
Energy-related carbon dioxide

Overview

The *Annual Energy Outlook 2018* (AEO2018) projects fossil fuel-related carbon dioxide (CO₂) emissions by fuel and by sector, and it also projects industrial activities that capture carbon in products such as plastics. This captured carbon is reflected in the CO₂ factors for those fossil fuel inputs (feedstocks) that are reduced accordingly. Some non-energy uses of fossil fuels are considered to capture 100% of the carbon inputs, while others are assumed to emit CO₂ in the production process. The amount of carbon captured and the amount of CO₂ released during the nonfuel use of fossil fuel inputs are not reported separately but are reflected in industrial sector emissions.

Fuel use

Emissions of CO₂ from energy use are dependent on the carbon content of the fossil fuel, the fraction of the fuel consumed during combustion, and the amount of that fuel that is 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 over time. For example, coal is reported as one fuel type. But if the underlying coal types that make up the coal category change, the carbon factor for coal can be different over time.

The product of the carbon content at full combustion and the combustion fraction yields an adjusted CO₂ factor for each fossil fuel. The emissions factors are expressed in millions of metric tons of carbon dioxide emitted per quadrillion British thermal units (Btu) of energy use, or equivalently, in kilograms of CO₂ per million Btu. The adjusted emissions factors are multiplied by the energy consumption of the fossil fuel to estimate the CO₂ emissions projections.

For fuel uses of energy, all of the carbon is assumed to be oxidized, so the combustion fraction is equal to 1.0 (in keeping with international convention). Although a small fraction of the carbon content of the fuel was previously assumed to remain unoxidized, in recent years that assumption has been dropped by the international community.

Nonfuel use

The carbon in nonfuel or non-combustion uses of fossil fuel inputs for products such as asphalt and road oil is assumed to be completely captured in the product. As a result, the carbon emissions factor is zero. For other fossil fuel inputs, such as those for petrochemical feedstocks, some carbon is assumed to be stored in the product (not released to the atmosphere), and some is released as CO₂ during the production process. Rather than having a combustion fraction of 1.0, these fossil fuel inputs have a fraction that reflects the reduced CO₂ emissions because of the carbon captured in the petrochemical product. The combustion fractions for fossil fuel categories that are mixes of fuel and nonfuel uses are presented in Table 1.

Biogenic inputs

In calculating CO₂ emissions for motor gasoline, the direct emissions from renewable blending stock (ethanol) are omitted. Similarly, direct emissions from biodiesel are omitted from reported CO₂ emissions. Any CO₂ emitted by biogenic renewable sources, such as biomass and alcohols, is considered balanced by the CO₂ sequestration that occurred in its creation. As a result, following convention in reporting energy-related CO₂ emissions, net emissions of CO₂ from biogenic renewable sources are assumed to be zero. However, to illustrate the potential for these emissions in the absence of any

offsetting sequestration—as might occur under related land-use change leading to deforestation—the CO₂ emissions from biogenic fuel use are calculated and reported separately.

Table 1 presents the assumed CO₂ factors at full combustion, the combustion fractions, and the adjusted CO₂ emission factors used for AEO2018.

Table 1. Carbon dioxide emissions factors

million metric tons carbon dioxide equivalent per quadrillion Btu

Fuel Type	Carbon Dioxide Coefficient at		Adjusted Emission Factor
	Full Combustion	Combustion Fraction ¹	
Petroleum			
Propane used as fuel	63.07	1.000	63.07
Propane used as feedstock	63.07	0.200	12.61
Ethane used as feedstock	59.58	0.200	11.92
Butane used as feedstock	64.94	0.200	12.98
Isobutane used as feedstock	65.08	0.200	13.02
Natural gasoline used as feedstock	66.88	0.316	21.12
Motor gasoline (net of ethanol)	71.28	1.000	71.28
Jet fuel	70.88	1.000	70.88
Distillate fuel (net of biodiesel)	73.15	1.000	73.15
Residual fuel	78.80	1.000	78.80
Asphalt and road oil	75.61	0.000	0.00
Lubricants	74.21	0.500	37.11
Petrochemical feedstocks	71.01	0.410	29.11
Kerosene	72.31	1.000	72.31
Petroleum coke	101.09	0.956	97.61
Petroleum still gas	64.20	1.000	64.20
Other industrial	74.54	1.000	74.54
Coal			
Residential and commercial	95.33	1.000	95.33
Metallurgical	93.72	1.000	93.72
Coke	117.81	1.000	117.81
Industrial other	93.98	1.000	93.98
Electric utility ²	95.52	1.000	95.52
Natural gas			
Used as fuel	53.06	1.000	53.06
Used as feedstock	53.06	0.437	23.21
Biogenic energy sources³			
Biomass	93.81	1.000	93.81
Biogenic waste	90.64	1.000	90.64
Biofuels heats and coproducts	93.81	1.000	93.81
Ethanol	68.42	1.000	68.42
Biodiesel	72.73	1.000	72.73
Liquids from biomass	73.15	1.000	73.15

¹For feedstocks, the combustion fraction includes process emissions as well as inputs that might be combusted on site.

²Emission factors for coal used for electric power generation within NEMS are specified by coal supply region and types of coal, so the average CO₂ content for coal varies throughout the projection. The value of 95.52 shown here is representative of recent history.

³Biogenic sources are included for information purposes but not counted in total CO₂.

Sources: U.S. Energy Information Administration, *Annual Energy Outlook 2018*; National Energy Modeling System run: ref2018.d121317a.