Appendix A

British Thermal Unit Conversion Factors

British Thermal Unit Conversion Factors

The thermal conversion factors presented in the following tables can be used to estimate the heat content in British thermal units (Btu) of a given amount of energy measured in physical units, such as barrels or cubic feet. For example, 10 barrels of asphalt has a heat content of approximately 66.36 million Btu (10 barrels x 6.636 million Btu per barrel = 66.36 million Btu).

The heat content rates (i.e., thermal conversion factors) provided in this section represent the gross (or higher or upper) energy content of the fuels. Gross heat content rates are applied in all Btu calculations for the *Monthly Energy Review* and are commonly used in energy calculations in the United States; net (or lower) heat content rates are typically used in European energy calculations. The difference between the two rates is the amount of energy that is consumed to vaporize water that is created during the combustion process. Generally, the difference ranges from 2% to 10%, depending on the specific fuel and its hydrogen content. Some fuels, such as unseasoned wood, can be more than 40% different in their gross and net heat content rates. See "Heat Content" and "British Thermal Unit (Btu)" in the Glossary for more information.

In general, the annual thermal conversion factors presented in Tables A2 through A6 are computed from final annual data or from the best available data and labeled "preliminary." Often, the current year's factors are labeled "estimate," and are set equal to the previous year's values until data become available to calculate the factors. The source of each factor is described in the section entitled "Thermal Conversion Factor Source Documentation," which follows Table A6 in this appendix.

Table A1. Approximate Heat Content of Petroleum and Biofuels

(Million Btu per Barrel, Except as Noted)

Commodity	Heat Content	Commodity	Heat Content
Asphalt and Road Oil	6.636	Motor Gasoline (Finished)–see Tables A2 and A3	
Aviation Gasoline (Finished)	5.048	Motor Gasoline Blending Components (MGBC)	
Aviation Gasoline Blending Components	5.048	Through 2006	5.253
Crude Oil–see Table A2		Beginning in 2007	5.222
Distillate Fuel Oil–see Table A3 for averages		Oxygenates (excluding Fuel Ethanol)	4.247
15 ppm sulfur and under	5.770	Petrochemical Feedstocks	
Greater than 15 ppm to 500 ppm sulfur	5.817	Naphtha Less Than 401°F	5.248
Greater than 500 ppm sulfur	5.825	Other Oils Equal to or Greater Than 401°F	5.825
Hydrocarbon Gas Liquids		Petroleum Coke–see Table A3 for averages	
Natural Gas Liquids		Total, through 2003	6.024
Ethane	2.783	Catalyst, beginning in 2004	[a] 6.287
Propane	3.841	Marketable, beginning in 2004	5.719
Normal Butane	4.353	Residual Fuel Oil	6.287
Isobutane	4.183	Special Naphthas	5.248
Natural Gasoline (Pentanes Plus)	4.638	Still Gas	
Refinery Olefins		Through 2015	[b] 6.000
Ethylene	2.436	Beginning in 2016	[a] 6.287
Propylene	3.835	Unfinished Oils	5.825
Butylene	4.377	Waxes	5.537
Isobutylene	4.355	Miscellaneous Products	5.796
Hydrogen	[c] 6.287	Other Hydrocarbons	5.825
Jet Fuel, Kerosene Type	5.670	Biofuels, Fuel Ethanol–see Table A3	
Jet Fuel, Naphtha Type	5.355	Biofuels, Biodiesel	5.359
Kerosene	5.670	Biofuels, Renewable Diesel Fuel	5.494
Lubricants	6.065	Biofuels, Other	5.359

[a] Per residual fuel oil equivalent barrel (6.287 million Btu per barrel).

[b] Per fuel oil equivalent barrel (6.000 million Btu per barrel).

[c] Hydrogen has a gross heat content of 323.6 Btu per standard cubic foot (at 60 degrees Fahrenheit and 1 atmosphere), and 6.287 million Btu per residual fuel oil equivalent barrel. For hydrogen, barrels can be converted to standard cubic feet by multiplying by 19,426 standard cubic feet per barrel of residual fuel oil equivalent.

Note: The values in this table are for gross heat contents. See "Heat Content" in Glossary.

Web Page: http://www.eia.gov/totalenergy/data/monthly/#appendices.

Sources: See "Thermal Conversion Factor Source Documentation," which follows Table A6.

Table A2. Approximate Heat Content of Petroleum Production, Imports, and Exports

(Million Btu per Barrel)

	Production		Imports				Exports			
				Petroleum Products				Petroleum Products		
	Crude Oil[a]	Natural Gas Plant Liquids[b]	Crude Oil[a]	Motor Gasoline[c]	Total Products[d]	Total[d]	Crude Oil[a]	Motor Gasoline[e]	Total Products[d]	Total[d]
1950	5.800	4.470	5.943	5.253	6.263	6.080	5.800	5.253	5.751	5.766
1955	5.800	4.346	5.924	5.253	6.234	6.040	5.800	5.253	5.765	5.768
1960	5.800	4.253	5.911	5.253	6.161	6.021	5.800	5.253	5.835	5.834
1965	5.800	4.197	5.872	5.253	6.123	5.997	5.800	5.253	5.742	5.743
1970	5.800	4.090	5.822	5.253	6.088	5.985	5.800	5.253	5.811	5.810
1975	5.800	3.923	5.821	5.253	5.935	5.858	5.800	5.253	5.747	5.748
1980	5.800	[b] 3.864	5.812	5.253	5.748	5.796	5.800	5.253	5.841	5.820
1981	5.800	3.860	5.818	5.253	5.659	5.775	5.800	5.253	5.837	5.821
1982	5.800	3.798	5.826	5.253	5.664	5.775	5.800	5.253	5.829	5.820
1983	5.800	3.755	5.825	5.253	5.677	5.774	5.800	5.253	5.800	5.800
1984	5.800	3.745	5.823	5.253	5.613	5.745	5.800	5.253	5.867	5.850
1985	5.800	3.752	5.832	5.253	5.572	5.736	5.800	5.253	5.819	5.814
1986	5.800	3.733	5.903	5.253	5.624	5.808	5.800	5.253	5.839	5.832
1987	5.800	3.742	5.901	5.253	5.599	5.820	5.800	5.253	5.860	5.858
1988	5.800	3.751	5.900	5.253	5.618	5.820	5.800	5.253	5.842	5.840
1989	5.800	3.764	5.906	5.253	5.641	5.833	5.800	5.253	5.869	5.857
1990	5.800	3.758	5.934	5.253	5.614	5.849	5.800	5.253	5.838	5.833
1991	5.800	3.740	5.948	5.253	5.636	5.873	5.800	5.253	5.827	5.823
1992	5.800	3.739	5.953	5.253	5.623	5.877	5.800	5.253	5.774	5.777
1993	5.800	3.735	5.954	5.253	5.539	5.866	5.800	5.253	5.681	5.693
1994	5.800	3.728	5.950	5.253	5.416	5.835	5.800	5.253	5.693	5.704
1995	5.800	3.728	5.938	5.253	5.345	5.830	5.800	5.253	5.692	5.703
1996	5.800	3.703	5.947	5.253	5.373	5.828	5.800	5.253	5.663	5.678
1997	5.800	3.686	5.954	5.253	5.333	5.836	5.800	5.253	5.663	5.678
1998	5.800	3.694	5.953	5.253	5.314	5.833	5.800	5.253	5.505	5.539
1999	5.800	3.663	5.942	5.253	5.291	5.815	5.800	5.253	5.530	5.564
2000	5.800	3.648	5.959	5.253	5.309	5.823	5.800	5.253	5.529	5.542
2001	5.800	3.652	5.976	5.253	5.330	5.838	5.800	5.253	5.637	5.641
2002	5.800	3.646	5.971	5.253	5.362	5.845	5.800	5.253	5.517	5.519
2003	5.800	3.659	5.970	5.253	5.381	5.845	5.800	5.253	5.628	5.630
2004	5.800	3.636	5.981	5.253	5.429	5.853	5.800	5.253	5.532	5.539
2005	5.800	3.638	5.977	5.253	5.436	5.835	5.800	5.253	5.504	5.513
2006	5.800	3.622	5.980	5.253	5.431	5.836	5.800	[e] 5.219	5.415	5.423
2007	5.800	3.609	5.985	5.222	5.483	5.857	5.800	5.188	5.465	5.471
2008	5.800	3.614	5.990	5.222	5.459	5.861	5.800	5.215	5.587	5.591
2009	5.800	3.598	5.988	5.222	5.509	5.878	5.800	5.221	5.674	5.677
2010	5.800	3.573	5.989	5.222	5.545	5.892	5.800	5.214	5.601	5.604
2011	5.800	3.573	6.008	5.222	5.538	5.905	5.800	5.216	5.526	5.530
2012	5.800	3.588	6.165	5.222	5.501	6.035	5.800	5.217	5.520	5.526
2013	5.800	3.629	6.010	5.222	5.497	5.899	5.800	5.216	5.470	5.482
2014	5.800	3.640	6.035	5.222	5.518	5.929	5.800	5.218	5.369	5.406
2015	5.717	3.669	6.065	5.222	5.504	5.941	5.682	5.218	5.279	5.319
2016	5.722	3.632	6.053	5.222	5.491	5.929	5.724	5.218	5.184	5.245
2017	5.723	3.612	6.050	5.222	5.489	5.930	5.738	[e] 5.222	5.151	5.258
2018	5.706	3.591	6.063	5.222	[d] 5.491	[d] 5.938	5.721	5.222	[d] 5.088	[d] 5.259
2019	5.698	3.607	6.061	5.222	5.464	5.908	5.708	5.222	5.022	5.263
2020	5.691	3.593	6.066	5.222	5.513	5.927	5.709	5.222	4.924	5.220
2021	5.690	3.585	6.067	5.222	5.508	5.905	5.725	5.222	4.861	5.161
2022	5.684	3.575	6.085	5.222	5.519	5.928	5.721	5.222	4.866	5.187
2023	5.689	3.575	6.064	5.222	5.471	5.922	5.729	5.222	4.805	5.174
2024	[P] 5.689	[P] 3.577	[P] 6.062	[P] 5.222	[P] 5.459	[P] 5.963	[P] 5.719	[P] 5.222	[P] 4.803	[P] 5.153
2025	[E] 5.689	[E] 3.577	[E] 6.062	[E] 5.222	[E] 5.459	[E] 5.963	[E] 5.719	[E] 5.222	[E] 4.803	[E] 5.153

[a] Includes lease condensate.

[b] Natural gas processing plant production of natural gas liquids (ethane, propane, normal butane, isobutane, and natural gasoline). Through 1980, also includes natural gas processing plant production of finished petroleum products (aviation gasoline, distillate fuel oil, jet fuel, kerosene, motor gasoline, special naphthas, and miscellaneous products).

[c] Excludes fuel ethanol, methyl tertiary butyl ether (MTBE), and other oxygenates blended into motor gasoline.

[d] Through 2017, the imports and exports factors are developed using old hydrocarbon gas liquids heat content values shown in Table A1 of the September 2019 *Monthly Energy Review* (MER). Beginning in 2018, the factors are developed using heat content values shown in Table A1 of the current MER.

[e] For 2006–2016, includes MTBE blended into motor gasoline; excludes MTBE in other years. For all years, excludes fuel ethanol and other non-MTBE oxygenates blended into motor gasoline.

P=Preliminary. E=Estimate.

Note: The values in this table are for gross heat contents. See "Heat Content" in Glossary.

Web Page: See http://www.eia.gov/totalenergy/data/monthly/#appendices (Excel and CSV files) for all available annual data beginning in 1949.

Sources: See "Thermal Conversion Factor Source Documentation," which follows Table A6.

Table A3. Approximate Heat Content of Petroleum Consumption and Fuel Ethanol

(Million Btu per Barrel)

	Total Petroleum[a] Consumption by Sector						Distillate Fuel Oil Consumption[f]	Hydrocarbon Gas Liquids Consumption[g]	Motor Gasoline (Finished) Consumption[h]	Petroleum Coke Consumption[i]	Fuel Ethanol[j]	*Fuel Ethanol Feedstock Factor*[k]
	Residential	Commercial[b]	Industrial[b]	Transportation[b,c]	Electric Power[d,e]	Total[b,c]						
1950	5.473	5.817	5.927	5.461	6.254	5.642	5.825	3.810	5.253	6.024	NA	*NA*
1955	5.470	5.781	5.847	5.407	6.254	5.581	5.825	3.810	5.253	6.024	NA	*NA*
1960	5.418	5.781	5.772	5.387	6.267	5.542	5.825	3.810	5.253	6.024	NA	*NA*
1965	5.365	5.761	5.695	5.386	6.267	5.517	5.825	[g]3.810	5.253	6.024	NA	*NA*
1970	5.262	5.709	5.579	5.393	6.252	5.499	5.825	3.731	5.253	6.024	NA	*NA*
1975	5.255	5.649	5.490	5.392	6.250	5.489	5.825	3.671	5.253	6.024	NA	*NA*
1980	5.322	5.752	5.340	5.441	6.254	5.472	5.825	3.669	5.253	6.024	3.564	*6.586*
1981	5.284	5.693	5.268	5.433	6.258	5.440	5.825	3.632	5.253	6.024	3.564	*6.562*
1982	5.267	5.699	5.211	5.423	6.258	5.406	5.825	3.588	5.253	6.024	3.564	*6.539*
1983	5.141	5.592	5.214	5.416	6.255	5.396	5.825	3.535	5.253	6.024	3.564	*6.515*
1984	5.308	5.658	5.167	5.418	6.251	5.385	5.825	3.580	5.253	6.024	3.564	*6.492*
1985	5.264	5.598	5.159	5.423	6.247	5.377	5.825	3.584	5.253	6.024	3.564	*6.469*
1986	5.269	5.632	5.237	5.426	6.257	5.410	5.825	3.631	5.253	6.024	3.564	*6.446*
1987	5.241	5.594	5.203	5.429	6.249	5.395	5.825	3.663	5.253	6.024	3.564	*6.423*
1988	5.259	5.598	5.196	5.433	6.250	5.402	5.825	3.643	5.253	6.024	3.564	*6.400*
1989	5.195	5.549	5.190	5.438	[d]6.240	5.403	5.825	3.679	5.253	6.024	3.564	*6.377*
1990	5.146	5.554	5.219	5.442	6.244	5.403	5.825	3.630	5.253	6.024	3.564	*6.355*
1991	5.096	5.529	5.130	5.441	6.246	5.375	5.825	3.626	5.253	6.024	3.564	*6.332*
1992	5.126	5.514	5.133	5.443	6.238	5.369	5.825	3.643	5.253	6.024	3.564	*6.309*
1993	5.103	[b]5.505	[b]5.140	[b]5.413	6.230	[b]5.354	5.825	3.628	[h]5.217	6.024	3.564	*6.287*
1994	5.097	5.513	5.115	5.413	6.213	5.344	[f]5.820	3.657	5.214	6.024	3.564	*6.264*
1995	5.062	5.476	5.084	5.409	6.187	5.326	5.820	3.641	5.204	6.024	3.564	*6.242*
1996	4.997	5.431	5.076	5.416	6.194	5.323	5.820	3.629	5.211	6.024	3.564	*6.220*
1997	4.988	5.389	5.083	5.410	6.198	5.322	5.820	3.627	5.205	6.024	3.564	*6.198*
1998	4.974	5.363	5.101	5.406	6.210	5.335	5.819	3.619	5.203	6.024	3.564	*6.176*
1999	4.902	5.289	5.052	5.406	6.204	5.313	5.819	3.628	5.202	6.024	3.564	*6.167*
2000	4.908	5.313	5.015	5.415	6.188	5.311	5.819	3.610	5.201	6.024	3.564	*6.159*
2001	4.936	5.323	5.104	5.405	6.199	5.331	5.819	3.604	5.201	6.024	3.564	*6.151*
2002	4.885	5.291	5.053	5.404	6.172	5.309	5.819	3.588	5.199	6.024	3.564	*6.143*
2003	4.920	5.313	5.108	5.400	6.182	5.326	5.819	3.610	5.197	6.024	3.564	*6.106*
2004	4.952	5.324	5.106	5.407	6.134	5.330	5.818	3.591	5.196	[i]5.982	3.564	*6.069*
2005	4.915	5.360	5.143	5.408	6.126	5.342	5.818	3.589	5.192	5.982	3.564	*6.032*
2006	4.886	5.296	5.120	5.405	6.038	5.323	5.803	3.551	5.185	5.987	3.564	*5.995*
2007	4.833	5.270	5.079	5.376	6.064	5.293	5.784	3.544	5.142	5.996	3.564	*5.959*
2008	4.772	5.156	5.103	5.342	6.013	5.268	5.780	3.549	5.106	5.992	3.564	*5.922*
2009	4.664	5.217	4.959	[c]5.320	5.987	[c]5.218	5.781	3.487	5.090	6.017	3.564	*5.901*
2010	4.664	5.195	4.920	5.316	5.956	5.204	5.778	3.489	5.067	6.059	3.562	*5.880*
2011	4.657	5.176	4.887	5.315	5.900	5.193	5.776	3.423	5.063	6.077	3.561	*5.859*
2012	4.714	5.126	4.843	5.306	5.925	5.176	5.774	3.440	5.062	6.084	3.560	*5.838*
2013	4.648	5.053	4.801	5.302	5.892	5.157	5.774	3.468	5.060	6.089	3.560	*5.831*
2014	4.664	5.016	4.804	5.300	5.906	5.161	5.773	3.439	5.059	6.100	3.559	*5.825*
2015	4.721	5.050	4.767	5.302	5.915	5.154	5.773	3.461	5.057	6.085	3.558	*5.818*
2016	4.631	5.022	4.799	5.303	5.885	5.161	5.773	3.424	5.055	6.104	3.558	*5.811*
2017	4.623	5.006	4.769	5.305	5.893	5.153	5.772	3.400	5.053	6.132	3.556	*5.804*
2018	4.620	4.971	4.664	5.309	5.896	5.122	5.772	3.381	5.054	6.122	3.553	*5.797*
2019	4.540	4.962	4.646	5.307	5.900	5.111	5.771	3.401	5.052	6.132	3.555	*5.790*
2020	4.536	4.889	4.534	5.301	5.883	5.054	5.770	3.349	5.052	6.130	3.557	*5.784*
2021	4.611	4.909	4.524	5.307	5.883	5.067	5.770	3.369	5.050	6.135	3.555	*5.777*
2022	4.596	4.942	4.441	5.314	5.902	5.058	5.770	3.229	5.049	6.164	3.553	*5.777*
2023	4.621	4.957	4.388	5.308	5.931	5.039	5.770	3.224	5.049	6.153	3.554	*5.777*
2024	[E]4.622	[E]4.961	[E]4.320	[E]5.307	[P]5.943	[P]5.018	[P]5.770	[P]3.201	[P]5.049	[P]6.245	[P]3.553	*5.777*
2025	[E]4.622	[E]4.961	[E]4.320	[E]5.307	[E]5.943	[E]5.018	[E]5.770	[E]3.201	[E]5.049	[E]6.245	[E]3.553	*5.777*

[a] Petroleum products supplied, including natural gas plant liquids and crude oil burned directly as fuel. Quantity-weighted averages of the petroleum products included in each category are calculated by using heat content values for individual products shown in Tables A1 and A3.

[b] Beginning in 1993, includes fuel ethanol blended into motor gasoline.

[c] Beginning in 2009, includes biodiesel and renewable diesel fuel blended into distillate fuel oil.

[d] Electricity-only and combined-heat-and-power (CHP) plants within the NAICS 22 category whose primary business is to sell electricity, or electricity and heat, to the public. Through 1988, data are for electric utilities only; beginning in 1989, data are for electric utilities and independent power producers.

[e] Electric power sector factors are weighted average heat contents for distillate fuel oil, petroleum coke, and residual fuel oil; they exclude other liquids.

[f] There is a discontinuity in this time series between 1993 and 1994; beginning in 1994, the single constant factor is replaced by a quantity-weighted factor. Quantity-weighted averages of the sulfur-content categories of distillate fuel oil are calculated by using heat content values shown in Table A1. Excludes biodiesel and renewable diesel fuel blended into distillate fuel oil.

[g] Quantity-weighted averages of the major components of hydrocarbon gas liquids are calculated by using heat content values shown in Table A1. The factor for 1967 is used as the estimated factor for 1949–1966.

[h] Through 1992, excludes oxygenates. Beginning in 1993, includes fuel ethanol blended into motor gasoline; and for 1993–2006, also includes methyl tertiary butyl ether (MTBE) and other oxygenates blended into motor gasoline.

[i] There is a discontinuity in this time series between 2003 and 2004; beginning in 2004, the single constant factor is replaced by a quantity-weighted factor. Quantity-weighted averages of the two categories of petroleum coke are calculated by using heat content values shown in Table A1.

[j] Includes denaturant (petroleum added to ethanol to make it undrinkable). Fuel ethanol factors are weighted average heat contents for undenatured ethanol (3.539 million Btu per barrel) and products used as denaturant (natural gasoline, finished motor gasoline, and motor gasoline blending components—see Tables A1 and A3 for factors). The factor for 2009 is used as the estimated factor for 1980–2008.

[k] Corn input to the production of undenatured ethanol (million Btu corn per barrel undenatured ethanol), used as the factor to estimate total biomass inputs to the production of undenatured ethanol. Observed ethanol yields (gallons undenatured ethanol per bushel of corn) are 2.5 in 1980, 2.666 in 1998, 2.68 in 2002, 2.78 in 2008, and 2.82 in 2012; yields in other years are estimated. Corn is assumed to have a gross heat content of 0.392 million Btu per bushel. Undenatured ethanol is assumed to have a gross heat content of 3.539 million Btu per barrel.

P=Preliminary. E=Estimate. NA=Not available.

Note: The heat content values in this table are for gross heat contents. See "Heat Content" in Glossary.

Web Page: See http://www.eia.gov/totalenergy/data/monthly/#appendices (Excel and CSV files) for all available annual data beginning in 1949.

Sources: See "Thermal Conversion Factor Source Documentation," which follows Table A6.

Table A4. Approximate Heat Content of Natural Gas

(Btu per Cubic Foot)

	Production		Consumption[a]				
	Marketed	Dry	End-Use Sectors[b]	Electric Power Sector[c]	Total	Imports	Exports
1950	1,119	1,035	1,035	1,035	1,035	– –	1,035
1955	1,120	1,035	1,035	1,035	1,035	1,035	1,035
1960	1,107	1,035	1,035	1,035	1,035	1,035	1,035
1965	1,101	1,032	1,032	1,032	1,032	1,032	1,032
1970	1,102	1,031	1,031	1,031	1,031	1,031	1,031
1975	1,095	1,021	1,020	1,026	1,021	1,026	1,014
1980	1,098	1,026	1,024	1,035	1,026	1,022	1,013
1981	1,103	1,027	1,025	1,035	1,027	1,014	1,011
1982	1,107	1,028	1,026	1,036	1,028	1,018	1,011
1983	1,115	1,031	1,031	1,030	1,031	1,024	1,010
1984	1,109	1,031	1,030	1,035	1,031	1,005	1,010
1985	1,112	1,032	1,031	1,038	1,032	1,002	1,011
1986	1,110	1,030	1,029	1,034	1,030	997	1,008
1987	1,112	1,031	1,031	1,032	1,031	999	1,011
1988	1,109	1,029	1,029	1,028	1,029	1,002	1,018
1989	1,107	1,031	1,032	[c] 1,028	1,031	1,004	1,019
1990	1,105	1,029	1,029	1,027	1,029	1,012	1,018
1991	1,108	1,030	1,031	1,025	1,030	1,014	1,022
1992	1,110	1,030	1,031	1,025	1,030	1,011	1,018
1993	1,106	1,027	1,027	1,025	1,027	1,020	1,016
1994	1,105	1,028	1,029	1,025	1,028	1,022	1,011
1995	1,106	1,026	1,027	1,021	1,026	1,021	1,011
1996	1,109	1,026	1,027	1,020	1,026	1,022	1,011
1997	1,107	1,026	1,027	1,020	1,026	1,023	1,011
1998	1,109	1,031	1,033	1,024	1,031	1,023	1,011
1999	1,107	1,027	1,028	1,022	1,027	1,022	1,006
2000	1,107	1,025	1,026	1,021	1,025	1,023	1,006
2001	1,105	1,028	1,029	1,026	1,028	1,023	1,010
2002	1,103	1,024	1,025	1,020	1,024	1,022	1,008
2003	1,103	1,028	1,029	1,025	1,028	1,025	1,009
2004	1,104	1,026	1,026	1,027	1,026	1,025	1,009
2005	1,104	1,028	1,028	1,028	1,028	1,025	1,009
2006	1,103	1,028	1,028	1,028	1,028	1,025	1,009
2007	1,102	1,027	1,027	1,027	1,027	1,025	1,009
2008	1,100	1,027	1,027	1,027	1,027	1,025	1,009
2009	1,101	1,025	1,025	1,025	1,025	1,025	1,009
2010	1,098	1,023	1,023	1,022	1,023	1,025	1,009
2011	1,142	1,022	1,022	1,021	1,022	1,025	1,009
2012	1,091	1,024	1,025	1,022	1,024	1,025	1,009
2013	1,101	1,027	1,028	1,025	1,027	1,025	1,009
2014	1,116	1,032	1,033	1,029	1,032	1,025	1,009
2015	1,124	1,037	1,038	1,035	1,037	1,025	1,009
2016	1,128	1,037	1,039	1,034	1,037	1,025	1,009
2017	1,129	1,036	1,037	1,034	1,036	1,025	1,009
2018	1,134	1,036	1,038	1,033	1,036	1,025	1,009
2019	1,140	1,038	1,040	1,034	1,038	1,025	1,009
2020	1,145	1,037	1,039	1,034	1,037	1,025	1,009
2021	1,146	1,037	1,039	1,034	1,037	1,025	1,009
2022	1,149	1,036	1,038	1,033	1,036	1,025	1,009
2023	1,156	1,036	1,038	1,033	1,036	1,025	1,009
2024	[E] 1,156	[P] 1,037	[P] 1,039	[P] 1,034	[P] 1,037	[E] 1,025	[E] 1,009
2025	[E] 1,156	[E] 1,037	[E] 1,039	[E] 1,034	[E] 1,037	[E] 1,025	[E] 1,009

[a] Consumption factors are for natural gas, plus a small amount of supplemental gaseous fuels.

[b] Residential, commercial, industrial, and transportation sectors.

[c] Electricity-only and combined-heat-and-power (CHP) plants within the NAICS 22 category whose primary business is to sell electricity, or electricity and heat, to the public. Through 1988, data are for electric utilities only; beginning in 1989, data are for electric utilities and independent power producers.

P=Preliminary. E=Estimate. – – =Not applicable.

Note: The values in this table are for gross heat contents. See "Heat Content" in Glossary.

Web Page: See http://www.eia.gov/totalenergy/data/monthly/#appendices (Excel and CSV files) for all available annual data beginning in 1949.

Sources: See "Thermal Conversion Factor Source Documentation," which follows Table A6.

Table A5. Approximate Heat Content of Coal and Coal Coke

(Million Btu per Short Ton)

	Coal									Coal Coke
			Consumption							
	Production[a]	Waste Coal Supplied[b]	Residential and Commercial Sectors[c]	Industrial Sector: Coke Plants	Industrial Sector: Other[d]	Electric Power Sector[e,f]	Total	Imports	Exports	Imports and Exports
1950	25.090	NA	24.461	26.798	24.820	23.937	24.989	25.020	26.788	24.800
1955	25.201	NA	24.373	26.794	24.821	24.056	24.982	25.000	26.907	24.800
1960	24.906	NA	24.226	26.791	24.609	23.927	24.713	25.003	26.939	24.800
1965	24.775	NA	24.028	26.787	24.385	23.780	24.537	25.000	26.973	24.800
1970	23.842	NA	23.203	26.784	22.983	22.573	23.440	25.000	26.982	24.800
1975	22.897	NA	22.261	26.782	22.436	21.642	22.506	25.000	26.562	24.800
1980	22.415	NA	22.543	26.790	22.690	21.295	21.947	25.000	26.384	24.800
1981	22.308	NA	22.474	26.794	22.585	21.085	21.713	25.000	26.160	24.800
1982	22.239	NA	22.695	26.797	22.712	21.194	21.674	25.000	26.223	24.800
1983	22.052	NA	22.775	26.798	22.691	21.133	21.576	25.000	26.291	24.800
1984	22.010	NA	22.844	26.799	22.543	21.101	21.573	25.000	26.402	24.800
1985	21.870	NA	22.646	26.798	22.020	20.959	21.366	25.000	26.307	24.800
1986	21.913	NA	22.947	26.798	22.198	21.084	21.462	25.000	26.292	24.800
1987	21.922	NA	23.404	26.799	22.381	21.136	21.517	25.000	26.291	24.800
1988	21.823	NA	23.571	26.799	22.360	20.900	21.328	25.000	26.299	24.800
1989	21.765	[b] 10.391	23.650	26.800	22.347	[e] 20.898	21.307	25.000	26.160	24.800
1990	21.822	9.303	23.137	26.799	22.457	20.779	21.197	25.000	26.202	24.800
1991	21.681	10.758	23.114	26.799	22.460	20.730	21.120	25.000	26.188	24.800
1992	21.682	10.396	23.105	26.799	22.250	20.709	21.068	25.000	26.161	24.800
1993	21.418	10.638	22.994	26.800	22.123	20.677	21.010	25.000	26.335	24.800
1994	21.394	11.097	23.112	26.800	22.068	20.589	20.929	25.000	26.329	24.800
1995	21.326	11.722	23.118	26.800	21.950	20.543	20.880	25.000	26.180	24.800
1996	21.322	12.147	23.011	26.800	22.105	20.547	20.870	25.000	26.174	24.800
1997	21.296	12.158	22.494	26.800	22.172	20.518	20.830	25.000	26.251	24.800
1998	21.418	12.639	21.620	27.426	23.164	20.516	20.881	25.000	26.800	24.800
1999	21.070	12.552	23.880	27.426	22.489	20.490	20.818	25.000	26.081	24.800
2000	21.072	12.360	25.020	27.426	22.433	20.511	20.828	25.000	26.117	24.800
2001	[a] 20.772	12.169	24.909	27.426	22.622	20.337	20.671	25.000	25.998	24.800
2002	20.673	12.165	22.962	27.426	22.562	20.238	20.541	25.000	26.062	24.800
2003	20.499	12.360	22.242	27.425	22.468	20.082	20.387	25.000	25.972	24.800
2004	20.424	12.266	22.324	27.426	22.473	19.980	20.290	25.000	26.108	24.800
2005	20.348	12.093	22.342	26.279	22.178	19.988	20.246	25.000	25.494	24.800
2006	20.310	12.080	22.066	26.271	22.050	19.931	20.181	25.000	25.453	24.800
2007	20.340	12.090	22.069	26.329	22.371	19.909	20.168	25.000	25.466	24.800
2008	20.208	12.121	[c] 23.035	26.281	22.304	19.713	19.979	25.000	25.399	24.800
2009	19.963	12.076	22.852	26.334	21.823	19.521	19.741	25.000	25.633	24.800
2010	20.173	11.960	22.611	26.295	21.846	19.623	19.870	25.000	25.713	24.800
2011	20.142	11.604	22.099	26.299	21.568	19.341	19.600	25.000	25.645	24.800
2012	20.215	11.539	21.300	28.636	21.449	19.211	19.544	23.128	24.551	24.800
2013	20.182	11.103	21.233	28.705	21.600	19.174	19.513	22.379	24.605	24.800
2014	20.146	11.474	21.307	28.458	21.525	19.290	19.611	22.187	25.032	24.800
2015	19.880	11.527	20.699	28.526	21.258	19.146	19.482	22.633	25.048	24.800
2016	19.977	11.496	20.078	28.608	21.055	19.153	19.459	22.327	25.655	24.800
2017	20.025	11.438	19.467	28.673	20.802	18.981	19.303	21.489	24.628	24.800
2018	20.160	11.419	19.269	28.608	20.739	18.915	19.258	20.415	24.294	24.800
2019	20.053	11.513	19.084	28.629	20.721	18.903	19.292	20.558	24.584	24.800
2020	19.845	11.268	18.297	28.717	20.425	18.882	19.260	20.347	24.969	24.800
2021	19.933	11.268	18.399	28.666	20.578	18.941	19.331	20.295	24.216	24.800
2022	20.100	11.268	18.083	28.669	20.388	18.792	19.180	21.447	24.346	24.800
2023	20.172	11.268	17.375	28.859	20.490	18.717	19.185	21.929	24.055	24.800
2024	[P] 20.497	[P] 11.268	[P] 17.321	[P] 28.932	[P] 20.339	[P] 18.767	[P] 19.213	[P] 23.445	[P] 24.292	[P] 24.800
2025	[E] 20.497	[E] 11.268	[E] 17.321	[E] 28.932	[E] 20.339	[E] 18.767	[E] 19.213	[E] 23.445	[E] 24.292	[E] 24.800

[a] Beginning in 2001, includes a small amount of refuse recovery (coal recaptured from a refuse mine, and cleaned to reduce the concentration of noncombustible materials).

[b] Waste coal (including fine coal, coal obtained from a refuse bank or slurry dam, anthracite culm, bituminous gob, and lignite waste) consumed by the electric power and industrial sectors. Beginning in 1989, waste coal supplied is counted as a supply-side item to balance the same amount of waste coal included in "Consumption."

[c] Through 2007, used as the thermal conversion factor for coal consumption by the residential and commercial sectors. Beginning in 2008, used as the thermal conversion factor for coal consumption by the commercial sector only.

[d] Includes transportation. Excludes coal synfuel plants.

[e] Electricity-only and combined-heat-and-power (CHP) plants within the NAICS 22 category whose primary business is to sell electricity, or electricity and heat, to the public. Through 1988, data are for electric utilities only; beginning in 1989, data are for electric utilities and independent power producers.

[f] Electric power sector factors are for anthracite, bituminous coal, subbituminous coal, lignite, waste coal, and, beginning in 1998, coal synfuel.

P=Preliminary. E=Estimate. NA=Not available.

Note: The values in this table are for gross heat contents. See "Heat Content" in Glossary.

Web Page: See http://www.eia.gov/totalenergy/data/monthly/#appendices (Excel and CSV files) for all available annual data beginning in 1949.

Table A6. Approximate Heat Rates for Electricity, and Heat Content of Electricity

(Btu per Kilowatthour)

	Approximate Heat Rates[a] for Electricity Net Generation					Thermal Conversion Factor for Noncombustible Renewable Energy[i,k]	Heat Content[j] of Electricity[k]
	Fossil Fuels[b]						
	Coal[c]	Petroleum[d]	Natural Gas[e]	Total Fossil Fuels[f,g]	Nuclear[h]		
1950	NA	NA	NA	14,030	– –	3,412	3,412
1955	NA	NA	NA	11,699	– –	3,412	3,412
1960	NA	NA	NA	10,760	11,629	3,412	3,412
1965	NA	NA	NA	10,453	11,804	3,412	3,412
1970	NA	NA	NA	10,494	10,977	3,412	3,412
1975	NA	NA	NA	10,406	11,013	3,412	3,412
1980	NA	NA	NA	10,388	10,908	3,412	3,412
1981	NA	NA	NA	10,453	11,030	3,412	3,412
1982	NA	NA	NA	10,454	11,073	3,412	3,412
1983	NA	NA	NA	10,520	10,905	3,412	3,412
1984	NA	NA	NA	10,440	10,843	3,412	3,412
1985	NA	NA	NA	10,447	10,622	3,412	3,412
1986	NA	NA	NA	10,446	10,579	3,412	3,412
1987	NA	NA	NA	10,419	10,442	3,412	3,412
1988	NA	NA	NA	10,324	10,602	3,412	3,412
1989	NA	NA	NA	10,432	10,583	3,412	3,412
1990	NA	NA	NA	10,402	10,582	3,412	3,412
1991	NA	NA	NA	10,436	10,484	3,412	3,412
1992	NA	NA	NA	10,342	10,471	3,412	3,412
1993	NA	NA	NA	10,309	10,504	3,412	3,412
1994	NA	NA	NA	10,316	10,452	3,412	3,412
1995	NA	NA	NA	10,312	10,507	3,412	3,412
1996	NA	NA	NA	10,340	10,503	3,412	3,412
1997	NA	NA	NA	10,213	10,494	3,412	3,412
1998	NA	NA	NA	10,197	10,491	3,412	3,412
1999	NA	NA	NA	10,226	10,450	3,412	3,412
2000	NA	NA	NA	10,201	10,429	3,412	3,412
2001	10,378	10,742	10,051	[b] 10,333	10,443	3,412	3,412
2002	10,314	10,641	9,533	10,173	10,442	3,412	3,412
2003	10,297	10,610	9,207	10,125	10,422	3,412	3,412
2004	10,331	10,571	8,647	10,016	10,428	3,412	3,412
2005	10,373	10,631	8,551	9,999	10,436	3,412	3,412
2006	10,351	10,809	8,471	9,919	10,435	3,412	3,412
2007	10,375	10,794	8,403	9,884	10,489	3,412	3,412
2008	10,378	11,015	8,305	9,854	10,452	3,412	3,412
2009	10,414	10,923	8,160	9,760	10,459	3,412	3,412
2010	10,415	10,984	8,185	9,756	10,452	3,412	3,412
2011	10,444	10,829	8,152	9,716	10,464	3,412	3,412
2012	10,498	10,991	8,039	9,516	10,479	3,412	3,412
2013	10,459	10,713	7,948	9,541	10,449	3,412	3,412
2014	10,428	10,814	7,907	9,509	10,459	3,412	3,412
2015	10,495	10,687	7,869	9,314	10,458	3,412	3,412
2016	10,493	10,811	7,863	9,228	10,459	3,412	3,412
2017	10,465	10,834	7,803	9,208	10,459	3,412	3,412
2018	10,481	11,095	7,811	9,098	10,455	3,412	3,412
2019	10,551	11,205	7,725	8,899	10,442	3,412	3,412
2020	10,655	11,259	7,725	8,767	10,446	3,412	3,412
2021	10,583	11,224	7,689	8,844	10,429	3,412	3,412
2022	10,689	11,166	7,740	8,813	10,448	3,412	3,412
2023	10,745	11,465	7,721	8,630	10,452	3,412	3,412
2024	[E] 10,745	[E] 11,465	[E] 7,721	[E] 8,630	[E] 10,452	3,412	3,412
2025	[E] 10,745	[E] 11,465	[E] 7,721	[E] 8,630	[E] 10,452	3,412	3,412

[a] The values in columns 1–5 of this table are for net heat rates. See "Heat Rate" in Glossary.
[b] Through 2000, heat rates are for fossil-fueled steam-electric plants at electric utilities. Beginning in 2001, heat rates are for all fossil-fueled plants at electric utilities and electricity-only independent power producers.
[c] Includes anthracite, bituminous coal, subbituminous coal, lignite, and, beginning in 2002, waste coal and coal synfuel.
[d] Includes distillate fuel oil, residual fuel oil, jet fuel, kerosene, petroleum coke, and waste oil.
[e] Includes natural gas and supplemental gaseous fuels.
[f] Includes coal, petroleum, natural gas, and, beginning in 2001, other fossil gases (blast furnace gas, propane gas, and other manufactured and waste gases derived from fossil fuels).
[g] Through 2000, used as the thermal conversion factor for wood and waste electricity net generation at electric utilities; beginning in 2001, Btu data for wood and waste at electric utilities are available from surveys.
[h] Used as the thermal conversion factor for nuclear electricity net generation.
[i] Technology-based geothermal heat rates are no longer used in Btu calculations in this report. For technology-based geothermal heat rates for 1960–2010, see the *Annual Energy Review 2010*, Table A6.
[j] See "Heat Content" in Glossary.
[k] The value of 3,412 Btu per kilowatthour, which is the heat content of electricity, is a constant. It is used as the thermal conversion factor for electricity net generation from noncombustible renewable energy (hydro, geothermal, solar thermal, photovoltaic, and wind), electricity sales to ultimate customers, and electricity imports and exports.
E=Estimate. NA=Not available. – – =Not applicable.
Web Page: See http://www.eia.gov/totalenergy/data/monthly/#appendices (Excel and CSV files) for all available annual data beginning in 1949.
Sources: See "Thermal Conversion Factor Source Documentation," which follows this table.

Approximate Heat Content of Petroleum and Natural Gas Liquids

Asphalt. The U.S. Energy Information Administration (EIA) adopted the thermal conversion factor of 6.636 million British thermal units (Btu) per barrel as estimated by the Bureau of Mines and first published in the *Petroleum Statement, Annual, 1956*.

Aviation Gasoline Blending Components. Assumed by EIA to be 5.048 million Btu per barrel or equal to the thermal conversion factor for **Aviation Gasoline (Finished)**.

Aviation Gasoline (Finished). EIA adopted the thermal conversion factor of 5.048 million Btu per barrel as adopted by the Bureau of Mines from the Texas Eastern Transmission Corporation publication *Competition and Growth in American Energy Markets 1947–1985*, a 1968 release of historical and projected statistics.

Butylene. EIA estimated the thermal conversion factor to be 4.377 million Btu per barrel, based on data for enthalpy of combustion from the National Institute of Standards and Technology, *NIST Chemistry WebBook, NIST Standard Reference Database Number 69,* 2018; and data for density of liquids at 60 degrees Fahrenheit and equilibrium pressure from the American Petroleum Institute.

Crude Oil Exports. • 1949–2014: Assumed by EIA to be 5.800 million Btu per barrel or equal to the thermal conversion factor for crude oil produced in the United States. See **Crude Oil Production**. • 2015 forward: Calculated annually by EIA based on conversion of American Petroleum Institute (API) gravity ranges of crude oil exports as reported in trade data from the U.S. Census Bureau. Specific gravity (SG) = 141.5 / (131.5 + API gravity). The higher heating value (HHV) in million Btu per barrel = SG * (7.801796 - 1.3213 * SG^2).

Crude Oil Imports. Calculated annually by EIA as the average of the thermal conversion factors for each type of crude oil imported weighted by the quantities imported. Thermal conversion factors for each type were calculated on a foreign country basis, by determining the average American Petroleum Institute (API) gravity of crude oil imported from each foreign country from Form ERA-60 in 1977 and converting average API gravity to average Btu content by using National Bureau of Standards, Miscellaneous Publication No. 97, *Thermal Properties of Petroleum Products*, 1933.

Crude Oil Production. • 1949–2014: EIA adopted the thermal conversion factor of 5.800 million Btu per barrel as reported in a Bureau of Mines internal memorandum, "Bureau of Mines Standard Average Heating Values of Various Fuels, Adopted January 3, 1950." • 2015 forward: Calculated annually by EIA based on conversion of American Petroleum Institute (API) gravity ranges of crude oil production as reported on Form EIA-914, "Monthly Crude Oil, Lease Condensate, and Natural Gas Production Report." Specific gravity (SG) = 141.5 / (131.5 + API gravity). The higher heating value (HHV) in million Btu per barrel = SG * (7.801796 - 1.3213 * SG^2).

Distillate Fuel Oil Consumption. • 1949–1993: EIA adopted the Bureau of Mines thermal conversion factor of 5.825 million Btu per barrel as reported in a Bureau of Mines internal memorandum, "Bureau of Mines Standard Average Heating Values of Various Fuels, Adopted January 3, 1950." • 1994 forward: Calculated by EIA as the annual quantity-weighted average of the conversion factors for **Distillate Fuel Oil, 15 ppm Sulfur and Under** (5.770 million Btu per barrel), **Distillate Fuel Oil, Greater Than 15 ppm to 500 ppm Sulfur** (5.817 million Btu per barrel), and **Distillate Fuel Oil, Greater Than 500 ppm Sulfur** (5.825 million Btu per barrel).

Distillate Fuel Oil, 15 ppm Sulfur and Under. EIA adopted the thermal conversion factor of 5.770 million Btu per barrel (137,380 Btu per gallon) for U.S. conventional diesel from U.S. Department of Energy, Argonne National Laboratory, "The Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies Model" (GREET), version R&D GREET1_2024, January 2025.

Distillate Fuel Oil, Greater Than 15 ppm to 500 ppm Sulfur. EIA adopted the thermal conversion factor of 5.817 million Btu per barrel (138,490 Btu per gallon) for low-sulfur diesel from U.S. Department of Energy, Argonne Laboratory, "The Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies Model" (GREET), version R&D GREET1_2024, January 2025.

Distillate Fuel Oil, Greater Than 500 ppm Sulfur. EIA adopted the Bureau of Mines thermal conversion factor of 5.825 million Btu per barrel as reported in a Bureau of Mines internal memorandum, "Bureau of Mines Standard Average Heating Values of Various Fuels, Adopted January 3, 1950."

Ethane. EIA estimated the thermal conversion factor to be 2.783 million Btu per barrel, based on data for enthalpy of combustion from the National Institute of Standards and Technology, *NIST Chemistry WebBook, NIST Standard Reference Database Number 69,* 2018; and data for density of liquids at 60 degrees Fahrenheit and equilibrium pressure from the American Petroleum Institute.

Ethylene. EIA adopted the thermal conversion factor of 2.436 million Btu per barrel (0.058 million Btu per gallon) as published in the Federal Register EPA; 40 CFR part 98; e-CRF; Table C1; April 5, 2019. The ethylene higher heating value is determined at 41 degrees Fahrenheit at saturation pressure.

Hydrocarbon Gas Liquids. • 1949–1966: EIA used the 1967 factor. • 1967 forward: Calculated annually by EIA as the average of the thermal conversion factors for all hydrocarbon gas liquids consumed (see Table A1) weighted by the quantities consumed. The component products of hydrocarbon gas liquids are ethane, propane, normal butane, isobutane, natural gasoline (pentanes plus), and refinery olefins (ethylene, propylene, butylene, and isobutylene). For 1967–1980, quantities consumed are from EIA, Energy Data Reports, "Petroleum Statement, Annual." For 1981 forward, quantities consumed are from EIA, *Petroleum Supply Annual.*

Hydrogen. EIA estimated a thermal conversion factor of 323.6 Btu per standard cubic foot (at 60 degrees Fahrenheit and 1 atmosphere), based on data published by the National Research Council and National Academy of Engineering, in Appendix H of *The Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs*, 2004. EIA also assumed a thermal conversion factor of 6.287 million Btu per residual fuel oil equivalent barrel or equal to the thermal conversion factor for **Residual Fuel Oil**.

Isobutane. EIA estimated the thermal conversion factor to be 4.183 million Btu per barrel, based on data for enthalpy of combustion from the National Institute of Standards and Technology, *NIST Chemistry WebBook, NIST Standard Reference Database Number 69,* 2018; and data for density of liquids at 60 degrees Fahrenheit and equilibrium pressure from the American Petroleum Institute.

Isobutylene. EIA estimated the thermal conversion factor to be 4.355 million Btu per barrel, based on data for enthalpy of combustion from the National Institute of Standards and Technology, *NIST Chemistry WebBook, NIST Standard Reference Database Number 69,* 2018; and data for density of liquids at 60 degrees Fahrenheit and equilibrium pressure from the American Petroleum Institute.

Jet Fuel, Kerosene-Type. EIA adopted the Bureau of Mines thermal conversion factor of 5.670 million Btu per barrel for "Jet Fuel, Commercial" as published by the Texas Eastern Transmission Corporation in the report *Competition and Growth in American Energy Markets 1947–1985*, a 1968 release of historical and projected statistics.

Jet Fuel, Naphtha-Type. EIA adopted the Bureau of Mines thermal conversion factor of 5.355 million Btu per barrel for "Jet Fuel, Military" as published by the Texas Eastern Transmission Corporation in the report *Competition and Growth in American Energy Markets 1947–1985*, a 1968 release of historical and projected statistics.

Kerosene. EIA adopted the Bureau of Mines thermal conversion factor of 5.670 million Btu per barrel as reported in a Bureau of Mines internal memorandum, "Bureau of Mines Standard Average Heating Values of Various Fuels, Adopted January 3, 1950."

Lubricants. EIA adopted the thermal conversion factor of 6.065 million Btu per barrel as estimated by the Bureau of Mines and first published in the *Petroleum Statement, Annual, 1956*.

Miscellaneous Products. EIA adopted the thermal conversion factor of 5.796 million Btu per barrel as estimated by the Bureau of Mines and first published in the *Petroleum Statement, Annual, 1956*.

Motor Gasoline Blending Components. • 1949–2006: EIA adopted the Bureau of Mines thermal conversion factor of 5.253 million Btu per barrel for "Gasoline, Motor Fuel" as published by the Texas Eastern Transmission Corporation in Appendix V of *Competition and Growth in American Markets 1947-1985,* a 1968 release of historical and projected statistics. • 2007 forward: EIA adopted the thermal conversion factor of 5.222 million Btu per barrel (124,340 Btu per gallon) for gasoline blendstock from U.S. Department of Energy, Argonne National Laboratory, "The Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies Model" (GREET), version R&D GREET1_2024, January 2025.

Motor Gasoline Exports. • 1949–2005: EIA adopted the Bureau of Mines thermal conversion factor of 5.253 million Btu per barrel for "Gasoline, Motor Fuel" as published by the Texas Eastern Transmission Corporation in Appendix V of *Competition and Growth in American Energy Markets 1947–1985*, a 1968 release of historical and projected statistics. • 2006 forward: Calculated by EIA as the annual quantity-weighted average of the conversion factors for gasoline blendstock and the methyl tertiary butyl ether (MTBE) blended into motor gasoline exports. The factor for gasoline

blendstock is 5.253 million Btu per barrel in 2006 and 5.222 million Btu per barrel beginning in 2007 (see **Motor Gasoline Blending Components**). For MTBE, EIA adopted the thermal conversion factor of 4.247 million Btu per barrel (101,130 Btu per gallon) from U.S. Department of Energy, Argonne National Laboratory, "The Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies Model" (GREET), version R&D GREET1_2024, January 2025.

Motor Gasoline (Finished) Consumption. • 1949–1992: EIA adopted the Bureau of Mines thermal conversion factor of 5.253 million Btu per barrel for "Gasoline, Motor Fuel" as published by the Texas Eastern Transmission Corporation in Appendix V of *Competition and Growth in American Markets 1947-1985,* a 1968 release of historical and projected statistics. • 1993–2006: Calculated by EIA as the annual quantity-weighted average of the conversion factors for gasoline blendstock and the oxygenates blended into motor gasoline. The factor for gasoline blendstock is 5.253 million Btu per barrel (the motor gasoline factor used for previous years). The factors for fuel ethanol are shown in Table A3 (see **Fuel Ethanol, Denatured**). The following factors for other oxygenates are from U.S. Department of Energy, Argonne National Laboratory, "The Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies Model" (GREET), version R&D GREET1_2024, January 2025—methyl tertiary butyl ether (MTBE): 4.247 million Btu per barrel (101,130 Btu per gallon); tertiary amyl methyl ether (TAME): 4.560 million Btu per barrel (108,570 Btu per gallon); ethyl tertiary butyl ether (ETBE): 4.390 million Btu per barrel (104,530 Btu per gallon); methanol: 2.738 million Btu per barrel (65,200 Btu per gallon); and butanol: 4.555 million Btu per barrel (108,458 Btu per gallon). • 2007 forward: Calculated by EIA as the annual quantity-weighted average of the conversion factors for gasoline blendstock and fuel ethanol blended into motor gasoline. The factor for gasoline blendstock is 5.222 million Btu per barrel (124,340 Btu per gallon), which is from the GREET model (see above). The factors for fuel ethanol are shown in Table A3 (see **Fuel Ethanol, Denatured**).

Motor Gasoline Imports. • 1949–2006: EIA adopted the Bureau of Mines thermal conversion factor of 5.253 million Btu per barrel for "Gasoline, Motor Fuel" as published by the Texas Eastern Transmission Corporation in Appendix V of *Competition and Growth in American Energy Markets 1947–1985*, a 1968 release of historical and projected statistics. • 2007 forward: EIA adopted the thermal conversion factor of 5.222 million Btu per barrel (124,340 Btu per gallon) for gasoline blendstock from U.S. Department of Energy, Argonne National Laboratory, "The Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies Model" (GREET), version R&D GREET1_2024, January 2025.

Natural Gas Plant Liquids Production. Calculated annually by EIA as the average of the thermal conversion factors for each natural gas plant liquid produced weighted by the quantities produced.

Natural Gasoline. EIA estimated the thermal conversion factor to be 4.638 million Btu per barrel, based on data for enthalpy of combustion from the National Institute of Standards and Technology, *NIST Chemistry WebBook, NIST Standard Reference Database Number 69,* 2018; and data for density of liquids at 60 degrees Fahrenheit and equilibrium pressure from the American Petroleum Institute. EIA assumes a natural gasoline ratio of 29% isopentane, 29% neopentane, 20% normal pentane, 13% normal hexane, 4% cyclohexane, 3% benzene, and 2% toluene in these calculations.

Normal Butane. EIA estimated the thermal conversion factor to be 4.353 million Btu per barrel, based on data for enthalpy of combustion from the National Institute of Standards and Technology, *NIST Chemistry WebBook, NIST Standard Reference Database Number 69,* 2018; and data for density of liquids at 60 degrees Fahrenheit and equilibrium pressure from the American Petroleum Institute.

Other Hydrocarbons. Assumed by EIA to be 5.825 million Btu per barrel or equal to the thermal conversion factor for **Unfinished Oils**.

Oxygenates (Excluding Fuel Ethanol). EIA adopted the thermal conversion factor of 4.247 million Btu per barrel (101,130 Btu per gallon) for methyl tertiary butyl ether (MTBE) from U.S. Department of Energy, Argonne National Laboratory, "The Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies Model" (GREET), version R&D GREET1_2024, January 2025.

Petrochemical Feedstocks, Naphtha Less Than 401 Degrees Fahrenheit. Assumed by EIA to be 5.248 million Btu per barrel or equal to the thermal conversion factor for **Special Naphthas**.

Petrochemical Feedstocks, Other Oils Equal to or Greater Than 401 Degrees Fahrenheit. Assumed by EIA to be 5.825 million Btu per barrel or equal to the thermal conversion factor for **Distillate Fuel Oil**.

Petrochemical Feedstocks, Still Gas. Assumed by EIA to be equal to the thermal conversion factor for **Still Gas**.

Petroleum Coke, Catalyst. Assumed by EIA to be 6.287 million Btu per barrel or equal to the thermal conversion factor for **Residual Fuel Oil**.

Petroleum Coke, Marketable. EIA adopted the thermal conversion factor of 5.719 million Btu per barrel, calculated by dividing 28,595,925 Btu per short ton for petroleum coke (from U.S. Department of Energy, Argonne National Laboratory, "The Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies Model" (GREET), version R&D GREET1_2024, January 2025) by 5.0 barrels per short ton (as given in the Bureau of Mines Form 6-1300-M and successor EIA forms).

Petroleum Coke, Total. • 1949–2003: EIA adopted the thermal conversion factor of 6.024 million Btu per barrel as reported in Btu per short ton in the Bureau of Mines internal memorandum, "Bureau of Mines Standard Average Heating Values of Various Fuels, Adopted January 3, 1950." The Bureau of Mines calculated this factor by dividing 30.120 million Btu per short ton, as given in the referenced Bureau of Mines internal memorandum, by 5.0 barrels per short ton, as given in the Bureau of Mines Form 6-1300-M and successor EIA forms. • 2004 forward: Calculated by EIA as the annual quantity-weighted average of the conversion factors for **Petroleum Coke, Catalyst** (6.287 million Btu per barrel) and **Petroleum Coke, Marketable** (5.719 million Btu per barrel).

Petroleum Consumption, Commercial Sector. Calculated annually by EIA as the average of the thermal conversion factors for all petroleum products consumed by the commercial sector weighted by the estimated quantities consumed by the commercial sector. The quantities of petroleum products consumed by the commercial sector are estimated in the State Energy Data System—see documentation at http://www.eia.gov/state/seds/sep_use/notes/use_petrol.pdf.

Petroleum Consumption, Electric Power Sector. Calculated annually by EIA as the average of the thermal conversion factors for distillate fuel oil, petroleum coke, and residual fuel oil consumed by the electric power sector weighted by the quantities consumed by the electric power sector. Data are from Form EIA-923, "Power Plant Operations Report," and predecessor forms.

Petroleum Consumption, Industrial Sector. Calculated annually by EIA as the average of the thermal conversion factors for all petroleum products consumed by the industrial sector weighted by the estimated quantities consumed by the industrial sector. The quantities of petroleum products consumed by the industrial sector are estimated in the State Energy Data System—see documentation at http://www.eia.gov/state/seds/sep_use/notes/use_petrol.pdf.

Petroleum Consumption, Residential Sector. Calculated annually by EIA as the average of the thermal conversion factors for all petroleum products consumed by the residential sector weighted by the estimated quantities consumed by the residential sector. The quantities of petroleum products consumed by the residential sector are estimated in the State Energy Data System—see documentation at http://www.eia.gov/state/seds/sep_use/notes/use_petrol.pdf.

Petroleum Consumption, Total. Calculated annually by EIA as the average of the thermal conversion factors for all petroleum products consumed weighted by the quantities consumed.

Petroleum Consumption, Transportation Sector. Calculated annually by EIA as the average of the thermal conversion factors for all petroleum products consumed by the transportation sector weighted by the estimated quantities consumed by the transportation sector. The quantities of petroleum products consumed by the transportation sector are estimated in the State Energy Data System—see documentation at http://www.eia.gov/state/seds/sep_use/notes/use_petrol.pdf.

Petroleum Products Exports. Calculated annually by EIA as the average of the thermal conversion factors for each petroleum product exported weighted by the quantities exported.

Petroleum Products Imports. Calculated annually by EIA as the average of the thermal conversion factors for each petroleum product imported weighted by the quantities imported.

Plant Condensate. • 1973–1983: Estimated to be 5.418 million Btu per barrel by EIA from data provided by McClanahan Consultants, Inc., Houston, Texas.

Propane. EIA estimated the thermal conversion factor to be 3.841 million Btu per barrel, based on data for enthalpy of combustion from the National Institute of Standards and Technology, *NIST Chemistry WebBook, NIST Standard Reference Database Number 69,* 2018; and data for density of liquids at 60 degrees Fahrenheit and equilibrium pressure from the American Petroleum Institute.

Propylene. EIA estimated the thermal conversion factor to be 3.835 million Btu per barrel, based on data for enthalpy of combustion from the National Institute of Standards and Technology, *NIST Chemistry WebBook, NIST Standard Reference Database Number 69,* 2018; and data for density of liquids at 60 degrees Fahrenheit and equilibrium pressure from the American Petroleum Institute.

Residual Fuel Oil. EIA adopted the thermal conversion factor of 6.287 million Btu per barrel as reported in the Bureau of Mines internal memorandum, "Bureau of Mines Standard Average Heating Values of Various Fuels, Adopted January 3, 1950."

Road Oil. EIA adopted the Bureau of Mines thermal conversion factor of 6.636 million Btu per barrel, which was assumed to be equal to that of **Asphalt** and was first published by the Bureau of Mines in the *Petroleum Statement, Annual, 1970*.

Special Naphthas. EIA adopted the Bureau of Mines thermal conversion factor of 5.248 million Btu per barrel, which was assumed to be equal to that of the total gasoline (aviation and motor) factor and was first published in the *Petroleum Statement, Annual, 1970*.

Still Gas. • 1949–2015: EIA adopted the Bureau of Mines estimated thermal conversion factor of 6.000 million Btu per barrel, first published in the *Petroleum Statement, Annual, 1970*. • 2016 forward: Assumed by EIA to be 6.287 million Btu per barrel or equal to the thermal conversion factor for **Residual Fuel Oil.**

Total Petroleum Exports. Calculated annually by EIA as the average of the thermal conversion factors for crude oil and each petroleum product exported weighted by the quantities exported. See **Crude Oil Exports** and **Petroleum Products Exports**.

Total Petroleum Imports. Calculated annually by EIA as the average of the thermal conversion factors for each type of crude oil and petroleum product imported weighted by the quantities imported. See **Crude Oil Imports** and **Petroleum Products Imports**.

Unfinished Oils. EIA assumed the thermal conversion factor to be 5.825 million Btu per barrel, the average of all natural gas or equal to that for **Distillate Fuel Oil** and first published it in EIA's *Annual Report to Congress, Volume 3, 1977*.

Unfractionated Stream. • 1979–1982: EIA assumed the thermal conversion factor to be 3.800 million Btu per barrel, the average of all natural gas plant liquids calculated on their contribution to total barrels produced.

Waxes. EIA adopted the thermal conversion factor of 5.537 million Btu per barrel as estimated by the Bureau of Mines and first published in the *Petroleum Statement, Annual, 1956*.

Approximate Heat Content of Biofuels

Biodiesel. EIA estimated the thermal conversion factor for biodiesel to be 5.359 million Btu per barrel, or 17,253 Btu per pound.

Biodiesel Feedstock. EIA used soybean oil input to the production of biodiesel (million Btu soybean oil per barrel biodiesel) as the factor to estimate total biomass inputs to the production of biodiesel. EIA assumed that 7.65 pounds of soybean oil are needed to produce one gallon of biodiesel, and 5.433 million Btu of soybean oil are needed to produce one barrel of biodiesel. EIA also assumed that soybean oil has a gross heat content of 16,909 Btu per pound, or 5.483 million Btu per barrel.

Ethanol (Undenatured). EIA adopted the thermal conversion factor of 3.539 million Btu per barrel published in "Oxygenate Flexibility for Future Fuels," a paper presented by William J. Piel of the ARCO Chemical Company at the National Conference on Reformulated Gasolines and Clean Air Act Implementation, Washington, DC, October 1991.

Fuel Ethanol (Denatured). • 1981–2008: EIA used the 2009 factor. • 2009 forward: Calculated by EIA as the annual quantity-weighted average of the thermal conversion factors for undenatured ethanol (3.539 million Btu per barrel), natural gasoline used as denaturant (4.638 million Btu per barrel), and conventional motor gasoline and motor gasoline blending components used as denaturant (5.253 million Btu per barrel). The quantity of ethanol consumed is from EIA's *Petroleum Supply Annual* (PSA) and *Petroleum Supply Monthly* (PSM), Table 1, data for renewable fuels and oxygenate plant net production of fuel ethanol. The quantity of natural gasoline used as denaturant is from PSA/PSM, Table 1, data for renewable fuels and oxygenate plant net production of natural gasoline, multiplied by -1. The quantity of conventional motor gasoline and motor gasoline blending components used as denaturant is from PSA/PSM, Table 1, data for renewable fuels and oxygenate plant net production of conventional motor gasoline and motor gasoline blending components, multiplied by -1.

Fuel Ethanol Feedstock. EIA used corn input to the production of undenatured ethanol (million Btu corn per barrel undenatured ethanol) as the annual factor to estimate total biomass inputs to the production of undenatured ethanol. EIA used the following observed ethanol yields (in gallons undenatured ethanol per bushel of corn) from U.S.

Department of Agriculture: 2.5 in 1980, 2.666 in 1998, 2.68 in 2002; and from University of Illinois at Chicago, Energy Resources Center, "2012 Corn Ethanol: Emerging Plant Energy and Environmental Technologies": 2.78 in 2008, and 2.82 in 2012. EIA estimated the ethanol yields in other years. EIA also assumed that corn has a gross heat content of 0.392 million Btu per bushel.

Other Biofuels. EIA assumed the thermal conversion factor to be 5.359 million Btu per barrel or equal to the thermal conversion factor for **Biodiesel.**

Renewable Diesel Fuel. EIA adopted the thermal conversion factor of 5.494 million Btu per barrel (130,817 Btu per gallon) for renewable diesel II (UOP-HDO) from U.S. Department of Energy, Argonne National Laboratory, "The Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies Model" (GREET), version R&D GREET1_2024, January 2025.

Approximate Heat Content of Natural Gas

Natural Gas Consumption, Electric Power Sector. Calculated annually by EIA by dividing the heat content of natural gas consumed by the electric power sector by the quantity consumed. Data are from Form EIA-923, "Power Plant Operations Report," and predecessor forms.

Natural Gas Consumption, End-Use Sectors. Calculated annually by EIA by dividing the heat content of natural gas consumed by the end-use sectors (residential, commercial, industrial, and transportation) by the quantity consumed. The heat content of natural gas consumed by the end-use sectors is calculated as the total heat content of natural gas consumed minus the heat content of natural gas consumed by the electric power sector. The quantity of natural gas consumed by the end-use sectors is calculated as the total quantity of natural gas consumed minus the quantity of natural gas consumed by the electric power sector. Data are from Form EIA-176, "Annual Report of Natural and Supplemental Gas Supply and Disposition"; and Form EIA-923, "Power Plant Operations Report," and predecessor forms.

Natural Gas Consumption, Total. • 1949–1962: EIA adopted the thermal conversion factor of 1,035 Btu per cubic foot as estimated by the Bureau of Mines and first published in the *Petroleum Statement, Annual, 1956*. • 1963–1979: EIA adopted the thermal conversion factor calculated annually by the American Gas Association (AGA) and published in *Gas Facts*, an AGA annual publication. • 1980 forward: Calculated annually by EIA by dividing the total heat content of natural gas consumed by the total quantity consumed.

Natural Gas Exports. • 1949–1972: Assumed by EIA to be equal to the thermal conversion factor for dry natural gas consumed (see **Natural Gas Consumption, Total**). • 1973 forward: Calculated annually by EIA by dividing the heat content of natural gas exported by the quantity exported. For 1973–1995, data are from Form FPC-14, "Annual Report for Importers and Exporters of Natural Gas." Beginning in 1996, data are from U.S. Department of Energy, Office of Fossil Energy, *Natural Gas Imports and Exports*.

Natural Gas Imports. • 1949–1972: Assumed by EIA to be equal to the thermal conversion factor for dry natural gas consumed (see **Natural Gas Consumption, Total**). • 1973 forward: Calculated annually by EIA by dividing the heat content of natural gas imported by the quantity imported. For 1973–1995, data are from Form FPC-14, "Annual Report for Importers and Exporters of Natural Gas." Beginning in 1996, data are from U.S. Department of Energy, Office of Fossil Energy, *Natural Gas Imports and Exports*.

Natural Gas Production, Dry. Assumed by EIA to be equal to the thermal conversion factor for dry natural gas consumed. See **Natural Gas Consumption, Total**.

Natural Gas Production, Marketed. Calculated annually by EIA by dividing the heat content of dry natural gas produced (see **Natural Gas Production, Dry**) and natural gas liquids produced (see **Natural Gas Liquids Production**) by the total quantity of marketed natural gas produced.

Approximate Heat Content of Coal and Coal Coke

Coal Coke Imports and Exports. EIA adopted the Bureau of Mines estimate of 24.800 million Btu per short ton.

Coal Consumption, Electric Power Sector. Calculated annually by EIA by dividing the heat content of coal consumed by the electric power sector by the quantity consumed. Data are from Form EIA-923, "Power Plant Operations Report," and predecessor forms.

Coal Consumption, Industrial Sector, Coke Plants. • 1949–2011: Calculated annually by EIA based on the reported volatility (low, medium, or high) of coal received by coke plants. (For 2011, EIA used the following volatility factors, in million Btu per short ton: low volatile—26.680; medium volatile—27.506; and high volatile—25.652.) Data are from Form EIA-5, "Quarterly Coal Consumption and Quality Report—Coke Plants," and predecessor forms. • 2012 forward: Calculated annually by EIA by dividing the heat content of coal received by coke plants by the quantity received. Through June 2014, data are from Form EIA-5, "Quarterly Coal Consumption and Quality Report—Coke Plants"; beginning in July 2014, data are from Form EIA-3, "Quarterly Survey of Industrial, Commercial, and Institutional Coal Users" (formerly called "Quarterly Survey of Non-Electric Sector Coal Data").

Coal Consumption, Industrial Sector, Other. • 1949–2007: Calculated annually by EIA by dividing the heat content of coal received by manufacturing plants by the quantity received. Data are from Form EIA-3, "Quarterly Coal Consumption and Quality Report—Manufacturing Plants," and predecessor forms. • 2008 forward: Calculated annually by EIA by dividing the heat content of coal received by manufacturing, gasification, and liquefaction plants by the quantity received. Data are from Form EIA-3, "Quarterly Survey of Industrial, Commercial, and Institutional Coal Users" (formerly called "Quarterly Survey of Non-Electric Sector Coal Data").

Coal Consumption, Residential and Commercial Sectors. • 1949–1999: Calculated annually by EIA by dividing the heat content of coal received by the residential and commercial sectors by the quantity received. Data are from Form EIA-6, "Coal Distribution Report," and predecessor forms. • 2000–2007: Calculated annually by EIA by dividing the heat content of coal consumed by commercial combined-heat-and-power (CHP) plants by the quantity consumed. Data are from Form EIA-923, "Power Plant Operations Report," and predecessor forms. • 2008 forward: Calculated annually by EIA by dividing the heat content of coal received by commercial and institutional users by the quantity received. Data are from Form EIA-3, "Quarterly Survey of Industrial, Commercial, and Institutional Coal Users" (formerly called "Quarterly Survey of Non-Electric Sector Coal Data").

Coal Consumption, Total. Calculated annually by EIA by dividing the total heat content of coal consumed by all sectors by the total quantity consumed.

Coal Exports. • 1949–2011: Calculated annually by EIA by dividing the heat content of steam coal and metallurgical coal exported by the quantity exported. Data are from U.S. Department of Commerce, U.S. Census Bureau, "Monthly Report EM 545," and predecessor forms. • 2012 forward: Calculated annually by EIA by dividing the heat content of steam coal and metallurgical coal exported by the quantity exported. The average heat content of steam coal is derived from receipts data from Form EIA-3, "Quarterly Survey of Industrial, Commercial, and Institutional Coal Users" (formerly called "Quarterly Survey of Non-Electric Sector Coal Data"), and Form EIA-923, "Power Plant Operations Report." Through June 2014, the average heat content of metallurgical coal is derived from receipts data from Form EIA-5, "Quarterly Coal Consumption and Quality Report—Coke Plants"; beginning in July 2014, the average heat content of metallurgical coal is derived from receipts data from Form EIA-3, "Quarterly Survey of Industrial, Commercial, and Institutional Coal Users" (formerly called "Quarterly Survey of Non-Electric Sector Coal Data"). Data for export quantities are from U.S. Department of Commerce, U.S. Census Bureau, "Monthly Report EM 545."

Coal Imports. • 1949–1963: Calculated annually by EIA by dividing the heat content of coal imported by the quantity imported. Data are from U.S. Department of Commerce, U.S. Census Bureau, "Monthly Report IM 145," and predecessor forms. • 1964–2011: Assumed by EIA to be 25.000 million Btu per short ton. • 2012 forward: Calculated annually by EIA by dividing the heat content of coal imported (received) by the quantity imported (received). Data are from Form EIA-3, "Quarterly Survey of Industrial, Commercial, and Institutional Coal Users" (formerly called "Quarterly Survey of Non-Electric Sector Coal Data"); Form EIA-5, "Quarterly Coal Consumption and Quality Report—Coke Plants" (data through June 2014); and Form EIA-923, "Power Plant Operations Report."

Coal Production. • 1949–2011: Calculated annually by EIA by dividing the heat content of domestic coal (excluding waste coal) received by the quantity received. Data are from Form EIA-3, "Quarterly Coal Consumption and Quality Report—Manufacturing and Transformation/Processing Coal Plants and Commercial and Institutional Users"; Form EIA-5, "Quarterly Coal Consumption and Quality Report—Coke Plants"; Form EIA-923, "Power Plant Operations Report"; and predecessor forms. • 2012 forward: Calculated annually by EIA by dividing the heat content of domestic coal (excluding waste coal) received and exported by the quantity received and exported. Data are from Form EIA-3, "Quarterly Survey of Industrial, Commercial, and Institutional Coal Users" (formerly called "Quarterly Survey of Non-Electric Sector Coal Data"); Form EIA-5, "Quarterly Coal Consumption and Quality Report—Coke Plants" (data through June 2014); Form EIA-

923, “Power Plant Operations Report”; U.S. Department of Commerce, U.S. Census Bureau, “Monthly Report EM 545”; and predecessor forms.

Waste Coal Supplied. • 1989–2000: Calculated annually by EIA by dividing the heat content of waste coal consumed by the quantity consumed. Data are from Form EIA-860B, “Annual Electric Generator Report—Nonutility,” and predecessor form. • 2001 forward: Calculated by EIA by dividing the heat content of waste coal received (or consumed) by the quantity received (or consumed). Receipts data are from Form EIA-3, “Quarterly Survey of Industrial, Commercial, and Institutional Coal Users” (formerly called “Quarterly Survey of Non-Electric Sector Coal Data”), and predecessor forms. Consumption data are from Form EIA-923, “Power Plant Operations Report,” and predecessor forms.

Table A6 Sources

Approximate Heat Rates for Electricity Net Generation, Coal. • 2001 forward: Calculated annually by EIA by using fuel consumption and net generation data reported on Form EIA-923, “Power Plant Operations Report,” and predecessor forms. The computation includes data for all electric utilities and electricity-only independent power producers using anthracite, bituminous coal, subbituminous coal, lignite, and beginning in 2002, waste coal and coal synfuel.

Approximate Heat Rates for Electricity Net Generation, Petroleum. • 2001 forward: Calculated annually by EIA by using fuel consumption and net generation data reported on Form EIA-923, “Power Plant Operations Report,” and predecessor forms. The computation includes data for all electric utilities and electricity-only independent power producers using distillate fuel oil, residual fuel oil, jet fuel, kerosene, petroleum coke, and waste oil.

Approximate Heat Rates for Electricity Net Generation, Natural Gas. • 2001 forward: Calculated annually by EIA by using fuel consumption and net generation data reported on Form EIA-923, “Power Plant Operations Report,” and predecessor forms. The computation includes data for all electric utilities and electricity-only independent power producers using natural gas and supplemental gaseous fuels.

Approximate Heat Rates for Electricity Net Generation, Total Fossil Fuels. • 1949–1955: The weighted annual average heat rate for fossil-fueled steam-electric power plants in the United States, as published by EIA in *Thermal-Electric Plant Construction Cost and Annual Production Expenses—1981* and *Steam-Electric Plant Construction Cost and Annual Production Expenses—1978*. • 1956–1988: The weighted annual average heat rate for fossil-fueled steam-electric power plants in the United States, as published in EIA, *Electric Plant Cost and Power Production Expenses 1991*, Table 9. • 1989–2000: Calculated annually by EIA by using heat rate data reported on Form EIA-860, “Annual Electric Generator Report,” and predecessor forms; and net generation data reported on Form EIA-759, “Monthly Power Plant Report.” The computation includes data for all electric utility steam-electric plants using fossil fuels. • 2001 forward: Calculated annually by EIA by using fuel consumption and net generation data reported on Form EIA-923, “Power Plant Operations Report,” and predecessor forms. The computation includes data for all electric utilities and electricity-only independent power producers using coal, petroleum, natural gas, and other fossil gases (blast furnace gas, propane gas, and other manufactured and waste gases derived from fossil fuels).

Approximate Heat Rates for Electricity Net Generation, Nuclear. • 1957–1984: Calculated annually by dividing the total heat content consumed in nuclear generating units by the total (net) electricity generated by nuclear generating units. The heat content and electricity generation were reported on Form FERC-1, “Annual Report of Major Electric Utilities, Licensees, and Others”; Form EIA-412, “Annual Report of Public Electric Utilities”; and predecessor forms. For 1982, the factors were published in EIA, *Historical Plant Cost and Annual Production Expenses for Selected Electric Plants 1982*, page 215. For 1983 and 1984, the factors were published in EIA, *Electric Plant Cost and Power Production Expenses 1991*, Table 13. • 1985 forward: Calculated annually by EIA by using the heat rate data reported on Form EIA-860, “Annual Electric Generator Report,” and predecessor forms.

Thermal Conversion Factor for Noncombustible Renewable Energy. There is no generally accepted practice for measuring the thermal conversion rates for power plants that generate electricity from hydro, geothermal, solar thermal, photovoltaic, and wind energy sources. Therefore, EIA uses the heat content of electricity, 3,412 Btu per kilowatthour. See Appendix E for more information.

Heat Content of Electricity. The value of 3,412 Btu per kilowatthour, which is the heat content of electricity, is a constant. It is used as the thermal conversion factor for electricity net generation from noncombustible renewable energy (hydro, geothermal, solar thermal, photovoltaic, and wind), electricity sales to ultimate customers, and electricity imports and exports.

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Appendix B

Metric Conversion Factors, Metric Prefixes, and Other Physical Conversion Factors

Metric Conversion Factors, Metric Prefixes, and Other Physical Conversion Factors

Data presented in the *Monthly Energy Review* and in other U.S. Energy Information Administration publications are expressed predominately in units that historically have been used in the United States, such as British thermal units, barrels, cubic feet, and short tons. The metric conversion factors presented in Table B1 can be used to calculate the metric-unit equivalents of values expressed in U.S. Customary units. For example, 500 short tons are the equivalent of 453.6 metric tons (500 short tons x 0.9071847 metric tons/short ton = 453.6 metric tons).

In the metric system of weights and measures, the names of multiples and subdivisions of any unit may be derived by combining the name of the unit with prefixes, such as deka, hecto, and kilo, meaning, respectively, 10, 100, 1,000, and deci, centi, and milli, meaning, respectively, one-tenth, one-hundredth, and one-thousandth. Common metric prefixes can be found in Table B2.

The conversion factors presented in Table B3 can be used to calculate equivalents in various physical units commonly used in energy analyses. For example, 10 barrels are the equivalent of 420 U.S. gallons (10 barrels x 42 gallons/barrel = 420 gallons).

Table B1. Metric Conversion Factors

Type of Unit	U.S. Unit		Equivalent in	Metric Units
Mass	1 short ton (2,000 lb)	=	0.907 184 7	metric tons (t)
	1 long ton	=	1.016 047	metric tons (t)
	1 pound (lb)	=	0.453 592 37[a]	kilograms (kg)
	1 pound uranium oxide (lb U_3O_8)	=	0.384 647[b]	kilograms uranium (kgU)
	1 ounce, avoirdupois (avdp oz)	=	28.349 52	grams (g)
Volume	1 barrel of oil (bbl)	=	0.158 987 3	cubic meters (m^3)
	1 cubic yard (yd^3)	=	0.764 555	cubic meters (m^3)
	1 cubic foot (ft^3)	=	0.028 316 85	cubic meters (m^3)
	1 U.S. gallon (gal)	=	3.785 412	liters (L)
	1 ounce, fluid (fl oz)	=	29.573 53	milliliters (mL)
	1 cubic inch (in^3)	=	16.387 06	milliliters (mL)
Length	1 mile (mi)	=	1.609 344[a]	kilometers (km)
	1 yard (yd)	=	0.914 4[a]	meters (m)
	1 foot (ft)	=	0.304 8[a]	meters (m)
	1 inch (in)	=	2.54[a]	centimeters (cm)
Area	1 acre	=	0.404 69	hectares (ha)
	1 square mile (mi^2)	=	2.589 988	square kilometers (km^2)
	1 square yard (yd^2)	=	0.836 127 4	square meters (m^2)
	1 square foot (ft^2)	=	0.092 903 04[a]	square meters (m^2)
	1 square inch (in^2)	=	6.451 6[a]	square centimeters (cm^2)
Energy	1 British thermal unit (Btu)[c]	=	1,055.055 852 62[a]	joules (J)
	1 calorie (cal)	=	4.186 8[a]	joules (J)
	1 kilowatthour (kWh)	=	3.6[a]	megajoules (MJ)
Temperature[d]	32 degrees Fahrenheit (°F)	=	0[a]	degrees Celsius (°C)
	212 degrees Fahrenheit (°F)	=	100[a]	degrees Celsius (°C)

[a] Exact conversion.
[b] Calculated by the U.S. Energy Information Administration.
[c] The Btu used in this table is the International Table Btu adopted by the Fifth International Conference on Properties of Steam, London, 1956.
[d] To convert degrees Fahrenheit (°F) to degrees Celsius (°C) exactly, subtract 32, then multiply by 5/9.

Notes: • Spaces have been inserted after every third digit to the right of the decimal for ease of reading. • Most metric units belong to the International System of Units (SI), and the liter, hectare, and metric ton are accepted for use with the SI units. For more information about the SI units, see http://physics.nist/gov/cuu/Units/index.html.

Web Page: http://www.eia.gov/totalenergy/data/monthly/#appendices.

Sources: • General Services Administration, Federal Standard 376B, *Preferred Metric Units for General Use by the Federal Government* (Washington, DC, January 1993), pp. 9–11, 13, and 16. • U.S. Department of Commerce, National Institute of Standards and Technology, Special Publications 330, 811, and 814. • American National Standards Institute/Institute of Electrical and Electronic Engineers, ANSI/IEEE Std268-1992, pp. 28 and 29.

Table B2. Metric Prefixes

Unit Multiple	Prefix	Symbol	Unit Subdivision	Prefix	Symbol
10^{1}	deka	da	10^{-1}	deci	d
10^{2}	hecto	h	10^{-2}	centi	c
10^{3}	kilo	k	10^{-3}	milli	m
10^{6}	mega	M	10^{-6}	micro	μ
10^{9}	giga	G	10^{-9}	nano	n
10^{12}	tera	T	10^{-12}	pico	p
10^{15}	peta	P	10^{-15}	femto	f
10^{18}	exa	E	10^{-18}	atto	a
10^{21}	zetta	Z	10^{-21}	zepto	z
10^{24}	yotta	Y	10^{-24}	yocto	y

Web Page: http://www.eia.gov/totalenergy/data/monthly/#appendices.
Sources: U.S. Department of Commerce, National Institute of Standards and Technology, *The International System of Units (SI)*, NIST Special Publication 330, 1991 Edition (Washington, DC, August 1991), p.10.

Table B3. Other Physical Conversion Factors

Energy Source	Original Unit		Equivalent in Final Units	
Petroleum	1 barrel (bbl)	=	42[a]	U.S. gallons (gal)
Coal	1 short ton	=	2,000[a]	pounds (lb)
	1 long ton	=	2,240[a]	pounds (lb)
	1 metric ton (t)	=	1,000[a]	kilograms (kg)
Wood	1 cord (cd)	=	1.25[b]	shorts tons
	1 cord (cd)	=	128[a]	cubic feet (ft^3)

[a] Exact conversion.
[b] Calculated by the U.S. Energy Information Administration.
Web Page: http://www.eia.gov/totalenergy/data/monthly/#appendices.
Sources: U.S. Department of Commerce, National Institute of Standards and Technology, *Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices*, NIST Handbook 44, 1994 Edition (Washington, DC, October 1993), pp. B-10, C-17, and C-21.

Appendix C

Population, U.S. Gross Domestic Product, and U.S. Gross Output

Population, U.S. Gross Domestic Product, and U.S. Gross Output

Table C1. Population, U.S. Gross Domestic Product, and U.S. Gross Output

	Population			U.S. Gross Domestic Product			U.S. Gross Output[a]
	United States[b]	World	United States as Share of World	Billion Nominal Dollars[d]	Billion Chained (2017) Dollars[e]	Implicit Price Deflator[c] (2017 = 1.00000)	Billion Nominal Dollars[d]
	Million People		Percent				
1950	152.3	2,558.0	6.0	299.8	2,458.5	0.12195	577.8
1955	165.9	2,783.0	6.0	425.5	3,083.0	.13801	802.6
1960	180.7	3,043.7	5.9	542.4	3,500.3	.15495	1,006.0
1965	194.3	3,351.4	5.8	742.3	4,478.6	.16574	1,356.0
1970	205.1	3,714.3	5.5	1,073.3	5,316.4	.20189	1,903.0
1975	216.0	4,090.1	5.3	1,684.9	6,060.9	.27800	3,055.3
1980	227.2	4,446.6	5.1	2,857.3	7,257.3	.39371	5,462.0
1981	229.5	4,528.1	5.1	3,207.0	7,441.5	.43097	6,033.5
1982	231.7	4,610.5	5.0	3,343.8	7,307.3	.45759	6,175.0
1983	233.8	4,694.4	5.0	3,634.0	7,642.3	.47552	6,631.0
1984	235.8	4,776.1	4.9	4,037.6	8,195.3	.49267	7,313.8
1985	237.9	4,860.9	4.9	4,339.0	8,537.0	.50826	7,775.7
1986	240.1	4,948.0	4.9	4,579.6	8,832.6	.51849	8,031.0
1987	242.3	5,037.8	4.8	4,855.2	9,137.7	.53134	8,707.5
1988	244.5	5,128.7	4.8	5,236.4	9,519.4	.55008	9,434.2
1989	246.8	5,219.5	4.7	5,641.6	9,869.0	.57165	10,069.8
1990	249.6	5,311.7	4.7	5,963.1	10,055.1	.59305	10,624.6
1991	253.0	5,399.2	4.7	6,158.1	10,044.2	.61310	10,808.0
1992	256.5	5,485.4	4.7	6,520.3	10,398.0	.62707	11,381.0
1993	259.9	5,568.6	4.7	6,858.6	10,684.2	.64194	12,024.4
1994	263.1	5,649.6	4.7	7,287.2	11,114.6	.65564	12,826.8
1995	266.3	5,731.6	4.6	7,639.7	11,413.0	.66939	13,653.2
1996	269.4	5,812.8	4.6	8,073.1	11,843.6	.68164	14,463.4
1997	272.6	5,892.6	4.6	8,577.6	12,370.3	.69340	15,393.6
1998	275.9	5,971.3	4.6	9,062.8	12,924.9	.70119	16,217.0
1999	279.0	6,049.5	4.6	9,631.2	13,543.8	.71111	17,273.4
2000	282.2	6,127.8	4.6	10,251.0	14,096.0	.72722	18,625.7
2001	285.0	6,206.7	4.6	10,581.9	14,230.7	.74360	18,884.5
2002	287.6	6,285.8	4.6	10,929.1	14,472.7	.75515	19,173.8
2003	290.1	6,364.8	4.6	11,456.5	14,877.3	.77006	20,140.7
2004	292.8	6,444.4	4.5	12,217.2	15,449.8	.79077	21,689.1
2005	295.5	6,524.1	4.5	13,039.2	15,988.0	.81556	23,517.9
2006	298.4	6,605.8	4.5	13,815.6	16,433.1	.84071	24,925.5
2007	301.2	6,689.5	4.5	14,474.2	16,762.4	.86349	26,250.3
2008	304.1	6,775.1	4.5	14,769.9	16,781.5	.88013	27,024.9
2009	306.8	6,861.0	4.5	14,478.1	16,349.1	.88556	24,959.3
2010	309.3	6,946.0	4.5	15,049.0	16,789.8	.89632	26,479.5
2011	311.6	7,030.4	4.4	15,599.7	17,052.4	.91481	28,050.3
2012	313.8	7,115.5	4.4	16,254.0	17,442.8	.93185	29,232.2
2013	316.0	7,202.0	4.4	16,880.7	17,812.2	.94771	30,388.8
2014	318.3	7,288.4	4.4	17,608.1	18,261.7	.96421	31,795.7
2015	320.6	7,373.9	4.3	18,295.0	18,799.6	.97316	32,233.9
2016	322.9	7,458.5	4.3	18,804.9	19,141.7	.98241	32,898.1
2017	325.0	7,541.7	4.3	19,612.1	19,612.1	1.00000	34,468.1
2018	326.7	7,623.7	4.3	20,656.5	20,193.9	1.02291	36,504.5
2019	328.2	7,704.7	4.3	21,540.0	20,715.7	1.03979	37,658.0
2020	331.6	7,784.6	4.3	21,354.1	20,267.6	1.05361	36,710.1
2021	332.1	7,855.2	4.2	23,681.2	21,494.8	1.10172	41,809.3
2022	334.0	7,919.2	4.2	26,006.9	22,034.8	1.18026	46,633.5
2023	336.8	7,985.2	4.2	27,720.7	22,671.1	1.22273	48,386.8
2024	340.1	8,056.1	4.2	29,183.8	23,303.5	1.25234	NA

[a] Gross output is the value of gross domestic product (GDP) plus the value of intermediate inputs used to produce GDP.

[b] Resident population of the 50 states and the District of Columbia estimated for July 1 of each year.

[c] The gross domestic product implicit price deflator is used to convert nominal dollars to chained (2017) dollars.

[d] See "Nominal Dollars" in Glossary.

[e] See "Chained Dollars" in Glossary.

NA=Not available.

Notes: • Data are estimates. • U.S. geographic coverage is the 50 states and the District of Columbia.

Web Page: See http://www.eia.gov/totalenergy/data/monthly/#appendices (Excel and CSV files) for all available annual data beginning in 1949.

Sources: • **United States Population: 1949–1989**—U.S. Department of Commerce (DOC), U.S. Census Bureau, Current Population Reports Series P-25 (June 2000). **1990–1999**—DOC, U.S. Census Bureau, "Time Series of Intercensal State Population Estimates" (April 2002). **2000–2009**—DOC, U.S. Census Bureau, "Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico" (September 2011). **2010–2019**—DOC, U.S. Census Bureau, "Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico" (December 2019). **2020 forward**—DOC, U.S. Census Bureau, "Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico" (December 2024). • **World Population: 1950 forward**—DOC, U.S. Census Bureau, International Database (December 2024). • **United States as Share of World Population:** Calculated as U.S. population divided by world population. • **U.S. Gross Domestic Product: 1949 forward**—DOC, Bureau of Economic Analysis (BEA), National Income and Product Accounts (February 2025), Tables 1.1.5, 1.1.6, and 1.1.9. • **U.S. Gross Output: 1949–1996**—DOC, BEA, GDP by industry (Historical) data (November 2021). **1997 forward**—DOC, BEA, GDP by Industry data (December 2024).

Appendix D

Estimated Primary Energy Consumption in the United States, Selected Years, 1635-1945

Estimated Primary Energy Consumption in the United States, Selected Years, 1635-1945

Table D1. Estimated Primary Energy Consumption in the United States, Selected Years, 1635–1945 (Quadrillion Btu)

	Fossil Fuels				Renewable Energy				
					Conventional Hydroelectric Power	Biomass		Electricity Net Imports[b]	Total
	Coal	Natural Gas	Petroleum	Total		Wood [a]	Total		
1635	NA	– –	– –	NA	– –	(s)	(s)	– –	(s)
1645	NA	– –	– –	NA	– –	0.001	0.001	– –	0.001
1655	NA	– –	– –	NA	– –	.002	.002	– –	.002
1665	NA	– –	– –	NA	– –	.005	.005	– –	.005
1675	NA	– –	– –	NA	– –	.007	.007	– –	.007
1685	NA	– –	– –	NA	– –	.009	.009	– –	.009
1695	NA	– –	– –	NA	– –	.014	.014	– –	.014
1705	NA	– –	– –	NA	– –	.022	.022	– –	.022
1715	NA	– –	– –	NA	– –	.037	.037	– –	.037
1725	NA	– –	– –	NA	– –	.056	.056	– –	.056
1735	NA	– –	– –	NA	– –	.080	.080	– –	.080
1745	NA	– –	– –	NA	– –	.112	.112	– –	.112
1755	NA	– –	– –	NA	– –	.155	.155	– –	.155
1765	NA	– –	– –	NA	– –	.200	.200	– –	.200
1775	NA	– –	– –	NA	– –	.249	.249	– –	.249
1785	NA	– –	– –	NA	– –	.310	.310	– –	.310
1795	NA	– –	– –	NA	– –	.402	.402	– –	.402
1805	NA	– –	– –	NA	– –	.537	.537	– –	.537
1815	NA	– –	– –	NA	– –	.714	.714	– –	.714
1825	NA	– –	– –	NA	– –	.960	.960	– –	.960
1835	NA	– –	– –	NA	– –	1.305	1.305	– –	1.305
1845	NA	– –	– –	NA	– –	1.757	1.757	– –	1.757
1850	0.219	– –	– –	0.219	– –	2.138	2.138	– –	2.357
1855	.421	– –	– –	.421	– –	2.389	2.389	– –	2.810
1860	.518	– –	0.003	.521	– –	2.641	2.641	– –	3.162
1865	.632	– –	.010	.642	– –	2.767	2.767	– –	3.409
1870	1.048	– –	.011	1.059	– –	2.893	2.893	– –	3.952
1875	1.440	– –	.011	1.451	– –	2.872	2.872	– –	4.323
1880	2.054	– –	.096	2.150	– –	2.851	2.851	– –	5.001
1885	2.840	0.082	.040	2.962	– –	2.683	2.683	– –	5.645
1890	4.062	.257	.156	4.475	0.001	2.515	2.516	– –	6.991
1895	4.950	.147	.168	5.265	.003	2.306	2.309	– –	7.574
1900	6.841	.252	.229	7.322	.010	2.015	2.025	– –	9.347
1905	10.001	.372	.610	10.983	.017	1.843	1.860	– –	12.843
1910	12.714	.540	1.007	14.261	.029	1.765	1.794	– –	16.055
1915	13.294	.673	1.418	15.385	.045	1.688	1.733	0.002	17.120
1920	15.504	.813	2.676	18.993	.064	1.610	1.674	.003	20.670
1925	14.706	1.191	4.280	20.177	.087	1.533	1.620	.004	21.801
1930	13.639	1.932	5.897	21.468	.122	1.455	1.577	.005	23.050
1935	10.634	1.919	5.675	18.228	.146	1.397	1.543	.005	19.776
1940	12.535	2.665	7.760	22.960	.171	1.358	1.529	.007	24.496
1945	15.972	3.871	10.110	29.953	.289	[a]1.261	1.550	.009	31.512

[a] There is a discontinuity in the "Wood" time series between 1945 (in this table) and 1949 (in Table 10.1). Through 1945, data are for fuelwood only; beginning in 1949, data are for wood and wood-derived fuels.

[b] Electricity transmitted across U.S. borders. Net imports equal imports minus exports.

NA=Not available. – – =Not applicable. (s)=Less than 0.5 trillion Btu.

Notes: • For years not shown, data are not available. • See Tables 1.3 and 10.1 for continuation of these data series beginning in 1949. • See Note, "Geographic Coverage of Statistics for 1635–1945," at end of section.

Sources: • **Fossil Fuels:** *Energy in the American Economy, 1850–1975*, Table VII. • **Conventional Hydroelectric Power:** *Energy in the American Economy, 1850–1975*, Table I. Data are converted to Btu by multiplying by 3,412 Btu per kilowatthour. • **Wood: 1635–1845**—U.S. Department of Agriculture, Circular No. 641, *Fuel Wood Used in the United States 1630–1930*, February 1942. This source estimates fuelwood consumption in cords per decade, which were converted to Btu using the conversion factor of 20 million Btu per cord. The annual average value for each decade was assigned to the fifth year of the decade on the assumption that annual use was likely to increase during any given decade and the average annual value was more likely to reflect mid-decade yearly consumption than use at either the beginning or end of the decade. Values thus begin in 1635 and are plotted at 10-year intervals. **1850–1945**—*Energy in the American Economy, 1850–1975*, Table VII. • **Electricity Net Imports:** *Energy in the American Economy, 1850–1975*, Tables I and VI. Electricity net imports are assumed to equal hydroelectric consumption minus hydroelectric production (data are converted to Btu by multiplying by 3,412 Btu per kilowatthour).

Note. Geographic Coverage of Statistics for 1635–1945.
Table D1 presents estimates of U.S. energy consumption by energy source for a period that begins a century and a half before the original 13 colonies formed a political union and continues through the decades during which the United States was still expanding territorially. The question thus arises, what exactly is meant by "U.S. consumption" of an energy source for those years when the United States did not formally exist or consisted of less territory than is now encompassed by the 50 states and the District of Columbia?

The documents used to assemble the estimates, and (as far as possible) the sources of those documents, were reviewed carefully for clues to geographic coverage. For most energy sources, the extent of coverage expanded more rapidly than the nation, defined as all the official states and the District of Columbia. Estimates or measurements of consumption of each energy source generally appear to follow settlement patterns. That is, they were made for areas of the continent that were settled enough to have economically significant consumption even though those areas were not to become states for years. The wood data series, for example, begins in 1635 and includes 12 of the original colonies (excepting Georgia), as well as Maine, Vermont, and the area that would become the District of Columbia. By the time the series reaches 1810, the rest of the continental states are all included, although the last of the 48 states to achieve statehood did not do so until 1912. Likewise, the coal data series begins in 1850 but includes consumption in areas, such as Utah and Washington (state), which were significant coal producing regions but had not yet attained statehood. (Note: No data were available on state-level historical coal consumption. The coal data shown in Table D1 through 1945 describe *apparent* consumption, i.e., production plus imports minus exports. The geographic coverage for coal was therefore based on a tally of coal-*producing* states listed in various historical issues of *Minerals Yearbook*. It is likely that coal was consumed in states where it was not mined in significant quantities.)

By energy source, the extent of coverage can be summarized as follows: • Coal—35 coal-producing states by 1885. • Natural Gas—All 48 contiguous states, the District of Columbia, and Alaska by 1885. • Petroleum—All 48 contiguous states, the District of Columbia, and Alaska by 1885. • Conventional Hydroelectric Power—Coverage for 1890 and 1895 is uncertain, but probably the 48 contiguous states and the District of Columbia. Coverage for 1900–1945 is the 48 contiguous states, and the District of Columbia. • Wood—All 48 contiguous states and the District of Columbia by 1810.

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Appendix E

Alternative Measures for the Energy Content of Noncombustible Renewables

Alternative Measures for the Energy Content of Noncombustible Renewables

Energy sources are measured in different physical units: liquid fuels in barrels or gallons, gases in cubic feet, coal in short tons, and electricity in kilowatthours. EIA converts each source into common British thermal units (Btu) to allow comparison among different types of energy and to calculate total energy concepts.

Noncombustible renewables (hydroelectric, geothermal, solar, and wind energy) are resources from which energy is extracted without burning or combusting fuel. When noncombustible renewables generate electricity, there is no fuel combustion and, therefore, no set Btu conversion factors for the energy sources.[1]

There are three broadly accepted ways to convert electricity generated from noncombustible renewables into Btu of primary energy—the captured energy, fossil fuel equivalency, and incident energy approaches. Each of these methods are described in detail below.

Captured Energy Approach

The captured energy approach converts primary energy consumption of noncombustible renewables from kilowatthours (kWh) to Btu using the constant conversion factor representing the heat content of electricity—3,412 Btu per kWh. Captured energy reflects the primary energy captured for economic use and does not include losses. In other words, it represents the net energy available for direct consumption after the transformation of a noncombustible renewable source of energy into electricity, where captured energy is the energy measured as the "output" of a generating unit, such as electricity from a wind turbine or solar plant.

The captured energy approach is often used to show the economically significant portion of the energy transformation associated with renewable energy sources. There is no market for the resource-specific energy apart from its immediate, site-specific energy conversion, and there is no substantive opportunity cost to its continued exploitation.[2] This approach is preferred by the *UN International Recommendations for Energy Statistics* (IRES) because the detailed data needed to estimate quantities of incident energy are not available now and are not likely to develop soon. This approach is also more closely tied to a physical market commodity, that is, electricity net generation, than the conceptual measure derived using the fossil fuel equivalency approach.

Fossil Fuel Equivalency Approach

The fossil fuel equivalency approach converts the consumption of noncombustible renewable electricity (in kWh) to Btu by applying a fossil fuel equivalency factor, based on the fossil-fuels heat rate (Table A6). The fossil-fuels heat rate is equal to the average thermal efficiency across fossil-fueled fired generating plants based on fuel consumption and net generation data reported to EIA. The fossil fuel equivalent consumption represents the energy consumed as if the electricity were generated by fossil fuels and is useful for analysis when considering the amount of primary fossil fuel energy displaced by renewable energy sources.

However, unlike the captured energy approach, the fossil fuel equivalency approach is not as directly tied to any real market or physical quantity. The fossil fuel equivalency approach measures neither primary energy consumption nor fossil fuels actually displaced. Additionally, its use becomes increasingly problematic as noncombustible renewables begin to displace other renewables instead of fossil fuels.

Incident Energy Approach

Incident energy is the mechanical, radiation, or thermal energy that is measurable as the "input" of the device. EIA defines "incident energy" for noncombustible renewables as the gross energy that first strikes an energy conversion device:

- For hydroelectric, the energy contained in the water passing through the penstock (a closed conduit for carrying water to the turbines)
- For geothermal, the energy contained in the hot fluid at the surface of the wellbore
- For wind, the energy contained in the wind that passes through the rotor disc
- For solar, the energy contained in the sunlight that strikes the panel or collector mirror

The incident energy approach converts noncombustible renewable electricity to Btu by accounting for the "losses" that result from an inability to convert 100% of incident energy to a useful form of energy. EIA has not published total primary energy consumption statistics based on this approach because it is difficult to obtain accurate estimates of input energy without creating undue burden on survey respondents and possible concern about the quality of the resulting data. Few renewable electricity power plants track cumulative input energy due to its lack of economic significance or other purpose. In addition, estimated energy efficiencies of renewable conversion technologies vary significantly across technologies, site-specific configurations, and environmental factors.[3]

EIA now using the captured energy approach

Starting with the September 2023 *Monthly Energy Review* (MER), EIA began converting electricity generation from noncombustible renewables into Btu using the captured energy approach rather than the fossil fuel equivalency approach in its main data tables (reflected in MER Sections 1, 2, and 10). The Btu values of hydroelectric, geothermal, solar, and wind energy consumption and, consequently, total primary energy consumption and total energy production are lower for all time periods because of the new conversion factor (the heat content of electricity from Table A6).

After a thorough review of the alternative approaches, EIA made the change for two primary reasons. First, adopting the captured energy approach promotes international comparability in energy statistics by adopting the standards provided in IRES. Second, as renewable energy continues to represent an increasingly larger portion of U.S. energy consumption over time, the fossil fuel equivalent values of generation from renewable sources become less relevant to our data users than the electrical energy provided by renewable sources.

Some analysts may still prefer to use the measures based on the fossil fuel equivalency approach, which was previously used by EIA. MER Tables E1–E4 present noncombustible renewable energy statistics using the fossil fuel equivalency approach.

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[1]Direct use of noncombustible renewables in the form of heat (e.g., solar thermal heating) is estimated separately and is measured in Btu.
[2]There is an initial opportunity cost when a facility is first built: water behind a dam might flood land that could have been used for other purposes, or a solar panel might shade an area that could have used the sunlight. But that is a "fixed" opportunity cost that does not change during the operation of the plant.
[3]Based on EIA research conducted in 2016, engineering estimates of conversion efficiencies for noncombustible renewables range from less than 20% for solar photovoltaics and geothermal to 90% for large-scale hydroelectricity plants. Those estimates are notional indications of the energy output as a percent of energy input at each technology based on typical equipment operating within the normal operating range for that technology.

Table E1. Primary Energy Overview, Fossil Fuel Equivalency Approach

(Quadrillion Btu)

	Production				Trade			Stock Change and Other[d]	Consumption			
	Fossil Fuels[a]	Nuclear Electric Power	Renewable Energy[b]	Total	Imports	Exports	Net Imports[c]		Fossil Fuels[e]	Nuclear Electric Power	Renewable Energy[b]	Total[f]
1950 Total	**32.553**	**0.000**	**2.978**	**35.531**	**1.913**	**1.465**	**0.448**	**-1.380**	**31.615**	**0.000**	**2.978**	**34.599**
1955 Total	**37.347**	**.000**	**2.784**	**40.131**	**2.790**	**2.286**	**.504**	**-.457**	**37.380**	**.000**	**2.784**	**40.178**
1960 Total	**39.855**	**.006**	**2.928**	**42.789**	**4.188**	**1.477**	**2.710**	**-.458**	**42.091**	**.006**	**2.928**	**45.041**
1965 Total	**47.205**	**.043**	**3.396**	**50.644**	**5.892**	**1.829**	**4.063**	**-.754**	**50.515**	**.043**	**3.396**	**53.953**
1970 Total	**59.152**	**.239**	**4.070**	**63.462**	**8.342**	**2.632**	**5.709**	**-1.354**	**63.501**	**.239**	**4.070**	**67.817**
1975 Total	**54.697**	**1.900**	**4.687**	**61.284**	**14.032**	**2.323**	**11.709**	**-1.062**	**65.323**	**1.900**	**4.687**	**71.931**
1980 Total	**58.979**	**2.739**	**5.428**	**67.147**	**15.796**	**3.695**	**12.101**	**-1.227**	**69.782**	**2.739**	**5.428**	**78.021**
1985 Total	**57.502**	**4.076**	**6.084**	**67.661**	**11.781**	**4.196**	**7.584**	**1.088**	**66.035**	**4.076**	**6.084**	**76.334**
1990 Total	**58.523**	**6.104**	**6.040**	**70.668**	**18.817**	**4.752**	**14.065**	**-.299**	**72.281**	**6.104**	**6.040**	**84.433**
1995 Total	**57.496**	**7.075**	**6.557**	**71.129**	**22.180**	**4.496**	**17.684**	**2.118**	**77.162**	**7.075**	**6.559**	**90.931**
2000 Total	**57.307**	**7.862**	**6.102**	**71.271**	**28.865**	**3.962**	**24.904**	**2.528**	**84.620**	**7.862**	**6.104**	**98.702**
2005 Total	**54.995**	**8.161**	**6.221**	**69.377**	**34.659**	**4.462**	**30.197**	**.527**	**85.623**	**8.161**	**6.233**	**100.101**
2010 Total	**58.159**	**8.434**	**8.312**	**74.906**	**29.866**	**8.176**	**21.690**	**.916**	**80.723**	**8.434**	**8.266**	**97.512**
2011 Total	**60.529**	**8.269**	**9.306**	**78.104**	**28.748**	**10.373**	**18.375**	**.389**	**79.263**	**8.269**	**9.210**	**96.868**
2012 Total	**62.298**	**8.062**	**8.890**	**79.249**	**27.068**	**11.267**	**15.801**	**-.670**	**77.304**	**8.062**	**8.853**	**94.380**
2013 Total	**64.180**	**8.244**	**9.438**	**81.862**	**24.623**	**11.788**	**12.835**	**2.433**	**79.224**	**8.244**	**9.464**	**97.130**
2014 Total	**69.599**	**8.338**	**9.795**	**87.732**	**23.241**	**12.270**	**10.971**	**-.409**	**80.017**	**8.338**	**9.758**	**98.294**
2015 Total	**70.171**	**8.337**	**9.760**	**88.267**	**23.794**	**12.902**	**10.892**	**-1.761**	**79.090**	**8.337**	**9.743**	**97.398**
2016 Total	**65.442**	**8.427**	**10.468**	**84.337**	**25.378**	**14.119**	**11.259**	**1.776**	**78.319**	**8.427**	**10.399**	**97.372**
2017 Total	**68.488**	**8.419**	**11.250**	**88.158**	**25.458**	**17.946**	**7.512**	**1.971**	**77.901**	**8.419**	**11.129**	**97.641**
2018 Total	**75.798**	**8.438**	**11.571**	**95.807**	**24.833**	**21.224**	**3.610**	**1.815**	**81.281**	**8.438**	**11.361**	**101.232**
2019 Total	**81.405**	**8.452**	**11.619**	**101.476**	**22.865**	**23.476**	**-.610**	**-.396**	**80.425**	**8.452**	**11.460**	**100.470**
2020 Total	**76.155**	**8.251**	**11.577**	**95.983**	**19.988**	**23.464**	**-3.476**	**.487**	**73.169**	**8.251**	**11.412**	**92.993**
2021 Total	**77.987**	**8.131**	**12.209**	**98.327**	**21.455**	**25.071**	**-3.616**	**3.054**	**77.454**	**8.131**	**12.046**	**97.765**
2022 Total	**82.225**	**8.061**	**13.240**	**103.526**	**21.507**	**27.335**	**-5.828**	**2.057**	**78.529**	**8.061**	**13.024**	**99.755**
2023 January	7.208	.741	1.078	9.027	1.853	2.275	-.422	.249	7.043	.741	1.059	8.854
February	6.501	.636	1.053	8.190	1.747	2.216	-.470	.274	6.315	.636	1.037	7.994
March	7.336	.657	1.171	9.163	1.789	2.647	-.858	.268	6.753	.657	1.155	8.574
April	6.990	.592	1.150	8.732	1.754	2.380	-.626	-.496	5.875	.592	1.137	7.611
May	7.262	.639	1.184	9.085	1.810	2.454	-.643	-.667	5.948	.639	1.179	7.775
June	7.047	.677	1.087	8.811	1.825	2.398	-.572	-.340	6.138	.677	1.077	7.899
July	7.271	.730	1.116	9.117	1.804	2.472	-.668	.028	6.645	.730	1.098	8.477
August	7.408	.729	1.105	9.242	1.915	2.567	-.652	.021	6.781	.729	1.096	8.610
September	7.202	.685	1.026	8.913	1.785	2.441	-.656	-.476	6.087	.685	1.009	7.782
October	7.383	.642	1.071	9.095	1.705	2.534	-.830	-.346	6.216	.642	1.061	7.920
November	7.242	.651	1.043	8.936	1.818	2.465	-.647	-.087	6.525	.651	1.023	8.201
December	7.405	.720	1.092	9.216	1.853	2.807	-.954	.471	6.946	.720	1.063	8.733
Total	**86.255**	**8.099**	**13.175**	**107.529**	**21.658**	**29.656**	**-7.998**	**-1.102**	**77.271**	**8.099**	**12.994**	**98.429**
2024 January	7.123	.722	1.061	8.906	1.899	2.559	-.660	1.140	7.619	.722	1.040	9.387
February	6.945	.675	1.118	8.739	1.710	2.546	-.837	.237	6.362	.675	1.101	8.139
March	7.244	.662	1.255	9.161	1.736	2.641	-.906	-.051	6.310	.662	1.234	8.205
April	6.913	.602	1.244	8.760	1.772	2.389	-.618	-.492	5.819	.602	1.230	7.650
May	7.187	.679	1.247	9.112	1.934	2.540	-.606	-.528	6.056	.679	1.243	7.978
June	7.100	.713	1.244	9.056	1.814	2.604	-.790	-.186	6.134	.713	1.228	8.080
July	7.336	.730	1.179	9.246	1.964	2.537	-.573	-.039	6.728	.730	1.167	8.634
August	7.422	.729	1.187	9.338	1.783	2.628	-.845	.102	6.691	.729	1.168	8.595
September	7.129	.655	1.083	8.867	1.725	2.518	-.793	-.288	6.057	.655	1.068	7.787
October	7.396	.614	1.167	9.177	1.722	2.563	-.841	-.363	6.198	.614	1.154	7.973
November	7.111	.647	1.143	8.900	1.745	2.680	-.934	.046	6.244	.647	1.119	8.012
December	7.438	.744	1.152	9.334	1.860	2.716	-.856	.591	7.196	.744	1.123	9.070
Total	**86.344**	**8.173**	**14.081**	**108.598**	**21.663**	**30.921**	**-9.258**	**.170**	**77.415**	**8.173**	**13.875**	**99.510**
2025 January	R7.329	.750	1.194	R9.273	R1.894	2.551	-.656	R1.357	8.056	.750	1.157	9.973
February	R6.652	.646	1.113	R8.411	R1.607	R2.425	R-.818	R.917	R6.771	.646	1.087	R8.511
March	7.603	.653	1.350	9.606	1.664	2.708	-1.044	-.197	6.388	.653	1.320	8.364
3-Month Total	**21.584**	**2.049**	**3.657**	**27.290**	**5.165**	**7.684**	**-2.518**	**2.076**	**21.215**	**2.049**	**3.565**	**26.847**
2024 3-Month Total	**21.313**	**2.059**	**3.435**	**26.807**	**5.345**	**7.746**	**-2.402**	**1.326**	**20.291**	**2.059**	**3.376**	**25.731**
2023 3-Month Total	**21.045**	**2.033**	**3.302**	**26.380**	**5.388**	**7.138**	**-1.750**	**.791**	**20.111**	**2.033**	**3.251**	**25.421**

[a] Coal, natural gas (dry), crude oil, and natural gas plant liquids.
[b] See Table E4 for notes on series components and estimation.
[c] Net imports equal imports minus exports.
[d] Includes petroleum stock change and adjustments; natural gas net storage withdrawals and balancing item; coal stock change, losses, and unaccounted for; fuel ethanol stock change; and biodiesel stock change and balancing item.
[e] Coal, coal coke net imports, natural gas, and petroleum.
[f] Also includes electricity net imports.
R=Revised.

Notes: • See "Primary Energy," "Primary Energy Production," and "Primary Energy Consumption," in Glossary. • Totals may not equal sum of components due to independent rounding. • Geographic coverage is the 50 states and the District of Columbia.

Web Page: See http://www.eia.gov/totalenergy/data/monthly/#appendices (Excel and CSV files) for all available annual data beginning in 1949 and monthly data beginning in 1973.

Sources: • **Production:** Table E2. • **Trade:** Tables 1.4a and 1.4b. • **Stock Change and Other:** Calculated as consumption minus production and net imports. • **Consumption:** Table E3.

Table E2. Primary Energy Production by Source, Fossil Fuel Equivalency Approach

(Quadrillion Btu)

	Fossil Fuels						Renewable Energy[a]						
	Coal[b]	Natural Gas (Dry)	Crude Oil[c]	NGPL[d]	Total	Nuclear Electric Power	Hydro-electric Power[e]	Geo-thermal	Solar	Wind	Bio-mass	Total	Total
1950 Total	**14.060**	**6.233**	**11.447**	**0.813**	**32.553**	**0.000**	**1.415**	**NA**	**NA**	**NA**	**1.562**	**2.978**	**35.531**
1955 Total	**12.370**	**9.345**	**14.410**	**1.223**	**37.347**	**.000**	**1.360**	**NA**	**NA**	**NA**	**1.424**	**2.784**	**40.131**
1960 Total	**10.817**	**12.656**	**14.935**	**1.447**	**39.855**	**.006**	**1.608**	**(s)**	**NA**	**NA**	**1.320**	**2.928**	**42.789**
1965 Total	**13.055**	**15.775**	**16.521**	**1.853**	**47.205**	**.043**	**2.059**	**.002**	**NA**	**NA**	**1.335**	**3.396**	**50.644**
1970 Total	**14.607**	**21.666**	**20.401**	**2.478**	**59.152**	**.239**	**2.634**	**.006**	**NA**	**NA**	**1.431**	**4.070**	**63.462**
1975 Total	**14.989**	**19.640**	**17.729**	**2.338**	**54.697**	**1.900**	**3.155**	**.034**	**NA**	**NA**	**1.499**	**4.687**	**61.284**
1980 Total	**18.598**	**19.908**	**18.249**	**2.225**	**58.979**	**2.739**	**2.900**	**.053**	**NA**	**NA**	**2.475**	**5.428**	**67.147**
1985 Total	**19.325**	**16.980**	**18.992**	**2.204**	**57.502**	**4.076**	**2.970**	**.097**	**(s)**	**(s)**	**3.016**	**6.084**	**67.661**
1990 Total	**22.488**	**18.326**	**15.571**	**2.138**	**58.523**	**6.104**	**3.046**	**.171**	**.059**	**.029**	**2.735**	**6.040**	**70.668**
1995 Total	**22.130**	**19.082**	**13.887**	**2.398**	**57.496**	**7.075**	**3.205**	**.152**	**.068**	**.033**	**3.099**	**6.557**	**71.129**
2000 Total	**22.735**	**19.662**	**12.358**	**2.551**	**57.307**	**7.862**	**2.811**	**.164**	**.063**	**.057**	**3.006**	**6.102**	**71.271**
2005 Total	**23.185**	**18.556**	**10.974**	**2.280**	**54.995**	**8.161**	**2.703**	**.181**	**.058**	**.178**	**3.101**	**6.221**	**69.377**
2010 Total	**22.038**	**21.806**	**11.610**	**2.705**	**58.159**	**8.434**	**2.539**	**.208**	**.090**	**.923**	**4.553**	**8.312**	**74.906**
2011 Total	**22.221**	**23.406**	**12.012**	**2.890**	**60.529**	**8.269**	**3.103**	**.212**	**.110**	**1.168**	**4.712**	**9.306**	**78.104**
2012 Total	**20.677**	**24.610**	**13.849**	**3.162**	**62.298**	**8.062**	**2.629**	**.212**	**.156**	**1.340**	**4.554**	**8.890**	**79.249**
2013 Total	**20.001**	**24.859**	**15.868**	**3.451**	**64.180**	**8.244**	**2.562**	**.214**	**.225**	**1.601**	**4.835**	**9.438**	**81.862**
2014 Total	**20.286**	**26.718**	**18.590**	**4.005**	**69.599**	**8.338**	**2.466**	**.214**	**.337**	**1.727**	**5.049**	**9.795**	**87.732**
2015 Total	**17.946**	**28.067**	**19.682**	**4.476**	**70.171**	**8.337**	**2.320**	**.212**	**.427**	**1.776**	**5.025**	**9.760**	**88.267**
2016 Total	**14.667**	**27.576**	**18.534**	**4.665**	**65.442**	**8.427**	**2.471**	**.210**	**.570**	**2.095**	**5.122**	**10.468**	**84.337**
2017 Total	**15.625**	**28.325**	**19.551**	**4.987**	**68.488**	**8.419**	**2.765**	**.210**	**.777**	**2.342**	**5.156**	**11.250**	**88.158**
2018 Total	**15.363**	**31.882**	**22.825**	**5.727**	**75.798**	**8.438**	**2.661**	**.209**	**.915**	**2.481**	**5.306**	**11.571**	**95.807**
2019 Total	**14.256**	**35.187**	**25.610**	**6.352**	**81.405**	**8.452**	**2.562**	**.201**	**1.016**	**2.633**	**5.207**	**11.619**	**101.476**
2020 Total	**10.703**	**35.062**	**23.585**	**6.805**	**76.155**	**8.251**	**2.501**	**.203**	**1.211**	**2.963**	**4.700**	**11.577**	**95.983**
2021 Total	**11.596**	**35.807**	**23.485**	**7.099**	**77.987**	**8.131**	**2.225**	**.205**	**1.518**	**3.345**	**4.916**	**12.209**	**98.327**
2022 Total	**12.043**	**37.560**	**24.880**	**7.742**	**82.225**	**8.061**	**2.245**	**.205**	**1.872**	**3.827**	**5.090**	**13.240**	**103.526**
2023 January	1.037	3.277	2.224	.669	7.208	.741	.196	.018	.105	.331	.428	1.078	9.027
February	.931	2.953	2.006	.612	6.501	.636	.172	.016	.123	.357	.384	1.053	8.190
March	1.057	3.315	2.260	.704	7.336	.657	.184	.018	.162	.376	.430	1.171	9.163
April	.955	3.179	2.164	.691	6.990	.592	.171	.017	.194	.369	.399	1.150	8.732
May	.981	3.324	2.245	.712	7.262	.639	.239	.017	.221	.278	.429	1.184	9.085
June	.959	3.205	2.196	.687	7.047	.677	.186	.016	.224	.238	.423	1.087	8.811
July	.950	3.319	2.281	.721	7.271	.730	.190	.017	.236	.242	.432	1.116	9.117
August	1.030	3.342	2.301	.735	7.408	.729	.184	.016	.224	.245	.436	1.105	9.242
September	.986	3.238	2.249	.729	7.202	.685	.146	.017	.197	.245	.421	1.026	8.913
October	.967	3.342	2.319	.754	7.383	.642	.135	.018	.180	.311	.427	1.071	9.095
November	.967	3.280	2.267	.727	7.242	.651	.147	.018	.137	.315	.427	1.043	8.936
December	.932	3.390	2.347	.737	7.405	.720	.164	.018	.121	.328	.460	1.092	9.216
Total	**11.752**	**39.164**	**26.858**	**8.480**	**86.255**	**8.099**	**2.114**	**.205**	**2.125**	**3.634**	**5.097**	**13.175**	**107.529**
2024 January	.912	E 3.325	E 2.214	.672	7.123	.722	.189	.018	.129	.301	.424	1.061	8.906
February	.910	E 3.185	E 2.162	.689	6.945	.675	.174	.016	.159	.359	.411	1.118	8.739
March	.866	E 3.298	E 2.323	.758	7.244	.662	.201	.017	.204	.394	.440	1.255	9.161
April	.740	E 3.163	E 2.261	.748	6.913	.602	.167	.017	.239	.409	.412	1.244	8.760
May	.814	E 3.263	E 2.328	.782	7.187	.679	.195	.016	.272	.334	.429	1.247	9.112
June	.890	E 3.197	E 2.260	.753	7.100	.713	.183	.016	.291	.329	.425	1.244	9.056
July	.898	E 3.347	E 2.327	.765	7.336	.730	.183	.017	.292	.241	.446	1.179	9.246
August	.973	E 3.313	E 2.357	.780	7.422	.729	.184	.017	.287	.248	.451	1.187	9.338
September	.943	E 3.167	E 2.250	.768	7.129	.655	.144	.016	.246	.250	.427	1.083	8.867
October	.915	E 3.308	E 2.372	.802	7.396	.614	.137	.016	.232	.346	.437	1.167	9.177
November	.846	E 3.204	E 2.279	.782	7.111	.647	.158	.016	.171	.353	.445	1.143	8.900
December	.883	E 3.394	E 2.370	.791	7.438	.744	.176	.017	.158	.348	.452	1.152	9.334
Total	**10.591**	**E 39.164**	**E 27.501**	**9.088**	**86.344**	**8.173**	**2.090**	**.199**	**2.680**	**3.913**	**5.199**	**14.081**	**108.598**
2025 January	.912	RE 3.355	RE 2.317	.744	R 7.329	.750	.183	.017	.182	.377	.435	1.194	R 9.273
February	.799	RE 3.049	RE 2.109	.695	R 6.652	.646	.167	.016	.196	.340	.394	1.113	R 8.411
March	.963	E 3.449	E 2.379	.812	7.603	.653	.190	.018	.274	.437	.431	1.350	9.606
3-Month Total	**2.674**	**E 9.854**	**E 6.805**	**2.251**	**21.584**	**2.049**	**.540**	**.051**	**.652**	**1.154**	**1.260**	**3.657**	**27.290**
2024 3-Month Total	**2.688**	**E 9.808**	**E 6.698**	**2.118**	**21.313**	**2.059**	**.564**	**.051**	**.492**	**1.054**	**1.275**	**3.435**	**26.807**
2023 3-Month Total	**3.025**	**9.545**	**6.490**	**1.986**	**21.045**	**2.033**	**.553**	**.052**	**.391**	**1.065**	**1.242**	**3.302**	**26.380**

[a] Most data are estimates. See Table E4 for notes on series components and estimation.

[b] Beginning in 1989, includes waste coal supplied. Beginning in 2001, also includes a small amount of refuse recovery. See Table 6.1.

[c] Includes lease condensate.

[d] Natural gas processing plant production of natural gas liquids (ethane, propane, normal butane, isobutane, and natural gasoline). Through 1980, also includes natural gas processing plant production of finished petroleum products (aviation gasoline, distillate fuel oil, jet fuel, kerosene, motor gasoline, special naphthas, and miscellaneous products).

[e] Conventional hydroelectric power.

R=Revised. E=Estimate. NA=Not available. (s)=Less than 0.5 trillion Btu.

Notes: • See "Primary Energy Production" in Glossary. • Totals may not equal sum of components due to independent rounding. • Geographic coverage is the 50 states and the District of Columbia.

Web Page: See http://www.eia.gov/totalenergy/data/monthly/#appendices (Excel and CSV files) for all available annual data beginning in 1949 and monthly data beginning in 1973.

Sources: • **Fossil Fuels** and **Nuclear Electric Power:** Table 1.2. • **Renewable Energy:** Table E4. • **Total:** Calculated as the sum of Fossil Fuels, Nuclear Electric Power, and Renewable Energy.

Table E3. Primary Energy Consumption by Source, Fossil Fuel Equivalency Approach

(Quadrillion Btu)

	Fossil Fuels[a]					Renewable Energy[b]						
	Coal	Natural Gas[c]	Petroleum[d]	Total[e]	Nuclear Electric Power	Hydroelectric Power[f]	Geothermal	Solar	Wind	Biomass	Total	Total[g]
1950 Total	**12.347**	**5.968**	**13.298**	**31.615**	**0.000**	**1.415**	**NA**	**NA**	**NA**	**1.562**	**2.978**	**34.599**
1955 Total	**11.167**	**8.998**	**17.225**	**37.380**	**.000**	**1.360**	**NA**	**NA**	**NA**	**1.424**	**2.784**	**40.178**
1960 Total	**9.838**	**12.385**	**19.874**	**42.091**	**.006**	**1.608**	**(s)**	**NA**	**NA**	**1.320**	**2.928**	**45.041**
1965 Total	**11.581**	**15.769**	**23.184**	**50.515**	**.043**	**2.059**	**.002**	**NA**	**NA**	**1.335**	**3.396**	**53.953**
1970 Total	**12.265**	**21.795**	**29.499**	**63.501**	**.239**	**2.634**	**.006**	**NA**	**NA**	**1.431**	**4.070**	**67.817**
1975 Total	**12.663**	**19.948**	**32.699**	**65.323**	**1.900**	**3.155**	**.034**	**NA**	**NA**	**1.499**	**4.687**	**71.931**
1980 Total	**15.423**	**20.235**	**34.159**	**69.782**	**2.739**	**2.900**	**.053**	**NA**	**NA**	**2.475**	**5.428**	**78.021**
1985 Total	**17.478**	**17.703**	**30.866**	**66.035**	**4.076**	**2.970**	**.097**	**(s)**	**(s)**	**3.016**	**6.084**	**76.334**
1990 Total	**19.173**	**19.603**	**33.500**	**72.281**	**6.104**	**3.046**	**.171**	**.059**	**.029**	**2.735**	**6.040**	**84.433**
1995 Total	**20.089**	**22.671**	**34.341**	**77.162**	**7.075**	**3.205**	**.152**	**.068**	**.033**	**3.101**	**6.559**	**90.931**
2000 Total	**22.580**	**23.824**	**38.152**	**84.620**	**7.862**	**2.811**	**.164**	**.063**	**.057**	**3.008**	**6.104**	**98.702**
2005 Total	**22.797**	**22.565**	**40.217**	**85.623**	**8.161**	**2.703**	**.181**	**.058**	**.178**	**3.114**	**6.233**	**100.101**
2010 Total	**20.834**	**24.575**	**35.321**	**80.723**	**8.434**	**2.539**	**.208**	**.090**	**.923**	**4.506**	**8.266**	**97.512**
2011 Total	**19.658**	**24.955**	**34.639**	**79.263**	**8.269**	**3.103**	**.212**	**.110**	**1.168**	**4.616**	**9.210**	**96.868**
2012 Total	**17.378**	**26.089**	**33.833**	**77.304**	**8.062**	**2.629**	**.212**	**.156**	**1.340**	**4.517**	**8.853**	**94.380**
2013 Total	**18.039**	**26.805**	**34.398**	**79.224**	**8.244**	**2.562**	**.214**	**.225**	**1.601**	**4.861**	**9.464**	**97.130**
2014 Total	**17.998**	**27.383**	**34.658**	**80.017**	**8.338**	**2.466**	**.214**	**.337**	**1.727**	**5.013**	**9.758**	**98.294**
2015 Total	**15.549**	**28.191**	**35.368**	**79.090**	**8.337**	**2.320**	**.212**	**.427**	**1.776**	**5.008**	**9.743**	**97.398**
2016 Total	**14.226**	**28.400**	**35.712**	**78.319**	**8.427**	**2.471**	**.210**	**.570**	**2.095**	**5.053**	**10.399**	**97.372**
2017 Total	**13.837**	**28.049**	**36.043**	**77.901**	**8.419**	**2.765**	**.210**	**.777**	**2.342**	**5.035**	**11.129**	**97.641**
2018 Total	**13.252**	**31.163**	**36.892**	**81.281**	**8.438**	**2.661**	**.209**	**.915**	**2.481**	**5.096**	**11.361**	**101.232**
2019 Total	**11.316**	**32.264**	**36.866**	**80.425**	**8.452**	**2.562**	**.201**	**1.016**	**2.633**	**5.048**	**11.460**	**100.470**
2020 Total	**9.181**	**31.669**	**32.331**	**73.169**	**8.251**	**2.501**	**.203**	**1.211**	**2.963**	**4.535**	**11.412**	**92.993**
2021 Total	**10.549**	**31.711**	**35.243**	**77.454**	**8.131**	**2.225**	**.205**	**1.518**	**3.345**	**4.753**	**12.046**	**97.765**
2022 Total	**9.888**	**33.379**	**35.319**	**78.529**	**8.061**	**2.245**	**.205**	**1.872**	**3.827**	**4.874**	**13.024**	**99.755**
2023 January	.750	3.428	2.868	7.043	.741	.196	.018	.105	.331	.409	1.059	8.854
February	.582	3.057	2.678	6.315	.636	.172	.016	.123	.357	.368	1.037	7.994
March	.620	3.129	3.006	6.753	.657	.184	.018	.162	.376	.415	1.155	8.574
April	.500	2.499	2.878	5.875	.592	.171	.017	.194	.369	.386	1.137	7.611
May	.550	2.386	3.014	5.948	.639	.239	.017	.221	.278	.425	1.179	7.775
June	.705	2.445	2.991	6.138	.677	.186	.016	.224	.238	.412	1.077	7.899
July	.913	2.760	2.975	6.645	.730	.190	.017	.236	.242	.414	1.098	8.477
August	.903	2.773	3.108	6.781	.729	.184	.016	.224	.245	.427	1.096	8.610
September	.716	2.464	2.911	6.087	.685	.146	.017	.197	.245	.404	1.009	7.782
October	.628	2.523	3.067	6.216	.642	.135	.018	.180	.311	.418	1.061	7.920
November	.629	2.920	2.978	6.525	.651	.147	.018	.137	.315	.407	1.023	8.201
December	.676	3.300	2.975	6.946	.720	.164	.018	.121	.328	.431	1.063	8.733
Total	**8.172**	**33.683**	**35.448**	**77.271**	**8.099**	**2.114**	**.205**	**2.125**	**3.634**	**4.916**	**12.994**	**98.429**
2024 January	.877	3.856	2.886	7.619	.722	.189	.018	.129	.301	.403	1.040	9.387
February	.559	3.076	2.728	6.362	.675	.174	.016	.159	.359	.394	1.101	8.139
March	.491	2.899	2.924	6.310	.662	.201	.017	.204	.394	.418	1.234	8.205
April	.466	2.482	2.876	5.819	.602	.167	.017	.239	.409	.398	1.230	7.650
May	.563	2.416	3.080	6.056	.679	.195	.016	.272	.334	.425	1.243	7.978
June	.720	2.518	2.901	6.134	.713	.183	.016	.291	.329	.409	1.228	8.080
July	.835	2.843	3.052	6.728	.730	.183	.017	.292	.241	.434	1.167	8.634
August	.815	2.812	3.068	6.691	.729	.184	.017	.287	.248	.432	1.168	8.595
September	.663	2.504	2.893	6.057	.655	.144	.016	.246	.250	.411	1.068	7.787
October	.591	2.517	3.092	6.198	.614	.137	.016	.232	.346	.424	1.154	7.973
November	.571	2.807	2.869	6.244	.647	.158	.016	.171	.353	.421	1.119	8.012
December	.746	3.473	2.981	7.196	.744	.176	.017	.158	.348	.423	1.123	9.070
Total	**7.896**	**34.205**	**35.349**	**77.415**	**8.173**	**2.090**	**.199**	**2.680**	**3.913**	**4.992**	**13.875**	**99.510**
2025 January	.941	4.058	3.058	8.056	.750	.183	.017	.182	.377	.398	1.157	9.973
February	.737	3.352	2.682	R 6.771	.646	.167	.016	.196	.340	.369	1.087	R 8.511
March	.598	2.840	2.951	6.388	.653	.190	.018	.274	.437	.401	1.320	8.364
3-Month Total	**2.277**	**10.251**	**8.691**	**21.215**	**2.049**	**.540**	**.051**	**.652**	**1.154**	**1.168**	**3.565**	**26.847**
2024 3-Month Total	**1.927**	**9.832**	**8.539**	**20.291**	**2.059**	**.564**	**.051**	**.492**	**1.054**	**1.215**	**3.376**	**25.731**
2023 3-Month Total	**1.952**	**9.614**	**8.552**	**20.111**	**2.033**	**.553**	**.052**	**.391**	**1.065**	**1.191**	**3.251**	**25.421**

[a] Includes non-combustion use of fossil fuels.
[b] Most data are estimates. See Table E4 for notes on series components and estimation.
[c] Natural gas only; excludes supplemental gaseous fuels. See Note 3, "Supplemental Gaseous Fuels," at end of Section 4.
[d] Petroleum products supplied; excludes biofuels. Biofuels are included in "Biomass."
[e] Includes coal coke net imports. See Tables 1.4c.
[f] Conventional hydroelectric power.
[g] Includes coal coke net imports and electricity net imports, which are not separately displayed. See Tables 1.4c.
R=Revised. NA=Not available. (s)=Less than 0.5 trillion Btu.

Notes: • See "Primary Energy Consumption" in Glossary. • See Table D1 for estimated energy consumption for 1635–1945. • Totals may not equal sum of components due to independent rounding. • Geographic coverage is the 50 states and the District of Columbia.
Web Page: See http://www.eia.gov/totalenergy/data/monthly/#appendices (Excel and CSV files) for all available annual data beginning in 1949 and monthly data beginning in 1973.
Sources: • **Fossil Fuels** and **Nuclear Electric Power:** Table 1.3. • **Renewable Energy:** Table E4. • **Total:** Calculated as the sum of Fossil Fuels, Nuclear Electric Power, Renewable Energy, and Electricity Net Imports (see Table 1.4c).

Table E4. Renewable Energy Production and Consumption by Source, Fossil Fuel Equivalency Approach (Trillion Btu)

	Production[a]				Consumption								
	Biomass			Total Renewable Energy[e]	Noncombustible (Fossil Fuel Equivalent)				Biomass				Total Renewable Energy
	Wood[b]	Biofuels[c]	Total[d]		Hydroelectric Power[f]	Geothermal[g]	Solar[h]	Wind[i]	Wood[j]	Waste[k]	Biofuels[l]	Total	
1950 Total	**1,562**	**NA**	**1,562**	**2,978**	**1,415**	**NA**	**NA**	**NA**	**1,562**	**NA**	**NA**	**1,562**	**2,978**
1955 Total	**1,424**	**NA**	**1,424**	**2,784**	**1,360**	**NA**	**NA**	**NA**	**1,424**	**NA**	**NA**	**1,424**	**2,784**
1960 Total	**1,320**	**NA**	**1,320**	**2,928**	**1,608**	**(s)**	**NA**	**NA**	**1,320**	**NA**	**NA**	**1,320**	**2,928**
1965 Total	**1,335**	**NA**	**1,335**	**3,396**	**2,059**	**2**	**NA**	**NA**	**1,335**	**NA**	**NA**	**1,335**	**3,396**
1970 Total	**1,429**	**NA**	**1,431**	**4,070**	**2,634**	**6**	**NA**	**NA**	**1,429**	**2**	**NA**	**1,431**	**4,070**
1975 Total	**1,497**	**NA**	**1,499**	**4,687**	**3,155**	**34**	**NA**	**NA**	**1,497**	**2**	**NA**	**1,499**	**4,687**
1980 Total	**2,474**	**NA**	**2,475**	**5,428**	**2,900**	**53**	**NA**	**NA**	**2,474**	**2**	**NA**	**2,475**	**5,428**
1985 Total	**2,687**	**93**	**3,016**	**6,084**	**2,970**	**97**	**NA**	**(s)**	**2,687**	**236**	**93**	**3,016**	**6,084**
1990 Total	**2,216**	**111**	**2,735**	**6,040**	**3,046**	**171**	**59**	**29**	**2,216**	**408**	**111**	**2,735**	**6,040**
1995 Total	**2,370**	**198**	**3,099**	**6,557**	**3,205**	**152**	**68**	**33**	**2,370**	**531**	**200**	**3,101**	**6,559**
2000 Total	**2,262**	**233**	**3,006**	**6,102**	**2,811**	**164**	**63**	**57**	**2,262**	**511**	**236**	**3,008**	**6,104**
2005 Total	**2,137**	**561**	**3,101**	**6,221**	**2,703**	**181**	**58**	**178**	**2,137**	**403**	**574**	**3,114**	**6,233**
2010 Total	**2,217**	**1,868**	**4,553**	**8,312**	**2,539**	**208**	**90**	**923**	**2,217**	**468**	**1,821**	**4,506**	**8,266**
2011 Total	**2,213**	**2,037**	**4,712**	**9,306**	**3,103**	**212**	**110**	**1,168**	**2,213**	**462**	**1,941**	**4,616**	**9,210**
2012 Total	**2,151**	**1,936**	**4,554**	**8,890**	**2,629**	**212**	**156**	**1,340**	**2,151**	**467**	**1,899**	**4,517**	**8,853**
2013 Total	**2,338**	**2,000**	**4,835**	**9,438**	**2,562**	**214**	**225**	**1,601**	**2,338**	**496**	**2,026**	**4,861**	**9,464**
2014 Total	**2,398**	**2,135**	**5,049**	**9,795**	**2,466**	**214**	**337**	**1,727**	**2,398**	**516**	**2,099**	**5,013**	**9,758**
2015 Total	**2,305**	**2,201**	**5,025**	**9,760**	**2,320**	**212**	**427**	**1,776**	**2,305**	**518**	**2,185**	**5,008**	**9,743**
2016 Total	**2,290**	**2,329**	**5,122**	**10,468**	**2,471**	**210**	**570**	**2,095**	**2,217**	**503**	**2,333**	**5,053**	**10,399**
2017 Total	**2,254**	**2,407**	**5,156**	**11,250**	**2,765**	**210**	**777**	**2,342**	**2,176**	**495**	**2,364**	**5,035**	**11,129**
2018 Total	**2,348**	**2,471**	**5,306**	**11,571**	**2,661**	**209**	**915**	**2,481**	**2,254**	**487**	**2,355**	**5,096**	**11,361**
2019 Total	**2,333**	**2,432**	**5,207**	**11,619**	**2,562**	**201**	**1,016**	**2,633**	**2,229**	**442**	**2,376**	**5,048**	**11,460**
2020 Total	**2,066**	**2,194**	**4,700**	**11,577**	**2,501**	**203**	**1,211**	**2,963**	**1,960**	**440**	**2,136**	**4,535**	**11,412**
2021 Total	**2,112**	**2,374**	**4,916**	**12,209**	**2,225**	**205**	**1,518**	**3,345**	**1,992**	**430**	**2,331**	**4,753**	**12,046**
2022 Total	**2,167**	**2,511**	**5,090**	**13,240**	**2,245**	**205**	**1,872**	**3,827**	**2,029**	**412**	**2,433**	**4,874**	**13,024**
2023 January	174	219	428	1,078	196	18	105	331	166	35	208	409	1,059
February	155	198	384	1,053	172	16	123	357	147	31	189	368	1,037
March	176	221	430	1,171	184	18	162	376	161	34	220	415	1,155
April	156	212	399	1,150	171	17	194	369	148	32	207	386	1,137
May	168	228	429	1,184	239	17	221	278	157	34	234	425	1,179
June	162	229	423	1,087	186	16	224	238	150	32	231	412	1,077
July	167	232	432	1,116	190	17	236	242	157	33	224	414	1,098
August	173	230	436	1,105	184	16	224	245	159	33	235	427	1,096
September	165	226	421	1,026	146	17	197	245	152	31	222	404	1,009
October	162	232	427	1,071	135	18	180	311	151	33	234	418	1,061
November	164	230	427	1,043	147	18	137	315	155	33	219	407	1,023
December	176	248	460	1,092	164	18	121	328	160	36	235	431	1,063
Total	**1,998**	**2,705**	**5,097**	**13,175**	**2,114**	**205**	**2,125**	**3,634**	**1,863**	**394**	**2,659**	**4,916**	**12,994**
2024 January	165	225	424	1,061	189	18	129	301	157	34	212	403	1,040
February	153	227	411	1,118	174	16	159	359	142	31	221	394	1,101
March	166	241	440	1,255	201	17	204	394	153	33	233	418	1,234
April	159	222	412	1,244	167	17	239	409	148	31	219	398	1,230
May	165	232	429	1,247	195	16	272	334	153	33	240	425	1,243
June	157	237	425	1,244	183	16	291	329	146	30	233	409	1,228
July	163	252	446	1,179	183	17	292	241	151	32	251	434	1,167
August	169	250	451	1,187	184	17	287	248	156	31	244	432	1,168
September	163	235	427	1,083	144	16	246	250	151	30	231	411	1,068
October	158	247	437	1,167	137	16	232	346	146	32	246	424	1,154
November	163	251	445	1,143	158	16	171	353	151	31	239	421	1,119
December	168	253	452	1,152	176	17	158	348	156	32	235	423	1,123
Total	**1,949**	**2,871**	**5,199**	**14,081**	**2,090**	**199**	**2,680**	**3,913**	**1,811**	**379**	**2,802**	**4,992**	**13,875**
2025 January	[R] 168	235	435	1,194	183	17	182	377	155	32	210	398	1,157
February	151	214	394	1,113	167	16	196	340	139	30	201	369	1,087
March	165	234	431	1,350	190	18	274	437	153	32	216	401	1,320
3-Month Total	**483**	**683**	**1,260**	**3,657**	**540**	**51**	**652**	**1,154**	**447**	**94**	**627**	**1,168**	**3,565**
2024 3-Month Total	**484**	**693**	**1,275**	**3,435**	**564**	**51**	**492**	**1,054**	**451**	**98**	**666**	**1,215**	**3,376**
2023 3-Month Total	**504**	**638**	**1,242**	**3,302**	**553**	**52**	**391**	**1,065**	**474**	**100**	**618**	**1,191**	**3,251**

[a] For hydroelectric power, geothermal, solar, wind, and biomass waste, production equals consumption.
[b] Wood and wood-derived fuels. Through 2015, wood production equals consumption. Beginning in 2016, wood production equals consumption plus densified biomass exports.
[c] Total biomass inputs to the production of fuel ethanol and biodiesel. Beginning in 2011, also includes production of renewable diesel fuel. Beginning in 2014, also includes production of other biofuels.
[d] Includes biomass waste.
[e] Hydroelectric power, geothermal, solar, wind, and biomass.
[f] Conventional hydroelectricity net generation (converted to Btu by multiplying by the total fossil fuels heat rate factors in Table A6).
[g] Geothermal electricity net generation (converted to Btu by multiplying by the total fossil fuels heat rate factors in Table A6), and geothermal heat pump and direct use energy.
[h] Solar photovoltaic (PV) and solar thermal electricity net generation (converted to Btu by multiplying by the total fossil fuels heat rate factors in Table A6), and solar thermal direct use energy.
[i] Wind electricity net generation (converted to Btu by multiplying by the total fossil fuels heat rate factors in Table A6).
[j] Wood and wood-derived fuels.
[k] Municipal solid waste from biogenic sources, landfill gas, sludge waste, agricultural byproducts, and other biomass. Through 2000, also includes non-renewable waste (municipal solid waste from non-biogenic sources, and tire-derived fuels).
[l] Fuel ethanol (minus denaturant), biodiesel, renewable diesel fuel, and other biofuels consumption; plus losses and co-products from the production of fuel ethanol and biodiesel.

R=Revised. NA=Not available. (s)=Less than 0.5 trillion Btu.

Notes: • Production data are estimates. Consumption data are estimates, except for hydroelectric power in 1949–1978 and 1989 forward, and wind. • Totals may not equal sum of components due to independent rounding. • Geographic coverage is the 50 states and the District of Columbia.

Web Page: See http://www.eia.gov/totalenergy/data/monthly/#appendices (Excel and CSV files) for all available annual data beginning in 1949 and monthly data beginning in 1973.

Sources: • **Biomass:** Table 10.1. • **Hydroelectric Power** and **Wind:** Calculated as electricity net generation (see Table 7.2a) multiplied by the total fossil fuels heat rate factors (see Table A6). • **Geothermal:** Calculated as geothermal electricity net generation (see Table 7.2a) multiplied by the total fossil fuels heat rate factors (see Table A6); plus geothermal heat pump and direct use energy in the residential, commercial, and industrial sectors (see Tables 10.2a and 10.2b) .• **Solar:** Calculated as solar electricity net generation (see Table 7.2a) multiplied by the total fossil fuels heat rate factors (see Table A6); plus solar thermal direct use energy (see Table 10.5). • **Total Production:** Calculated as the sum of biomass production and noncombustible consumption. • **Total Consumption:** Calculated as the sum of biomass consumption and noncombustible consumption.

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Appendix F
Electric Vehicle Charging Infrastructure

Table F1. Electric Vehicle Charging Infrastructure

(Number)

	Locations[a]							Ports						
	With Public Ports Only	With Private Ports Only	With Public and Private Ports	With Networked Ports Only[b]	With Non-Networked Ports Only[c]	With Networked and Non-Networked Ports	Total	DC[d] Fast-Charging Ports	Level 2 Charging Ports	Level 1 Charging Ports	Legacy Charging Ports	Total	DC[d] Fast-Charging Ports per Location[e]	Level 2 Charging Ports per Location[f]
2007 Year	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**432**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
2008 Year	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**440**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
2009 Year	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**484**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
2010 Year	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**626**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
2011 Year	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**5,070**	**NA**	**NA**
2012 Year	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**15,192**	**NA**	**NA**
2013 Year	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**19,472**	**NA**	**NA**
2014 Year	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**1,494**	**20,636**	**3,781**	**NA**	**25,913**	**NA**	**NA**
2015 Year	**12,222**	**1,222**	**1,457**	**9,562**	**4,479**	**860**	**14,901**	**6,915**	**45,221**	**4,178**	**597**	**56,911**	**3.21**	**3.33**
2016 Year	**16,030**	**1,720**	**1,511**	**12,733**	**4,982**	**1,546**	**19,261**	**10,725**	**60,322**	**4,054**	**362**	**75,463**	**3.56**	**3.49**
2017 Year	**19,669**	**1,795**	**1,431**	**15,633**	**5,178**	**2,084**	**22,895**	**12,395**	**74,880**	**3,733**	**453**	**91,461**	**3.75**	**3.61**
2018 Year	**21,859**	**1,868**	**1,419**	**17,132**	**5,348**	**2,666**	**25,146**	**11,563**	**83,216**	**2,873**	**108**	**97,760**	**3.92**	**3.59**
2019 Year	**24,304**	**2,183**	**1,297**	**19,193**	**5,923**	**2,668**	**27,784**	**14,707**	**92,591**	**3,046**	**92**	**110,436**	**3.96**	**3.67**
2020 Year	**28,143**	**1,889**	**1,467**	**22,585**	**6,202**	**2,712**	**31,499**	**19,094**	**107,235**	**2,774**	**61**	**129,164**	**4.18**	**3.78**
2021 Year	**45,315**	**2,424**	**1,503**	**39,324**	**7,165**	**2,753**	**49,242**	**24,263**	**126,507**	**3,627**	**56**	**154,453**	**3.98**	**2.87**
2022 Year	**52,341**	**2,655**	**1,586**	**48,145**	**8,023**	**414**	**56,582**	**29,723**	**146,717**	**3,257**	**45**	**179,742**	**4.08**	**2.91**
2023 January	53,005	2,874	1,331	48,868	7,946	396	57,210	30,227	146,079	3,225	39	179,570	4.06	2.87
February	53,984	2,834	1,092	49,615	7,901	394	57,910	30,840	146,680	3,173	36	180,729	4.07	2.85
March	54,962	2,858	1,092	50,520	7,992	400	58,912	31,893	148,772	3,170	35	183,870	4.10	2.85
April	55,734	2,906	1,082	51,289	8,010	423	59,722	32,534	150,807	3,163	34	186,538	4.09	2.85
May	56,576	2,918	1,085	52,122	8,026	431	60,579	33,276	153,183	3,170	33	189,662	4.09	2.86
June	58,346	2,960	1,077	53,881	8,051	451	62,383	34,908	155,939	3,152	30	194,029	4.12	2.83
July	59,221	2,979	1,074	54,757	8,049	468	63,274	35,766	157,794	3,270	29	196,859	4.11	2.83
August	60,145	3,002	1,065	55,738	8,009	465	64,212	36,465	160,406	3,267	29	200,167	4.10	2.84
September	60,828	3,035	1,066	56,414	8,027	488	64,929	37,355	155,992	3,267	29	196,643	4.08	2.74
October	61,817	3,054	1,066	57,382	8,033	522	65,937	38,229	158,805	3,265	29	200,328	4.09	2.75
November	62,545	3,073	1,060	58,097	8,055	526	66,678	39,827	160,342	3,267	29	203,465	4.15	2.75
December	**63,069**	**3,106**	**1,043**	**58,606**	**8,066**	**546**	**67,218**	**40,695**	**161,534**	**3,104**	**29**	**205,362**	**4.15**	**2.75**
2024 January	63,734	3,128	1,008	59,313	8,047	510	67,870	41,679	162,720	3,044	29	207,472	4.16	2.75
February	64,258	3,161	1,000	59,929	7,992	498	68,419	42,519	163,559	3,032	29	209,139	4.15	2.75
March	64,860	3,185	1,002	60,564	7,990	493	69,047	43,501	164,959	3,032	29	211,521	4.15	2.76
April	65,804	3,194	1,000	61,502	8,001	495	69,998	44,747	167,488	3,033	29	215,297	4.15	2.77
May	66,224	3,202	988	61,881	8,027	506	70,414	45,562	169,030	3,034	29	217,655	4.15	2.78
June	66,795	3,209	985	62,459	8,035	495	70,989	46,259	170,368	3,032	29	219,688	4.14	2.78
July	67,467	3,502	968	63,401	8,045	491	71,937	47,165	173,574	3,027	29	223,795	4.13	2.80
August	67,694	3,514	955	63,650	8,023	490	72,163	48,403	174,664	3,016	29	226,112	4.18	2.82
September	67,981	3,499	947	63,967	7,980	480	72,427	49,088	172,116	3,013	29	224,246	4.19	2.77
October	68,801	3,555	906	64,657	8,194	411	73,262	50,505	174,292	2,986	29	227,812	4.19	2.78
November	69,255	3,562	894	65,161	8,145	405	73,711	51,796	174,955	2,979	28	229,758	4.23	2.78
December	**69,616**	**3,546**	**885**	**65,560**	**8,086**	**401**	**74,047**	**52,539**	**172,220**	**2,975**	**28**	**227,762**	**4.22**	**2.73**
2025 January	70,243	3,472	869	66,239	8,234	111	74,584	53,444	172,255	2,742	28	228,469	4.22	2.72
February	70,597	3,473	869	66,593	8,235	111	74,939	54,042	172,487	2,742	28	229,299	4.23	2.71
March	70,571	3,473	869	66,566	8,236	111	74,913	55,333	174,331	2,742	28	232,434	4.29	2.75
April	R 69,819	3,482	864	R 65,819	8,244	102	R 74,165	R 55,341	R 173,392	2,752	28	R 231,513	R 4.44	2.75
May	70,194	3,482	860	66,750	7,702	84	74,536	56,609	173,211	2,619	26	232,465	4.51	2.73

[a] Includes all of the electric vehicle (EV) charging ports located at a single location regardless of who is able to access the ports, what charging network they belong to, or the level of charging. Ports are determined to be at the same location based on latitude, longitude, and AFDC equipment ID number.

[b] Networked ports are connected to the internet, can communicate with their EV service provider, have a dedicated platform that allows users to find the chargers, and pay to charge. The service provider can manage who can access the port and the cost of charging. The charging infrastructure may also be able to communicate directly with drivers, other charging infrastructure, and utilities.

[c] Non-networked ports are not connected to the internet and provide only basic charging capabilities.

[d] Direct current.

[e] Calculated as the total number of DC fast charging ports divided by the total number of locations with DC fast charging ports (available in the microdata file). Includes only locations with DC fast charging ports.

[f] Calculated as the total number of Level 2 charging ports divided by the total number of locations with Level 2 charging ports (available in the microdata file). Includes only locations with Level 2 charging ports.

R=Revised. NA=Not available.

Notes: • Does not include data on charging infrastructure at single-family residential locations. • See "Appendix F Methodology and Sources" and end of section. • See "Electric Vehicle" in Glossary. • Data are at end of period. • Geographic coverage is the 50 states and the District of Columbia.

Web Page: See http://www.eia.gov/totalenergy/data/monthly/#appendices (Excel and CSV files) for all available national and state annual and monthly data beginning in June 2015 and monthly microdata file.

Sources: See end of section.

Data Source

The U.S. Energy Information Administration (EIA) receives administrative electric vehicle (EV) charging infrastructure data from the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy Alternative Fuels Data Center (AFDC).[1] AFDC collects and publishes location-level charging infrastructure data that allows alternative fuel vehicle owners to find fueling and charging stations near them or along a route. AFDC receives daily updates from many of the networked providers.[2] Networked providers that do not provide daily updates provide regular updates. AFDC contacts non-networked[3] providers every two years to determine if the stations are still in service.[4] AFDC does not collect data on charging infrastructure at single-family residential locations.

Historical annual data (2007-2014)

Historical annual data come from the AFDC Alternative Fueling Station Counts by State (https://afdc.energy.gov/stations/states?count=total&include_temporarily_unavailable=false&date=) and are included in the 2023 historical data file (https://afdc.energy.gov/files/docs/historical-station-counts.xlsx?year=2023). Estimated location counts for 2011-2013 are from AFDC analysis (https://afdc.energy.gov/data/10964).

Historical monthly data (June 2015 – December 2021)

The National Renewable Energy Laboratory (NREL), which manages the AFDC, provided the historical data to EIA. The data began in June 2015 and went through December 2021, however not all months were available. The table below shows the months of data EIA received. For the months that are blacked out, EIA did not receive any data.

2015	2016	2017	2018	2019	2020	2021
			January	January	January	January
	February	February	February	February	February	February
	March	March	March	March	March	March
	April	April	April	April	April	April
		May		May	May	
June	June	June	June	June	June	June
	July		July	July	July	July
August		August	August	August	August	August
September	September	September	September	September	September	September
		October	October	October	October	October
November	November	November	November	November		November
		December	December	December	December	December

Monthly updates (January 2022 – present)

Beginning in January 2022, EIA began pulling the data through the AFDC API[5] on the last business day of every month.

Data

EIA uses multiple variables from the AFDC database to develop the MER PDF, excel, CSV, microdata and monthly state data output files. AFDC variables of interest include:

- Location information – station name, ID, fuel type code, open date, access code, status code, facility type, EV renewable source, EV pricing
- Physical location information – latitude, longitude, street address, city, state, zip, intersection/directions

- Charing port information – EV network, EV connector types, EV DC fast num, EV level 1 EVSE num, EV level 2 EVSE num, EV other EVSE

Historical data series included variables with different names but with the same data. The charging port information was structured differently in historical datasets. Work was completed to convert the data in the historical datasets into the same format as the current datasets.

Data quality

The EV charging infrastructure data are administrative data and do not have the same level of statistical accuracy as data published from many of EIA's surveys.

Coverage

The data do not represent the entire population or a statistically representative subset of the population of EV charging infrastructure. Instead, the data represent the known to NREL EV charging infrastructure at the time of the data pull. NREL works with EV charging network providers to receive daily updates.[6] The accuracy and timeliness of the networked providers charging infrastructure will continue to improve as additional networked providers convert to providing daily updates to NREL. There are also non-networked public and private EV chargers, and it is harder to track when these ports become available for use or are decommissioned. These challenges result in less EV charging infrastructure reported than exists, but it is unknown how many additional EV charger locations and ports exist. It is likely that the networked EV charging infrastructure are more accurately represented than the non-networked charging infrastructure. It is also likely that that the public charging infrastructure is more accurately represented than the private charging infrastructure due to a lack of incentive for the owners of private charging infrastructure to make the existence of their ports known to the public.

Data Cleaning

EIA has not verified the accuracy of the administrative data and only conducted minimal cleaning of the data. The cleaning EIA did complete included:

- Fixing latitudes and longitudes if they equaled 0, 0 or 1, -1, to facility creation of location ID
- Normalizing the naming convention of several variables including the electric network providers and the facility type
- Removing charging infrastructure outside of the United States, that had not opened yet, and non-EV locations

Breaks in series

There was a break in series in the number of charging locations between December 2020 and January 2021 because of a definitional change to align with the international standard – Open Charge Point Interface (OCPI).[7]

Duplicate observations

It is likely that duplicate observations exist. Duplicate observations may be introduced multiple ways:

- Multiple people adding the same charging port
- Updates to the networked providers database creating the appearance of a new charging port
- Changes in the underlying data structure of the historical data series creating the appearance of new ports
- EIA's imputation of number of charging ports to the date the charging port opened, not the date it first appeared

Because EIA cannot verify if these are duplicates, the details of the possibly duplicated charging infrastructure remain in the database.

Creation of the location and port id

In most historical datasets, the AFDC data included an equipment ID variable that is helpful to identify EV charging locations. However, this variable was inadequate to track EV charging location overtime for a couple reasons:

1. Between February 2017 and January 2018, 10 monthly datasets are missing equipment IDs
2. Ports located at the same location could have different equipment IDs for various reasons:
    a. Co-located public and private ports have different equipment IDs
    b. Co-located networked and non-networked ports have different equipment IDs
    c. Ports that either came online or were added to the AFDC database at different times have different equipment IDs
    d. Changes in underlying systems could cause an already established port to receive a new equipment ID

For these reasons, EIA created a new ID variable called the "Location ID" using latitude and longitude pairings and equipment ID. It is common for a location ID to be associated with multiple latitudes and longitudes parings as well as multiple equipment IDs due to responses to these variables changing in the historical datasets.

To allow for variation across ports at a location, EIA created a "Port ID" variable using access group (public versus private access), network provider, port level (DC fast charger, Level 2, Level 1, or Legacy), and equipment ID. Every unique combination of the previously mentioned variables received a different Port ID.

Imputation

EIA imputes all missing and incomplete data. Historical datasets had missing subsets of data, so EIA had to fill in the missing data. The missing subsets varied from large (all private charging ports) to small (ports missing for one month and then reappearing during the next month). EIA filled in the missing month with the port count data from the following month.

EIA also imputed data in months that we did not receive any data from NREL. EIA imputed the data using data from the first month following the missing month if the location open date was during the missing month or prior. We did not extend the life of any ports if the last month they appeared in was the month prior to the missing month. We assumed the last month in service was the last month the port appeared, not during the missing month.

In addition, we imputed to remove errors that only appear in one month. For each historical month, EIA compared the previous and following months. If those months were equal but the middle month was different, then EIA updated the middle month to match the other months. New EV ports require a long time lag to install, so it is unlikely that the number of ports would change for a single month then return to their original number.

It is common for EV infrastructure to be added to the AFDC website months or years after the location came online. Because of this, EIA also backfilled EV charging port data to cover all months since the port was available, not only when it appeared in the AFDC database. The MER conducts this backfill imputation twice per year, in the May and November MERs, to correspond with the release of data in the State Energy Data System (SEDS).[8]

Data quality analysis

In December 2023 and January 2024, we conducted a data quality evaluation study to assess the accuracy of the number of electric vehicle (EV) charging ports and charging locations. The study relied on a virtual ground truthing process that compared the number of charging ports listed for 120 randomly sampled charging locations from the August 2023 MER File compared to what EIA observed in online resources available, particularly online street-level imagery. A paired t-test found no significant mean difference between the MER File charging port counts versus observed charging port counts at a 99% confidence level. The MER File reflected the observed number of charging ports approximately 94% of the time, and the MER File reflected the observed number of charging ports within an absolute value difference of two charging ports approximately 99% of the time. The study also identified potential sources of error that contributed to charging port count differences but based on the quantitative findings of the study, these possible sources of error

seemed to have limited effect on the MER File's accuracy. Overall, the study findings show that the MER File's data quality accuracy was generally high at reflecting observable charging port counts.

Available data

In addition to the monthly and annual national data, monthly state level data and a microdata file are also available at http://www.eia.gov/totalenergy/data/monthly/#appendices.

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1. Alternative Fuels Data Center: https://afdc.energy.gov/stations/#/find/nearest
2. Networked ports are connected to the internet, can communicate with their EV service provider, have a dedicated platform that allows users to find the chargers and pay to charge. The service provider can manage who can access the station and the cost of charging. The charging infrastructure may also be able to communicate directly with drivers, other charging infrastructure, and utilities.
3. Non-networked ports are not connected to the internet and provide only basic charging capabilities.

4 . Details on the EV charging infrastructure data received by AFDC:
https://afdc.energy.gov/stations/#/find/nearest?show_about=true

5. AFDC API details: https://developer.nrel.gov/docs/transportation/alt-fuel-stations-v1/all/
6. For more details of the networked providers NREL is currently receiving daily updates from see:
https://afdc.energy.gov/stations/#/find/nearest?show_about=true
7. For more details on the OCIP see https://afdc.energy.gov/stations/#/find/nearest?show_about=true
8. For more information on SEDS see https://www.eia.gov/state/seds/