Energy-Related Carbon Dioxide

Overview

The *Annual Energy Outlook 2022* (AEO2022) projects fossil fuel-related carbon dioxide (CO_2) emissions by fuel and by sector, and it also projects industrial activities that capture carbon in products such as plastics. The AEO2022 reflects this captured carbon in the CO_2 factors for the fossil fuel inputs (feedstocks) that were reduced by EIA based on our estimates of how much carbon remains in the product. We assume some nonfuel uses of fossil fuels capture 100% of their carbon inputs, but we assume other non-energy uses emit CO_2 in the production process. We don't report separately the amount of carbon captured and the amount of CO_2 released during the nonfuel use of fossil fuel inputs, but industrial sector emissions reflect these values.

Fuel use

Emissions of CO_2 from energy use depend on the carbon content of the fossil fuel, the fraction of the fuel combusted, and the amount of that fuel consumed. Most fossil fuels are relatively stable over time in terms of their chemical composition, so their carbon factors do not change. Some fuel categories have greater variability. For example, coal is reported as a single fuel type. However, if the underlying coal ranks (types) that account for the coal category change, the carbon factor for coal can also change over time.

The product of the CO_2 coefficient at full combustion and the combustion fraction yields an adjusted CO_2 emission factor for each fossil fuel whether it is used solely for its energy content or whether it is also used for non-energy purposes. We express the emission factors in millions of metric tons of CO_2 emitted per quadrillion British thermal units (quads) of energy use. We multiply the adjusted emission factors by the energy consumption of the fossil fuel to estimate the CO_2 emissions projections.

For fuel uses of energy, we assume all of the carbon is oxidized, so the combustion fraction is equal to 1.0 (in keeping with international convention). Some products, such as petroleum coke, have both fuel and nonfuel uses, and we adjusted their combustion fraction accordingly. Lubricants are not used for their energy value, but we assume that half of the lubricants are disposed of by combustion and half are not.

Nonfuel use

For some product categories, such as asphalt and road oil, we assume that a product completely captures the carbon in nonfuel, or non-combustion, uses. As a result, the carbon emissions factor is zero. For other fossil fuel inputs, such as those for petrochemical feedstocks, the product stores some carbon (not released to the atmosphere), and the production process releases some as CO_2. Rather than having a combustion fraction of 1.0, these fossil fuel inputs have a fraction that reflects the reduced CO_2 emissions because of the carbon captured in the petrochemical product. Table 1 presents the combustion fractions for fossil fuel categories that are mixes of fuel and nonfuel uses.

Biogenic inputs

In calculating CO_2 emissions for motor gasoline, we omit the direct emissions from renewable blending stock (ethanol). Similarly, we omit direct emissions from biodiesel from reported CO_2 emissions. We consider any CO_2 emitted by biogenic renewable sources, such as biomass and alcohols, to be balanced by the CO_2 sequestration that occurred in its creation. As a result, by following convention in reporting energy-related CO_2 emissions, we assume net emissions of CO_2 from biogenic renewable sources are

zero. However, to illustrate the potential for these emissions in the absence of any offsetting sequestration—as might occur under related land-use changes leading to deforestation—we calculate and report the CO_2 emissions from biogenic fuel use separately.

Table 1 presents the assumed CO_2 coefficients at full combustion, the combustion fractions, and the adjusted CO_2 emission factors we used for AEO2022.

Table 1. Carbon dioxide emissions factors

million metric tons carbon dioxide equivalent per quadrillion British thermal units

Fuel type	CO_2 coefficient at full combustion	Combustion fraction[a]	Adjusted emission factor
Petroleum			
Propane used as fuel	62.88	1.0	62.88
Propane used as feedstock	62.88	0.2	12.58
Ethane used as fuel	59.58	1.0	59.58
Ethane used as feedstock	59.58	0.2	11.92
Butane used as fuel	64.75	1.0	64.75
Butane used as feedstock	64.75	0.2	12.95
Isobutane used as fuel	64.94	1.0	64.94
Isobutane used as feedstock	64.94	0.2	12.99
Natural gasoline (pentanes plus) used as fuel	66.88	1.0	66.88
Natural gasoline (pentanes plus) used as feedstock	66.88	0.2	13.38
Motor gasoline (not including ethanol)	70.66	1.0	70.66
Jet fuel	72.23	1.0	72.23
Distillate fuel (not including biodiesel)	74.14	1.0	74.14
Residual fuel	75.09	1.0	75.09
Asphalt and road oil	75.35	0.0	0.0
Lubricants	74.07	0.5	37.03
Petrochemical feedstocks	70.22	0.41	28.79
Kerosene	73.19	1.0	73.19
Petroleum coke (industrial)	102.12	0.956	97.59
Petroleum coke (electric power)	102.12	1.0	102.12
Petroleum still gas	66.73	1.0	66.73
Other industrial[b]	48.89	1.0	48.89
Coal			
Residential and commercial	95.74	1.0	95.74
Metallurgical	93.83	1.0	93.83
Coke	114.14	1.0	114.14
Industrial other[c]	95.59	1.0	95.59
Electric power[d]	95.63	1.0	95.63
Natural gas			
Used as fuel	52.91	1.0	52.91
Used as feedstock	52.91	0.464	24.57
Biogenic energy sources[e]			
Biogenic waste	89.65	1.0	89.65
Ethanol	74.07	1.0	74.07

Source: U.S. Energy Information Administration, *Annual Energy Outlook 2022*; National Energy Modeling System run: ref2022.d121521

[a] For feedstocks, the combustion fraction includes process emissions as well as inputs that might be combusted onsite.

[b] *Other industrial petroleum* includes industrial lubricants, special naphtha (solvents), and miscellaneous products such as sulfur.

[c] *Industrial other coal* is for process heat other than the manufacture of raw steel (metallurgical coal).

[d] The National Energy Modeling System specifies emission factors for coal used for electric power generation by coal supply region and types of coal, so the average carbon dioxide (CO_2) content for coal varies throughout the projection period. The electric power value of 95.63 shown here illustrates a typical coal-fired emissions factor.

[e] We include biogenic sources for informational purposes, but we do not count them in total CO_2 emissions.