (Unit 1&2)	9,338.68	1-Mar-08
6. BLCP Power Co., Ltd. (Unit 1&2)	10,018.13	1-Feb-07
Summary	38,323.76	
Percentage as of 2009 Grid Generation (145,300.19 GWh)	26.38	

[7] Electricity report 2009/ Electricity Generating Authority of Thailand

Table 7 Fuel consumptions of the most recently built power plants as listed in Table 6 [8]

Fuel type	Fuel Consumption		CO_2 Emission ($kgCO_2$/Unit)	CO_2 Emission (tCO_2)
	Unit	Volume		
Total				20,991,690
Natural Gas	scf.	223,467,679,056	0.0554	12,376,981
Lignite	ton	—	951.7230	—
Bituminous	ton	3,645,721	2,360.1150	8,604,321
Bunker	liter	—	3.0026	—
Diesel	liter	3,929,038	2.6441	10,389

[8] Electricity report 2009/ Electricity Generating Authority of Thailand

As shown in Table 6, electricity generated by the most recently built power plants is 38,323.76 GWh (26.38% of the total electricity generated in 2009 which is 145,300.19 GWh). Fuel consumptions of the most recently built power plants as listed in Table 7 emit CO_2 20,991,690 ton. The Build Margin Emission Factor calculated by using equation 1 is shown in Table 8. The value is 0.5477 tCO_2/MWh (547.70 gCO_2/kWh).

Table 8 Calculation of Build Margin Emission Factor

Year	CO_2 Emission (tCO_2)	Grid Consumption (GWh)	BM Emission Factor (tCO_2/MWh)
2009	20,991,690	38,323.76	0.5477

Method to determine the Combined Margin (CM)

The Combined Margin Emission Factor can be calculated by using equation 2

$$EF_{grid,CM,y} = \left(EF_{grid,OM,y} \times w_{OM}\right) + \left(EF_{grid,BM,y} \times w_{BM}\right) \quad (2)$$

$EF_{grid,CM,y}$	=	Combined margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EF_{grid,OM,y}$	=	Operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
w_{OM}	=	Weighting of operating margin emission factor
w_{BM}	=	Weighting of build margin emission factor

The weighting of general CDM projects is different from wind and solar power generation CDM projects as shown in Table 9.

Table 9 Weighting of operating and build margin emissions factor for general CDM projects and wind and solar power generation CDM projects

CDM project type	w_{OM}	w_{BM}
General project	0.50	0.50
Wind and solar power generation project	0.75	0.25

The Combined Margin Emission Factors of general CDM projects and wind and solar power generation projects calculated by using equation 2 following **Methodological Tool (Version 02) "Tool to calculate the emission factor for an electricity system"** are 0.5812 and 0.5980 tCO_2/MWh, respectively. Emission Factors are listed in Table 10.

Table 10 Calculated Combined Margin Emission Factor

CDM project type	Emission Factor (tCO_2/MWh)		
	$EF_{grid,OM}$	$EF_{grid,BM}$	$EF_{grid,CM}$
General project	0.6147	0.5477	0.5812
Wind and solar power generation project	0.6147	0.5477	0.5980

Reference Table Comparison of name of fuel type from different reports

Report [9]	DEDE [10] (Thailand)	IPCC [11]
Natural Gas	Natural Gas (Dry)	Natural Gas
Lignite	Lignite (Mae Moh)	Lignite
Bituminous	Coal Import	Other Bituminous Coal
Bunker	Fuel Oil	Residual Fuel Oil
Diesel	Diesel	Diesel Oil

[9] The Study of emission factor for an electricity system in Thailand 2009

[10] Electric Power in Thailand 2008/ Department of Alternative Energy Development and Efficiency, Ministry of Energy

[11] 2006 IPCC Guidelines for National Greenhouse Gas Inventories

List of the committee for study the grid emission factor of Thailand

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ปริมาณพลังงานของเชื้อเพลิง (ค่าความร้อนสุทธิ)

ENERGY CONTENT OF FUEL (NET CALORIFIC VALUE)

ประเภท(หน่วย)	กิโล-แคลอรี่ /หน่วย kcal / UNIT	ตันเทียบเท่าน้ำมันดิบ/ ล้านหน่วย toe / 10^6 UNIT	เมกะจูล /หน่วย MJ / UNIT	พันบีทียู /หน่วย 10^3 Btu / UNIT	TYPE(UNIT)
พลังงานเชิงพาณิชย์					COMMERCIAL ENERGY
1. น้ำมันดิบ (ลิตร)	8680	860.00	36.33	34.44	1. CRUDE OIL (litre)
2. คอนเดนเสท (ลิตร)	7900	782.72	33.07	31.35	2. CONDENSATE (litre)
3. ก๊าซธรรมชาติ					3. NATURAL GAS
3.1 ชื้น (ลูกบาศก์ฟุต)	248	24.57	1.04	0.98	3.1 WET (scf.)
3.2 แห้ง (ลูกบาศก์ฟุต)	244	24.18	1.02	0.97	3.2 DRY (scf.)
4. ผลิตภัณฑ์ปิโตรเลียม					4. PETROLEUM PRODUCTS
4.1 ก๊าซปิโตรเลียมเหลว (ลิตร)	6360	630.14	26.62	25.24	4.1 LPG (litre)
4.2 น้ำมันเบนซิน (ลิตร)	7520	745.07	31.48	29.84	4.2 GASOLINE (litre)
4.3 น้ำมันเครื่องบิน (ลิตร)	8250	817.40	34.53	32.74	4.3 JET FUEL (litre)
4.4 น้ำมันก๊าด (ลิตร)	8250	817.40	34.53	32.74	4.4 KEROSENE (litre)
4.5 น้ำมันดีเซล (ลิตร)	8700	861.98	36.42	34.52	4.5 DIESEL (litre)
4.6 น้ำมันเตา (ลิตร)	9500	941.24	39.77	37.70	4.6 FUEL OIL (litre)
4.7 ยางมะตอย (ลิตร)	9840	974.93	41.19	39.05	4.7 BITUMEN (litre)
4.8 ปิโตรเลียมโค๊ก (กก.)	8400	832.26	35.16	33.33	4.8 PETROLEUM COKE (kg)
5. ไฟฟ้า (กิโลวัตต์ชั่วโมง)	860	85.21	3.60	3.41	5. ELECTRICITY (kWh)
6. ไฟฟ้าพลังน้ำ (กิโลวัตต์ชั่วโมง)	2236	221.54	9.36	8.87	6. HYDROELECTRIC (kWh)
7. พลังงานความร้อนใต้พิภพ (กิโลวัตต์ชั่วโมง)	9500	941.24	39.77	37.70	7. GEOTHERMAL (kWh)
8. ถ่านหินนำเข้า (กก.)	6300	624.19	26.37	25.00	8. COAL IMPORT (kg.)
9. ถ่านโค๊ก (กก.)	6600	653.92	27.63	26.19	9. COKE (kg.)
10. แอนทราไซต์ (กก.)	7500	743.09	31.40	29.76	10. ANTHRACITE (kg.)
11. อีเทน (กก.)	11203	1110.05	46.89	44.45	11. ETHANE (kg.)
12. โปรเพน (กก.)	11256	1115.34	47.11	44.67	12. PROPANE (kg.)
13. ลิกไนต์					13. LIGNITE
13.1 ลี้ (กก.)	4400	435.94	18.42	17.46	13.1 LI (kg.)
13.2 กระบี่ (กก.)	2600	257.60	10.88	10.32	13.2 KRABI (kg.)
13.3 แม่เมาะ (กก.)	2500	247.70	10.47	9.92	13.3 MAE MOH (kg.)
13.4 แจ้คอน(กก.)	3610	357.67	15.11	14.32	13.4 CHAE KHON (kg.)
พลังงานใหม่และหมุนเวียน					NEW & RENEWABLE ENERGY
1. ฟืน (กก.)	3820	378.48	15.99	15.16	1. FUEL WOOD (kg.)
2. ถ่าน (กก.)	6900	683.64	28.88	27.38	2. CHARCOAL (kg.)
3. แกลบ (กก.)	3440	340.83	14.40	13.65	3. PADDY HUSK (kg.)
4. กากอ้อย (กก.)	1800	178.34	7.53	7.14	4. BAGASSE (kg.)
5. ขยะ (กก.)	1160	114.93	4.86	4.60	5. GARBAGE (kg.)
6. ขี้เลื่อย(กก.)	2600	257.60	10.88	10.32	6. SAW DUST (kg.)
7. วัสดุเหลือใช้ ทางการเกษตร (กก.)	3030	300.21	12.68	12.02	7. AGRICULTURAL WASTE (kg.)
8. ก๊าซชีวภาพ (ลูกบาศก์เมตร)	5000	495.39	20.93	19.84	8. BIOGAS (m^3)

TABLE 1.4
DEFAULT CO_2 EMISSION FACTORS FOR COMBUSTION [1]

Fuel type English description		Default carbon content (kg/GJ)	Default carbon oxidation factor	Effective CO_2 emission factor (kg/TJ) [2]		
				Default value [3]	95% confidence interval	
		A	B	C=A*B*44/12*1000	Lower	Upper
Crude Oil		20.0	1	73 300	71 100	75 500
Orimulsion		21.0	1	77 000	69 300	85 400
Natural Gas Liquids		17.5	1	64 200	58 300	70 400
Gasoline	Motor Gasoline	18.9	1	69 300	67 500	73 000
	Aviation Gasoline	19.1	1	70 000	67 500	73 000
	Jet Gasoline	19.1	1	70 000	67 500	73 000
Jet Kerosene		19.5	1	71 500	69 700	74 400
Other Kerosene		19.6	1	71 900	70 800	73 700
Shale Oil		20.0	1	73 300	67 800	79 200
Gas/Diesel Oil		20.2	1	74 100	72 600	74 800
Residual Fuel Oil		21.1	1	77 400	75 500	78 800
Liquefied Petroleum Gases		17.2	1	63 100	61 600	65 600
Ethane		16.8	1	61 600	56 500	68 600
Naphtha		20.0	1	73 300	69 300	76 300
Bitumen		22.0	1	80 700	73 000	89 900
Lubricants		20.0	1	73 300	71 900	75 200
Petroleum Coke		26.6	1	97 500	82 900	115 000
Refinery Feedstocks		20.0	1	73 300	68 900	76 600
Other Oil	Refinery Gas	15.7	1	57 600	48 200	69 000
	Paraffin Waxes	20.0	1	73 300	72 200	74 400
	White Spirit & SBP	20.0	1	73 300	72 200	74 400
Other Petroleum Products		20.0	1	73 300	72 200	74 400
Anthracite		26.8	1	98 300	94 600	101 000
Coking Coal		25.8	1	94 600	87 300	101 000
Other Bituminous Coal		25.8	1	94 600	89 500	99 700
Sub-Bituminous Coal		26.2	1	96 100	92 800	100 000
Lignite		27.6	1	101 000	90 900	115 000
Oil Shale and Tar Sands		29.1	1	107 000	90 200	125 000
Brown Coal Briquettes		26.6	1	97 500	87 300	109 000
Patent Fuel		26.6	1	97 500	87 300	109 000
Coke	Coke oven coke and lignite Coke	29.2	1	107 000	95 700	119 000
	Gas Coke	29.2	1	107 000	95 700	119 000
Coal Tar		22.0	1	80 700	68 200	95 300
Derived Gases	Gas Works Gas	12.1	1	44 400	37 300	54 100
	Coke Oven Gas	12.1	1	44 400	37 300	54 100
	Blast Furnace Gas [4]	70.8	1	260 000	219 000	308 000
	Oxygen Steel Furnace Gas [5]	49.6	1	182 000	145 000	202 000

TABLE 1.4 (CONTINUED)
DEFAULT CO_2 EMISSION FACTORS FOR COMBUSTION [1]

Fuel type English description		Default carbon content (kg/GJ)	Default carbon oxidation Factor	Effective CO_2 emission factor (kg/TJ) [2]		
				Default value	95% confidence interval	
		A	B	C=A*B*44/12*1000	Lower	Upper
Natural Gas		15.3	1	56 100	54 300	58 300
Municipal Wastes (non-biomass fraction)		25.0	1	91 700	73 300	121 000
Industrial Wastes		39.0	1	143 000	110 000	183 000
Waste Oil		20.0	1	73 300	72 200	74 400
Peat		28.9	1	106 000	100 000	108 000
Solid Biofuels	Wood/Wood Waste	30.5	1	112 000	95 000	132 000
	Sulphite lyes (black liquor)[5]	26.0	1	95 300	80 700	110 000
	Other Primary Solid Biomass	27.3	1	100 000	84 700	117 000
	Charcoal	30.5	1	112 000	95 000	132 000
Liquid Biofuels	Biogasoline	19.3	1	70 800	59 800	84 300
	Biodiesels	19.3	1	70 800	59 800	84 300
	Other Liquid Biofuels	21.7	1	79 600	67 100	95 300
Gas biomass	Landfill Gas	14.9	1	54 600	46 200	66 000
	Sludge Gas	14.9	1	54 600	46 200	66 000
	Other Biogas	14.9	1	54 600	46 200	66 000
Other non-fossil fuels	Municipal Wastes (biomass fraction)	27.3	1	100 000	84 700	117 000

Notes:

[1] The lower and upper limits of the 95 percent confidence intervals, assuming lognormal distributions, fitted to a dataset, based on national inventory reports, IEA data and available national data. A more detailed description is given in section 1.5

[2] TJ = 1000GJ

[3] The emission factor values for BFG includes carbon dioxide originally contained in this gas as well as that formed due to combustion of this gas.

[4] The emission factor values for OSF includes carbon dioxide originally contained in this gas as well as that formed due to combustion of this gas

[5] Includes the biomass-derived CO_2 emitted from the black liquor combustion unit and the biomass-derived CO_2 emitted from the kraft mill lime kiln.

The Ratio of Low Cost / Must Run (LC/MR) in last 5 years (2005 – 2009)

Generation type	Unit	Electricity Generation			
		EGAT	IPP	SPP	Total
2009					
Total	GWh	66,488.10	64,840.72	13,971.37	145,300.19
Non LC/MR	GWh	59,541.66	64,840.72	11,811.42	136,193.80
LC/MR	GWh	6,946.44	0.00	2,159.95	9,106.39
% of LC/MR	%				6.27
2008					
Total	GWh	63,719.02	67,420.14	14,092.83	145,232.00
Non LC/MR	GWh	56,791.19	67,420.14	11,904.81	136,116.14
LC/MR	GWh	6,927.83	0.00	2,188.03	9,115.86
% of LC/MR	%				6.28
2007					
Total	GWh	67,704.95	62,233.44	14,426.00	144,364.39
Non LC/MR	GWh	59,765.33	62,233.44	11,982.99	133,981.76
LC/MR	GWh	7,939.62	0.00	2,443.02	10,382.64
% of LC/MR	%				7.19
2006					
Total	GWh	70,409.11	55,360.65	13,652.19	139,421.94
Non LC/MR	GWh	62,480.23	55,360.65	11,619.95	129,460.82
LC/MR	GWh	7,928.88	0.00	2,032.23	9,961.12
% of LC/MR	%				7.14
2005					
Total	GWh	66,650.81	51,989.60	13,571.59	132,212.00
Non LC/MR	GWh	60,999.89	51,989.60	11,841.22	124,830.70
LC/MR	GWh	5,650.93	0.00	1,730.37	7,381.30
% of LC/MR	%				5.58