Energy-related carbon dioxide

Overview

The *Annual Energy Outlook 2020* (AEO2020) 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 the fossil fuel inputs (feedstocks) that we reduced based on EIA estimates of how much carbon remains in the product. Some non-energy uses of fossil fuels are considered to capture 100% of the carbon inputs, but others are assumed to emit CO2 in the production process. We don't report the amount of carbon captured and the amount of CO2 released during the nonfuel use of fossil fuel inputs separately, but they are reflected in industrial sector emissions.

Fuel use

Emissions of CO2 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 carbon dioxide coefficient at full combustion and the combustion fraction yields an adjusted CO2 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. The emission factors are expressed in millions of metric tons of carbon dioxide emitted per quadrillion British thermal units (Btu) of energy use. The adjusted emission factors are multiplied by the energy consumption of the fossil fuel to estimate the CO2 emissions projections.

For fuel uses of energy, we assumed 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 assumed that half of the lubricants are disposed of by combustion and half are not.

Nonfuel use

We assumed that the carbon in nonfuel, or non-combustion, uses of fossil fuel inputs for a product category such as asphalt and road oil 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, we assumed some carbon is 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, we omitted the direct emissions from renewable blending stock (ethanol). Similarly, we omitted direct emissions from biodiesel from reported CO2 emissions. We considered any CO2 emitted by biogenic renewable sources, such as biomass and alcohols, to be balanced by the CO2 sequestration that occurred in its creation. As a result, by following

convention in reporting energy-related CO2 emissions, we assume net emissions of CO2 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 calculated and reported the CO2 emissions from biogenic fuel use separately.

Table 1 presents the assumed CO2 coefficients at full combustion, the combustion fractions, and the adjusted CO2 emission factors we used for AEO2020.

Table 1. Carbon dioxide emissions factors

million metric tons carbon dioxide equivalent per quadrillion British thermal units

Fuel type	Carbon dioxide coefficient at full combustion	Combustion fraction[1]	Adjusted emission factor
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	12.99
Isobutane used as feedstock	65.08	0.200	13.02
Natural gasoline used as feedstock	66.88	0.316	21.13
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	96.64
Petroleum still gas	64.20	1.000	64.20
Other industrial[2]	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[3]	93.98	1.000	93.98
Electric power[4]	94.98	1.000	94.98
Natural gas			
Used as fuel	53.06	1.000	53.06
Used as feedstock	53.06	0.437	23.19
Biogenic energy sources[5]			
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

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

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

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

[4]Emission factors for coal used for electric power generation within the National Energy Modeling System are specified by coal supply region and types of coal, so the average CO2 content for coal varies throughout the projection period. The electric power value of 94.98 shown here illustrates a typical coal-fired emissions factor.

[5]Biogenic sources are included for information purposes but are not counted in total CO2.

Sources: U.S. Energy Information Administration, *Annual Energy Outlook 2020*; National Energy Modeling System run: ref2020.d112119a.