

**Updated State-level
Greenhouse Gas
Emission Coefficients
for Electricity Generation
1998-2000**

Energy Information Administration
Office of Integrated Analysis and Forecasting
Energy Information Administration
U.S. Department of Energy

April 2002

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 originally presented in these instructions were state-level coefficients 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. Last year, these state-level factors were updated again, but based on a weighted average of three-years worth of data (1997, 1998, and 1999) rather than a single year. The adoption of this new three-year "rolling average" approach was intended 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.

The updated 1997-1999 coefficients from last year reflected only electric utilities; data for non-utility generators were purposely excluded from the computations performed to derive the coefficients. 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 Therefore, EIA has included all generators, including utilities, nonutilities, and industrial cogenerators, in this year's update of the state-level electricity emission factors.

This report documents the preparation of these updated state-level electricity coefficients for carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O), which represent a three-year weighted average for 1998-2000.

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 a table with the final State average electricity emissions coefficients for carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) (Table 1). These coefficients are included in the instructions to Forms EIA-1605 and EIA-1605EZ for the 2001 (data year) reporting cycle. Table 2 offers a comparison between these updated coefficients and the 1997-1999, utility-only coefficients included with the instructions to Forms EIA-1605 and EIA-1605EZ last year.

Carbon Dioxide

The national average coefficient for carbon dioxide declined by 2.7 percent from 0.686 tons per MWH to 0.668 tons per MWH. Several States exhibited increases, including California (99.7 percent), Vermont (80.5 percent), Oregon (59.7 percent), Washington (33.3 percent), New Jersey (24.7 percent), and Rhode Island (14.1 percent). These are States where either nonutility generators generate a significant proportion of the power or hydroelectric power is a significant source of electricity. The inclusion of nonutility generators in the average emission factors changes the basis of the calculations and typically results in the addition of a relatively higher proportion of fossil fuel-fired generating plants than was in the universe of utility-only plants included in the calculations for last year's emission coefficients. The generation of hydroelectric power in the United States in 2000 was 23 percent lower than in 1997.³ Years in which

hydroelectric power is low results in higher carbon dioxide emissions as generation from fossil fuel increases. The effect on the U.S. average emission factors was offset by the an increasing share of national electricity generation provided by low- or zero-emission sources, including natural gas and nuclear power plants.

Nitrous Oxide and Methane

The emission coefficient for nitrous oxide declined by 2.8 percent, from 0.0197 to 0.092 lbs/MWH, which is similar to the decline for carbon dioxide. In contrast, the emission coefficient for methane increased by 21.9 percent, from 0.0096 to 0.0118 lbs per MWH. This increase can be attributed to greater proportion of power generated from wood and waste by the electric power industry as a whole compared to electric utilities. Wood accounted for 3.1 percent of the heat input to conventional (combustion) utility and non-utility power plants in the U.S. 1998-2000. For utility plants only over the 1997-1999 time period on which last year's coefficients were based, wood accounted for 0.1 percent of the heat input to conventional power plants. The methane emissions produced by wood- and waste-fired power plants is about an order of magnitude or more greater than emissions from plants using fossil fuels (0.0111 lbs methane/MMBtu versus 0.000287 to 0.00163 lbs methane/MMBtu).⁴

³Energy Information Administration, *Annual Energy Review 2000*, DOE/EIA-0384(2000), August 2001, Table 8.2, p. 221.

⁴See Table 3 and the discussion of the methodology used to calculate these updated coefficients in the following section.

Table 1. 1998-2000 Average State-level Carbon Dioxide Emissions Coefficients for Electric Power

Region/State	Carbon Dioxide			Methane	Nitrous Oxide
	lbs/kWh	short tons/ MWH	metric tons/ MWH	lbs/MWH	lbs/MWH
New England	0.98	0.491	0.446	0.0207	0.0146
Connecticut	0.94	0.471	0.427	0.0174	0.0120
Maine	0.85	0.426	0.386	0.0565	0.0270
Massachusetts	1.28	0.639	0.579	0.0174	0.0159
New Hampshire	0.68	0.341	0.310	0.0172	0.0141
Rhode Island	1.05	0.526	0.477	0.0068	0.0047
Vermont	0.03	0.014	0.013	0.0096	0.0039
Mid Atlantic	1.04	0.520	0.471	0.0093	0.0145
New Jersey	0.71	0.353	0.320	0.0077	0.0079
New York	0.86	0.429	0.389	0.0081	0.0089
Pennsylvania	1.26	0.632	0.574	0.0107	0.0203
East-North Central	1.63	0.815	0.740	0.0123	0.0257
Illinois	1.16	0.582	0.528	0.0082	0.0180
Indiana	2.08	1.038	0.942	0.0143	0.0323
Michigan	1.58	0.790	0.717	0.0146	0.0250
Ohio	1.80	0.900	0.817	0.0130	0.0288
Wisconsin	1.64	0.821	0.745	0.0138	0.0260
West-North Central	1.73	0.864	0.784	0.0127	0.0269
Iowa	1.88	0.941	0.854	0.0138	0.0298
Kansas	1.68	0.842	0.764	0.0112	0.0254
Minnesota	1.52	0.762	0.691	0.0157	0.0247
Missouri	1.84	0.920	0.835	0.0126	0.0288
Nebraska	1.40	0.700	0.635	0.0095	0.0219
North Dakota	2.24	1.121	1.017	0.0147	0.0339
South Dakota	0.80	0.399	0.362	0.0053	0.0121
South Atlantic	1.35	0.674	0.612	0.0127	0.0207
Delaware	1.83	0.915	0.830	0.0123	0.0227
Florida	1.39	0.697	0.632	0.0150	0.0180
Georgia	1.37	0.683	0.619	0.0129	0.0226
Maryland*	1.37	0.683	0.620	0.0118	0.0206
North Carolina	1.24	0.621	0.563	0.0105	0.0203
South Carolina	0.83	0.417	0.378	0.0091	0.0145
Virginia	1.16	0.582	0.528	0.0137	0.0192
West Virginia	1.98	0.988	0.897	0.0137	0.0316
East-South Central	1.49	0.746	0.677	0.0128	0.0240
Alabama	1.31	0.656	0.595	0.0137	0.0223
Kentucky	2.01	1.004	0.911	0.0140	0.0321
Mississippi	1.29	0.647	0.587	0.0132	0.0165
Tennessee	1.30	0.648	0.588	0.0105	0.0212
West-South Central	1.43	0.714	0.648	0.0087	0.0153
Arkansas	1.29	0.643	0.584	0.0125	0.0203
Louisiana	1.18	0.589	0.534	0.0094	0.0112
Oklahoma	1.72	0.861	0.781	0.0110	0.0223
Texas	1.46	0.732	0.664	0.0077	0.0146

Table 1. 1998-2000 Average State-Level Carbon Dioxide Emissions Coefficients for Electric Power (Cont'd)

Region/State	Carbon Dioxide			Methane	Nitrous Oxide
	lbs/kWh	short tons/ MWH	metric tons/ MWH	lbs/MWH	lbs/MWH
Mountain	1.56	0.781	0.709	0.0108	0.0236
Arizona	1.05	0.525	0.476	0.0068	0.0154
Colorado	1.93	0.963	0.873	0.0127	0.0289
Idaho	0.03	0.014	0.013	0.0080	0.0033
Montana	1.43	0.717	0.650	0.0108	0.0227
Nevada	1.52	0.759	0.688	0.0090	0.0195
New Mexico	2.02	1.009	0.915	0.0131	0.0296
Utah	1.93	0.967	0.878	0.0134	0.0308
Wyoming	2.15	1.073	0.973	0.0147	0.0338
Pacific Contiguous	0.45	0.224	0.203	0.0053	0.0037
California	0.61	0.303	0.275	0.0067	0.0037
Oregon	0.28	0.141	0.127	0.0033	0.0034
Washington	0.25	0.123	0.111	0.0037	0.0040
Pacific Non-contiguous	1.56	0.780	0.707	0.0161	0.0149
Alaska	1.38	0.690	0.626	0.0068	0.0089
Hawaii	1.66	0.831	0.754	0.0214	0.0183
United States	1.34	0.668	0.606	0.0111	0.0192

Note: These state- and regional-level electricity emission factors represent average emissions per kWh or MWH generated by utility and nonutility electric generators for the 1998-2000 time period. The Voluntary Reporting of Greenhouse Gases Program believes these factors provide reasonably accurate default values for power generated in a given state or region (U.S. Census Division). However, reporters should use these state- and regional-level factors only if utility-specific or power pool-specific emission factors are not available.

*Includes the District of Columbia

Source: Energy Information Administration, *Updated State- and Regional-level Greenhouse Gas Emission Factors for Electricity* (March 2002), <http://www.eia.doe.gov/oiaf/1605/e-factor.html>.

Table 2. Comparison of Updated 1998-2000 Average State-level Utility Emission Coefficients with Last Year's 1997-1999 Emissions Coefficients

State	2000 Data Year (1997-1999)			2001 Data Year (1998-2000)			Difference		
	CO ₂	CH ₄	N ₂ O	CO ₂	CH ₄	N ₂ O	CO ₂	CH ₄	N ₂ O
	tons/MWH	lbs/MWH	lbs/MWH	tons/MWH	lbs/MWH	lbs/MWH	Percent	Percent	Percent
Alabama	0.673	0.0092	0.0212	0.656	0.0137	0.0223	-2.5	48.9	5.0
Alaska	0.620	0.0060	0.0067	0.690	0.0068	0.0089	11.3	13.7	33.2
Arizona	0.508	0.0067	0.0152	0.525	0.0068	0.0154	3.3	1.9	1.4
Arkansas	0.655	0.0084	0.0189	0.643	0.0125	0.0203	-1.8	49.2	7.6
California	0.152	0.0009	0.0007	0.303	0.0067	0.0037	99.7	644.1	423.8
Colorado	1.024	0.0138	0.0316	0.963	0.0127	0.0289	-6.0	-7.8	-8.6
Connecticut	0.568	0.0131	0.0115	0.471	0.0174	0.0120	-17.2	32.5	4.0
Delaware	0.928	0.0124	0.0232	0.915	0.0123	0.0227	-1.4	-0.4	-2.3
Florida	0.716	0.0098	0.0170	0.697	0.0150	0.0180	-2.7	52.7	5.9
Georgia	0.710	0.0098	0.0223	0.683	0.0129	0.0226	-3.9	31.3	1.3
Hawaii	0.909	0.0175	0.0150	0.831	0.0214	0.0183	-8.6	22.4	21.8
Idaho	0.000	0.0000	0.0000	0.014	0.0080	0.0033	—	—	—
Illinois	0.589	0.0079	0.0179	0.582	0.0082	0.0180	-1.2	4.0	0.3
Indiana	1.067	0.0146	0.0338	1.038	0.0143	0.0323	-2.7	-2.1	-4.4
Iowa	0.991	0.0134	0.0306	0.941	0.0138	0.0298	-5.0	2.9	-2.6
Kansas	0.870	0.0113	0.0257	0.842	0.0112	0.0254	-3.2	-0.7	-1.2
Kentucky	0.993	0.0138	0.0317	1.004	0.0140	0.0321	1.1	1.2	1.2
Louisiana	0.665	0.0065	0.0127	0.589	0.0094	0.0112	-11.4	44.3	-12.0
Maine	0.450	0.0085	0.0073	0.426	0.0565	0.0270	-5.3	564.4	270.4
Maryland*	0.676	0.0096	0.0202	0.683	0.0118	0.0206	1.1	23.3	1.8
Massachusetts	0.618	0.0076	0.0167	0.639	0.0174	0.0159	3.3	128.7	-4.6
Michigan	0.871	0.0117	0.0264	0.790	0.0146	0.0250	-9.3	24.9	-5.4
Minnesota	0.794	0.0118	0.0248	0.762	0.0157	0.0247	-4.1	32.9	-0.5
Mississippi	0.660	0.0082	0.0149	0.647	0.0132	0.0165	-1.9	61.4	10.9
Missouri	0.950	0.0128	0.0292	0.920	0.0126	0.0288	-3.1	-1.8	-1.4
Montana	0.645	0.0086	0.0199	0.717	0.0108	0.0227	11.1	26.1	13.9
Nebraska	0.703	0.0094	0.0215	0.700	0.0095	0.0219	-0.5	1.1	1.6
Nevada	0.832	0.0103	0.0227	0.759	0.0090	0.0195	-8.8	-12.8	-14.3
New Hampshire	0.373	0.0056	0.0105	0.341	0.0172	0.0141	-8.5	206.5	34.0
New Jersey	0.283	0.0035	0.0072	0.353	0.0077	0.0079	24.7	119.8	10.2
New Mexico	1.050	0.0135	0.0306	1.009	0.0131	0.0296	-3.9	-3.2	-3.4
New York	0.398	0.0050	0.0080	0.429	0.0081	0.0089	7.9	62.0	11.5
North Carolina	0.622	0.0086	0.0198	0.621	0.0105	0.0203	-0.2	21.8	2.6

Table 2. Comparison of Updated 1998-2000 Average State-level Utility Emission Factors with Last Year's 1997-1999 Emissions Factors (Cont'd)

State	2000 Data Year (1997-1999)			2001 Data Year (1998-2000)			Difference		
	CO ₂	CH ₄	N ₂ O	CO ₂	CH ₄	N ₂ O	CO ₂	CH ₄	N ₂ O
	tons/MWH	lbs/MWH	lbs/MWH	tons/MWH	lbs/MWH	lbs/MWH	Percent	Percent	Percent
North Dakota	1.095	0.0145	0.0335	1.121	0.0147	0.0339	2.4	1.2	1.1
Ohio	0.907	0.0126	0.0290	0.900	0.0130	0.0288	-0.7	3.2	-0.5
Oklahoma	0.884	0.0102	0.0223	0.861	0.0110	0.0223	-2.6	8.2	-0.1
Oregon	0.088	0.0010	0.0020	0.141	0.0033	0.0034	59.7	226.7	68.4
Pennsylvania	0.611	0.0085	0.0192	0.632	0.0107	0.0203	3.5	26.1	5.8
Rhode Island	0.461	0.0024	0.0019	0.526	0.0068	0.0047	14.1	184.0	147.0
South Carolina . . .	0.408	0.0057	0.0129	0.417	0.0091	0.0145	2.1	60.4	12.3
South Dakota	0.359	0.0047	0.0107	0.399	0.0053	0.0121	11.1	13.4	12.7
Tennessee	0.623	0.0086	0.0198	0.648	0.0105	0.0212	4.0	22.4	7.0
Texas	0.774	0.0083	0.0173	0.732	0.0077	0.0146	-5.4	-7.7	-15.7
Utah	0.970	0.0134	0.0308	0.967	0.0134	0.0308	-0.3	0.2	0.1
Vermont	0.008	0.0045	0.0019	0.014	0.0096	0.0039	80.5	112.5	106.4
Virginia	0.544	0.0076	0.0165	0.582	0.0137	0.0192	7.0	80.4	16.2
Washington	0.092	0.0016	0.0029	0.123	0.0037	0.0040	33.3	128.3	36.6
West Virginia	0.986	0.0137	0.0316	0.988	0.0137	0.0316	0.2	-0.1	-0.1
Wisconsin	0.896	0.0129	0.0278	0.821	0.0138	0.0260	-8.3	6.6	-6.4
Wyoming	1.097	0.0148	0.0341	1.073	0.0147	0.0338	-2.2	-1.0	-0.8
U.S. Average	0.686	0.0091	0.0197	0.668	0.0111	0.0192	-2.7	21.9	-2.8

*Includes the District of Columbia

3. METHODOLOGY

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

1. Generation data for electric utilities and non-utilities for 1998-2000 by state were obtained from EIA's Office of Coal, Nuclear Energy, and Alternative Fuels (CNEAF).⁵
2. Estimates of carbon dioxide emissions for 1998-2000 by state were also obtained from CNEAF.⁶
3. Carbon dioxide emission coefficients were calculated by dividing emissions (in tons) by generation (in MWH). These calculations were also performed on data aggregated by U.S. Census Division to provide regional coefficients.

⁵Energy Information Administration, Form EIA-759, *Monthly Power Plant Report*; Form EIA-767, *Steam-Electric Plant Operation and Design Report*; Form EIA-860B, *Annual Nonutility Power Producer Report*; Form EIA-900, *Monthly Nonutility Power Report*; Federal Energy Regulatory Commission, FERC Form 423, *Monthly Cost and Quality of Fuels for Electric Power Plants*.

⁶Energy Information Administration, Office of Coal, Nuclear Energy, and Alternative Fuels, *Electric Power Industry Estimated CO2 Emissions 1998-1999*, December 27, 2000. (Unpublished data). Personal communication between Paul McArdle, Office of Integrated Analysis and Forecasting and Channelle Carner, June 2001.

4. Data on the consumption of coal, fuel oil, natural gas, wood and wood waste (in billion Btu) by non-utilities, and municipal solid waste by state for 1998-2000 were obtained from CNEAF. As utility wood consumption data for 1998-2000 was unavailable, the 1997-1999 values used in calculating last year's coefficients were used as proxies.⁷
5. Emission factors for methane and nitrous oxide were calculated using the above fuel consumption data and the emissions coefficients presented in Table 3 using the following equation:

$$\text{Fuel consumption (BBtu)} * \text{Emission coefficient (lbs gas/MMBtu)} * 1000 \text{ MMBtu}/1 \text{ BBtu}$$

Again, these calculations were also performed on data aggregated by U.S. Census Division to provide regional methane and nitrous oxide coefficients.

⁷Energy Information Administration, Form EIA-759, *Monthly Power Plant Report*; Form EIA-767, *Steam-Electric Plant Operation and Design Report*; Form EIA-860B, *Annual Nonutility Power Producer Report*; Form EIA-900, *Monthly Nonutility Power Report*; Federal Energy Regulatory Commission, FERC Form 423, *Monthly Cost and Quality of Fuels for Electric Power Plants*.

Table 3. Fuel Emissions Coefficients for Methane and Nitrous Oxide

Fuel	Emission Coefficient (lbs gas/MMBtu)	Source*
Methane		
Anthracite	0.00141	A
Bituminous	0.00141	A
Subbituminous	0.00141	A
Lignite	0.00141	A
Coke	0.00141	B
Residual Fuel (No. 6 Fuel Oil)	0.00163	A
Distillate Fuel (No. 2 Fuel Oil)	0.00163	A
Natural Gas	0.000287	A
Wood	0.0111	E
Waste (Refuse)	0.0111	E
Nitrous Oxide		
Anthracite	0.00326	C
Bituminous	0.00326	C
Subbituminous	0.00326	C
Lignite	0.00326	C
Coke	0.00326	B
Residual Fuel (No. 6 Fuel Oil)	0.0014	C
Distillate Fuel (No. 2 Fuel Oil)	0.0014	C
Natural Gas	0.000233	C
Wood	0.00444	E
Waste (Refuse)	0.00444	E

* Key to Sources:

- A: 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.
- B: 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
- C: 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 CO₂ 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>).
- E: The coefficient for wood is taken from EPA's AP-42 (using their assumed 4500 Btu/lb and their coefficients of 0.1 lb CH₄/ton and 0.04 lb N₂O/ton). Coefficients for refuse assumed to be the same as for wood.