

Section 3. Natural Gas

Physical Units

Eight natural gas data series are used to derive the natural gas consumption estimates in the State Energy Data System (SEDS). Four of these data series are deliveries of natural gas to the end user by State and are used as consumption because actual consumption data at these levels are not available. The sources for the natural gas data are the reports in the *Natural Gas Annual* series published by the Energy Information Administration (EIA) and its predecessors. For 1989 forward these data are available via EIA's Natural Gas Navigator on the Internet. These series, in million cubic feet, for each State are as follows (the two-letter State code is represented by "ZZ" in the following variable names):

- NGCCPZZ = natural gas delivered to the commercial sector (includes gas used by nonmanufacturing organizations, such as hotels, restaurants, retail stores, laundries, and other service enterprises) plus natural gas delivered to other consumers (includes deliveries to municipalities and public authorities for institutional heating and street lighting). Prior to 1996, includes gas used in agriculture, forestry, and fisheries;
- NGEIPZZ = natural gas consumed by the electric power sector;
- NGINPZZ = a portion of the natural gas delivered to the industrial sector (includes gas used as fuel and feedstock in chemical plants and to produce carbon black). Beginning in 1996, includes gas used in agriculture, forestry, and fisheries;
- NGLEPZZ = natural gas consumed as lease fuel;
- NGPLPZZ = natural gas consumed as plant fuel;
- NGPZPZZ = natural gas consumed as pipeline fuel;
- NGRCPZZ = natural gas delivered to the residential sector; and
- NGVHPZZ = natural gas consumed as vehicle fuel.

The U.S. totals of these independent variables are calculated as the sum of the States' values.

The data are combined into the four major end-use sectors used in SEDS as closely as possible. However, natural gas data are collected using different aggregations of users. The industrial sector in SEDS is intended to contain energy used in agriculture, forestry, and fisheries. For natural gas, these categories were reported with commercial use of natural gas through 1995 and in the industrial sector for 1996 forward. These data cannot be separately identified and no adjustment for this end-use inconsistency could be made in SEDS.

The residential sector's consumption of natural gas is represented by the variable for deliveries to the residential sector, NGRCPZZ.

The commercial sector's consumption of natural gas is represented by the variable for deliveries to the commercial sector, NGCCPZZ.

The industrial sector's consumption of natural gas in SEDS, NGICPZZ, is estimated to be the sum of natural gas delivered to the industrial sector, NGINPZZ, natural gas consumed as lease fuel, NGLEPZZ, and natural gas consumed as plant fuel, NGPLPZZ. SEDS contains lease and plant fuel data combined for 1960 through 1982; the combined data series is stored as NGLEPZZ. Beginning in 2001, Federal Offshore natural gas lease fuel for Alabama, Louisiana, and Texas are reported combined. See "Additional Notes" on page 23 for the method of estimating the individual State values.

$$\text{NGICPZZ} = \text{NGINPZZ} + \text{NGLEPZZ} + \text{NGPLPZZ}$$

The transportation sector's consumption of natural gas, NGACPZZ, is the sum of natural gas consumed in pipeline operations, primarily in compressors, NGPZPZZ, and natural gas consumed as vehicle fuel, NGVHPZZ. Prior to 1990, the small amounts of natural gas consumed as vehicle fuel are included in the commercial sector consumption and cannot be identified separately; therefore, NGVHPZZ is zero prior to 1990.

$$NGACPZZ = NGPZPZZ + NGVHPZZ$$

Electric power sector's consumption of natural gas is represented by the data series NGEIPZZ.

The total consumption of natural gas, estimated for each State, is the sum of the consumption by the end-use sectors and for electricity generation:

$$NGTCPZZ = NGRCPZZ + NGCCPZZ + NGICPZZ + NGACPZZ + NGEIPZZ$$

The U.S. consumption estimates for each of the sectors and the U.S. total are calculated as the sum of the States' values.

British Thermal Units (Btu)

Natural gas consumption in physical units contains a small amount of supplemental gaseous fuels (SGF). These 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 Btu stabilization, and manufactured gas.

In calculating natural gas consumption in Btu, the heat content of SGF is not counted because it has already been accounted for in the primary energy sources that produced the gaseous fuels. The Btu consumption of natural gas excluding SGF is a better measure of the use of natural gas as an energy source and allows for the computation of total energy consumption without double-counting the SGF components. A two-stage procedure to compute Btu consumption estimates is described below.

Stage 1 - Natural Gas, including supplemental gaseous fuels

Three factors for each State are used for converting the consumption of natural gas from its physical units of million cubic feet into thousand Btu per cubic foot. Two of these State-level factors are:

NGEIKZZ = The factor for converting natural gas consumed by the electric power sector from physical units to Btu; and

NGTCKZZ = The factor for converting natural gas consumed by all sectors from physical units to Btu.

These two factors are used to derive a third factor, NGTXKZZ, for converting natural gas used by all sectors other than electric power from physical units to Btu:

$$NGTCBZZ = NGTCPZZ * NGTCKZZ$$

$$NGEIBZZ = NGEIPZZ * NGEIKZZ$$

$$NGTXKZZ = (NGTCBZZ - NGEIBZZ) / (NGTCPZZ - NGEIPZZ)$$

Natural gas consumption in Btu for the residential, commercial, industrial, and transportation sectors in each State is calculated by multiplying the physical unit data by the factor NGTXKZZ, such as:

$$NGACBZZ = NGACPZZ * NGTXKZZ$$

$$NGCCBZZ = NGCCPZZ * NGTXKZZ$$

The U.S. consumption estimates in Btu for each of the sectors and the U.S. total are calculated as the sum of the States' Btu values, such as:

$$NGTCBUS = \sum NGTCBZZ$$

$$NGEIBUS = \sum NGEIBZZ$$

$$NGACBUS = \sum NGACBZZ$$

$$NGCCBUS = \sum NGCCBZZ$$

Prior to 1972, conversion factors for natural gas consumed for electricity generation were not collected; therefore, the factor for all natural gas consumed (NGTCKZZ) is used for electric power (NGEIKZZ) and for the other sectors (NGTXKZZ) for 1963 through 1971. Prior to 1963, State-level conversion factors for natural gas consumption were not collected and a standard factor of 1.035 thousand Btu per cubic foot is used for all sectors in all States for 1960 through 1962. The factor for converting natural gas consumption by the electric power sector from cubic feet to Btu in North Dakota for 2003 is not available in the source data and the 2002 North Dakota value is assigned.

Stage 2 - Natural gas, excluding supplemental gaseous fuels

The actual consumption of SGF cannot be measured since once the fuel enters into a pipeline or a distribution system, it is commingled with natural gas and cannot be traced. However, annual data on SGF supplies in physical units are available for each State from 1980 forward in EIA's *Natural Gas Annual*. For all States except North Dakota, this data series is

used to approximate SGF contained in the natural gas delivered to users. See “Additional Note 2” on page 24 for the method of assigning North Dakota SGF supplies to North Dakota and other States for consumption. Unknown quantities of SGF are included in the Btu consumption data for 1979 and earlier years.

NGSFPZZ = supplemental gaseous fuels supplies by State in million cubic feet.

It is assumed that SGF are commingled with natural gas consumed by the commercial, other industrial, residential, and electric power sectors, but are not commingled with natural gas used for lease and plant fuel, pipelines, or vehicle fuel. The estimated consumption of SGF within each sector is calculated using the sector’s natural gas consumption share.

$$\text{NGTZPZZ} = \text{NGCCPZZ} + \text{NGINPZZ} + \text{NGRCPZZ} + \text{NGEIPZZ}$$

$$\begin{aligned} \text{SFCCPZZ} &= \text{NGSFPZZ} * (\text{NGCCPZZ} / \text{NGTZPZZ}) \\ \text{SFINPZZ} &= \text{NGSFPZZ} * (\text{NGINPZZ} / \text{NGTZPZZ}) \\ \text{SFRCPPZZ} &= \text{NGSFPZZ} * (\text{NGRCPZZ} / \text{NGTZPZZ}) \\ \text{SFEIPZZ} &= \text{NGSFPZZ} * (\text{NGEIPZZ} / \text{NGTZPZZ}) \end{aligned}$$

To convert SGF from physical units to Btu, the appropriate natural gas conversion factors are used:

$$\begin{aligned} \text{SFCCBZZ} &= \text{SFCCPZZ} * \text{NGTXKZZ} \\ \text{SFINBZZ} &= \text{SFINPZZ} * \text{NGTXKZZ} \\ \text{SFRCBZZ} &= \text{SFRCPPZZ} * \text{NGTXKZZ} \end{aligned}$$

$$\text{SFEIBZZ} = \text{SFEIPZZ} * \text{NGEIKZZ}$$

Total SGF consumed by State in Btu is equal to the sum of the four sectors with SGF supplies:

$$\text{SFTCBZZ} = \text{SFCCBZZ} + \text{SFINBZZ} + \text{SFRCBZZ} + \text{SFEIBZZ}$$

The U.S. consumption estimates for each of the variables and sectors and the U.S. total are calculated as the sum of the States’ values.

A new set of variables is introduced for consumption of natural gas excluding supplemental gaseous fuels in Btu:

$$\begin{aligned} \text{NNACBZZ} &= \text{NGACBZZ} \\ \text{NNCCBZZ} &= \text{NGCCBZZ} - \text{SFCCBZZ} \\ \text{NNICBZZ} &= \text{NGICBZZ} - \text{SFINBZZ} \\ \text{NNRCBZZ} &= \text{NGRCBZZ} - \text{SFRCBZZ} \\ \text{NNEIBZZ} &= \text{NGEIBZZ} - \text{SFEIBZZ} \\ \text{NNTCBZZ} &= \text{NGTCBZZ} - \text{SFTCBZZ} \end{aligned}$$

The U.S. consumption estimates for each of the sectors and the U.S. total are calculated as the sum of the States’ values.

Additional Calculations

Although SEDS does not use U.S.-level conversion factors for calculating natural gas consumption, these factors are calculated by SEDS for reference and are shown in the natural gas tables in Appendix B, http://www.eia.doe.gov/emeu/states/seds_updates_tech_notes.html:

$$\begin{aligned} \text{NGEIKUS} &= \text{NGEIBUS} / \text{NGEIPUS} \\ \text{NGTCKUS} &= \text{NGTCBUS} / \text{NGTCPUS} \\ \text{NGTXKUS} &= (\text{NGTCBUS} - \text{NGEIBUS}) / (\text{NGTCPUS} - \text{NGEIPUS}) \end{aligned}$$

To produce price and expenditure data, SEDS differentiates between natural gas used in the transportation sector as pipeline fuel, which is not sold and has no price, and natural gas purchased and consumed as vehicle fuel. SEDS also differentiates between natural gas used as lease and plant fuel by the natural gas industry, which is not costed, and natural gas purchased by industrial consumers. Btu values for the price and expenditure tables are calculated in SEDS as follows:

$$\begin{aligned} \text{NGPZBZZ} &= \text{NGPZPZZ} * \text{NGTXKZZ} \\ \text{NGVHBZZ} &= \text{NGVHPZZ} * \text{NGTXKZZ} \\ \text{NGLPPZZ} &= \text{NGLEPZZ} + \text{NGPLPZZ} \\ \text{NGLPBZZ} &= \text{NGLPPZZ} * \text{NGTXKZZ} \end{aligned}$$

The U.S. totals for each series are calculated as the sum of the States’ values.

Additional Notes

- Beginning with 2001 data, Federal Offshore natural gas lease fuel consumption for Alabama, Louisiana, and Texas is reported

combined under “Gulf of Mexico” in the source publication. To estimate each State's portion, data from the U.S. Minerals Management Service on natural gas production for the Eastern Gulf, Central Gulf, and Western Gulf areas are totaled. Alabama's share of the Gulf of Mexico lease fuel consumption is calculated in proportion to the Eastern Gulf's share of the production total; Louisiana's share is the same proportion as the Central Gulf share, and the Texas share is in proportion to the Western Gulf share.

2. In general, SGF supplies are small relative to total natural gas consumption, and are assumed to be a good measure of SGF consumption. The only exception is North Dakota. Since 1985, North Dakota's volume of SGF supplies is significant and sometimes exceeds its total natural gas consumption. SEDS assumes that 10 percent of SGF produced in North Dakota is consumed in the State and the rest is distributed to Iowa, Illinois and Indiana through the Northern Border Pipeline, according to the capacity of the pipeline going into each State. The percentage allocations of the supplemental gaseous fuels supplies in North Dakota are as follows:
 - From 1985 through 1998: North Dakota (10%), Iowa (90%).
 - From 1999 forward: North Dakota (10%), Iowa (62%), Illinois (22%), Indiana (6%).

Data Sources

NGCCPZZ — Natural gas delivered to the commercial sector and to other consumers (municipalities and public authorities for institutional heating and street lighting), including natural gas consumed as vehicle fuel through 1989 and natural gas used in agriculture, forestry, and fisheries through 1995, by State.

- 1960 through 1966: U.S. Department of the Interior, Bureau of Mines, *Mineral Industry Surveys*, “Natural Gas Production and Consumption,” table titled “Number of consumers and volume of natural gas consumed by principal users in the United States,” column “Commercial.”
- 1967 through 1988: EIA, *Historical Natural Gas Annual 1930 Through 2000*, Table 16, http://www.eia.doe.gov/oil_gas/natural_gas/data_publications/historical_natural_gas_annual/hnga_historical.html.
- 1989 forward: EIA, Natural Gas Navigator, http://tonto.eia.doe.gov/dnav/ng/ng_cons_sum_a_EPG0_vcs_mmcf_a.htm and published in the EIA, *Natural Gas Annual*, Tables 26 through 76.

NGEIKZZ — Factor for converting natural gas consumed by the electric power sector from physical units to Btu by State.

- 1960 through 1971: Assumed by the EIA to be equal to the thermal conversion factor for the consumption of natural gas by all users (NGTCKZZ).
- 1972 through 1982: Calculated annually by EIA by dividing the total heat content of natural gas received at steam electric plants 25 megawatts or greater by the total quantity received at those electric plants. The heat contents and quantities received are from the FERC Form 423, “Monthly Report of Cost and Quality of Fuels for Electric Plants.”
- 1983 through 1988: The average heat content of natural gas received at steam electric plants 50 megawatts capacity or larger from FERC Form 423 and published from 1993 forward in Btu per cubic foot in the EIA, *Cost and Quality of Fuels for Electric Utility Plants*, Table 14, http://www.eia.doe.gov/cneaf/electricity/cq/cq_sum.html. Note: For States that reported consumption on EIA-759 but were not large enough to report on FERC Form 423, factors were estimated by using previous years' factors or the factor for total natural gas consumption in the State.
- 1989 forward: Calculated by dividing the total heat content of natural gas received at electric power plants (including electric utilities, nonutility power plants and combined heat-and-power plants) by the total quantity consumed in physical units collected by the EIA on Forms EIA-906, “Power Plant Report,” and the EIA-920, “Combined Heat and Power Plant Report,” and predecessor forms http://www.eia.doe.gov/cneaf/electricity/page/eia906_920.html.

NGEIPZZ — Natural gas consumed by the electric power sector by State.

- 1960 through 1975: Federal Power Commission, News Release, “Power Production, Fuel Consumption, and Installed Capacity Data,” table titled “Consumption of Fuel by Electric Utilities for Production of Electric Energy by State, Kind of Fuel, and Type of Prime Mover,” sum of columns, “steam and gas turbine” and “internal combustion” under column heading “gas.”
- 1976 through 1981: EIA, *Electric Power Annual* (1981), Table 67.
- 1982 through 1986: Unrounded data as published in rounded form in EIA, *Electric Power Annual*, 1986, Table 14.
- 1987: Unrounded data as published in rounded form in EIA, *Electric Power Annual 1988*, Table 13.

- 1988: Unrounded data as published in rounded form in EIA, *Electric Power Annual 1989*, Table 19.
- 1989 forward: EIA, Forms EIA-906, “Power Plant Report,” and EIA-920, “Combined Heat and Power Plant Report,” and predecessor forms http://www.eia.doe.gov/cneaf/electricity/page/eia906_920.html.

NGINPZZ — A portion of the natural gas delivered to the industrial sector, including natural gas used in agriculture, forestry, and fisheries beginning in 1996, by State.

- 1960 through 1966: U.S. Department of the Interior, Bureau of Mines, *Mineral Industry Surveys*, “Natural Gas Production and Consumption,” table titled “Number of consumers and volume of natural gas consumed by principal users in the United States.” Sum of data in columns “Carbon black,” “Refinery fuel,” and “Other industrial fuel” (which includes electric utility fuel) minus data in column “Fuel used at electric utility plants.”
- 1967 through 1992: EIA, *Historical Natural Gas Annual 1930 Through 2000*, Table 16, http://www.eia.doe.gov/oil_gas/natural_gas/data_publications/historical_natural_gas_annual/hnga_historical.html.
- 1993 through 1996: Unpublished data comparable to data contained in the *Natural Gas Annual*, Tables 26 through 76.
- 1997 forward: EIA, Natural Gas Navigator, http://tonto.eia.doe.gov/dnav/ng/ng_cons_sum_a_EPG0_vin_mmcf_a.htm and published in the EIA, *Natural Gas Annual*, Tables 26 through 76.

NGLEPZZ — Natural gas consumed as lease fuel by State (includes natural gas consumed as plant fuel in 1960 through 1990).

- 1960 through 1966: U.S. Department of the Interior, Bureau of Mines, *Minerals Yearbook*, Natural Gas chapter. State data are not available from 1960 through 1966, although U.S. totals are available. State estimates were calculated by apportioning the U.S. totals to the States on the basis of each State’s share of the U.S. total in 1967.
- 1967 through 1982: EIA, *Natural Gas Annual 1994 Volume II*, Table 14.
- 1983 forward: EIA, Natural Gas Navigator, http://tonto.eia.doe.gov/dnav/ng/ng_cons_sum_a_EPG0_vcl_mmcf_a.htm and published in the EIA, *Natural Gas Annual*, Tables 26 through 76.

NGPLPZZ — Natural gas consumed as plant fuel by State.

- 1960 through 1982: Included with natural gas consumed as lease fuel (see NGLEPZZ).
- 1983 forward: EIA, Natural Gas Navigator, http://tonto.eia.doe.gov/dnav/ng/ng_cons_sum_a_EPG0_VCF_mmcf_a.htm and published in the EIA, *Natural Gas Annual*, Tables 26 through 76.

NGPZPZZ — Natural gas consumed as pipeline fuel by State.

- 1960 through 1966: U.S. Department of the Interior, Bureau of Mines, *Mineral Industry Surveys*, “Natural Gas Production and Consumption,” table titled “Number of consumers and volume of natural gas consumed by principal users in the United States,” column “Used as pipeline fuel.”
- 1967 through 1992: EIA, *Natural Gas Annual 1994 Volume II*, Table 14.
- 1993 through 1996: EIA, *Historical Natural Gas Annual 1930 Through 2000*, Table 15. This report is available only via the Internet at http://www.eia.doe.gov/oil_gas/natural_gas/data_publications/historical_natural_gas_annual/hnga.html.
- 1997 forward: EIA, Natural Gas Navigator, http://tonto.eia.doe.gov/dnav/ng/ng_cons_sum_a_EPG0_vgp_mmcf_a.htm and published in the EIA, *Natural Gas Annual*, Tables 26 through 76.

NGRCPZZ — Natural gas delivered to the residential sector, used as consumption, by State.

- 1960 through 1966: U.S. Department of the Interior, Bureau of Mines, *Mineral Industry Surveys*, “Natural Gas Production and Consumption,” table titled “Number of consumers and volume of natural gas consumed by principal users in the United States,” column “Residential.”
- 1967 through 1988: EIA, *Historical Natural Gas Annual 1930 Through 2000*, Table 16, http://www.eia.doe.gov/oil_gas/natural_gas/data_publications/historical_natural_gas_annual/hnga_historical.html.
- 1989 forward: EIA, Natural Gas Navigator, http://tonto.eia.doe.gov/dnav/ng/ng_cons_sum_a_EPG0_vrs_mmcf_a.htm and published in the EIA, *Natural Gas Annual*, Tables 26 through 76.

NGSFPZZ ---- Supplemental gaseous fuels supplies by State.

- 1980 forward: EIA, Natural Gas Navigator, http://tonto.eia.doe.gov/dnav/ng/ng_prod_ss_a_EPG0_ovl_mmcf_a.htm and published in the EIA, *Natural Gas Annual*, Table 8.

NGTCKZZ — Factor for converting natural gas consumed by all users from physical units to Btu by State.

- 1960 through 1962: EIA adopted the thermal conversion factor of 1,035 Btu per cubic foot as estimated by the Bureau of Mines and first published in the *Petroleum Statement, Annual, 1956*.
- 1963 through 1979: EIA adopted the thermal conversion factors calculated annually by the American Gas Association (AGA) and published in *Gas Facts*, an AGA annual.
- 1980 through 1996: EIA, *Historical Natural Gas Annual 1930 Through 2000*, Table 16, http://www.eia.doe.gov/oil_gas/natural_gas/data_publications/historical_natural_gas_annual/hnga.html.
- 1997 forward: EIA, *Natural Gas Annual*, Table 16, http://www.eia.doe.gov/oil_gas/natural_gas/data_publications/natural_gas_annual/nga_historical.html and unpublished revisions.

NGVHPZZ — Natural gas delivered for use as vehicle fuel by State.

- 1960 through 1989: Included in natural gas consumed by the commercial sector (See NGCCPZZ).
- 1990 through 1991: EIA, *Historical Natural Gas Annual 1930 Through 2000*, Table 16, http://www.eia.doe.gov/oil_gas/natural_gas/data_publications/historical_natural_gas_annual/hnga.html.
- 1992 through 2000: EIA, unpublished data from the Office of Coal, Nuclear, Electric and Alternate Fuels (U.S. totals for 1992 forward and State values for 1997 forward) and from the Office of Energy Markets and End Use (State values for 1992 through 1996).
- 2001 forward: EIA, Natural Gas Navigator, http://tonto.eia.doe.gov/dnav/ng/ng_cons_sum_a_EPG0_vdv_mmcfa.htm and published in the EIA, *Natural Gas Annual*, Tables 26 through 76.