Section 4. Petroleum

The State Energy Data System (SEDS) estimates energy-related carbon dioxide (CO2) emissions from petroleum products using state-level primary energy consumption estimates from SEDS, as well as national-level non-combustion (nonfuel) consumption shares, carbon sequestration factors, and CO2 conversion factors from the U.S. Energy Information Administration's (EIA) *Monthly Energy Review* (MER).

The term energy-related CO2 emissions refers to emissions from primary energy consumption, released at the location where fossil fuels are combusted (burned). In SEDS, we attribute CO2 emissions for electricity generation to the state where the petroleum product is combusted, even if the electricity is later consumed in a different state. Similarly, for industrial nonfuel consumption of petroleum products, we attribute the carbon stored in products, such as plastics, to the states where the products are consumed as primary energy at production plants, regardless of where the final products are used.

Energy consumption

The State Energy Data System (SEDS) estimates the amount of petroleum products consumed in thousand barrels for each individual product by sector. At the national level, SEDS assumes consumption of each petroleum product is equal to the U.S. Energy Information Administration's (EIA) U.S. "product supplied" data series as published in the EIA *Petroleum Supply Annual*. Product supplied measures the disappearance of petroleum products from primary sources, such as: refineries, natural gas-processing plants, blending plants, pipelines, and bulk terminals. In general, EIA calculates product supplied of each product as follows: field production, plus refinery production, plus imports, plus unaccounted-for crude oil, minus stock change, minus crude oil losses, minus refinery inputs, and minus exports.

At the state level, no product supplied data by state or sector are available, so SEDS estimates state-level product supplied for each individual petroleum product by sector using many methods and sources. EIA collects petroleum electricity data on survey Form EIA-923, "Power Plant Operations Report," and predecessor forms. SEDS uses these data directly as estimates for electric power sector petroleum consumption and any industrial and commercial generators greater than 1 megawatt capacity. For the other sectors, we subtract the EIA-923 data from EIA's *Petroleum Supply Annual* total U.S. "product supplied" and allocate the remainder to the residential, commercial, industrial, and transportation sectors by state using the various methods for each individual fuel described in the SEDS consumption technical notes. Lastly, we convert physical unit data in barrels into British thermal units (Btu) for each individual fuel using various conversion factors each state and sector.

See the SEDS consumption technical notes for all consumption variables, heat conversion factors, estimation methods, and data sources https://www.eia.gov/state/seds/seds-technical-notes-complete.php?sid=US.

The individual petroleum product consumption variables SEDS uses for total petroleum, excluding biofuels, CO2 emissions calculations include:

- asphalt and road oil
- aviation gasoline
- distillate fuel oil, excluding biofuels
- hydrocarbon gas liquids (HGL)
  - For 1960 through 1983 including:
    - liquefied petroleum gases (LPG)
    - natural gasoline/isopentane mixtures
    - plant condensate
    - unfractionated streams
  - For 1984 through 2009 including:
    - liquefied petroleum gases (LPG)
    - natural gasoline (pentanes plus)
  - For 2010 forward including:
    - normal butane
    - butylene
    - ethane
    - ethylene
    - isobutane
    - isobutylene
    - natural gasoline (pentanes plus)
    - propane
    - propylene
- jet fuel
- kerosene

- lubricants
- motor gasoline, excluding fuel ethanol
- other petroleum products, excluding biofuels:
  - aviation gasoline blending components
  - crude oil, including lease condensate
  - miscellaneous petroleum products
  - motor gasoline blending components
  - petrochemical feedstocks, naphtha less than 401˚F
  - petrochemical feedstocks, other oils equal to or greater than 401˚F
  - petrochemical feedstocks, still gas
  - special naphthas
  - still gas
  - unfinished oils
  - waxes
- petroleum coke
- residual fuel oil

See Appendix A Table A2 of this report for all individual petroleum product consumption variables https://www.eia.gov/state/seds/sep_fuel/notes/CO2_a.pdf.

SEDS removes renewable energy in the form of biofuels blended with petroleum products consumption to estimate pure petroleum fossil fuels emissions, including fuel ethanol, biodiesel, renewable diesel, and other biofuels. The underlying assumption is that biofuels, which are a renewable energy source of biomass, CO2 emissions are carbon neutral, meaning they are fully offset by land sinks in a sustainable biomass cycle and the natural processes by which trees, crops, and other biomass remove CO2 from the atmosphere to grow. EIA does not separately estimate other biofuels consumption by individual fuel (renewable jet fuel, renewable propane, renewable naphtha, etc.), so other biofuels product supplied is removed from EIA CO2 emissions data but not other unknown blended consumption. CO2 emissions data may underestimate actual CO2 emissions to the extent that actual biomass energy consumption may not be carbon neutral.

Non-combustion (nonfuel) consumption

Most fossil fuels consumed in the United States are combusted (burned) to produce heat and power. However, some are used directly for non-combustion (nonfuel) uses such as construction materials, chemical feedstocks, lubricants, solvents, and waxes. The U.S. Energy Information Administration (EIA) assumes most non-combustion use of petroleum products occurs in the industrial sector for chemicals and plastics. EIA also assumes all lubricants consumption in the industrial and transportation sectors are nonfuel use.

EIA's *Monthly Energy Review* (MER) estimates annual U.S.-level non-combustion use shares of individual petroleum products for 1973 forward. Each share is a number between 0 and 1. A share of 0 means that the fuel is always burned when consumed, and a share of 1 means that none of the fuel is burned when consumed. For years prior to 1973, SEDS assumes the 1973 shares. All other petroleum products not listed below have a nonfuel share of 0. The U.S.-level petroleum non-combustion use share (number between 0 and 1) variables used in SEDS are:

ARNFSUS = asphalt and road oil non-combustion share;
BUNFSUS = normal butane/butylene non-combustion share;
DMNFSUS = distillate fuel oil, excluding biofuels, non-combustion share;
ETNFSUS = ethane/ethylene non-combustion share;
FNNFSUS = naphthas for petrochemical feedstock use non-combustion share;
FONFSUS = other oils for petrochemical feedstock use non-combustion share;
FSNFSUS = petrochemical feedstocks, still gas, non-combustion share (through 1985);
IBNFSUS = isobutane/isobutylene non-combustion share;
LUNFSUS = lubricants non-combustion share;
MSNFSUS = miscellaneous petroleum products non-combustion share;
NANFSUS = natural gasoline/isopentane non-combustion share (through 1983);
PCNFSUS = petroleum coke non-combustion share;
PLNFSUS = plant condensate non-combustion share (through 1983);
PPNFSUS = natural gasoline (pentanes plus) non-combustion share;
PQNFSUS = propane non-combustion share;
PYNFSUS = propylene non-combustion share;
RFNFSUS = residual fuel oil non-combustion share;
SGNFSUS = still gas and still gas for petrochemical feedstock non-combustion share;
SNNFSUS = special naphthas non-combustion share;
UONFSUS = unfinished oils non-combustion share;
USNFSUS = unfractionated streams non-combustion share (through 1983); and
WXNFSUS = waxes non-combustion share.

See the MER Energy overview section for the exact methods and sources for each fuel https://www.eia.gov/totalenergy/data/monthly/.

Carbon sequestration from non-combustion use

In the non-combustion use of fossil fuels, some of the carbon is stored (sequestered) in the final product, and we subtract this from the fuel consumption values. SEDS calculates the amount of carbon sequestered as the product of the non-combustion use of fossil fuels and the carbon sequestration factor. EIA's *Monthly Energy Review* (MER) estimates national-level sequestration factors. SEDS assumes the state-level sequestration factors are equal to the MER's national-level factor for all years.

Sequestration factors range from 0 to 1. A factor of 0 indicates that the fuel does not sequester any carbon (all is emitted), while a factor of 1 indicates that the fuel sequesters all of the carbon (none is emitted). All other petroleum products not listed below have a nonfuel carbon sequestration factor of 0. See the MER Environment section for more information on the data sources and methods https://www.eia.gov/totalenergy/data/monthly/. See Appendix Table A1 of this report for the exact carbon sequestration factors https://www.eia.gov/state/seds/sep_fuel/notes/CO2_a.pdf.

The U.S.-level petroleum nonfuel sequestration factor (number between 0 and 1) variables used in SEDS are:

ARSQSUS = asphalt and road oil nonfuel carbon sequestration factor;
BQSQSUS = normal butane nonfuel carbon sequestration factor;
BYSQSUS = butylene nonfuel carbon sequestration factor;
DMSQSUS = distillate fuel oil, excluding biofuels, nonfuel carbon sequestration factor;
EQSQSUS = ethane nonfuel carbon sequestration factor;
EYSQSUS = ethylene nonfuel carbon sequestration factor;
FNSQSUS = naphthas used for petrochemical feedstocks nonfuel carbon sequestration factor;
FOSQSUS = other oils used for petrochemical feedstocks nonfuel carbon sequestration factor;
FSSQSUS = still gas for petrochemical feedstock use sequestration factor;
IQSQSUS = isobutane nonfuel carbon sequestration factor;
IYSQSUS = isobutylene nonfuel carbon sequestration factor;
LUSQSUS = lubricants nonfuel carbon sequestration factor;
MSSQSUS = miscellaneous petroleum products nonfuel carbon sequestration factor;
NASQSUS = natural gasoline/isopentane nonfuel carbon sequestration factor (through 1983);
PCSQSUS = petroleum coke used for other manufacturing nonfuel carbon sequestration factor;
PLSQSUS = plant condensate nonfuel carbon sequestration factor (through 1983);
PPSQSUS = natural gasoline (pentanes plus) nonfuel carbon sequestration factor;
PQSQSUS = propane nonfuel carbon sequestration factor;
PYSQSUS = propylene nonfuel carbon sequestration factor;
RFSQSUS = residual fuel oil nonfuel carbon sequestration factor;
SGSQSUS = still gas nonfuel carbon sequestration factor;
SNSQSUS = special naphthas nonfuel carbon sequestration factor;
UOSQSUS = unfinished oils nonfuel carbon sequestration factor;
USSQSUS = unfractionated streams carbon sequestration factor (through 1983); and
WXSQSUS = waxes nonfuel carbon sequestration factor.

Carbon dioxide (CO2) emissions

SEDS calculates carbon dioxide (CO2) emissions estimates for each petroleum product in million metric tons (MMmt) as the product of the SEDS consumption values, the carbon sequestered by non-combustion use for the industrial and transportation sectors, and the respective annual CO2 emissions factors by sector at https://www.eia.gov/environment/emissions/xls/CO2_coeffs_detailed.xls.

Except for plant condensate and unfractionated stream (which are EIA estimates), the CO2 emissions factors for fossil fuels are from the U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks*, Tables A-19, A-31, and A-215. EIA converts metric tons of carbon to metric tons of CO2 using the approximate molar mass (44/12)—see https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks.

The individual petroleum product CO2 emissions factors used for all states and sectors in million metric tons CO2 per quadrillion Btu are:

ABTCFUS = aviation gasoline blending components CO2 emissions factor for the United States;

ARTCFUS = asphalt and road oil CO2 emissions factor for the United States;
AVTCFUS = aviation gasoline CO2 emissions factor for the United States;
BQTCFUS = normal butane CO2 emissions factor for the United States;
BYTCFUS = butylene CO2 emissions factor for the United States;
COTCFUS = crude oil CO2 emissions factor for the United States;
DMTCFUS = distillate fuel oil, excluding biofuels, CO2 emissions factor for the United States;
EQTCFUS = ethane CO2 emissions factor for the United States;
EYTCFUS = ethylene CO2 emissions factor for the United States;
FNTCFUS = naphthas for petrochemical feedstock use CO2 emissions factor for the United States;
FOTCFUS = other oils for petrochemical feedstock use CO2 emissions factor for the United States;
IQTCFUS = isobutane CO2 emissions factor for the United States;
IYTCFUS = isobutylene CO2 emissions factor for the United States;
JFTCFUS = jet fuel CO2 emissions factor for the United States;
KSTCFUS = kerosene CO2 emissions factor for the United States;
LUTCFUS = lubricants CO2 emissions factor for the United States;
MBTCFUS = motor gasoline blending components CO2 emissions factor for the United States;
MMTCFUS = motor gasoline, excluding fuel ethanol, CO2 emissions factor for the United States;
MSTCFUS = miscellaneous petroleum products CO2 emissions factor for the United States;
NATCFUS = natural gasoline/isopentane CO2 emissions factor for the United States (through 1983);
PCTCFUS = petroleum coke CO2 emissions factor for the United States;
PLTCFUS = plant condensate CO2 emissions factor for the United States (through 1983);
PPTCFUS = natural gasoline (pentanes plus) CO2 emissions factor for the United States;
PQTCFUS = propane CO2 emissions factor for the United States;
PYTCFUS = propylene CO2 emissions factor for the United States;
RFTCFUS = residual fuel oil CO2 emissions factor for the United States;
SGTCFUS = still gas and still gas for petrochemical feedstock use CO2 emissions factor for the United States;
SNTCFUS = special naphthas CO2 emissions factor for the United States;
UOTCFUS = unfinished oils CO2 emissions factor for the United States;
USTCFUS = unfractionated streams CO2 emissions factor for the United States (through 1983); and
WXTCFUS = waxes CO2 emissions factor for the United States.

See Appendix A Table A1 of this report for all individual petroleum product CO2 emissions variables and formulas https://www.eia.gov/state/seds/sep_fuel/notes/CO2_a.pdf.

EIA publishes both individual petroleum products and total aggregate petroleum CO2 emissions data at the state level by sector for primary energy consumption.

Residential sector

For the residential sector, the individual petroleum product CO2 emissions variables in million metric tons are:

DMRCE = distillate fuel oil, excluding biofuels, residential sector CO2 emissions;
HLRCE = hydrocarbon gas liquids residential sector CO2 emissions; and
KSRCE = kerosene residential sector CO2 emissions.

For residential sector distillate fuel oil and kerosene, EIA calculates state- and national-level petroleum products CO2 emissions, excluding biofuels, as the product of energy consumption and the corresponding CO2 factor, with unit adjustments:

DMRCE = DMRCB * DMTCFUS / 1,000,000
KSRCE = KSRCB * KSTCFUS / 1,000,000

For residential sector hydrocarbon gas liquids (HGL) CO2 emissions, EIA assumes that propane is the only fuel consumed in the sector, but the consumption data differ depending on the year because of data availability. Pure propane consumption data are available for 2010 forward only. Before 2010, pure propane data are not available, and EIA uses liquified petroleum gas (LPG) consumption data. See the SEDS consumption technical notes for more details.

For 2010 forward, HGL CO2 emissions in the residential sector (HLRCE) are equal to propane CO2 emissions in the residential sector (PQRCE), which EIA calculates as the product of propane energy consumption in the residential sector (PQRCB) and the corresponding propane CO2 factor (PQTCFUS), with unit adjustments:

2010 forward:

PQRCE = PQRCB * PQTCFUS / 1,000,000
HLRCE = PQRCE

Before 2010, HGL CO2 emissions in the residential sector (HLRCE) are equal to LPG CO2 emissions in the residential sector (LGRCE), which EIA calculates as the product of LPG energy consumption in the residential sector (LGRCB) and the corresponding propane CO2 factor (PQTCFUS), with unit adjustments:

Before 2010:

LGRCE = LGRCB * PQTCFUS / 1,000,000
HLRCE = LGRCE

The total aggregate petroleum products, excluding biofuels, CO2 emissions for the residential sector (PMRCE) variable is the sum of all the individual products CO2 emissions in the sector, in million metric tons (MMmt):

PMRCE = DMRCE + HLRCE + KSRCE

Commercial sector

For the commercial sector, the individual petroleum product CO2 emissions variables in million metric tons are:

- DMCCE = distillate fuel oil, excluding biofuels, commercial sector CO2 emissions;
- HLCCE = hydrocarbon gas liquids commercial sector CO2 emissions;
- KSCCE = kerosene commercial sector CO2 emissions;
- MMCCE = motor gasoline, excluding ethanol, commercial sector CO2 emissions;
- PCCCE = petroleum coke commercial sector CO2 emissions; and
- RFCCE = residual fuel oil commercial sector CO2 emissions.

For commercial sector distillate fuel oil, kerosene, motor gasoline, petroleum coke, and residual fuel oil, EIA calculates state- and national-level petroleum products CO2 emissions, excluding biofuels, as the product of energy consumption and the corresponding CO2 factor, with unit adjustments:

DMCCE = DMCCB * DMTCFUS / 1,000,000
KSCCE = KSCCB * KSTCFUS / 1,000,000
MMCCE = MMCCB * MMTCFUS / 1,000,000
PCCCE = PCCCB * PCTCFUS / 1,000,000
RFCCE = RFCCB * RFTCFUS / 1,000,000

For commercial sector hydrocarbon gas liquids (HGL) CO2 emissions, EIA assumes that propane is the only fuel consumed in the sector, but the consumption data differ depending on the year because of data availability. Pure propane consumption data are available for 2010 forward only. Before 2010, pure propane data are not available, and EIA uses liquified petroleum gas (LPG) consumption data. See the SEDS consumption technical notes for more details.

For 2010 forward, HGL CO2 emissions in the commercial sector (HLCCE) are equal to propane CO2 emissions in the commercial sector (PQCCE), which EIA calculates as the product of propane energy consumption in the commercial sector (PQCCB) and the corresponding propane CO2 factor (PQTCFUS), with unit adjustments:

2010 forward:

PQCCE = PQCCB * PQTCFUS / 1,000,000
HLCCE = PQCCE

Before 2010, HGL CO2 emissions in the commercial sector (HLCCE) are equal to LPG CO2 emission in the commercial sector (LGCCE), which EIA calculates as the product of LPG energy consumption in the commercial sector (LGCCB) and the corresponding propane CO2 factor (PQTCFUS), with unit adjustments:

Before 2010:

LGCCE = LGCCB * PQTCFUS / 1,000,000
HLCCE = LGCCE

The total aggregate petroleum products, excluding biofuels, CO2 emissions for the commercial sector (PMCCE) variable is the sum of all the individual products CO2 emissions in the sector, in million metric tons (MMmt):

PMCCE = DMCCE + HLCCE + KSCCE + MMCCE + PCCCE + RFCCE

Industrial sector

For the industrial sector, the individual petroleum product CO2 emissions variables in million metric tons are:

ARICE = asphalt and road oil industrial sector CO2 emissions;
DMICE = distillate fuel oil, excluding biofuels, industrial sector CO2 emissions;
HLICE = hydrocarbon gas liquids industrial sector CO2 emissions;
KSICE = kerosene industrial sector CO2 emissions;
LUICE = lubricants industrial sector CO2 emissions;
MMICE = motor gasoline, excluding ethanol, industrial sector CO2 emissions;
OMICE = other petroleum products, excluding biofuels, industrial sector CO2 emissions;
PCICE = petroleum coke industrial sector CO2 emissions; and
RFICE = residual fuel oil industrial sector CO2 emissions.

For industrial sector asphalt and road oil, distillate fuel oil, kerosene, lubricants, motor gasoline, petroleum coke, and residual fuel oil, EIA calculates state- and national-level petroleum products CO2 emissions, excluding biofuels, as the product of energy consumption, excluding any CO2 emissions sequestered from nonfuel use where applicable, and the corresponding CO2 factor, with unit adjustments:

ARICE = (ARICB * ARTCFUS * (1 - ARNFSUS * ARSQSUS)) / 1,000,000
DMICE = (DMICB * DMTCFUS * (1 - DMNFSUS * DMSQSUS)) / 1,000,000
KSICE = KSICB * KSTCFUS / 1,000,000
LUICE = (LUICB * LUTCFUS * (1 - LUNFSUS * LUSQSUS)) / 1,000,000
MMICE = MMICB * MMTCFUS / 1,000,000
PCICE = (PCICB * PCTCFUS * (1 - PCNFSUS * PCSQSUS)) / 1,000,000
RFICE = (RFICB * RFTCFUS * (1 - RFNFSUS * RFSQSUS)) / 1,000,000

For industrial sector hydrocarbon gas liquids (HGL) CO2 emissions, EIA assumes that different fuels are consumed in the sector depending on the year and subject to data availability. Pure individual HGL product consumption data for butane, butylene, ethane, ethylene, isobutane, isobutylene, natural gasoline, propane, and propylene are available for 2010 forward only. For 1984 through 2009, pure individual HGL product consumption data are not available, and EIA uses liquified petroleum gas (LPG) and natural gasoline (formerly called “pentanes plus”) consumption data. Before 1984, EIA uses LPG and various historical mixtures of natural gasoline with isopentane, plant condensate, unfractionated streams industrial consumption. See the SEDS consumption technical notes for more details.

For 2010 forward, HGL CO2 emissions in the industrial sector (HLICE) are equal to the sum of all the individual components CO2 emissions in the industrial sector, which EIA calculates as the product of each fuel energy consumption in the industrial sector, excluding any CO2 emissions sequestered from nonfuel use where applicable, and the corresponding CO2 factor, with unit adjustments:

2010 forward:

BQICE = (BQICB * BQTCFUS * (1 - BUNFSUS * BQSQSUS)) / 1,000,000
BYICE = (BYICB * BYTCFUS * (1 - BUNFSUS * BYSQSUS)) / 1,000,000
EQICE = (EQICB * EQTCFUS * (1 - ETNFSUS * EQSQSUS)) / 1,000,000
EYICE = (EYICB * EYTCFUS * (1 - ETNFSUS * EYSQSUS)) / 1,000,000
IQICE = (IQICB * IQTCFUS * (1 - IBNFSUS * IQSQSUS)) / 1,000,000
IYICE = (IYICB * IYTCFUS * (1 - IBNFSUS * IYSQSUS)) / 1,000,000
PPICE = (PPICB * PPTCFUS * (1 - PPNFSUS * PPSQSUS)) / 1,000,000
PQICE = PQICB * PQTCFUS * (1 - PQNFSUS * PQSQSUS)) / 1,000,000
PYICE = (PYICB * PYTCFUS * (1 - PYNFSUS * PYSQSUS)) / 1,000,000
HLICE = BQICE + BYICE + EQICE + EYICE + IQICE + IYICE + PPICE + PQICE + PYICE

For 1984 through 2009, HGL CO2 emissions in the industrial sector (HLICE) are equal to the sum of LPG CO2 emissions in the industrial sector (LGICE) and natural gasoline CO2 emissions in the industrial

sector (PPICE), which EIA calculates as the product of each fuel energy consumption in the industrial sector, excluding any CO2 emissions sequestered from nonfuel use where applicable, and the corresponding CO2 factor, with unit adjustments. Because of data availability for state-level LPG subcomponents, SEDS directly uses the U.S.-level LPG CO2 emissions data from EIA's *Monthly Energy Review* and estimates state-level LPG CO2 emissions proportionally to the state-level share of U.S. total LPG consumption in the industrial sector. See the *Monthly Energy Review* endnotes for more details https://www.eia.gov/totalenergy/data/monthly/.

LGICEUS = U.S. total LPG CO2 emissions in the industrial sector, used directly from EIA's *Monthly Energy Review*; and
LGICEZZ = state-level LPG CO2 emissions in the industrial sector (where "ZZ" in the variable name represents the two-letter state code that differs for each state).

1984 through 2009:

LGICEZZ = (LGICBZZ / LGICBUS) * LGICEUS
PPICE = (PPICB * PPTCFUS * (1 - PPNFSUS * PPSQSUS)) / 1,000,000
HLICE = LGICE + PPICE

Before 1984, HGL CO2 emissions in the industrial sector (HLICE) are equal to the sum of LPG CO2 emissions in the industrial sector (LGICE), historical mixtures of natural gasoline with isopentane CO2 emissions in the industrial sector (NAICE), historical plant condensate CO2 emissions in the industrial sector (PLICE), and historical unfractionated streams CO2 emissions in the industrial sector (USICE). See the SEDS consumption technical notes for more details on the historical consumption data series. EIA calculates each individual fuel CO2 emissions estimate as the product of energy consumption, excluding any CO2 emissions sequestered from nonfuel use where applicable, and the corresponding CO2 factor, with unit adjustments. Because of data availability for state-level LPG subcomponents, SEDS directly uses the U.S.-level LPG CO2 emissions data from EIA's *Monthly Energy Review* and estimates state-level LPG CO2 emissions proportionally to the state-level share of U.S. total LPG consumption in the industrial sector. See the *Monthly Energy Review* endnotes for more details https://www.eia.gov/totalenergy/data/monthly/.

Before 1984:

LGICEZZ = (LGICBZZ / LGICBUS) * LGICEUS
NAICE = (NAICB * NATCFUS * (1 - NANFSUS * NASQFUS)) / 1,000,000
PLICE = (PLICB * PLTCFUS * (1 - PLNFSUS * PLSQSUS)) / 1,000,000
USICE = (USICB * USTCFUS * (1 - USNFSUS * USSQSUS)) / 1,000,000
HLICE = LGICE + NAICE + PLICE + USICE

Other petroleum products, excluding biofuels, industrial sector CO2 emissions are a grouping of smaller fuels and equal to the sum of industrial sector CO2 emissions for: aviation gasoline blending components (ABICE), crude oil (COICE), naphthas for petrochemical feedstock use (FNICE), other oils for petrochemical feedstock use (FOICE), still gas for petrochemical feedstock through 1985 (FSICE), motor gasoline blending components (MBICE), miscellaneous petroleum products (MSICE), still gas (SGICE), special naphthas (SNICE), unfinished oils (UOICE), and waxes (WXICE). EIA calculates each individual fuel CO2 emissions estimate as the product of energy consumption, excluding any CO2 emissions sequestered from nonfuel use where applicable, and the corresponding CO2 factor, with unit adjustments:

ABICE = ABICB * ABTCFUS / 1,000,000
COICE = COICB * COTCFUS / 1,000,000
FNICE = (FNICB * FNTCFUS * (1 - FNNFSUS * FNSQSUS)) / 1,000,000
FOICE = (FOICB * FOTCFUS * (1 - FONFSUS * FOSQSUS)) / 1,000,000
FSICE = (FSICB * SGTCFUS * (1 - FSNFSUS * FSSQSUS)) / 1,000,000
MBICE = (MBICB * MBTCFUS) / 1,000,000
MSICE = (MSICB * MSTCFUS * (1 - MSNFSUS * MSSQSUS)) / 1,000,000
SGICE = (SGICB * SGTCFUS * (1 - SGNFSUS * SGSQSUS)) / 1,000,000
SNICE = (SNICB * SNTCFUS * (1 - SNNFSUS * SNSQSUS)) / 1,000,000
UOICE = (UOICB * UOTCFUS * (1 - UONFSUS * UOSQSUS)) / 1,000,000
WXICE = (WXICB * WXTCFUS * (1 - WXNFSUS * WXSQSUS)) / 1,000,000
OMICE = ABICE + COICE + FNICE + FOICE + FSICE + MBICE + MSICE + SGICE + SNICE + UOICE + WXICE

The total aggregate petroleum products, excluding biofuels, CO2 emissions for the industrial sector (PMICE) variable is the sum of all the individual products CO2 emissions in the sector, in million metric tons (MMmt):

PMICE = ARICE + DMICE + HLICE + KSICE + LUICE + MMICE + OMICE + PCICE + RFICE

Transportation sector

For the transportation sector, the individual petroleum product CO2 emissions variables in million metric tons are:

- AVACE = aviation gasoline transportation sector CO2 emissions;
- DMACE = distillate fuel oil, excluding biofuels, transportation sector CO2 emissions;
- HLACE = hydrocarbon gas liquids transportation sector CO2 emissions;
- JFACE = jet fuel transportation sector CO2 emissions;
- LUACE = lubricants transportation sector CO2 emissions;
- MMACE = motor gasoline, excluding ethanol, transportation sector CO2 emissions; and
- RFACE = residual fuel oil transportation sector CO2 emissions.

For transportation sector aviation gasoline, distillate fuel oil, jet fuel, lubricants, motor gasoline, and residual fuel oil, EIA calculates state- and national-level petroleum products CO2 emissions, excluding biofuels, as the product of energy consumption, excluding any CO2 emissions sequestered from nonfuel use where applicable, and the corresponding CO2 factor, with unit adjustments:

AVACE = AVACB * AVTCFUS / 1,000,000
DMACE = DMACB * DMTCFUS / 1,000,000
JFACE = JFACB * JFTCFUS / 1,000,000
LUACE = (LUACB * LUTCFUS * (1 - LUNFSUS * LUSQSUS)) / 1,000,000
MMACE = MMACB * MMTCFUS / 1,000,000
RFACE = RFACB * RFTCFUS / 1,000,000

For transportation sector hydrocarbon gas liquids (HGL) CO2 emissions, EIA assumes that propane is the only fuel consumed in the sector, but the consumption data differ depending on the year because of data availability. Pure propane consumption data are available for 2010 forward only. Before 2010, pure propane data are not available and EIA uses liquified petroleum gas (LPG) consumption data. See the SEDS consumption technical notes for more details.

For 2010 forward, HGL CO2 emissions in the transportation sector (HLACE) are equal to propane CO2 emissions in the transportation sector (PQACE), which EIA calculates as the product of propane energy consumption in the transportation sector (PQACB) and the corresponding propane CO2 factor (PQTCFUS), with unit adjustments:

2010 forward:

PQACE = PQACB * PQTCFUS / 1,000,000
HLACE = PQACE

Before 2010, HGL CO2 emissions in the transportation sector (HLACE) are equal to LPG CO2 emissions in the transportation sector (LGACE), which EIA calculates as the product of LPG energy consumption in the transportation sector (LGACB) and the corresponding propane CO2 factor (PQTCFUS), with unit adjustments:

Before 2010:

LGACE = LGACB * PQTCFUS / 1,000,000
HLACE = LGACE

The total aggregate petroleum products, excluding biofuels, CO2 emissions for the transportation sector (PMACE) variable is the sum of all the individual products CO2 emissions in the sector, in million metric tons (MMmt):

PMACE = AVACE + DMACE + HLACE + JFACE + LUACE + MMACE + RFACE

Electric power sector

For the electric power sector, the individual petroleum product CO2 emissions variables in million metric tons are:

- DMEIE = distillate fuel oil, excluding biofuels, electric power sector CO2 emissions;
- JFEIE = jet fuel electric power sector CO2 emissions (through 1982);
- PCEIE = petroleum coke electric power sector CO2 emissions; and
- RFEIE = residual fuel oil electric power sector CO2 emissions.

For each electric power sector fuel, EIA calculates state- and national-level petroleum products CO2 emissions, excluding biofuels, as the product of energy consumption and the corresponding CO2 factor, with unit adjustments:

DMEIE = DMEIB * DMTCFUS / 1,000,000
JFEIE = JFEUB * JFTCFUS / 1,000,000
PCEIE = PCEIB * PCTCFUS / 1,000,000
RFEIE = RFEIB * RFTCFUS / 1,000,000

The total aggregate petroleum products, excluding biofuels, CO2 emissions for the electric power sector (PMEIE) variable is the sum of all the individual products CO2 emissions in the sector, in million metric tons (MMmt):

PMEIE = DMEIE + JFEIE + PCEIE + RFEIE

Total, all sectors

For total energy in all sectors, the individual petroleum product CO2 emissions variables in million metric tons are:

ARTCE = asphalt and road oil total CO2 emissions;
AVTCE = aviation gasoline total CO2 emissions;
DMTCE = distillate fuel oil, excluding biofuels, total CO2 emissions;
HLTCE = hydrocarbon gas liquids total CO2 emissions;
JFTCE = jet fuel total CO2 emissions;
KSTCE = kerosene total CO2 emissions;
LUTCE = lubricants total CO2 emissions;
MMTCE = motor gasoline, excluding ethanol, total CO2 emissions;
OMTCE = other petroleum products, excluding biofuels, total CO2 emissions;
PCTCE = petroleum coke total CO2 emissions; and
RFTCE = residual fuel oil total CO2 emissions.

SEDS calculates total CO2 emissions for each petroleum product, excluding biofuels, as the sum of the sectors:

ARTCE = ARICE
AVTCE = AVACE
DMTCE = DMACE + DMCCE + DMEIE + DMICE + DMRCE
HLTCE = HLACE + HLCCE + HLICE + HLRCE
JFTCE = JFACE + JFEIE
KSTCE = KSCCE + KSICE + KSRCE
LUTCE = LUACE + LUICE
MMTCE = MMACE + MMCCE + MMICE
OMTCE = OMICE
PCTCE = PCCCE + PCEIE + PCICE
RFTCE = RFACE + RFCCE + RFEIE + RFICE

The total aggregate petroleum products, excluding biofuels, CO2 emissions for all sectors (PMTCE) variable is the sum of all the individual products CO2 emissions for all sectors, in million metric tons (MMmt):

PMTCE = ARTCE + AVTCE + DMTCE + HLTCE + JFTCE + KSTCE + LUTCE + MMTCE + OMTCE + PCTCE + RFTCE

Data sources

State-level energy consumption estimates from EIA's State Energy Data System (SEDS) https://www.eia.gov/state/seds/.

U.S.-level: non-combustion use shares, carbon sequestration factors, and CO2 emissions conversion factors from EIA's *Monthly Energy Review* (MER) https://www.eia.gov/totalenergy/data/monthly/.