

## RESIDENTIAL AND COMMERCIAL/INSTITUTIONAL NATURAL GAS AND LIQUEFIED PETROLEUM GAS (LPG) COMBUSTION

### DESCRIPTION

This source category covers air emissions from natural gas and liquefied petroleum gas (LPG) combustion in the residential and commercial sectors for space heating, water heating, or cooking. LPG includes propane, propylene, butane, and butylenes. The product used for domestic heating is composed primarily of propane. There are three grades of LPG available as heating fuels: commercial-grade propane, engine fuel-grade propane, and commercial-grade butane. This category includes small boilers, furnaces, heaters and other heating units that are not inventoried as point sources. Residential and commercial sectors comprise housing units; wholesale and retail businesses; health institutions; social and educational institutions; and Federal, state and local government institutions (e.g., military installations, prisons, office buildings). In addition, for natural gas combustion, the commercial/institutional sector includes agriculture, forestry, and fishing.

### POLLUTANTS

For LPG, emissions include particulate matter (PM), sulfur dioxide (SO<sub>2</sub>), carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), nitrous oxide (N<sub>2</sub>O), methane and non-methane total organic carbon (TOC).

Natural gas emissions include those listed for LPG as well as volatile organic compounds (VOC), polycyclic aromatic hydrocarbons (7-PAH and 16-PAH), extractable organic matter (EOM), lead, speciated metals, and organic compounds.

### AVAILABLE METHODS

**Activity-Natural gas:** For natural gas, the preferred source for activity information is local distributors. Typically the number of natural gas distributors for an inventory area is well defined so that each distributor can be contacted to obtain separate estimates of residential and commercial deliveries.

An alternative source for natural gas activity data is the state energy office. If an assumption is required to separate residential and commercial consumption, the following resources may be used:

- Contact a small number of local distributors to obtain estimates for the residential and commercial portions of deliveries; or

- The U.S. Census Bureau<sup>1</sup> reports the number of households at state and county levels that use natural gas as their primary space heating fuel. Household data are available from the 1990 census.

If very few households use natural gas, then natural gas deliveries can be assumed to be entirely to the commercial sector.

A second alternative for natural gas activity is the Department of Energy (DOE) Energy Information Administration (EIA).<sup>2</sup> The annual EIA publication titled *State Energy Data Report* provides state-level fuel consumption separately for the residential and commercial/institutional sectors. The *State Energy Data Report* summarizes natural gas consumption from the *Natural Gas Annual*<sup>2</sup> which is compiled from an EIA survey of natural gas deliveries by all U.S. natural gas distributors. EIA does not collect the information necessary to separate natural gas combustion into residential and commercial/institutional consumption, but disaggregates data based on assumptions and statistical methods detailed in the *State Energy Data Report*. The assumptions used by EIA to disaggregate the data are applicable to the national level and may not be correct for the inventory area. To separate *State Energy Data Report* information into residential and commercial/institutional consumption, the following resources may be used:

- Use the EIA data as reported;
- Contact a small number of local distributors to obtain estimates for the residential and commercial portions of deliveries; or
- The U.S. Census Bureau<sup>1</sup> reports the number of households at state and county levels that use natural gas as their primary space heating fuel. Household data are available from the 1990 census.

If very few households use natural gas or LPG, then deliveries can be assumed to be entirely to the commercial sector.

**Activity-LPG:** The state energy office is the preferred source of data for LPG activity. As described for natural gas, information from a small number of local distributors or the U.S. Census Bureau may be used if necessary to estimate the residential and commercial portions of consumption.

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<sup>1</sup> <http://venus.census.gov/cdrom/lookup/CMD=LIST/DB=C90STF3A/LEV=STATE>

<sup>2</sup> <http://www.eia.doe.gov>

An alternative for LPG activity is the EIA *State Energy Data Report* which summarizes LPG consumption from the *Petroleum Supply Annual*.<sup>2</sup> Sales to farm houses are reported under farm use and included in the industrial sector. As noted for natural gas, EIA does not collect the information necessary to separate LPG combustion into residential and commercial/institutional consumption. Use the same resources identified for natural gas to separate *State Energy Data Report* information into residential and commercial/institutional LPG consumption.

**Emission Factors-Natural Gas:** Emission factors are available in Section 1.4 of *AP-42* (EPA, 1998a). Emission factors for natural gas combustion are given for residential furnaces and small boilers (Tables 1.4-1 thru 1.4-4). The emission factor for residential furnaces should be used for residential sources. Commercial/institutional sources will most likely use small boilers; however, combustion types will vary greatly within an inventory area and it is difficult to determine the predominant combustion method. To be conservative, the highest emission factor should be used for commercial sources. PM for natural gas combustion (filterable, condensable, and total) is assumed to be less than 1.0 micrometer in diameter. Therefore, the PM emission factors presented may be used to estimate PM<sub>10</sub>, PM<sub>2.5</sub> or PM<sub>1</sub>. Condensable PM is the particulate matter collected using EPA Method 202 or equivalent. Filterable PM is the particulate matter collected on, or prior to, the filter of an EPA Method 5 or equivalent sampling train. Total PM is the sum of filterable and condensable PM. Additional natural gas combustion emission factors are available for 7-PAH and 16-PAH from *Locating and Estimating Air Emissions from Sources of Polycyclic Organic Matter* (EPA, 1998b) and for EOM from *1990 Emission Inventory of Section 112(c)(6) Pollutants* (EPA, 1998c).<sup>3</sup>

**Emission Factors-LPG:** Emission factors for combustion of LPG in commercial boilers are presented in Table 1.5-1 of Section 1.5 of *AP-42* (EPA, 1998a). The LPG emission factor for PM may be assumed to represent PM<sub>10</sub> emissions. Because no emission factors were located for the combustion of LPG for residential consumption, emission factors for commercial boilers may be used for residential emissions.

## POINT SOURCE ADJUSTMENTS

A portion of the activity data may represent deliveries to larger commercial, institutional, or multi-family facilities that may be inventoried as point sources. Estimated area source activity or emissions should be adjusted by subtracting the activity or emissions attributable to point sources. It is preferable to use activity data when making point source adjustments because emission estimates are not easily comparable due to differences in emission estimation methods or emission factors. If only emissions are available, then it is preferable to subtract pre-control

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<sup>3</sup> See reference section of this abstract for websites.

emission estimates for point sources. See the EIIP Volume III, Chapter 1, Section 4 for methodology to account for point sources in an area source emission inventory.<sup>4</sup>

### **ADJUSTMENTS FOR CONTROLS**

Regulations for emissions from natural gas and LPG combustion are generally applicable to point sources and do not apply to the area sources in this category. Inventory preparers should research rules applying to this source category. If some controls are being used, then refer to EIIP Volume III, Chapter 1, Section 4.2.

### **SPATIAL AND TEMPORAL ALLOCATIONS**

**Natural Gas:** The preferred method for collecting activity information for natural gas consumption is from natural gas suppliers. Activity data may be collected by county or region and by month or season. The first alternative spatial and temporal allocation methods for residential natural gas consumption can be used if activity was collected at the state level.

**Residential Spatial Allocation:** The first alternative method to spatially allocate natural gas consumption is to develop an allocation factor from local and state totals of annual heating degree days and housing units heating with natural gas.

A “heating degree day” is a unit of measure used to indicate how cold it has been over a 24-hour period. Daily heating degree days are calculated as the difference between the base value of 65°F and the mean temperature for the day (mean of the high and low temperatures for the day). Annual heating degree days are the sum of the daily heating degree days. Heating degree data is available from the National Oceanographic and Atmospheric Administration (NOAA).<sup>5</sup>

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<sup>4</sup> <http://www.epa.gov/ttnchief/eiip/techrep.htm#areasrc>

<sup>5</sup> <http://www.noaa.gov> (home page) or <http://www.ncdc.noaa.gov/ol/climate/climateproducts.html#PUBS> (for a list of available data)

Residential Spatial Apportioning Factor =

$$\frac{HDD_{Inventory\ County} * NHU_{Inventory\ County}}{\left[ \sum_{\substack{all\ counties \\ in\ state}} (HDD_{county} * NHU_{county}) \right]}$$

Where:

$HDD_{Inventory\ County}$	=	Annual heating degree days for inventory county
$NHU_{Inventory\ County}$	=	Housing units using natural gas for inventory county
$HDD_{county}$	=	Annual heating degree days for each county in the state
$NHU_{county}$	=	Housing units using natural gas for each county in the state

The U.S. Census Bureau reports the number of households using natural gas as their primary household space heating fuel by state and county.<sup>6</sup>

Alternative spatial apportioning factors for residential emissions include households using natural gas as primary fuel, population data, or total number of households.

**Commercial/Institutional Spatial Allocation:** Commercial/institutional activity may be spatially apportioned based on employment data for SICs 50-99. Employment data may be obtained from the state department of labor or from U.S. Census Bureau Economic Census data.<sup>7</sup> Emissions from commercial/institutional sources that are combusting predominantly for heating purposes may be apportioned based on employment data for SICs 50-99 and heating degree days:

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<sup>6</sup> <http://venus.census.gov/cdrom/lookup/CMD=LIST/DB=C90STF3A/LEV=STATE>

<sup>7</sup> <http://govinfo.kerr.orst.edu/index.html>

Commercial/Institutional Spatial Apportioning Factor =

$$\frac{HDD_{InventoryCounty} * SE_{InventoryCounty}}{\left[ \sum_{\substack{allcounties \\ instate}} (HDD_{County} * SE_{County}) \right]}$$

Where:

$HDD_{Inventory\ County}$	=	Annual heating degree days for inventory county
$SE_{Inventory\ County}$	=	SIC 50-99 employment numbers for inventory county
$HDD_{county}$	=	Annual heating degree days for each county in the state
$SE_{county}$	=	SIC 50-99 employment for each county in the state

**Temporal Allocation:** In addition to space heating, natural gas is often used for cooking and water heating. For ozone and other seasonal inventories, consumption for cooking and water heating may be assumed to be constant through the year, but fuel used for space heating must be apportioned according to heating needs. To separate residential space heating usage from cooking and water heating, contact one representative natural gas company to obtain residential annual deliveries and the lowest monthly deliveries. Deliveries can be in cubic feet, Btus, or dollars. The residential deliveries for the month with the lowest deliveries can be assumed to be only for cooking and water heating. The percentage of natural gas consumption for cooking and water heating may then be calculated:

Annual Non-Space Heating Percent =

$$\frac{12 * \text{Lowest Monthly Fuel Use}}{\text{Annual Fuel Use}} * 100$$

This percentage may be applied to the inventory area's total residential natural gas consumption to calculate the cooking and water heating portion of usage. This portion can be subtracted from the annual total, and the remaining consumption, which is being used for space heating, can be allocated by month using proportions of annual and monthly heating degree days:

$$Residential\ Fuel_{month} = Residential\ Fuel_{annual} * \frac{Heating\ Degree\ Days_{month}}{Heating\ Degree\ Days_{annual}}$$

where:

Residential Fuel <sub>month</sub>	=	Space heating fuel use for inventory month
Residential Fuel <sub>annual</sub>	=	Space heating fuel use for inventory year
Heating Degree Days <sub>month</sub>	=	Heating degree days for inventory month
Heating Degree Days <sub>annual</sub>	=	Heating degree days for inventory year

Commercial natural gas consumption may be allocated using the same method, but with proportions calculated from commercial gas usage.

**LPG:** Use of detailed spatial and temporal activity information is the preferred method for spatial and temporal allocations for LPG combustion. If these data are not available, use the first or second alternative methods for natural gas apportioning.

#### OTHER EMISSION CALCULATION ISSUES

None.

#### REFERENCES

EPA. 1998a. *Compilation of Air Pollutant Emission Factors--Volume I: Stationary Point and Area Sources. Fifth Edition, AP-42*. U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards. (GPO 055-000-00251-7). Research Triangle Park, North Carolina.

EPA. 1998b. *Locating and Estimating Air Emissions from Sources of Polycyclic Organic Matter (EPA-454/R-98-014)*. U. S. Environmental Protection Agency, Air Quality Strategies and Standards Division. Research Triangle Park, North Carolina (<http://www.epa.gov/ttn/chief/pom.html>).

EPA. 1998c. *1990 Emission Inventory of Section 112(c)(6) Pollutants: Polycyclic Organic Matter (POM), 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TDCC), 2,3,7,8-Tetrachlorodibenzofuran (TDCF), Polychlorinated Biphenyl Compounds (PCBs), Hexachlorobenzene, Mercury and Alkylated Lead*. U. S. Environmental Protection Agency, Air Quality Strategies and Standards Division. Research Triangle Park, North Carolina (<http://www.epa.gov/ttncaaa1/t3/meta/m23804.html>).