

State Inventory Tool

User Guide for Estimating Methane and Nitrous Oxide Emissions from Mobile Combustion

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ACKNOWLEDGEMENTS

The SIT was originally developed in conjunction with EPA’s state and local programs to automate the steps states would need to take in developing their own emission estimates in a manner that was consistent with prevailing national and state guidelines. The result was a user-friendly set of eleven modules that help users estimate greenhouse gas emissions and removals at the state level. CGS is supporting updates to the tool to facilitate continuity in state inventory development and improvement work at the state level.

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This section of the User Guide provides instruction on using the Mobile Combustion module of the State Inventory Tool (SIT), and describes the methodology used for estimating greenhouse gas emissions from mobile combustion at the state level.

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1.1 MODULE OVERVIEW

This User Guide accompanies and explains the Mobile Combustion module of the SIT.

Because most state inventories developed today rely heavily on the SIT, User Guides have been developed for each of the SIT modules. These modules contain largely updated methodologies that are, for the most part, consistent with the Inventory of U.S. Greenhouse Gas Emissions and Sinks (EPA 2025a) and related disaggregated data by state. Users can refer to the chapters and annexes of the U.S. Inventory and the Center for Global Sustainability (CGS) FAQ page to obtain additional information not found in the SIT or in the companion User's Guides. Future updates will be consistent with the Center for Global Sustainability at University of Maryland's Greenhouse Gas Inventory and Analysis for the United States (GHGIA) (Desai et al. 2026).

In recent years, EPA also published an annual Inventory of U.S. Greenhouse Gas Emissions and Sinks by State (EPA 2024a) to make available consistent state-level GHG data for all states for use by states, researchers, and the general public. There will be differences between the latest EPA developed state-level estimates and inventory estimates developed by states using the SIT or other tools. Inventories compiled by states may differ for several reasons, and differences do not necessarily mean that one set of estimates is more accurate, or "correct". The CGS plans to continue EPA's initiative to publish an updated annual crosswalk guide to facilitate understanding methodological differences between methods in the current GHGIA, its disaggregation by state and SIT source categories, methods, and data.

The Mobile Combustion module calculates methane (CH_4) and nitrous oxide (N_2O) emissions from highway vehicles, aviation, boats and vessels, locomotives, other non-highway sources, and alternative fuel vehicles. This module also includes optional calculations of carbon dioxide (CO_2) from these sources, which are also calculated in the CO_2 from Fossil Fuel Combustion (CO_2FFC) module. The Mobile Combustion module-based CO_2 calculations are based on VMT data instead of fuel use and provide detail by transportation mode not available in the CO_2FFC module.

For highway vehicles, this module calculates non- CO_2 emissions based on vehicle miles traveled (VMT) for eight types of control technologies: three-way catalyst, early three-way catalyst, oxidation catalyst, non-catalyst, low-emission vehicle, advanced, moderate, and uncontrolled; and for seven classes of vehicles, using the Federal Highway Administration

(FHWA) vehicle classifications. For other transportation types, emissions are based on fuel consumption in gallons or British thermal units (BTU). While the module provides default data for most inputs, if you have access to more comprehensive data sources, they should be used in place of the default data (see Box 1 for suggestions of possible data sources). If using outside data sources, or for a more thorough understanding of the tool, please refer to the following discussion of data requirements and methodology.

Box 1: State Mobile Combustion Data Sources

In-state sources, such as state highway agencies, should be consulted first. Otherwise, default data provided by the Mobile Combustion module may be used.

Although there is virtually no CH_4 in either gasoline or diesel fuel, CH_4 is emitted as a combustion product that is influenced by fuel composition, combustion conditions, and control technologies. Depending on the control technologies used, CH_4 emissions may also result from hydrocarbons passing unburned or partially burned through the engine, and then be affected by any post-combustion control of hydrocarbon emissions, such as catalytic converters. For highway vehicles, the emissions of unburned hydrocarbons, including CH_4 , are generally lowest in uncontrolled engines when the air/fuel ratio is high or “lean,” which means that there is excess oxygen available relative to the quantity of hydrogen and carbon present. However, such conditions favor the formation of nitrogen oxides, which are a major air pollutant and key component in the formation of smog. In modern three-way closed loop catalyst highway vehicles, the lowest emissions are achieved when hydrogen, carbon, and oxygen are present in the ideal combination for complete combustion. Conditions favoring high CH_4 emissions include aggressive driving, low speed operation, and cold start operation. Poorly tuned highway vehicle engines may have a particularly high output of CH_4 .

Emissions are also strongly influenced by the engine type and the fuel combusted. N_2O formation in internal combustion engines is not yet well understood, and data on these emissions are scarce. It is believed that N_2O emissions come from two distinct processes. In the first process, during combustion in the cylinder, N_2O is formed as nitrogen oxide interacts with combustion intermediates such as imidogen (NH) and cyanate (NCO). The N_2O is then removed very rapidly in the post-flame gas by the reaction between N_2O and hydrogen. While a significant amount of N_2O may be formed in the flame, it can only survive if there is very rapid quenching of the flame, which is not common. Thus, only small amounts of N_2O are produced as engine-out emissions.

The second N_2O -forming process occurs during catalytic after-treatment of exhaust gases. The output of N_2O from the catalyst is highly temperature dependent. Prigent and De Soete (1989) showed that as the catalyst warms up after a cold start, N_2O levels increase greatly (to 4.5 times the inlet value) at around 360°C . The emissions then decrease to the inlet level as the catalyst reaches a temperature of 460°C . Above this temperature there is less N_2O exiting the catalyst than entering it. These results demonstrate that N_2O is formed primarily during cold starts of catalyst-equipped vehicles. This explains why N_2O emissions data for the Federal Test Procedure (which includes a cold-start phase) are much higher than data for the U.S. Highway Fuel Economy Test (which does not include a cold start phase).

Emissions of CH_4 and N_2O from non-highway mobile sources have received relatively little study. Non-highway sources include jet aircraft, gasoline-fueled piston aircraft, agricultural and construction equipment, railway locomotives, boats, and ships. Except for aircraft (fueled by jet fuel or gasoline), all these sources are typically equipped with diesel engines.

In 2013, additional updates were made to the mobile combustion module to improve disaggregation of CO_2 estimates, and compliment the CO_2 from Fossil Fuel Combustion module. An explanation of these updates can be found in Section 1.5, “Explanation of Mobile Combustion Module Updates.”

1.1.1 Data Requirements

To calculate GHG emissions from mobile combustion, the data listed in Table 1 are required inputs (again, note that defaults are available for most of these data).

Table 1. Required Data Inputs for the Mobile Combustion Module

Module Worksheet Name	Input Data Required
4a Highway Vehicles - Emission Factors and VMT	CH ₄ and N ₂ O emission factors (g/km traveled) for each type of control technology State total VMT, 1990-present, for all vehicle types
4b Highway Vehicles - Allocating VMT by Model Year	Average annual vehicle mileage accumulation (miles) for each model year in use Age distribution of vehicles (%) in the current year
4c Highway Vehicles - Allocating Control Technology by Model Year	Percentage of vehicles with each control type, 1960-present
5 Aviation Factors and Fuel Consumption	Energy contents (kg/million BTU) for kerosene jet fuel, naphtha jet fuel, and aviation gasoline N ₂ O and CH ₄ emission factors (g/kg fuel) for each type of fuel Aviation fuel consumption ^a (million BTU), 1990-present
6 Marine Factors and Fuel Consumption	Density factors (kg/gal) for residual fuel, distillate fuel, and motor gasoline N ₂ O and CH ₄ emission factors (g/kg fuel) for each type of fuel Marine fuel consumption ^b (gallons), 1990-present
7 Locomotive Factors and Fuel Consumption	Density factors (kg/gal or ton) for residual fuel, diesel fuel, and coal N ₂ O and CH ₄ emission factors (g/kg fuel) for each type of fuel Locomotive fuel consumption (gal or tons), 1990-present
8 Other Non-Highway Factors and Fuel Consumption	Density factors (kg/gal) for diesel and gasoline N ₂ O and CH ₄ emission factors (g/kg fuel) for diesel and gasoline tractors, construction equipment, snowmobiles, and other equipment Fuel consumption (gal), 1990-present, for the above types of equipment
9 Alternative Fuel Vehicles Factors and VMT	CH ₄ and N ₂ O emission factors (g/km traveled) for each type of alternative fuel (methanol, ethanol, LPG, LNG, CNG) State total VMT, 1990-present, for alternative fuel vehicles

^a Default data provided for Kerosene and Naphtha Jet Fuel includes international bunker fuels.

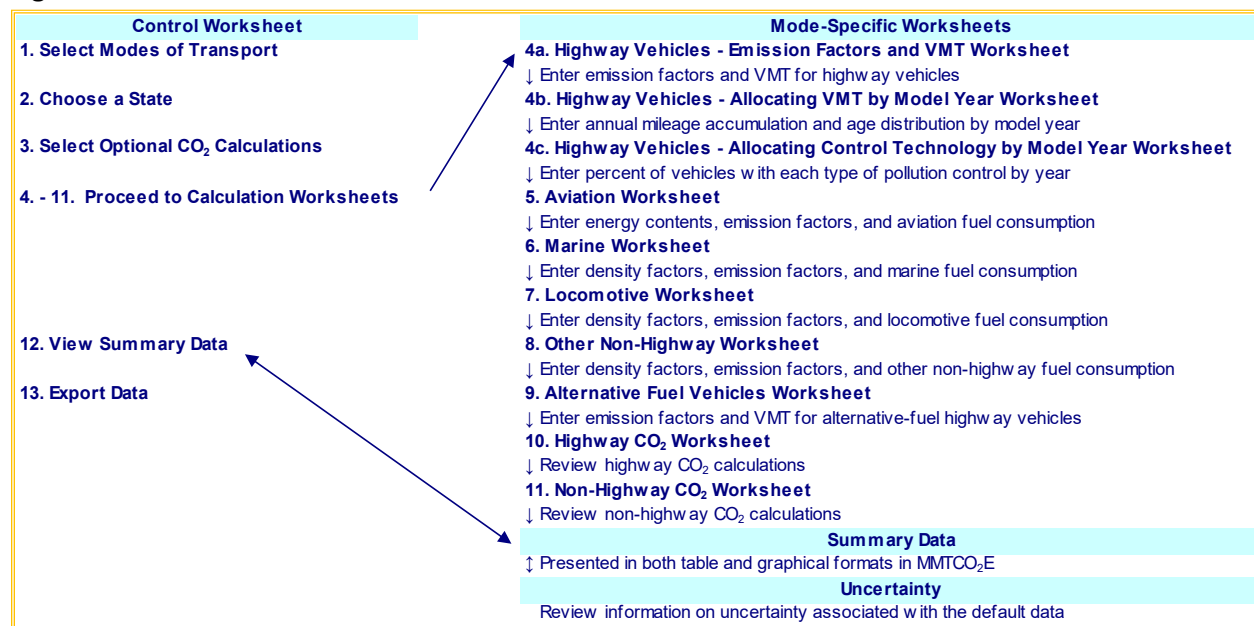
^b Default residual and distillate fuel oil includes international bunker fuels.

1.1.2 Tool Layout

Because there are multiple sections to complete within the Mobile Combustion module, it is important to understand the module's overall design. The layout of the module and the purpose of its worksheets

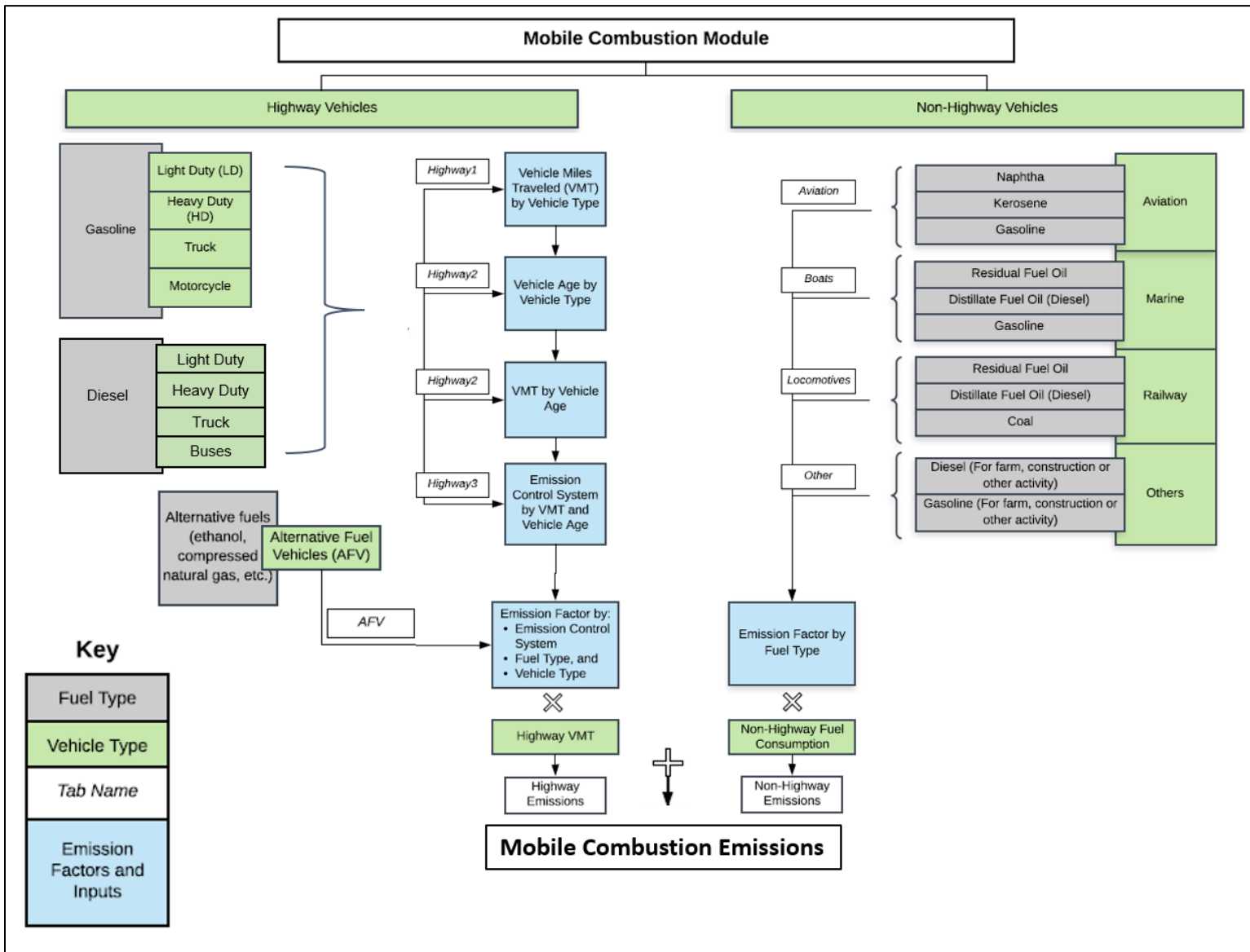
are presented in Figure 1. An overview of the calculation methodology in the Mobile Combustion module is presented in Figure 2.

Figure 1. Flow of Information in the Mobile Combustion Module*



* These worksheets are the primary worksheets used in the Mobile Combustion module; subsequent worksheets are used to populate the default data and are provided for informational purposes only.

Figure 2. Methodology Overview of the Mobile Combustion Module



1.2 METHODOLOGY

This section provides a guide to using the Mobile Combustion module of the SIT to estimate GHG emissions from the following types of vehicles (or transportation modes): highway vehicles, airplanes, boats, trains, non-highway equipment (e.g. tractors and snowmobiles), and alternative-fuel highway vehicles. The module estimates CH₄, N₂O, and CO₂ emissions from mobile sources using activity data, information on the combustion technologies used, and information on the type of emission control technologies employed during and after combustion. Operating conditions during combustion also have an impact on emissions and are reflected in the emission factor. The basic approach for estimating emissions is presented in Equation 1, but variations on this equation will be discussed in subsequent sections, following this general methodology discussion.

Equation 1. General Mobile Combustion Equation

$$\text{Emissions} = \Sigma(\text{EF}_{abc} \times \text{Activity}_{abc})$$

Where,

EF = emissions factor (e.g., grams/kilometer traveled);

Activity = activity level measured in the units appropriate to the emission factor (e.g., miles);

a = fuel type (e.g., diesel or gasoline);

b = vehicle type (e.g., passenger car, light duty truck, etc.); and

c = emission control type (if any)

The Mobile Combustion module automatically calculates emissions once you have entered the required data on the control and transportation mode worksheets. The tool provides default data for all parameters.

There are six general steps involved in estimating emissions using the Mobile Combustion module: (1) select relevant modes of transport; (2) select a state; (3) select an option to conduct optional CO₂ calculations; (4) complete highway vehicle worksheets; (5) complete aviation worksheet; (6) complete marine worksheet; (7) complete locomotives worksheet; (8) complete other non-highway worksheet; (9) complete alternative fuel vehicles worksheet; (10) review highway CO₂ emissions worksheet; (11) review off-road CO₂ emissions worksheet; and (12) review summary information.

Step (1) Select Modes of Transportation

For the emissions calculations to be successful, the user must choose the desired transportation modes. Once these selections are made, information on other modes will automatically drop out of the navigation scheme, saving time and streamlining the analysis.

Step (2) Choose a State

Next, select the state you are interested in evaluating. By selecting a state, the rest of the tool will automatically reset to reflect the appropriate state default data and assumptions for use in subsequent steps of the tool. Figure 3 shows the control worksheet with these two steps completed.

Figure 3. Control Worksheet for the Mobile Combustion Module

State Inventory Tool - CH₄ and N₂O Emissions from Mobile Combustion Module

1. Select those modes of transport you wish to analyze.
Select any or all of the modes listed below.

- ☒ Highway Vehicles
- ☒ Aviation
- ☒ Boats & Vessels
- ☒ Locomotives
- ☒ Other Non-Highway Sources
- ☒ Alternative Fuel Vehicles

2. Choose a State Colorado
This is very important - it selects the correct default variables for your state.

3. Would you like to conduct optional CO₂ calculations?
The CO₂FFC module is responsible for the main CO₂ calculations from the mobile sector, but this module provides a mode-specific analysis if desired.

☒ Yes ☐ No

4. - 11. Proceed with transportation mode-specific analysis. . .

Go!

You will be led through the following series of worksheets using navigational arrows located at the top of each worksheet:

- 4. Highway Vehicle Worksheets
- 4a. Highway Vehicles - Emission Factors and VMT Worksheet
- 4b. Highway Vehicles - Allocating VMT by Model Year Worksheet
- 4c. Highway Vehicles - Allocating Control Technology by Model Year Worksheet
- 5. Aviation Worksheet
- 6. Marine Worksheet
- 7. Locomotive Worksheet
- 8. Other Non-Highway Worksheet
- 9. Alternative Fuel Vehicles Worksheet
- 10. Highway CO₂ Worksheet
- 11. Off-Road CO₂ Worksheet

Step (3) Decide of an Option to Conduct CO₂ Calculations

The CO₂FFC module is responsible for the primary CO₂ emission calculations from the transportation sector, but this module provides an option for users to select a mode-specific analysis if desired. The CO₂FFC module calculates emissions using fuel consumption data, and this module calculates emissions using mode-specific activity data already used in this module.

Selecting “Yes” will allow you to walk through the CO₂ calculations worksheets later in the module. Selecting “No” will allow you to skip steps 10 and 11.

Step (4) Complete the Sector Worksheets for Highway Vehicles

The gray arrow on the control worksheet takes you to the first of the mode-specific worksheets.

The calculation of CH₄ and N₂O emissions from highway vehicles follows a complicated methodology. The module breaks highway vehicles into the following categories: heavy-duty diesel vehicles (HDDV), heavy-duty diesel buses (Hddb), heavy-duty gasoline vehicles (HDGV), light-duty diesel trucks (LDDT),

light-duty diesel vehicles (LDDV), light-duty gasoline trucks (LDGT), light-duty gasoline vehicles (LDGV), and motorcycles (MC). Emissions depend heavily on the type of emissions control technology used in the vehicle; the type of control technology used generally correlates with year of vehicle manufacture.

Due to the number of factors involved, the steps for estimating CH₄ and N₂O emissions from highway vehicles are spread out over three worksheets. The steps necessary to complete these worksheets are as follows: (1) enter emission factors for each control technology and vehicle class; (2) enter the vehicle miles traveled for each vehicle type, by year; (3) distribute vehicle miles traveled by vehicle age and enter age distribution for vehicles on the road, by year; and (4) enter percentage of vehicles with each control technology, by vehicle type. To complete these worksheets, follow the steps as explained below. Keep in mind that the tool provides default data for these parameters.

Step (4a) Highway Vehicles – Emission Factors and VMT Worksheet

1. Enter emission factors for each control technology and vehicle class, for both CH₄ and N₂O on the Highway 4a worksheet.
 - a. Default emission factors for each gas, control technology, and vehicle class are used to populate the tables and are from U.S. EPA (2025), as shown in Figure 4.
 - b. To use your state-specific emission factors, either click the “Clear Data” button and enter your emission factors in the yellow cells or overwrite the default emission factors in the yellow cells. To restore all default emission factors, click the “Restore Default Data” button.
2. Enter the vehicle miles traveled for each vehicle type, by year, from 1990 to the present year. These default data are from FHWA (2026).

Figure 4. Example of the Highway 4a Worksheet

4a. Highway Vehicles - Emission Factors and VMT

Click here for possible data sources.

CH₄ and N₂O emissions from highway vehicles are calculated using four steps: 1) calculate the vehicle miles traveled for each vehicle type; 2) convert the vehicle miles traveled data for use with existing emission factors; 3) distribute vehicle miles traveled by vehicle age, and 4) determine emissions control systems for each vehicle type.

This worksheet provides input cells for vehicle miles traveled (VMT) by vehicle type, and emission factors that are used to calculate CH₄ and N₂O emissions from highway vehicles. For further information, refer to the Mobile Combustion chapter of the User's Guide.

Previous Continue

1. Verify the Emission Factors that are used to calculate CH₄ and N₂O emissions from Highway Vehicles. [Click for Code Help](#)

N₂O Emission Factors (g/mile traveled)

Control Technology	LDGV	LDGT	HDGV	LDGY	LDGT	HDGY	HDGB	MC
Three-way Catalyst (T3)	0.001	0.001	0.006					
Low Emission Vehicle 3	0.001	0.001	0.014					
Three-way Catalyst (T2)	0.005	0.003	0.002					
Low Emission Vehicle 2	0.004	0.006	0.005					
Three-way Catalyst (T1)	0.043	0.087	0.175					
Early 3-way Catalyst (T0)	0.065	0.106	0.213					
Oxidation Catalyst	0.050	0.064	0.132					
Non-Catalyst	0.020	0.022	0.047					0.007
Low Emission Vehicle	0.021	0.022	0.047					
Aftreatment				0.019	0.021	0.043	0.074	
Advanced				0.001	0.001	0.005	0.006	0.018
Moderate				0.001	0.001	0.005	0.006	
Uncontrolled	0.020	0.022	0.050	0.001	0.002	0.005	0.008	0.009

Source: Default values from EPA, 2022. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020.

CH₄ Emission Factors (g/mile traveled)

Control Technology	LDGV	LDGT	HDGV	LDGY	LDGT	HDGY	HDGB	MC
Three-way Catalyst (T3)	0.006	0.009	0.025					
Low Emission Vehicle 3	0.005	0.007	0.041					
Three-way Catalyst (T2)	0.007	0.010	0.030					
Low Emission Vehicle 2	0.007	0.008	0.039					
Three-way Catalyst (T1)	0.027	0.045	0.066					
Early 3-way Catalyst (T0)	0.070	0.078	0.263					
Oxidation Catalyst	0.195	0.152	0.236					
Non-Catalyst	0.170	0.191	0.418					0.067
Low Emission Vehicle	0.010	0.015	0.030					
Aftreatment				0.030	0.029	0.009	0.013	
Advanced				0.000	0.001	0.005	0.007	0.066
Moderate				0.000	0.001	0.005	0.007	
Uncontrolled	0.178	0.202	0.460	0.001	0.001	0.005	0.007	0.090

Source: Default values from EPA, 2022. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020.

2. Enter state-specific data on vehicle miles traveled (VMT) by vehicle type. [Click for Code Help](#)

Enter custom data in the table below, or use the provided default data.

State Total Vehicle Miles Traveled (Millions)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
HDGB	281	287	295	307	317	324	329	343	352	368	405	373	410	417	432	451
HDGY	5,281	5,422	5,887	6,111	6,413	6,856	7,053	7,493	7,749	8,143	8,569	10,125	11,647	12,005	13,022	13,031
HDGV	1,415	1,533	1,525	1,467	1,434	1,473	1,470	1,464	1,506	1,526	1,544	1,512	1,770	1,858	2,006	1,990
LDGT	826	924	1,047	1,114	1,195	1,200	1,237	1,311	1,335	1,407	1,523	1,533	1,762	1,870	1,964	2,039
LDGY	706	851	859	839	812	596	571	569	543	527	535	490	549	565	599	612
LDGT	28,782	33,135	36,826	38,205	38,819	40,696	41,712	43,277	44,250	46,188	49,641	50,953	58,585	62,173	65,297	67,793
LDGV	72,260	70,908	73,144	72,120	72,957	76,149	77,297	79,069	81,659	83,275	83,363	90,150	103,048	106,012	112,458	114,937
MC	445	458	485	487	493	503	508	518	527	543	558	533	597	612	666	688

Step (4b) Highway Vehicles – Allocating VMT by Model Year Worksheet

- Distribute vehicle miles traveled by vehicle age on the Highway 4b worksheet. To account for changes over time in the control technologies used by vehicles, estimates of VMT by vehicle type must be distributed across vehicle model years. To make this apportionment, it is necessary to incorporate the following distributions: (1) vehicle age distribution for any given year, and (2) average annual age-specific individual vehicle mileage accumulation.¹ Vehicle age distribution simply refers to the age distribution of the vehicle fleet in a given year. This distribution may vary by state due to climate and road maintenance practices (e.g., whether roads are salted, which causes faster deterioration of cars), cultural reasons (e.g., higher demand for older “cruisers” in Los Angeles), and/or economic reasons.
 - First, choose the year of the inventory you are performing in the yellow box at the top of the sheet using the arrow buttons, as shown in Figure 5. Default data (U.S. EPA 2025) for the current year’s age distribution is automatically selected as you change the inventory year using the arrow buttons and shown in Table II (in the module); you may

¹ Users can first select the inventory year and then enter the average annual VMT and age distribution for the selected inventory year. If they are interested in only using the default data, they can “Restore default data for all years.”

overwrite it if you wish or clear it by clicking “Clear Age Distribution Entries”; to restore the default data, click “Restore Default Data.”

- Next, enter the mileage accumulation for each vehicle age class/model year in Table I. This table refers to the relative distance vehicles are driven annually, by vehicle type and model year. The vehicle ages are displayed as numbers in ascending order from the inventory year. That is, if the inventory year is 2005, cars built in 2005 are year “0” vehicles, cars built in 2004 are year “1” vehicles, and so forth.
- Enter or change the percent age distribution for vehicles in the inventory year in Table II. This age distribution represents the percent of vehicles on the road in the inventory year, based on the year the vehicle was manufactured. This table is similar to Table I in that if the inventory year is 2005, cars built in 2005 are year “0” vehicles, cars built in 2004 are year “1” vehicles, and so forth.
- Finally, click “Save Data” to save any entered data and populate similar tables for the entire time series. Alternatively, use default data for all years by clicking the “Restore Default Data for All Years” button at the top of the page. This will populate the historical time series based on default data from U.S. EPA (2025). This step creates an emission estimate for each year from 1990 to the current inventory year.

Figure 5. Example of the Highway 4b Worksheet

4b. Highway Vehicles - Allocating VMT by Model Year

CH₄ and N₂O emissions from highway vehicles are calculated using four steps: 1) calculate the annual vehicle miles accumulated for each vehicle type; 2) convert the vehicle miles accumulated data for use with existing emission factors; 3) distribute vehicle miles traveled by vehicle age, and 4) determine emissions control systems for each vehicle type.

This worksheet provides input cells for distributing vehicle miles traveled by vehicle age for highway vehicles. In order to apportion vehicle miles traveled by vehicle age, it is necessary to incorporate the following distributions: (1) annual age-specific vehicle mileage accumulation, and (2) vehicle age distribution. For further information, refer to the Mobile Combustion chapter of the User's Guide.

Click here for possible data sources.

Previous Continue

3. Verify the Age Distribution and Annual Vehicle Mileage Accumulation.

Enter/select inventory year

model year vehicle age, estimates will populate the yellow shaded cells in Table I and Table II.

Enter vehicle mileage accumulation by age class

wish to change any values, simply type your values in the yellow shaded cells. These values will remain constant for all inventory years. Next, review the values for vehicle age distribution in Table II. Again, you may table II may differ among inventory years. If you would like to restore the original values, click on the "Restore Default Data" button. If you would like to clear default data in Table I and Table II, click on the "Clear Age Distribution Entries" button, and your entries for the selected year will be saved.

steps by clicking on the "Restore Default Data for All Years" button. Table I and II will not have values, however values will be populated for all years.

Populate data for other years

Restore Default Data for All Years Clear Age Distribution Entries Save Data Restore Default Data for All Years Clear Mileage Accumulation Entries Clear Default Data for All Years

Table I: Annual Vehicle Mileage Accumulation (miles)

MY	LDGV	LDGT	HGV	LDV	LDOT	HDOV	MC	HDOB
0	14,378	16,252	20,153	14,378	16,252	44,728	9,371	24,727
1	14,106	15,946	20,080	14,106	15,946	45,692	5,004	23,925
2	13,811	15,601	19,977	13,811	15,601	45,575	3,786	23,181
3	13,495	15,224	19,864	13,495	15,224	47,435	3,130	22,275
4	13,163	14,818	19,739	13,163	14,818	45,931	2,708	21,888
5	12,814	14,388	19,621	12,814	14,388	47,685	2,400	20,603
6	12,453	13,932	19,447	12,453	13,932	43,838	2,184	20,027
7	12,080	13,461	19,225	12,080	13,461	44,919	2,005	19,878
8	11,698	12,977	19,140	11,698	12,977	37,523	1,858	18,969
9	11,309	12,484	19,046	11,309	12,484	30,684	1,734	17,312
10	10,916	11,988	18,946	10,916	11,988	33,491	1,631	18,507
11	10,521	11,487	18,842	10,521	11,487	30,280	1,537	17,077
12	10,126	10,991	18,737	10,126	10,991	16,963	1,462	15,997
13	9,733	10,503	18,630	9,733	10,503	22,707	1,387	16,144
14	9,345	10,027	18,524	9,345	10,027	16,990	1,321	16,228
15	8,963	9,568	18,418	8,963	9,568	14,740	1,285	14,332
16	8,590	9,125	18,312	8,590	9,125	10,722	1,218	13,620
17	8,228	8,708	18,206	8,228	8,708	10,185	1,171	15,064
18	7,886	8,304	18,100	7,886	8,304	9,443	1,125	13,654

Table II: Age Distribution, 2020. Each column must add up to 100%.

MY	LDGV	LDGT	HGV	LDV	LDOT	HDOV	MC	HDOB
0	6%	6%	5%	5%	10%	6%	6%	6%
1	6%	6%	5%	3%	9%	6%	6%	6%
2	6%	6%	5%	1%	7%	6%	6%	6%
3	5%	7%	5%	0%	8%	6%	4%	8%
4	6%	7%	5%	1%	6%	6%	4%	8%
5	6%	6%	5%	22%	5%	6%	4%	7%
6	6%	6%	4%	14%	3%	6%	4%	7%
7	6%	4%	3%	12%	3%	4%	3%	4%
8	5%	4%	4%	10%	3%	4%	3%	4%
9	4%	4%	3%	7%	3%	3%	2%	4%
10	4%	3%	1%	6%	1%	2%	2%	4%
11	4%	2%	2%	4%	1%	2%	4%	4%
12	4%	4%	4%	0%	3%	5%	5%	4%
13	5%	4%	3%	3%	5%	6%	6%	4%
14	4%	4%	4%	5%	5%	6%	4%	4%
15	4%	4%	3%	3%	4%	5%	5%	3%
16	3%	4%	3%	1%	4%	3%	4%	3%
17	3%	3%	2%	2%	3%	2%	4%	2%
18	3%	3%	2%	2%	3%	2%	4%	2%

Enter age distribution (%)

This tab automatically calculates a weighted average in Table III, using the values entered in Table I and Table II for each year to get VMT weighted by model year based on total VMT distribution and assumed annual miles traveled per vehicle MY.

Step (4c) Highway Vehicles – Allocating Control Technology by Model Year Worksheet

1. In the Highway 4c worksheet, you will enter percentage of vehicles with each control technology, by vehicle type and model year.
 - a. Enter the distribution of emissions control equipment type by vehicle model year for motorcycles and diesel vehicles in Table I, as shown in Figure 6. The three types of control technology for motorcycles and diesel vehicles are Advanced (A), Moderate (M), Uncontrolled (U), and Aftertreatment (AF). Default data from U.S. EPA (2025) are automatically entered in the yellow cells, but you may overwrite or delete them if you wish, using the “Restore Default Data” buttons above the Table I.
 - b. In Table II of this worksheet, enter the distribution of emissions control equipment type by vehicle model year for gasoline vehicles (LDGV, LDGT, and HDGV), as shown in Figure 8. The types of control technologies used are (in order of most recent employment): three-way catalyst (T3), low-emission vehicle (L3), three-way catalyst (T2), low-emission vehicle (L2), low-emission vehicle (L), three-way catalyst (T1), early three-way catalyst (T0), oxidation catalyst (O), non-catalyst (N), and uncontrolled (U). Defaults are automatically entered in the yellow cells, but you may overwrite or delete them if you wish, using the buttons above the table.

Figure 6. Example of the Highway 4c Worksheet

4c. Highway Vehicles - Allocating Control Technology by Model Year

CH₄ and N₂O emissions from highway vehicles are calculated using four steps: 1) calculate the vehicle miles traveled for each vehicle type; 2) convert the vehicle miles traveled data for use with existing emission factors; 3) distribute vehicle miles traveled by vehicle age, and 4) determine emissions control systems for each vehicle type.

This worksheet provides input cells for determining the control technologies used in highway vehicles. For further information, refer to the Mobile Combustion chapter of the User's Guide.

Click here for possible data sources.

Previous Continue

Enter percentage of vehicles with each control technology by model year for motorcycles and diesel vehicles in Table I. For vehicle types in Table I, each model year, enter a percentage of vehicles with each control technology. For vehicle types in Table II, more than one control technology may be used.

Click for Technology Definitions

Restore Default Data Clear Data

Restore Default Data Clear Data

Table I. Diesel Vehicles & Motorcycles

MY	LDGV(T)	HDGV(B,V)	MC
2020	AF	AF	A
2019	AF	AF	A
2018	AF	AF	A
2017	AF	AF	A
2016	AF	AF	A
2015	AF	AF	A
2014	AF	AF	A
2013	AF	AF	A
2012	AF	AF	A
2011	AF	AF	A
2010	AF	AF	A
2009	AF	AF	A
2008	AF	AF	A
2007	AF	AF	A
2006	A	A	A
2005	A	A	N
2004	A	A	N
2003	A	M	N
2002	A	M	N
2001	A	M	N
2000	A	M	N
1999	A	M	N

Table II. Motor Gasoline Vehicles (within each vehicle category, rows must total to 100%)

MY	LDGV								LDGT								HDGV							
	U	N	O	T0	T1	L	L2	T2	L3	T3	U	N	O	T0	T1	L	L2	T2	L3	T3				
2020						0%	0%	50%	50%											48%	52%			
2019						3%	0%	44%	53%											40%	50%			
2018						7%	0%	42%	52%											35%	52%			
2017						14%	0%	29%	56%											39%	45%			
2016						25%	50%	18%	6%											24%	44%			
2015						33%	50%	11%	6%											31%	5%			
2014						37%	62%	1%												19%	0%			
2013						40%	60%													17%	83%			
2012						41%	59%													17%	83%			
2011						42%	58%													7%	93%			
2010						44%	56%													24%	76%			
2009						0%	43%	57%												45%	55%			
2008						2%	42%	56%												46%	54%			
2007						4%	43%	53%												27%	73%			
2006						18%	35%	47%												50%	50%			
2005						13%	27%	60%												15%	85%			
2004						0%	24%	16%	60%											33%	67%			
2003						0%	35%	2%	12%											85%	14%			
2002						1%	99%													94%	6%			
2001						3%	97%													78%	22%			
2000						44%	56%	0%												93%	7%			
1999						0%	67%	33%	0%											98%	2%			

Enter emissions technology by model year for motorcycles and diesel vehicles

Enter emissions technology by model year for gasoline vehicles

Step (5) through Step (8) Complete the Non-Highway Worksheets

Although mobile sources other than road vehicles account for a significant fraction of total mobile CH₄ and N₂O emissions, they have received relatively little study compared to passenger cars and heavy-duty

trucks. Major sources of pollutant emissions among non-highway vehicles include jet aircraft, gasoline-fueled piston aircraft, agricultural and construction equipment, railway locomotives, boats, and ships. Although each transportation mode has its own worksheet in the module, the method used for estimating emissions for these non-highway sources is almost identical and will be described collectively. The steps below are illustrated in Figure 7 (the Marine worksheet is used as an example; the other worksheets are very similar).

1. Enter energy contents (for aviation, in kg/million Btu) or density factors (for modes other than aviation, in kg/gallon of fuel or ton coal). Select the defaults by clicking the “Restore Default Data” button.
2. Enter CH₄ and N₂O emission factors for each fuel type in g gas/kg fuel.²
3. Enter fuel consumption data from 1990 to present for each type of fuel in million Btu (aviation), gallons of liquid fuel (all modes except aviation), or tons of coal (locomotives).³
4. On the “Other non-highway” worksheet, you must complete the above steps three times: for farm equipment, for construction equipment, and for other non-highway equipment. Non-highway equipment can include small gasoline utility machines, which are motorized machines that are powered by compact gasoline engines, HD machines, which are larger motorized machines and can be powered by gasoline or diesel, and snowmobiles. .

² Default data are from U.S. EPA (2025) (alternative fuels, jet fuel); IPCC/UNEP/OECD/IEA (1997) (all other fuels).

³ Default data are from EIA (2025) (aviation); FHWA (2024) (marine); U.S. EPA (2025) (marine, other non-highway); EIA (2022) (locomotives).

Figure 7. Example of Data Required for Non-Highway Mobile Sources

6. Marine Factors and Fuel Consumption

Click here for possible data sources.

Previous Continue

CH₄ and N₂O emissions from boats are calculated using the following steps: (1) obtain data on fuel consumption for boats; (2) convert the fuel consumption data with existing emission factors and density factors. For further information, refer to the Mobile Combustion chapter of the User's Guide.

1. Verify the factors that are used to calculate CH₄ and N₂O emissions from boats.*

Density Factors (kg/gal)

	Default
Residual Fuel	3.575
Distillate Fuel	3.167
Motor Gasoline	2.839

Source: Default values from EPA, 2021. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019.

N₂O Emission Factors (g/kg fuel)

	Default
Residual Fuel	0.09
Distillate Fuel	0.05
Motor Gasoline	0.02

Source: Default values from EPA, 2021. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019.

CH₄ Emission Factors (g/kg fuel)

	Default
Residual Fuel	0.31
Distillate Fuel	2.01
Motor Gasoline	1.26

Source: Default values from EPA, 2021. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019.

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2. Verify the activity data (fuel consumption, in gallons) used to calculate CH₄ and N₂O emissions from boats.*

Vehicle / Fuel Type	1990	1991	1992	1993	1994	1995	1996	1997	1998
Residual Fuel Oil**	2,276,652,000	1,758,414,000	1,340,766,000	1,360,926,000	1,584,996,000	1,849,888,000	1,637,286,000	893,424,000	717,948,000
Distillate Fuel Oil**	692,599,351	524,954,262	416,149,765	486,944,876	588,543,765	711,330,503	717,092,178	483,630,493	413,958,708
Gasoline	95,910,000	131,907,000	104,142,000	63,031,000	63,582,000	76,132,000	65,224,000	55,933,000	69,641,000

*Default data for this table is not complete for all years for every state. Null values signify unavailable data.
 **Default data provided in this table includes international bunker fuels. Inventory estimates for boats should NOT include international bunker fuels, as emissions from these fuels are Please subtract bunker fuels from this fuel consumption estimate, to calculate the amount of fuel consumed by domestic boats.

Source: Default gasoline values from FHWA, 2020, Highway Statistics. Distillate and residual values derived from EPA, 2020. US Inventory of Greenhouse Gas Emissions and Sinks.

Step (9) Complete the Sector Worksheet for Alternative Fuel Vehicles

The methodology for alternative fuel vehicles is a simplified version of the methodology used for highway vehicles; an emission factor is multiplied by the VMT of each type of vehicle, based on the fuel used. The alternative fuels for which you can calculate emissions are methanol, ethanol, compressed natural gas (CNG), liquefied natural gas (LNG), and liquefied petroleum gas (LPG). The steps below are illustrated in Figure 8.

1. Enter CH₄ and N₂O emission factors for light-duty vehicles, heavy-duty vehicles, and buses for each relevant fuel type. The default data are from U.S. EPA (2025) and are populated by selecting the "Restore Default Data" buttons. If you would like to use different data, you may overwrite the yellow cells or use the "Clear Data" button and enter your state-specific data. Factors are assumed to be the same for all model years.
2. Enter VMT for each vehicle by fuel type from 1990 to present.
3. Check the box to correct for alternative fuel vehicle VMT included in highway vehicle VMT. Default data for highway VMT are assumed to include alternative fuel vehicle miles traveled, therefore this box is checked in its default state and AFV VMT is automatically subtracted from highway VMT. Uncheck this box if the highway VMT data you entered do not include alternative fuel vehicles.

Figure 8. Alternative Fuel Vehicles Worksheet Data Entry

State Inventory Tool - CH₄ and N₂O Emissions from Mobile Combustion Module

File Edit Module Options Type a question for help

9. Alternative Fuel Vehicle Factors and VMT

Click here for possible data

CH₄ and N₂O emissions from Alternative Fuel Vehicle sources are calculated using the following steps: (1) obtain data on vehicle miles traveled (VMT); (2) convert the fuel consumption data with existing emission factors (by vehicle and fuel type), and (3) subtract VMT of Alternative Fuel Vehicles (AFV) from VMT included in highway vehicles. For further information, refer to the Mobile Combustion chapter of the User's Guide.

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1. Verify the Factors that are used to calculate CH₄ and N₂O emissions from alternative fuel vehicles.

Vehicle Type	Fuel Type	N ₂ O Emission Factors (g/mi)	CH ₄ Emission Factors (g/mi)
Light Duty Vehicles	Methanol	0.07	0.02
	CNG	0.05	0.74
	LPG	0.07	0.04
Heavy Duty Vehicles	Ethanol	0.07	0.06
	Methanol	0.18	0.07
	CNG	0.18	1.97
Buses	LNG	0.18	1.97
		18	0.07
		18	0.20
		18	0.07
		18	1.97
		18	0.20

Restore Default Data Clear Data

Enter emission factors

Scroll down sheet for highway VMT offset

2. Enter the activity data (in VMT) used to calculate CH₄ and N₂O emissions from alternative fuel vehicles.

State Total Vehicle Miles Traveled (Millions)

Vehicle Type	Fuel Type	1990	1991	1992	1993	1994	1995	1996	1997	1998
Light Duty Vehicles	Ethanol	-	0	1	1	1	1	1	1	1
	CNG	2	2	2	3	3	5	8	14	15
	LPG	21	20	20	21	19	19	21	22	23
Heavy Duty Vehicles	Ethanol	0	0	0	0	0	0	0	1	1
	Methanol	0	0	0	0	0	0	-	-	-
	CNG	0	0	0	1	1	1	2	3	4

Restore Default Data Clear Data

Enter VMT data

Step (10) Review the CO₂ Emissions Calculation Worksheet for Highway Vehicles

The gray arrows in the upper left of your screen will take you through Steps 10 and 11 if you chose to conduct optional CO₂ calculations in Step 3. The methodology to calculate CO₂ emissions from highway vehicles requires a conversion from the measured activity (vehicle miles traveled) to fuel consumption because CO₂ emission factors are based on gallons of fuel consumed instead of miles driven. Because vehicle miles traveled have already been entered in Step 4, this step only requires the review of established data. Figure 9 shows the automatic CO₂ emissions calculations for highway vehicles.

1. Review the total vehicle miles traveled by highway vehicle type for each calendar year. These total vehicle miles traveled values are automatically summed for each calendar year based on the values entered in Step 4 of this module.
2. Review the total fuel consumption by highway vehicle type for each calendar year. The fuel consumption is calculated based on the total vehicle miles traveled and average vehicle fuel efficiency by vehicle class and model year. Vehicle fuel efficiency values are fixed inputs derived from EPA's Mobile 6.3 model, specifically Appendix G and H (U.S. EPA, 2002).
3. Review the total emissions calculations for each highway vehicle type. Fuel consumption is converted to MMBTU consumption using unit conversion factors and then gasoline consumption is adjusted to account for ethanol blending in gasoline. CO₂ emissions are calculated using unit conversion and default CO₂ emission factors.

Figure 9. Example of the Highway CO₂ Worksheet in the Mobile Combustion Module

State Inventory Tool - CH₄ and N₂O Emissions from Mobile Combustion Module

File Edit Module Options Type a question for help

10. Highway CO₂ Calculations

CO₂ emissions from highway vehicles are calculated using the following steps:

- (1) utilize the data on annual vehicle miles traveled for each vehicle type and model year as determined in step 4 of the module;
- (2) estimate gallons of fuel consumed for each vehicle type and model year with default fuel efficiency data; and
- (3) multiply fuel consumption by the appropriate energy content and carbon coefficient to estimate CO₂ emissions.

Gasoline fuel consumption is adjusted for ethanol. The uncertainty of these emission estimates stems from assumptions associated with the vehicle miles traveled data and uncertainty of the emission factors. The CO₂ emission estimates in this module has greater uncertainty than transportation emission estimates from the Co₂F₂C module because of varying data sources and methodologies. For further information, refer to the Mobile Combustion chapter of the User's Guide.

1. Review the total vehicle miles traveled (VMT, in millions) by highway vehicle type. Values here are based on the entries in Step 4 of the module. A more detailed breakdown is available on the "VMT by MY" sheet.

Fuel type	Vehicle Type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Gasoline	LDGV	17,802	17,131	18,576	19,352	19,850	20,566	21,140	21,899	22,944	23,552	24,146	24,862
Gasoline	LDGT	7,088	8,005	9,360	10,257	10,544	10,938	11,460	12,088	12,521	13,186	13,544	14,025
Gasoline	HDDV	382	403	421	424	421	437	443	447	451	467	452	442
Distillate Fuel Oil	LDGV	172	157	167	171	167	161	156	158	153	149	145	133
Distillate Fuel Oil	LDGT	202	224	267	300	310	326	341	367	379	402	416	423
Distillate Fuel Oil	HDDV	1,642	1,664	1,846	2,022	2,180	2,333	2,444	2,586	2,634	2,774	2,829	2,858
Gasoline	MC	110	112	125	132	136	142	145	149	154	159	159	147

**Default data for this table is not complete for all years for every state. Null values signify unavailable data.*

2. Review the total fuel consumption by vehicle type. Values here are based on the VMT above and default fuel efficiency ratings by vehicle type by model year. A more detailed breakdown is available on the "1W Fuel Consumption by Type" sheet.

Fuel type	Vehicle Type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Gasoline	LDGV	843,686,183	800,550,289	850,900,346	869,568,954	878,531,770	890,574,802	910,014,469	930,107,386	975,597,341	996,076,875	1,017,564,565	1,044,309,086
Gasoline	LDGT	397,081,986	445,536,282	514,465,889	550,167,856	563,827,216	594,044,236	614,461,807	646,651,316	668,288,559	698,973,106	719,621,902	749,915,509
Gasoline	HDDV	60,634,760	63,539,252	65,781,657	65,652,778	66,071,472	66,502,877	66,768,530	66,668,656	68,210,425	68,964,497	66,363,364	60,295,433
Distillate Fuel Oil	LDGV	6,075,947	5,443,846	5,687,544	5,725,090	5,486,167	5,224,517	5,014,981	5,013,284	4,822,392	4,695,646	4,531,983	4,126,273
Distillate Fuel Oil	LDGT	9,141,260	10,123,232	12,061,623	13,550,351	14,041,321	14,738,986	15,401,481	16,595,050	17,188,689	18,153,101	18,816,145	19,101,972
Distillate Fuel Oil	HDDV	276,686,429	278,499,169	306,700,862	333,395,211	356,334,863	378,088,326	392,455,357	411,750,536	425,894,225	436,123,585	442,288,884	445,063,451
Gasoline	MC	2,189,071	2,243,847	2,491,654	2,645,789	2,725,244	2,829,147	2,891,941	2,971,469	3,075,172	3,163,212	3,160,002	2,943,167

3. Review the total emissions calculations. Physical units are converted to MMBTU, gasoline is adjusted to account for ethanol, and the resulting consumption is converted to CO₂.

Convert gallons consumption to MMBTU consumption (MMBTU)

Fuel type	Vehicle Type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Gasoline	LDGV	105,452,274	100,063,796	106,270,043	108,696,063	109,816,846	112,321,763	114,226,809	117,273,423	121,935,668	124,609,609	127,195,571	130,538,636
Gasoline	LDGT	49,635,233	55,689,535	64,308,236	69,770,382	71,228,402	74,255,537	76,807,726	80,831,415	83,536,074	87,371,638	89,952,739	93,738,939
Gasoline	HDDV	7,579,344	7,942,406	8,222,707	8,206,597	8,258,934	8,312,860	8,345,616	8,333,582	8,526,303	8,620,562	8,295,395	7,536,929
Distillate Fuel Oil	LDGV	839,059	751,769	785,423	790,608	757,613	721,481	692,545	692,311	666,170	648,474	625,845	571,200
Distillate Fuel Oil	LDGT	1,262,364	1,397,970	1,685,653	1,871,239	1,939,040	2,035,329	2,126,871	2,291,697	2,364,009	2,506,857	2,598,420	2,637,591
Distillate Fuel Oil	HDDV	38,210,419	38,493,412	42,393,929	46,040,291	49,206,146	52,212,197	54,196,216	56,860,788	59,810,364	60,228,588	61,077,710	61,463,905
Gasoline	MC	274,759	280,491	311,457	330,723	340,405	354,893	361,493	371,436	384,397	397,301	395,100	367,898

Adjust MMBTU consumption for ethanol (MMBTU)

Fuel type	Vehicle Type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Gasoline	LDGV	104,906,332	99,611,862	105,510,602	107,504,390	108,697,597	110,577,569	112,420,947	114,405,625	119,143,675	122,299,611	124,544,297	126,397,021
Gasoline	LDGT	49,417,815	55,434,753	63,846,668	69,006,388	70,502,705	73,155,367	74,320,957	76,909,908	81,620,649	85,761,953	88,091,292	91,995,728
Gasoline	HDDV	7,546,144	7,906,070	8,163,945	8,116,664	8,174,789	8,199,895	8,140,803	8,135,478	8,320,801	8,460,795	8,122,812	7,332,446
Distillate Fuel Oil	LDGV	839,059	751,769	785,423	790,608	757,613	721,481	692,545	692,311	666,170	648,474	625,845	571,200
Distillate Fuel Oil	LDGT	1,262,364	1,397,970	1,685,653	1,871,239	1,939,040	2,035,329	2,126,871	2,291,697	2,364,009	2,506,857	2,598,420	2,637,591

Step (11) Review the CO₂ Emissions Calculation Worksheet for Non-Highway Vehicles

Step 11 conducts similar calculations as those done in Step 10, but for non-highway vehicles, including planes, boats, locomotives, and other off-road vehicles. This step requires users to review established data and automatic calculations in the sheet. Figure 10 shows the automatic CO₂ emissions calculations for non-highway vehicles. Note that calculations for each separate class of non-highway vehicles (planes, boats, locomotives, and other) are separately listed on the page. Scroll down through each section when conducting the following steps.

1. Review the total fuel consumption by non-highway vehicle type for each calendar year.
2. Review the total emissions calculations for each non-highway vehicle type. Fuel consumption was converted to carbon content consumed using unit conversion factors. CO₂ emissions in metric tonnes were calculated using unit conversion and default CO₂ emission factors.
3. Review the total emissions calculations at the bottom of the page, which sums up the emissions of each non-highway fuel type calculated in previous steps.

Figure 10. Example of the Off-road CO₂ Worksheet in the Mobile Combustion Module

CH₄ and N₂O Emissions from Mobile Combustion Module - State Inventory Tool

11. Non-highway CO₂ Calculations

CO₂ emissions from off-road vehicles are calculated using the following steps:

- Utilize consumption data for each mode and fuel type from steps 5 through 8 of the module; and
- Multiply fuel consumption by the appropriate energy content and carbon coefficient to estimate CO₂ emissions.

For further information, refer to the Mobile Combustion chapter of the User's Guide.

1. Review the emissions calculations for each off-road mode.

Aviation

Verify the activity data (fuel consumption, in gallons) used to calculate CO₂ emissions from aviation.

Fuel Type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Jet Fuel, Kerosene**	33,052,510	36,154,513	39,791,599	48,985,193	43,288,939	40,082,764	43,703,068	40,661,068	38,546,664	44,226,757	42,992,100
Jet Fuel, Naphtha**	1,498,487	678,995	1,850,257	1,713,254	1,581,285	1,919,376	306,233	31,254	-	-	-
Aviation Gasoline	840,462	780,894	685,524	624,946	643,399	624,176	624,673	719,741	725,916	983,601	789,100

Convert consumption to carbon content (lbs C)

Fuel Type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Jet Fuel, Kerosene**	1,413,887,227	1,546,581,615	1,701,287,846	2,092,199,239	1,846,998,331	1,709,317,425	1,898,103,710	1,766,964,096	1,674,151,695	1,920,846,469	1,867,251,100
Jet Fuel, Naphtha**	65,019,359	29,461,572	80,282,664	74,338,089	68,611,941	83,281,736	13,287,460	1,356,108	-	-	-
Aviation Gasoline	34,904,378	32,430,507	28,469,820	25,953,988	26,720,344	25,922,017	25,942,687	29,890,857	30,147,309	40,848,962	32,778,100

Convert carbon to emissions (lbs CO₂)

Fuel Type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Jet Fuel, Kerosene**	5,184,253,164.52	5,670,799,255	6,236,955,436	7,671,397,210	6,772,327,213	6,267,497,225	6,959,713,663	6,475,275,918	6,136,556,215	7,043,111,052	6,846,587,100
Jet Fuel, Naphtha**	238,404,317	106,025,763.23	294,369,769	272,672,994	251,577,115	305,366,365	48,720,686	4,972,394	-	-	-
Aviation Gasoline	127,982,720	118,911,660	104,389,338	95,164,622	97,974,595	95,047,397	95,123,184	109,599,809	110,540,132	149,779,526	120,189,100

Convert pounds to metric tons (MTCO₂)

Fuel Type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Jet Fuel, Kerosene	2,351,525	2,572,218	2,829,520	3,479,669	3,071,860	2,842,874	3,156,856	2,937,120	2,784,388	3,194,685	3,105,100
Jet Fuel, Naphtha	100,136	48,999	133,523	123,836	114,113	138,511	22,699	2,255	-	-	-
Aviation Gasoline	58,652	53,937	47,350	43,166	44,440	43,113	43,147	49,713	50,140	67,938	54,100
Total	2,517,715	2,675,154	3,010,393	3,646,671	3,230,413	3,024,488	3,222,103	2,989,089	2,834,528	3,262,623	3,160,100

Boats

Verify the activity data (fuel consumption, in gallons) used to calculate CO₂ emissions from boats.

Fuel Type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Residual Fuel Oil**	-	-	-	-	42,000	-	-	-	-	-	-
Distillate Fuel Oil**	-	-	-	-	15,596	-	-	-	-	-	-
Gasoline	5,750,000	7,318,000	5,647,000	4,757,000	4,855,000	5,986,000	5,250,000	5,416,000	5,497,000	6,021,000	6,301,000

Step (12) Review Summary Information

The information from each sector worksheet is collected on the summary worksheets.

Step (12a) Review CH₄ and N₂O Summary Information

The Steps 4-9 above provide estimates of total CH₄ and N₂O emissions from mobile combustion. This summary worksheet displays results in MTCO₂E, Gg CH₄, and Gg N₂O. Figure 11 shows the summary worksheet that sums the CH₄ and N₂O emissions from all sectors in the Mobile Combustion module. In addition, the results are displayed in graphical format at the right of the summary worksheet.

Figure 11. Example of the Emissions Summary Worksheet in the Mobile Combustion Module

12a. Mobile Source Emissions Summary, CH₄ and N₂O

Return to Control Review discussion of uncertainty associated with these results Continue to CO₂ Summary

Emissions were not calculated for the following mobile sources: Gasoline Highway Vehicles, Diesel Highway Vehicles, Non-Highway Vehicles and Equipment, and Alternative Fuel Vehicles.

Total CH₄ and N₂O Emissions from Mobile Sources (MTCO₂E)

Fuel Type/Vehicle Type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Gasoline Highway	71,073	75,495	73,736	76,582	81,239	80,859	80,000	83,993	84,444	84,444	84,444	71,713	69,214	65,464
Passenger Cars	45,086	44,778	42,242	42,598	44,964	44,208	43,422	44,666	44,666	44,666	44,666	37,220	35,600	33,025
Light-Duty Trucks	24,128	28,640	29,583	31,859	34,186	34,337	34,559	37,110	37,110	37,110	37,110	32,523	31,495	30,272
Heavy-Duty Vehicles	1,784	1,998	1,836	1,848	2,008	1,931	1,944	2,143	2,241	2,256	2,220	1,904	2,053	2,103
Motorcycles	76	79	75	77	81	83	75	74	73	77	75	66	65	64
Diesel Highway	411	418	401	426	471	405	401	524	530	539	542	487	505	505
Passenger Cars	8	7	6	6	6	6	5	5	5	5	5	5	5	5
Light-Duty Trucks	13	14	14	15	16	16	16	18	18	18	19	19	20	20
Heavy-Duty Vehicles	366	373	358	381	424	438	435	475	479	487	490	436	455	455
Heavy-Duty Buses	24	24	22	24	26	25	25	27	27	29	28	27	26	26
Non-Highway	79,306	79,552	71,809	66,069	71,079	76,988	80,185	89,285	97,528	99,317	105,962	99,664	103,445	115,050
Boats	2,251	1,685	3,914	2,158	1,165	1,338	288	368	104	2,555	1,263	928	1,085	816
Locomotives	555	474	454	323	273	314	298	377	454	336	390	440	484	653
Farm Equipment	81	91	95	266	243	286	240	253	79	133	144	260	274	302
Construction Equipment	2,128	2,681	2,797	2,756	5,631	4,192	5,531	2,894	3,928	4,060	3,696	4,662	5,703	9,290
Aircraft	68,033	68,325	58,071	57,505	60,296	65,437	69,408	80,885	81,301	91,178	99,349	90,854	93,324	101,297
Other*	6,258	6,296	6,478	3,061	3,471	5,421	4,420	4,509	11,661	1,085	1,120	2,519	2,577	2,692
Alternative Fuel Vehicles	13	14	13	16	18	16	19	17	16	17	19	22	22	25
Light Duty Vehicles	0	0	0	0	0	0	0	1	1	1	2	2	3	3
Heavy Duty Vehicles	12	13	11	14	13	12	13	13	13	11	12	14	14	16
Buses	1	1	1	2	2	3	6	4	2	4	5	5	6	7
Total	150,803	155,480	145,960	142,893	152,804	158,047	160,686	173,820	182,748	178,149	181,781	171,885	173,187	181,045

* "Other" includes snowmobiles, small gasoline powered utility equipment, heavy-duty gasoline powered utility equipment, and heavy-duty diesel powered utility equipment.

CH₄ Emissions from Mobile Sources (MTCO₂E)

Fuel Type/Vehicle Type	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Gasoline Highway	10,692	10,627	9,722	9,515	9,622	9,075	8,571	8,540	8,199	6,924	6,346	5,085	5,475	5,029
Passenger Cars	6,456	6,031	5,385	5,185	5,259	4,988	4,736	4,710	4,561	4,093	3,725	3,488	3,188	2,850
Light-Duty Trucks	3,515	3,846	3,688	3,713	3,724	3,495	3,292	3,310	3,167	2,399	2,260	2,107	2,011	1,919
Heavy-Duty Vehicles	681	709	609	577	597	549	505	482	434	392	324	256	243	226
Motorcycles	40	41	39	40	42	43	39	38	38	40	38	34	34	33
Diesel Highway	40	41	39	42	46	48	47	51	52	53	53	48	49	49
Passenger Cars	0	0	0	0	0	0	0	0	0	0	0	0	0	0

< > Control Highway1 Highway2 Highway3 Aviation Boats Locomotives Other AFV Highway CO₂ Non-highway CO₂ Summary CO₂ Summary

Step (12b) Review CO₂ Summary Information

If you conducted optional CO₂ calculations in Steps 10-11 above, this summary worksheet collects the CO₂ emission results. The results are displayed in MTCO₂E by mobile source and fuel type from all sectors in the Mobile Combustion module. In addition, the results are displayed in graphical format at the bottom of the summary worksheet.

1.3 UNCERTAINTY

In the upper right-hand corner of the summary worksheet is a button: “Review discussion of uncertainty associated with these results.” By clicking on this button, you are taken to a worksheet that discusses the uncertainty surrounding the activity data and emission factors, and how the uncertainty estimates for this source category affect the uncertainty of the emission estimates for your state.

The uncertainty for the optional CO₂ calculations bears special consideration because these calculations are supplemental to those already contained in the CO₂FFC module. The Mobile module provides an additional level of detail by estimating CO₂ emissions by transportation mode and vehicle type. The CO₂FFC module calculates CO₂ emissions based on total fuel consumption across all modes, while the Mobile module calculates CO₂ emissions based on activity data (such as vehicle miles traveled). It is anticipated that the CO₂FFC module provides a more accurate estimate of total CO₂ emissions in the transportation sector due to less uncertainty in the estimates of total fuel consumption than in the detailed activity data. However, fuel consumption is not otherwise available on the detailed level needed for analysis by mode and vehicle type at the state level.

With highway vehicles, the CO₂ calculations rely on the same disaggregation of total vehicle miles traveled by vehicle type and model year that is used for the non-CO₂ calculations. The module then uses average fuel economy by vehicle type and model year to estimate fuel consumption. Error in the vehicle split, age distribution, or fuel efficiency factors will affect the estimates. The estimates may also differ from the CO₂FFC module because there may be differences between the state where fuel is sold and the state where that fuel is consumed. For example, if a state has lower fuel taxes than its neighbors, interstate travelers may purchase fuel in a low-tax state and consume that fuel in a state with higher fuel taxes, causing a disconnect between reported fuel consumption based on sales and VMT.

The methods for non-highway vehicles are essentially the same as those used in the CO₂FFC module, because they rely on a simple multiplication of fuel consumption times the CO₂ emission factor. The only major source of uncertainty is with the data sources used for disaggregating fuel consumption by type.

Because of these issues, the uncertainty surrounding the CO₂ emissions estimates from gasoline and diesel is particularly high. Caution should be used when interpreting these results.

1.4 EXPLANATION OF MOBILE COMBUSTION MODULE UPDATES

The following updated methodologies were used:

Highway vehicles

1. Utilize the data on annual vehicle miles traveled for each vehicle type and model year as determined in step 4 of the module;
2. Estimate gallons of fuel consumed for each vehicle type and model year with default fuel efficiency data;
3. Adjust gasoline fuel consumption based on the reported amount of ethanol consumed annually by the transportation sector in each state; and
4. Multiply fuel consumption by the appropriate energy content and carbon coefficient to estimate CO₂ emissions.

Non-highway vehicles

1. Utilize consumption data for each mode and fuel type from steps 5 through 8 of the module (aviation, boats & vessels, locomotives, and other non-highway vehicles); and
2. Multiply fuel consumption by the appropriate energy content and carbon coefficient to estimate CO₂ emissions.

By contrast, the CO₂ calculations for highway vehicles require estimating fuel consumption based on vehicle miles traveled by vehicle type—which is itself the product of estimates—because fuel consumption is not otherwise available on the detailed level needed for analysis by mode and vehicle type at the state level.

1.5 REFERENCES

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