Updated State-level Greenhouse Gas Emission Factors for Electricity Generation

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1. INTRODUCTION

Authorized by Title XVI, Section 1605(b) of the Energy Policy Act of 1992 (Public Law 102-486), the Voluntary Reporting of Greenhouse Gases Program provides the opportunity for corporations, government agencies, households, and voluntary organizations to report to the Energy Information Administration (EIA) their emissions of greenhouse gases and their actions taken to reduce or avoid emissions or to sequester carbon.

To assist reporters in estimating emissions and emission reductions, EIA has made available in the instructions to Forms EIA-1605 and EIA-1605EZ emission coefficients for most commonly used fossil fuels and electricity. The emission coefficients for electricity presented in these instructions are state-level coefficients originally developed by the Department of Energy's Office of Policy for inclusion in the supporting documents to the Program's guidelines.[1] These coefficients were based on 1992 emissions and generation data. In 1999, updated coefficients were prepared based on the most recent data (1998) then available; however, the updated coefficients were not included in the instructions for the 1999 data year. This year, they have been updated again, but based on three-years worth of data (1997, 1998, and 1999) rather than a single year. The adoption of this new three-year "rolling average" approach should help to ameliorate the impact of transient anomalies (e.g., unusual weather) on the coefficients, while still enabling EIA to capture the impacts of long-term developments such as the deregulation of the utility industry. This report documents the updated coefficients for carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) using 1997-99 data.

The updated coefficients presented in this report reflect only electric utilities; data for non-utility generators were purposely excluded from the computations performed to derive the coefficients. Most reporters use the state-level electricity emission coefficients to estimate the emissions and emission reductions associated with power purchased from electric utilities. While the nonutility generators produce a significant share of the nation's power–-about 14 percent in 1999–-a smaller fraction can be considered to be marginal. In most states, nonutility generation is unlikely to be affected by reporters' emission reduction efforts.

However, in a few states, the percentage of power produced by nonutility generators has become quite high, particularly where independent power producers have purchased plants previously owned by electric utilities. In 1999, nonutility generation exceeded 20 percent of the total amount of power generated in the following 10 states: Rhode Island (100 percent), Maine (90 percent), Massachusetts (89 percent), California (52 percent), Hawaii (37 percent), New York (33 percent), New Jersey (32 percent), Connecticut (27 percent), Louisiana (27 percent), and Alaska (22 percent).[2] In recent years, as utilities have sold their generating plants to nonutility generators, the importance of nonutilities in providing power to the grid has increased significantly. As a result, EIA expects to include nonutility generators in the next iteration of these electricity emission factors, which will be released in 2002.

[1] U.S. Department of Energy, *Sector-Specific Issues and Reporting Methodologies Supporting the General Guidelines for the Voluntary Reporting of Greenhouse Gases under Section 1605(b) of the Energy Policy Act of 1992*, Volume I, October 1994 (DOE/PO-00280), pp. C.2-C.3.

[2] Energy Information Administration, *Electric Power Annual*, Volume I, DOE/EIA-0348(00)/1, June 2000, table A.7, p. 34.

2. UPDATED EMISSIONS COEFFICIENTS

This section presents three tables with the final State average emissions coefficients for electricity. Table 1 presents the new State average emissions coefficients for carbon dioxide and Table 2 presents the coefficients for nitrous oxide and methane. Table 3 offers a comparison between the updated state-level utility electricity emission factors and the adjusted combined utility and non-utility generator factors for carbon dioxide, nitrous oxide, and methane as published in the supporting documents to the Program's guidelines.[3]

Carbon Dioxide

The updated (1997-1999 average) emission factors decreased for 27 states compared to the 1992 factors published in the Program's guidelines. The factors for 21 states increased and for two states they remained unchanged. Most of the largest changes are in states located mainly in the Northeast, the Pacific Northwest, and California. These regions rely heavily on hydro and nuclear power; generation for these non-emitting energy sources can fluctuate significantly depending on such factors as refueling schedules and rainfall levels. It should also be noted that nonutilities produce a significant proportion of the power generated in many of these states.

Nitrous Oxide and Methane

The updated emission factors for nitrous oxide and methane have changed more dramatically than those for carbon dioxide. Almost all of the updated nitrous oxide factors are at least close to an order of magnitude lower than the 1992 factors. For all but 8 states, the updated methane emission factors are at least 60 percent lower than the 1992 factors. These differences are due to use of more accurate fuel emission factors (see discussion in following chapter).

[3]U.S. Department of Energy, *Sector-Specific Issues and Reporting Methodologies Supporting the General Guidelines for the Voluntary Reporting of Greenhouse Gases under Section 1605(b) of the Energy Policy Act of 1992*, Volume I, October 1994 (DOE/PO-00280), pp. C.2-C.3.

Table 1. 1997-99 State Average Carbon Dioxide Emissions Coefficients for Electric Utilities

State	lbs/kWh	short ton/MWh	metric ton/MWh
Alabama	1.347	0.673	0.611
Alaska	1.241	0.620	0.563
Arizona	1.015	0.508	0.461
Arkansas	1.310	0.655	0.594
California	0.305	0.152	0.138
Colorado	2.048	1.024	0.929
Connecticut	1.136	0.568	0.515
Delaware	1.857	0.928	0.842
Florida	1.432	0.716	0.650
Georgia	1.420	0.710	0.644
Hawaii	1.817	0.909	0.824
Idaho	0.000	0.000	0.000
Illinois	1.177	0.589	0.534
Indiana	2.134	1.067	0.968
Iowa	1.982	0.991	0.899
Kansas	1.741	0.870	0.790
Kentucky	1.986	0.993	0.901
Louisiana	1.330	0.665	0.603
Maine	0.900	0.450	0.408
Maryland*	1.352	0.676	0.613
Massachusetts	1.236	0.618	0.561
Michigan	1.742	0.871	0.790
Minnesota	1.587	0.794	0.720
Mississippi	1.320	0.660	0.599
Missouri	1.900	0.950	0.862
Montana	1.291	0.645	0.586
Nebraska	1.407	0.703	0.638
Nevada	1.664	0.832	0.755
New Hampshire	0.745	0.373	0.338
New Jersey	0.566	0.283	0.257
New Mexico	2.099	1.050	0.952
New York	0.796	0.398	0.361
North Carolina	1.244	0.622	0.564
North Dakota	2.190	1.095	0.993
Ohio	1.815	0.907	0.823
Oklahoma	1.768	0.884	0.802
Oregon	0.176	0.088	0.080
Pennsylvania	1.222	0.611	0.554
Rhode Island	0.921	0.461	0.418
South Carolina	0.815	0.408	0.370
South Dakota	0.718	0.359	0.325

Table 1. 1997-99 State Average Carbon Dioxide Emissions Coefficients for Electric Utilities (Continued)

State	lbs/kWh	short ton/MWh	metric ton/MWh
Tennessee	1.245	0.623	0.565
Texas	1.547	0.774	0.702
Utah	1.939	0.970	0.880
Vermont	0.017	0.008	0.008
Virginia	1.088	0.544	0.493
Washington	0.183	0.092	0.083
West Virginia	1.973	0.986	0.895
Wisconsin	1.792	0.896	0.813
Wyoming	2.193	1.097	0.995

*Includes the District of Columbia

Table 2. 1997-99 State Average Nitrous Oxide and Methane Emissions Coefficients for Electric Utilities

State	N_2O lbs/MWh	CH_4 lbs/MWh	State	N_2O lbs/MWh	CH_4 lbs/MWh
Alabama	0.0212	0.0092	Montana	0.0199	0.0086
Alaska	0.0067	0.0060	Nebraska	0.0215	0.0094
Arizona	0.0152	0.0067	Nevada	0.0227	0.0103
Arkansas	0.0189	0.0084	New Hampshire	0.0105	0.0056
California	0.0007	0.0009	New Jersey	0.0072	0.0035
Colorado	0.0316	0.0138	New Mexico	0.0306	0.0135
Connecticut	0.0115	0.0131	New York	0.0080	0.0050
Delaware	0.0232	0.0124	North Carolina	0.0198	0.0086
Florida	0.0170	0.0098	North Dakota	0.0335	0.0145
Georgia	0.0223	0.0098	Ohio	0.0290	0.0126
Hawaii	0.0150	0.0175	Oklahoma	0.0223	0.0102
Idaho	0.0000	0.0000	Oregon	0.0020	0.0010
Illinois	0.0179	0.0079	Pennsylvania	0.0192	0.0085
Indiana	0.0338	0.0146	Rhode Island	0.0019	0.0024
Iowa	0.0306	0.0134	South Carolina	0.0129	0.0057
Kansas	0.0257	0.0113	South Dakota	0.0107	0.0047
Kentucky	0.0317	0.0138	Tennessee	0.0198	0.0086
Louisiana	0.0127	0.0065	Texas	0.0173	0.0083
Maine	0.0073	0.0085	Utah	0.0308	0.0134
Maryland*	0.0202	0.0096	Vermont	0.0019	0.0045
Massachusetts	0.0167	0.0076	Virginia	0.0165	0.0076
Michigan	0.0264	0.0117	Washington	0.0029	0.0016
Minnesota	0.0248	0.0118	West Virginia	0.0316	0.0137
Mississippi	0.0149	0.0082	Wisconsin	0.0278	0.0129
Missouri	0.0292	0.0128	Wyoming	0.0341	0.0148

*Includes the District of Columbia

Table 3. Comparison of 1997-99 Average State-level Utility Emission Factors with Guidelines' Adjusted Combined Electricity Emission Factors by State (1992)
(Short tons per megawatt hour)

State	CO2			N2O			CH4		
	DOE Guidelines (1992)[a]	Updated (1997-99)	Percent Change due to Update	DOE Guidelines (1992)[a]	Updated (1997-99)	Percent Change due to Update	DOE Guidelines (1992)[a]	Updated (1997-99)	Percent Change due to Update
Alabama	0.684	0.673	-1.6	0.2277	0.021	-90.7	0.0271	0.009	-66.1
Alaska	0.016	0.620	3,775.0	0.1732	0.007	-96.1	0.0907	0.006	-93.4
Arizona	0.399	0.508	27.3	0.1709	0.015	-91.1	0.0232	0.007	-71.1
Arkansas	0.643	0.655	1.9	0.1825	0.019	-89.6	0.0250	0.008	-66.4
California	0.378	0.152	-59.8	0.0392	0.001	-98.2	0.0315	0.001	-97.1
Colorado	1.000	1.024	2.4	0.3137	0.032	-89.9	0.0385	0.014	-64.2
Connecticut	0.358	0.568	58.7	0.0683	0.012	-83.2	0.0104	0.013	26.0
Delaware	0.928	0.928	0.0	0.2161	0.023	-89.3	0.0344	0.012	-64.0
Florida	0.647	0.716	10.7	0.1640	0.017	-89.6	0.0275	0.010	-64.4
Georgia	0.610	0.710	16.4	0.2160	0.022	-89.7	0.0255	0.010	-61.6
Hawaii	0.757	0.909	20.1	0.0888	0.015	-83.1	0.0120	0.018	45.8
Idaho	0.134	0.000	—	0.0382	0.000	—	0.0067	0.000	—
Illinois	0.433	0.589	36.0	0.1360	0.018	-86.8	0.0164	0.008	-51.8
Indiana	1.086	1.067	-1.7	0.3346	0.034	-89.9	0.0398	0.015	-63.3
Iowa	0.843	0.991	17.6	0.2828	0.031	-89.2	0.0342	0.013	-60.8
Kansas	0.852	0.870	2.1	0.2386	0.026	-89.2	0.0302	0.011	-62.6
Kentucky	0.965	0.993	2.9	0.3230	0.032	-90.2	0.0380	0.014	-63.7
Louisiana	0.694	0.665	-4.2	0.1248	0.013	-89.8	0.0385	0.007	-83.1
Maine	0.483	0.450	-6.8	0.1170	0.007	-93.8	0.0180	0.009	-52.8
Maryland[b]	0.678	0.676	-0.3	0.2051	0.020	-90.2	0.0260	0.010	-63.1
Massachusetts	0.729	0.618	-15.2	0.1281	0.017	-87.0	0.0266	0.008	-71.4
Michigan	0.788	0.871	10.5	0.2450	0.026	-89.2	0.0327	0.012	-64.2
Minnesota	0.814	0.794	-2.5	0.2278	0.025	-89.1	0.0276	0.012	-57.2
Mississippi	0.537	0.660	22.9	0.1382	0.015	-89.2	0.0290	0.008	-71.7
Missouri	0.891	0.950	6.6	0.2814	0.029	-89.6	0.0334	0.013	-61.7
Montana	0.777	0.645	-17.0	0.2317	0.020	-91.4	0.0276	0.009	-68.8
Nebraska	0.644	0.703	9.2	0.1890	0.022	-88.6	0.0230	0.009	-59.1
Nevada	0.937	0.832	-11.2	0.2457	0.023	-90.8	0.0360	0.010	-71.4
New Hampshire	0.426	0.373	-12.4	0.1077	0.011	-90.3	0.0145	0.006	-61.4
New Jersey	0.387	0.283	-26.9	0.0731	0.007	-90.2	0.0241	0.004	-85.5
New Mexico	0.703	1.050	49.4	0.3111	0.031	-90.2	0.0404	0.014	-66.6
New York	0.518	0.398	-23.2	0.0859	0.008	-90.7	0.0208	0.005	-76.0
North Carolina	0.675	0.622	-7.9	0.2290	0.020	-91.4	0.0385	0.009	-77.7
North Dakota	1.151	1.095	-4.9	0.3194	0.034	-89.5	0.0376	0.015	-61.4
Ohio	0.904	0.907	0.3	0.3020	0.029	-90.4	0.0355	0.013	-64.5
Oklahoma	0.836	0.884	5.7	0.2211	0.022	-89.9	0.0470	0.010	-78.3
Oregon	0.118	0.088	-25.4	0.0448	0.002	-95.5	0.0102	0.001	-90.2
Pennsylvania	0.643	0.611	-5.0	0.2128	0.019	-91.0	0.0259	0.009	-67.2
Rhode Island	0.546	0.461	-15.6	0.0644	0.002	-97.0	0.0487	0.002	-95.1
South Carolina	0.344	0.408	18.6	0.1130	0.013	-88.6	0.0136	0.006	-58.1
South Dakota	0.456	0.359	-21.3	0.1430	0.011	-92.5	0.0170	0.005	-72.4
Tennessee	0.668	0.623	-6.7	0.2259	0.020	-91.2	0.0266	0.009	-67.7
Texas	0.776	0.774	-0.3	0.1637	0.017	-89.4	0.0413	0.008	-79.9
Utah	0.995	0.970	-2.5	0.3283	0.031	-90.6	0.0399	0.013	-66.4
Vermont	0.080	0.008	-90.0	0.0152	0.002	-87.5	0.0041	0.005	9.8
Virginia	0.554	0.544	-1.8	0.1805	0.017	-90.9	0.0253	0.008	-70.0

Table 3. Comparison of 1997-99 Average State-level Utility Emission Factors with Guidelines' Adjusted Combined Electricity Emission Factors by State (1992) (Continued)
(Short tons per megawatt hour)

State	CO2			N2O			CH4		
	DOE Guidelines (1992)[a]	Updated (1997-99)	Percent Change due to Update	DOE Guidelines (1992)[a]	Updated (1997-99)	Percent Change due to Update	DOE Guidelines (1992)[a]	Updated (1997-99)	Percent Change due to Update
Washington	0.153	0.092	-39.9	0.0461	0.003	-93.7	0.0069	0.002	-76.8
West Virginia	1.003	0.986	-1.7	0.3356	0.032	-90.6	0.0369	0.014	-62.9
Wisconsin	0.671	0.896	33.5	0.2430	0.028	-88.6	0.0292	0.013	-55.8
Wyoming	1.097	1.097	0.0	0.3343	0.034	-89.8	0.0393	0.015	-62.3

[a]U.S. Department of Energy, *Sector-Specific Issues and Reporting Methodologies Supporting the General Guidelines for the Voluntary Reporting of Greenhouse Gases under Section 1605(b) of the Energy Policy Act of 1992*, (DOE/PO-0028, October 1994), Volume I, Table C.1 "Adjusted Electricity Emissions Factors by State."
[b]Updated 1997-99 factor for Maryland includes the District of Columbia.

3. METHODOLOGY

The basic steps for determining each State's emissions coefficient are as follows:

1. **MMBtu consumed in 1997-99** = (1997-99 consumption of each fuel) * (the fuel's heat content, measured in MMBtu per ton combusted) * (combustion rate, measured in average percent combusted for the fuel)

2. **(CO_2/N_2O/CH_4 emitted from the fuel in 1997-99)** = (1997-99 MMBtu) * (the fuel's CO_2/N_2O/CH_4 emissions coefficient)

3. **Total 1997-99 CO_2/N_2O/CH_4 emissions from each State** = Σ (1997-99 emissions for each fuel)

4. **State CO_2/N_2O/CH_4 coefficient per MWh** = (Total 1997-99 CO_2/N_2O/CH_4 emissions) / (Total 1997-99 generation in MWh)

The remaining sections in this chapter discuss each step in detail.

Deriving 1997-99 State-level Fuel Consumption

Fuel Consumption Data

The 1997-99 fuel consumption and electricity generation data by fuel and by State were obtained from Form EIA-759, the Monthly Power Plant Report. This survey aggregates bituminous and subbituminous coal into one category called "bituminous." Given the difference in emissions from combustion of these two ranks of coal, it was considered necessary to divide this "bituminous" category into its appropriate percentages for each State.

Monthly Cost and Quality of Fuels for Electric Plants data from FERC Form 423 was used for this purpose. This form lists receipts of coal for each State by rank, and the assumption was made that receipts is a fair guide for consumption. The percentage split of bituminous / subbituminous coal was then calculated for each State for the period 1997-99, and applied to that State's EIA-759 "bituminous" figure to derive figures for the State's 1997-99 bituminous and subbituminous consumption.

Two inconsistencies became apparent between the FERC 423 and EIA-759 data. First, for the State of Alaska, FERC-423 shows no receipts of coal for 1997, 1998, and 1999, yet the EIA-759 shows 1997-99 combustion in its "bituminous" category. It was assumed that all of Alaska's consumption falls in the bituminous category, based on our knowledge of current coal mining in the State.

Secondly, the EIA-759 form collects data on generation from wood and from waste, but does not require reporting on the consumption of those fuels. The hope was to be able to use the FERC-423 receipt data, which include both wood and refuse categories, but too little correlation was found between the States that reported wood or refuse receipts on the 423 and those that reported generation from those fuels on the 759 for this assumption to be of use. As an alternative estimate, combustion was estimated from 759 generation data, using a heat rate of 11,500 Btu/kWh and a heat content of 9 MMBtu/st. The State most affected by the wood and waste data is Vermont, which generated a reported 4% of it's electricity from the combustion of wood in 1998.

Combustion Rates

For the calculation of CO_2 emissions, combustion coefficients were applied to the 1997-99 consumption data as follows: All renewables were calculated at a combustion coefficient of 1, and all non-renewables at a coefficient of 0.99 with the exception of natural gas, which was calculated with a coefficient of 0.995. The calculations for N_2O and CH_4 both assumed complete combustion, as N_2O is created from the heating, not the combustion, of the fuels and CH_4 is by definition the product of incomplete combustion, and so an additional coefficient need not be applied.

Heat Content of the Fuels

Heat content by rank of coal is also given in the FERC-423 for each State with 1997-99 receipts, and was used as that State's heat content for all applicable coal ranks. The FERC-423 data was also used to assign Btu contents to coke. For each remaining fuel and State the average Btu, as calculated from the "pounds CO_2 per unit volume or mass" and "pounds CO_2 per million Btu" data in Appendix B of the EIA-1605 Instructions, was used.

Identifying Fuel-Specific Emissions Coefficients in Terms of Gas Emitted per MMBtu Consumed

The fuel-specific emissions coefficients used in this analysis are summarized in Table 4. All renewable fuels were assumed to have carbon dioxide emissions coefficients of 0, as was wood and waste because ... (according to the IPCC)

The carbon dioxide emissions coefficient for coke was taken from Appendix A of *Emissions of Greenhouse Gases in the United States, 1987-1992,* page 90. The CO_2 coefficients for the remaining fuels were taken from Appendix B of the Instructions for Form EIA-1605.

The N_2O emissions coefficients for all non-coke fuels were drawn from the Intergovernmental Panel on Climate Change's guidelines for national inventories.[4]

Methane coefficients for the non-coke fuels were taken from EIA's *Emissions of Greenhouse Gases in the United States* source data, which were derived from the IPCC guidelines and the Environmental Protection Agency's AP-42 data.

Both nitrous oxide and methane emissions coefficients for coke were assumed to be the same as for anthracite, following the example of the *Electric Power Annual 1997*, which states in footnote 6 to Table A3 "Sulfur Dioxide, Nitrogen Oxide and Carbon Dioxide Emissions Factors" on page 121 that "Emissions factors for petroleum coke are assumed to be the same as those for anthracite."

[4]Intergovernmental Panel on Climate Change, *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Reference Manual (Volume 3)*, 1996, Table 1-8 (http://www.ipcc-nggip.iges.or.jp/ public/gl/invs1.htm).

Determining Total Emissions for Each State

Once total emissions from each gas were determined for each State, they were summed and compared to the *Emissions of Greenhouse Gases in the United States* data for 1997-99. According to the inventory, total carbon dioxide emissions from the utility sector were 5917 million metric tons in 1997-99. Our own estimate--5906 million metric tons--matches the inventory estimate within a very small margin of error (0.2 percent)[5]. Hence this comparison confirms the accuracy of the electricity emission factors presented in Table 1.

Calculating Final Emissions Coefficients

The final step was to divide total State emissions by that State's electricity generation, as obtained from the EIA-759. The resulting 1997-99 emissions of each gas per MWh generated give the final State Average Emissions Coefficients (see Tables 1 through 3).

[5]The slight difference between the two estimates is probably due to the use of different Btu content estimates (the Btu content data we derived from the FERC-423 differs slightly from the Btu contents used in the *Emissions of Greenhouse Gases in the United States*).

Table 4. Fuel Emissions Coefficients

Fuel	Emission Coefficient (lbs gas/MMBtu)	Source*
Carbon Dioxide		
Anthracite	227.4	A
Bituminous	205.3	A
Subbituminous	212.7	A
Lignite	215.4	A
Coke	225.13	B
Residual Fuel (No. 6 Fuel Oil)	173.906	A
Distillate Fuel (No. 2 Fuel Oil)	161.386	A
Natural Gas	117.08	A
Wood	0	F
Waste (Refuse)	0	F
Methane		
Anthracite	0.00141	C
Bituminous	0.00141	C
Subbituminous	0.00141	C
Lignite	0.00141	C
Coke	0.00141	D
Residual Fuel (No. 6 Fuel Oil)	0.00163	C
Distillate Fuel (No. 2 Fuel Oil)	0.00163	C
Natural Gas	0.000287	C
Wood	0.0111	G
Waste (Refuse)	0.0111	G
Nitrous Oxide		
Anthracite	0.00326	E
Bituminous	0.00326	E
Subbituminous	0.00326	E
Lignite	0.00326	E
Coke	0.00326	D
Residual Fuel (No. 6 Fuel Oil)	0.0014	E
Distillate Fuel (No. 2 Fuel Oil)	0.0014	E
Natural Gas	0.000233	E
Wood	0.00444	G
Waste (Refuse)	0.00444	G

* Key to Sources:

A: Appendix B, Instructions to Form EIA-1605

B: Appendix A, *Emissions of Greenhouse Gases in the United States, 1987-1992,* page 90

C: EIA's *Emissions of Greenhouse Gases in the United States* source data, derived from emissions coefficients for stationary fuel in the EPA's Office of Air Quality Planning and Standards, *Compilation of Air Pollutant Emission Factors*, AP-42, and Intergovernmental Panel on Climate Change, *Greenhouse Gas Inventory Reference Manual: Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, Vol. 3 (Paris, France, 1997),www.ipcc.ch/pub/guide.htm .

D: Assumed to be the same as for anthracite, following the example of the *Electric Power Annual 1997*, which states that "Emissions factors for petroleum coke are assumed to be the same as those for anthracite." Footnote 6 to Table A3 "Sulfur Dioxide, Nitrogen Oxide and Carbon Dioxide Emissions Factors," p.121

E: Intergovernmental Panel on Climate Change, *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Reference Manual (Volume 3)*, 1996, Table 1-8 (http://www.ipcc-nggip.iges.or.jp/public/gl/invs6a.htm).

F: Wood and waste are assumed to have no CO_2 emissions because the carbon in these fuels are considered to be part of the natural carbon cycle. See Intergovernmental Panel on Climate Change,*Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Reference Manual (Volume 3)*, 1996, p. 6.28 (http://www.ipcc-nggip.iges.or.jp/public/gl/invs6a.htm).

G: The coefficient for wood is taken from EPA's AP-42 (using their their assumed 4500 Btu/lb and their coefficients of 0.1 lb CH_4/ton and 0.04 lb N_2O/ton). Coefficients for refuse assumed to be the same as for wood.