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.

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 only publishes total aggregate petroleum CO2 emissions data at the state level, and not individual petroleum product CO2 emissions data.

The aggregate petroleum CO2 emissions variables in million metric tons (MMmt) used in SEDS are:

PMACE = all petroleum products, excluding biofuels, CO2 emissions for the transportation sector;
PMCCE = all petroleum products, excluding biofuels, CO2 emissions for the commercial sector;
PMEIE = all petroleum products, excluding biofuels, CO2 emissions for the electric power sector;
PMICE = all petroleum products, excluding biofuels, CO2 emissions for the industrial sector;
PMRCE = all petroleum products, excluding biofuels, CO2 emissions for the residential sector; and
PMTCE = all petroleum products, excluding biofuels, total CO2 emissions.

SEDS calculates aggregate state- and national-level petroleum products, excluding biofuels, CO2 emissions for the residential (PMRCE), commercial (PMCCE), and electric power (PMEIE) sectors as the sum of each petroleum products' CO2 emissions within each sector:

PMRCE = DMRCE + KSRCE + HLRCE
PMCCE = DMCCE + KSCCE + HLCCE + MMCCE + PCCCE + RFCCE
PMEIE = DMEIE + JFEIE + PCEIE + RFEIE

For the industrial (PMICE) and transportation (PMACE) sectors, SEDS sums the CO2 emissions from each individual product in those sectors. When applicable, each individual product removes the CO2 emissions sequestered from nonfuel use:

PMICE = ARICE + DMICE + KSICE + HLICE + LUICE + MMICE + PCICE + RFICE + OMICE
PMACE = AVACE + DMACE + JFACE + HLACE + LUACE + MMACE + RFACE

Total petroleum product CO2 emissions from all sectors (PMTCE) is the sum of all petroleum products total (all sectors) emissions:

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

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/.