

Section 3. Natural gas

The State Energy Data System (SEDS) estimates energy-related carbon dioxide (CO₂) emissions from natural gas, excluding supplemental gaseous fuels, 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 natural gas is combusted, even if the electricity is later consumed in a different state. Similarly, for industrial nonfuel consumption of natural gas, we attribute the carbon stored in products, such as fertilizers, 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 natural gas consumed, in million cubic feet for each primary energy-consuming sector: residential, commercial, industrial, transportation, and electric power. SEDS removes supplemental gaseous fuels (SGF) added to natural gas consumption. These supplemental fuels are introduced into or commingled with natural gas and increase the volume available for disposition. Such fuels include, but are not limited to: synthetic natural gas, propane-air, coke oven gas, refinery gas, biomass gas, air injected for heat content stabilization, and manufactured gas. Because SGF are mostly derived from fossil fuels, which are already accounted for as primary energy consumption in their respective fuel categories, SEDS removes them from total energy consumption in British thermal units (Btu) to eliminate double counting.

The U.S. Energy Information Administration (EIA) collects natural gas 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 natural gas consumption and any industrial and commercial generators greater than 1 megawatt capacity.

For the industrial, commercial, residential, and transportation sectors, SEDS uses data from EIA's *Natural Gas Annual*. We convert physical unit data in short tons into British thermal units (Btu) using state-level conversion factors for the end-use sectors.

We use these state-level natural gas, excluding SGF, variables from the SEDS consumption database in billion Btu:

NNACB	=	natural gas, excluding supplemental gaseous fuels, consumed by the transportation sector;
NNCCB	=	natural gas, excluding supplemental gaseous fuels, consumed by the commercial sector;
NNEIB	=	natural gas, excluding supplemental gaseous fuels, consumed by the electric power sector;
NNICB	=	natural gas, excluding supplemental gaseous fuels, consumed by the industrial sector; and
NNRCB	=	natural gas, excluding supplemental gaseous fuels, consumed by the residential sector.

SEDS assumes that the transportation sector is the only sector that does not consume supplemental gaseous fuels, so the variable is equal to natural gas consumed by the transportation sector (NGACB) used in the SEDS consumption data:

$$\text{NNACB} = \text{NGACB}$$

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>.

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 all non-combustion use of natural gas occurs in the industrial sector to make nitrogenous fertilizers and as chemical feedstocks, such as hydrogen.

EIA's *Monthly Energy Review* (MER) estimates annual U.S.-level non-combustion (nonfuel) use shares of natural gas for 1973 forward for manufacturing and hydrogen production. SEDS estimates nonfuel shares for manufacturing production only, because EIA assumes manufacturing is the only activity that sequesters carbon from natural gas nonfuel use. EIA assumes nonfuel use of natural gas for hydrogen production releases all carbon. SEDS estimates non-combustion shares of natural gas for manufacturing using total natural gas nonfuel use data from EIA, Form EIA-846, *Manufacturing Energy Consumption Survey* (MECS) and SEDS U.S.-level estimates of natural gas, excluding supplemental gaseous fuels, consumption (NNICBUS). For years prior to 1985 (the first year of MECS data), SEDS assumes the 1985 share. The variable for annual share of natural gas used for nonfuel manufacturing (number between 0 and 1), used in SEDS is:

NNNFSUS = natural gas excluding supplemental gaseous fuels,
non-combustion share.

See the *Monthly Energy Review* (MER) Energy overview and Environment sections for more information on the data sources and methods <https://www.eia.gov/totalenergy/data/monthly/>.

Carbon sequestration from non-combustion use

In the non-combustion (nonfuel) use of fossil fuels, some of the carbon is stored (sequestered) in the final product and not emitted. We account for carbon sequestered by sector from nonfuel use by removing it from the final sector CO2 emissions, using an annual factor.

EIA's *Monthly Energy Review* (MER) estimates national-level carbon sequestration factors for nonfuel use. 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 the carbon (none is emitted). EIA's carbon sequestration factor for natural gas used to produce hydrogen is 0 and natural gas used for other industrial manufacturing is 0.44 for all years. The U.S.-level natural gas sequestration factor (number between 0 and 1) variable used in SEDS is:

NNSQSUS = natural gas, excluding supplemental gaseous fuels,
nonfuel carbon sequestration factor.

See the MER Environment section for more information <https://www.eia.gov/totalenergy/data/monthly/>.

Carbon dioxide (CO2) emissions

SEDS calculates natural gas, excluding supplemental gaseous fuels, carbon dioxide (CO2) emissions estimates in million metric tons (MMmt) by sector as the product of the SEDS consumption values, the carbon sequestered by non-combustion use for the industrial sector, and the annual natural gas CO2 emissions factor at https://www.eia.gov/environment/emissions/xls/CO2_coefs_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 natural gas CO2 emissions factor used for all states and sectors in million metric tons CO2 per quadrillion Btu is:

NNTCFUS = natural gas, excluding supplemental gaseous fuels,
CO2 emissions factor for all sectors.

EIA calculates state- and national-level natural gas, excluding supplemental gaseous fuels, CO2 emissions for the residential, commercial, transportation, and electric power sectors as the product of energy consumption and the CO2 factor, with unit adjustments:

NNRCE = NNRCB * NNTCFUS / 1,000,000
NNCCE = NNCCB * NNTCFUS / 1,000,000
NNACE = NNACB * NNTCFUS / 1,000,000
NNEIE = NNEIB * NNTCFUS / 1,000,000

For the industrial sector, SEDS removes the CO2 emissions sequestered from nonfuel use of natural gas manufacturing from the sector total:

NNICE = (NNICB * NNTCFUS * (1 - NNNFSUS * NNSQSUS))
/ 1,000,000

Total natural gas, excluding supplemental gaseous fuels, CO2 emissions from all sectors are the sum of the sectors.

NNTCE = NNRCE + NNCCE + NNICE + NNACE + NNEIE

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/>.