

State Inventory Tool

User Guide for Estimating Direct Carbon Dioxide Emissions from Fossil Fuel Combustion

SEPTEMBER 2026

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 CO₂ from Fossil Fuel Combustion (CO₂FFC) module of the State Inventory Tool (SIT), and describes the methodology used for estimating greenhouse gas emissions from CO₂FFC at the state level.

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1.1 MODULE OVERVIEW

This User Guide accompanies and explains the CO₂FFC 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 CO₂FFC module calculates carbon dioxide (CO₂) emissions from the fuel types shown in Table 1 by end-use sector. While the module provides default data for fuel types (depending on availability), users are encouraged to use state-specific data, where available. If using outside data sources, or for a more thorough understanding of the tool, please refer to the following discussion for data requirements and methodology.

1.1.1 Data Requirements

To calculate CO₂ emissions from fossil fuel combustion, the following data are required:

- Fossil fuel energy and non-energy consumption by fuel type and sector (non-energy consumption applies only to the industrial sector and to lubricants in the transportation sector);
- Carbon content coefficients;
- Carbon stored in products; and
- Percentage of carbon oxidized during combustion.

Because the carbon content of fossil fuels varies by fuel type, it is necessary to compile consumption data for each type of fuel (the recommended list of fuels is provided in Table 1). Energy consumption statistics should be collected on an energy basis—preferably in British thermal units (Btu). Statistics providing energy consumption data in other units, such as barrels or tons, may be used, but require

conversion to Btu by using the heat content of the specific fuel. If the conversion to energy units is necessary, the heat contents that were used should be documented (default heat contents are provided in the CO₂FFC module on the “Variable CC’s” tab). Please note that even data given in Btu may be preceded by a prefix indicating order of magnitude (i.e. thousand, million, billion). For a better understanding of the quantity prefixes used with Btu, refer to Box 1.

Box 1: Energy Units

A British thermal unit (Btu) is the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit at or near 39.2° Fahrenheit.

Btu	British thermal unit	1 Btu
MBtu	Thousand Btu	1x10 ³ Btu
MMBtu	Million Btu	1x10 ⁶ Btu
BBtu	Billion Btu	1x10 ⁹ Btu
TBtu	Trillion Btu	1x10 ¹² Btu
QBtu	Quadrillion Btu	1x10 ¹⁵ Btu
Wh	Watt-hour	1 Wh
kWh	Kilowatt-hour	1x10 ³ Wh
MWh	Megawatt-hour	1x10 ⁶ Wh

Box 2: Caution When Using Non-Default Fuel Consumption Data

If you decide to use fuel consumption data that is different from the default, please be aware of the following possible data problems:

In some cases (e.g., the default EIA’s State Energy Consumption, Price, and Expenditure Estimates (EIA/SEDS) data) fuel consumption statistics can include data that is at odds with the methodology used in the CO₂FFC module. For example, SEDS motor gasoline consumption includes ethanol that is blended into gasoline. Ethanol is not a fossil fuel, and thus the default data in the CO₂FFC module has been adjusted to remove the portion of blended gasoline known to be ethanol. If you use external data sources, be sure to determine whether ethanol or other biofuels (e.g., biodiesel) are included in total consumption for any particular fuel type. If so, you must subtract the biofuel portion before entering the data into the CO₂FFC module. State ethanol data can be obtained from EIA/SEDS and are taken into account with default data provided in the CO₂FFC module.

Users should also be aware of double counting. For example, EIA’s SEDS data for industrial coal consumption includes coal used to make synthetic natural gas, which is accounted for in both industrial coal and natural gas consumption data. This double-counting issue has been corrected for in the default dataset contained in the CO₂FFC module; similar adjustments may need to be made to outside data sources. State-specific natural gas data can be obtained from Table 12 of EIA’s Historical Natural Gas Annual EIA (EIA 2001) and Table 8 of EIA’s Natural Gas Annual EIA (EIA 2025b) (and is also provided in the CO₂FFC module).

Table 1. Fuel Types Consumed by Sector

Residential	Commercial	Industrial	Transportation	Electric Power	International Bunker Fuels
Coal	Coal	Coking Coal Other Coal	Coal	Coal	
Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	
Petroleum: Distillate Fuel Kerosene	Petroleum: Distillate Fuel Kerosene	Petroleum: Distillate Fuel Kerosene	Petroleum: Distillate Fuel Hydrocarbon	Petroleum: Distillate Fuel	Petroleum: Jet Fuel, Kerosene

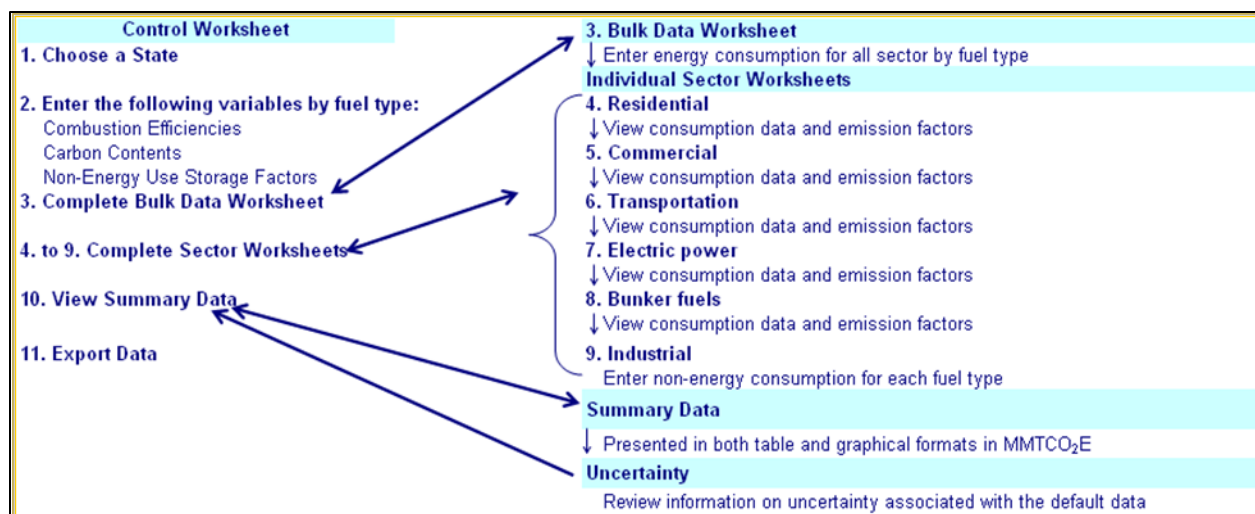
Hydrocarbon	Hydrocarbon	LPG	Gas Liquids	Residual	Distillate Fuel
Gas	Gas	Motor Gasoline	Motor Gasoline	Fuel	Residual Fuel
Liquids	Liquids	Residual Fuel	Residual Fuel	Petroleum	
	Motor	Lubricants	Lubricants	Coke	
	Gasoline	Asphalt/Road	Aviation		
	Residual Fuel	Oil	Gasoline		
		Crude Oil	Jet Fuel,		
		Feedstocks	Kerosene		
		Misc.	Jet Fuel,		
		Petroleum	Naphtha		
		Products			
		Petroleum			
		Coke			
		Pentanes Plus			
		Still Gas			
		Special			
		Naphthas			
		Unfinished Oils			
		Waxes			
		Aviation			
		Gasoline			
		Blending			
		Components			
		Motor Gasoline			
		Blending			
		Components			
Other	Other	Other	Other	Other	

Source: U.S. EPA 2025.

1.1.2 Tool Layout

Because there are multiple steps to complete within the CO₂FFC module, it is important to have an understanding of the module's overall design. The layout of the CO₂FFC module and the purpose of its worksheets are presented in Figure 1.

Figure 1. Flow of Information in the CO₂FFC Module*



* These worksheets are the primary worksheets used in the CO₂FFC module; subsequent worksheets are used to populate the default data and are provided for informational purposes only.

1.2 METHODOLOGY

This section provides a guide to using the CO₂FFC module of the SIT to estimate CO₂ emissions from sectors that consume fossil fuels. Within the CO₂FFC module, these sectors are residential, commercial, industrial, transportation, electric power, and bunker fuels. Because the methodology is similar in all sectors, a general methodology is discussed and specific examples for each sector are provided.

The CO₂FFC module automatically calculates emissions after you enter energy consumption data (and the factors on the control worksheet). The tool provides

default energy consumption data, which comes from the EIA's State Energy Consumption, Price, and Expenditure Estimates (SEDS) (EIA 2025a).¹ Default energy consumption data for vessel bunkering use of distillate fuel oil and residual fuel oil comes from the EIA's Fuel Oil and Kerosene Sales (FOKS) (EIA 2022).² However, other state-specific data may be used if available (see Box 3 for suggestions on where to find data).

The CO₂FFC module follows the general methodology from the Inventory of U.S. Greenhouse Gas Emissions and Sinks disaggregated by U.S. state (EPA 2024). However, SIT includes emissions from the

Box 3: State Energy Data Sources

In-state sources, such as state energy commissions or public utility commissions, should be consulted first. Otherwise, default data provided by the CO₂FFC module may be used. Fossil fuel statistics should be provided on an energy basis (e.g., in Btu).

¹ These data are available at <https://www.eia.gov/state/seds/>.

² These data are available at <https://www.eia.gov/petroleum/fueloilkerosene/>.

non-energy use of fossil fuels within the total emission estimates produced by the CO₂FCC module, while the NIR reports these separately.

This User Guide provides an overview of the estimation methodology used in the CO₂FCC module by walking through the following eleven steps: (1) select a state; (2) fill in the variables used throughout the module; (3) complete the Default State Energy Data Table worksheet; (4) complete the residential sector worksheet; (5) complete the commercial sector worksheet; (6) complete the transportation sector worksheet; (7) complete the electric power sector worksheet; (8) complete the bunker fuels sector worksheet; (9) complete the industrial sector worksheet; and (10) review summary information.

The general equation used to calculate CO₂ emissions from fossil fuel combustion is shown in Equation 1. The equation used for fuels in the industrial end-use sector is similar, but includes the non-energy use of fuels, as shown in Equation 2.

Equation 1. General Emission Equation

$$\begin{aligned} &\text{Emissions (MMTCO}_2\text{E)} = \\ &\text{Consumption (BBtu)} \times \text{Emission Factor (lbs C/BBtu)} \times 0.0005 \text{ short ton/lbs} \times \text{Combustion Efficiency (\%} \\ &\quad \text{as a decimal)} \times 0.9072 \text{ (Ratio of Short Tons to Metric Tons)} \div 1,000,000 \times \\ &\quad (44/12) \text{ (to yield MMTCO}_2\text{E)} \end{aligned}$$

Equation 2. Emission Equation for the Industrial Sector*

$$\begin{aligned} &\text{Emissions (MMTCO}_2\text{E)} = \\ &\quad (\text{Total Consumption (BBtu)} - [\text{Non-Energy Consumption (Bbtu)} \times \text{Storage Factor (\%)}]) \\ &\quad \times \text{Emission Factor (lbs C/MBtu)} \times 1000 \text{ (MBtu to BBtu)} \times \text{Combustion Efficiency (\% as a decimal)} \times \\ &\quad 0.9072 \text{ (Ratio of Short Tons to Metric Tons)} \div 1,000,000 \times (44/12) \\ &\quad \text{(to yield MMTCO}_2\text{E)} \end{aligned}$$

* This equation also applies to lubricants consumed in the transportation end-use sector.

Box 4: Treatment of Biofuels in the SIT

The CO₂ from Fossil Fuel Combustion (CO₂FFC) module relies on EIA's SEDS database for state-level energy consumption data. The SEDS data provides consumption estimates at the state level for ethanol blended into gasoline. Ethanol is not a fossil fuel, and thus the default data in the CO₂FFC module has been adjusted to remove the portion of blended gasoline known to be ethanol.

Ideally, biodiesel blended into diesel fuel and other biofuels blended into heating fuels, etc. should be treated in the same way to avoid counting emissions from non-fossil fuels. This module uses the diesel fuel values *excluding* biodiesel from EIA's SEDS database.

Users are encouraged to adjust the default data and/or enter their own data for diesel and heating oil consumption if more accurate data exists. Users are also encouraged to refer to EIA's documentation for SEDS energy consumption data for more information regarding the fuels included in the CO₂FFC module.

Step (1) Select a State

To begin, 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.

Step (2) Fill in the Variables Used Throughout the Module

Step 2 requires users to select appropriate factors for several key variables necessary for estimating CO₂ emissions from fossil fuel combustion. This can be done by selecting the default data provided or entering user-specified, fuel-specific data for combustion efficiencies, carbon contents, and non-energy use storage factors that will be used throughout the tool. To select the default data, select the "Clear/Select All Defaults" button for each group of variables (combustion efficiency, carbon content, and non-energy use storage factors) or check the default box directly to the right of individual yellow input cells. Note that users may select a default value and later override it if better data becomes available. To enter state-specific data from other sources, enter values directly into the yellow input cells. If the user-specific inputs do not match the default data in the control worksheet (i.e., the default value is overwritten), the text will appear red. See

Figure 2 for locations of the "Clear/Select All Defaults" buttons, individual default check boxes, and yellow input cells. Information for combustion efficiencies, carbon contents, and non-energy use storage factors are discussed individually below.

Figure 2. Control Worksheet for the CO₂FFC Module

State Inventory Tool - Direct CO₂ Emissions from Combustion of Fossil Fuels
Version 2025.1

This module provides default activity data, emission factors, and other relevant metrics for 1990-2022. Emissions Factors are provided for 2023-2025.

1. Choose a state:

2. Fill in the Variables that are used throughout the module. Either Type in the values/percentage or Click the Default Box. Default values are:

Combustion Efficiencies

Fuel	Default Efficiency	Efficiency Used	Use the Default? (check for Yes)
Coal	100.0%		☐
Natural Gas	100.0%		☐
Petroleum	100.0%		☐
HGL	100.0%		☐

Carbon Contents (lbs Carbon/million Btu)

Fuel	Default Carbon Content	Carbon Content Used	Use the Default? (check for Yes)
Asphalt and Road Oil	45.31		☐
Aviation Gasoline	41.57		☐
Distillate Fuel Oil	variable by year		☐
Jet Fuel, Kerosene	variable by year		☐
Jet Fuel, Naphtha	43.51		☐
Kerosene	44.01		☐
HGL (non-industrial)	variable by year		☐
HGL (industrial)	variable by year		☐
Lubricants	44.53		☐
Motor Gasoline	variable by year		☐
Residual Fuel	45.15		☐
Vlac. Petro Products	variable by year		☐
Feedstocks, Naphtha	40.90		☐
Feedstocks, Other Oil	44.47		☐
Portland Cement	40.21		☐
Petroleum Coke	61.39		☐
Still Gas	40.11		☐
Special Naphtha	43.51		☐
Unfinished Oil	variable by year		☐
Waxes	43.64		☐
Residential Coal	variable by year		☐
Commercial Coal	variable by year		☐
Industrial Coking Coal	variable by year		☐
Industrial Other Coal	variable by year		☐
Electric Power Coal	variable by year		☐
Natural Gas	variable by year		☐
Aviation Gasoline Blend Components	41.60		☐

Required Data

Individual Default Data Check Boxes

Buttons:

Navigation:

Combustion Efficiencies

The first type of required data in the control worksheet is combustion efficiency (percent carbon oxidized). This percent is applied if the carbon is not completely oxidized during the combustion of fossil fuels. The fraction oxidized was assumed to be 100 percent for petroleum, coal, natural gas, and LPG based on guidance from IPCC (2006). If values other than module defaults are available for state-level combustion, they should be used and documented. Combustion efficiencies are used throughout the module and are pulled into each sector's worksheet. Figure 3 presents an example of the combustion

efficiency used in the commercial sector worksheet. If the user-specific inputs do not match the default data in the control worksheet (i.e., the default value is overwritten), the text will appear red.

Figure 3. Example of Combustion Efficiency Data Applied in the Commercial Worksheet

State Inventory Tool - CO₂ Emissions from Combustion of Fossil Fuel

File Edit Module Options

4. Commercial Consumption and CO₂ Emissions in Colorado

Click here for possible data sources.

Click here for the bulk data worksheet.

Go to the Control Sheet

Go to the Transportation Sheet

Clear All Data

CO₂ emissions from fossil fuel combustion in the commercial sector are calculated by multiplying energy consumption (in the commercial sector) by carbon content coefficients for each fuel. These quantities are then multiplied by fuel-specific percentages of carbon oxidized during combustion ("combustion efficiency"). The resulting fuel emissions, in pounds of carbon, are then converted to short tons of carbon and million metric tons of carbon equivalent (MMTCE), then to million metric tons of carbon dioxide equivalent (MMTCE_{CO₂E}), and summed. Note that default emission factors are available through 2008. To facilitate emission calculations for later years, the tool utilizes 2008 emission factors as proxies for emission factors in subsequent years (2009 through 2020). Emission factors for 2009 and beyond will be updated as soon as new data become available. For further detail on this method, refer to CO₂FFC Chapter in the User's Guide. Click on the orange "Click here for the bulk data worksheet" button to return to the energy consumption data entry worksheet.

Commercial Sector 1990

Fuel Type	Consumption (Billion Btu)	Emission Factor (lbs C/Million Btu)	Combustion Efficiency (%)	Emissions (short tons carbon)	Emissions (MMTCE)	Emissions (MMTCE _{CO₂E})
Coal	992	57.93	100.0%	28,721	0.026	0.096
Distillate Fuel	2,576	44.43	100.0%	57,219	0.052	0.190
Kerosene	55	43.97	100.0%	1,495	0.001	0.004
LPG	1,000	37.16	100.0%	20,445	0.019	0.068
Motor Gasoline	1,385	42.85	100.0%	23,659	0.022	0.089
Residual Fuel	-	45.11	100.0%	-	0.000	0.000
Natural Gas	66,489	31.87	100.0%	1,059,494	0.961	3.524
Other	-	-	-	-	0.000	0.000

Commercial Sector 1991

Fuel Type	Consumption (Billion Btu)	Emission Factor (lbs C/Million Btu)	Combustion Efficiency (%)	Emissions (short tons carbon)	Emissions (MMTCE)	Emissions (MMTCE _{CO₂E})
Coal	1,143	57.93	100.0%	33,115	0.030	0.110
Distillate Fuel	2,772	44.43	100.0%	61,591	0.056	0.205
Kerosene	60	43.97	100.0%	1,323	0.001	0.004
LPG	1,228	37.16	100.0%	22,774	0.021	0.076
Motor Gasoline	1,755	42.85	100.0%	37,694	0.034	0.125
Residual Fuel	-	45.11	100.0%	-	0.000	0.000
Natural Gas	70,965	31.87	100.0%	1,130,827	1.026	3.762
Other	-	-	-	-	0.000	0.000

Commercial Sector 1992

Fuel Type	Consumption (Billion Btu)	Emission Factor (lbs C/Million Btu)	Combustion Efficiency (%)	Emissions (short tons carbon)	Emissions (MMTCE)	Emissions (MMTCE _{CO₂E})
Coal	1,004	57.95	100.0%	28,897	0.026	0.096
Distillate Fuel	4,016	44.43	100.0%	89,221	0.081	0.297
Kerosene	38	43.97	100.0%	937	0.001	0.003
LPG	1,097	37.16	100.0%	20,375	0.019	0.068
Motor Gasoline	940	42.85	100.0%	19,860	0.018	0.060
Residual Fuel	1	45.11	100.0%	24	0.000	0.000

Combustion Efficiency Data

Carbon Contents

The second type of data required for the control worksheet is the carbon content data, which is also pulled into the individual sector worksheets (depending on whether the fuel type is represented in the sector). The carbon content coefficients used in the CO₂FFC module are from the EPA's *Inventory of GHG Emissions* (EPA 2025). States are encouraged to use more detailed data if it is available and well documented. If the user-specific inputs do not match the default data in the control worksheet (i.e., the default value is overwritten), the text will appear red.

Carbon content represents the maximum amount of carbon emitted per unit of energy released, assuming 100 percent combustion efficiency. Coal has the highest carbon content of the major fuel types, petroleum has roughly 79 percent of carbon per energy as compared to coal, and natural gas has about 57 percent. However, carbon contents also vary within the major fuel types, as noted below:

- Carbon emissions per ton of coal vary considerably depending on the coal's composition of carbon, hydrogen, sulfur, ash, oxygen, and nitrogen. While variability of carbon emissions on a mass basis can be considerable, carbon emissions per unit of energy (e.g., per Btu) vary less.

- The carbon/energy ratio of different petroleum fractions generally correlates with API (American Petroleum Institute) gravity (Marland and Rotty 1984).³ Lighter fractions (e.g., gasoline) usually have less carbon per unit energy than heavier fractions (e.g., residual fuel oil).
- Natural gas is a mixture of several gases, and the carbon content depends on the relative proportions of methane, ethane, propane, other hydrocarbons, CO₂, and other gases, which vary from one gas production site to another.

Non-Energy Use Storage Factors

The third and final type of data requested in the control worksheet is the percent of carbon in each fuel that is stored from non-energy uses. Many fossil fuels have potential non-energy uses. For example, LPG is used for production of solvents and synthetic rubber; oil is used to produce asphalt, naphthas, and lubricants; and coal is used to produce coke, yielding crude light oil and crude tar as by-products that are used in the chemical industry.

However, not all non-energy uses of fossil fuels result in carbon storage. For example, the carbon from natural gas used in ammonia production is oxidized quickly; many products from the chemical and refining industries are burned or decompose within a few years; and the carbon in coke is oxidized when the coke is used. The CO₂FFC module provides national default values for storage factors, but state-level fractions may differ depending on the type of non-energy uses. Where state-specific estimates are available, their use is preferred, if adequate supporting documentation is available. If the user-specific inputs do not match the default data in the control worksheet (i.e., the default value is overwritten), the text will appear red. Data on the non-energy use storage factor is used in the transportation sector and industrial sector worksheets (Step 9).

Step (3) Complete the Default State Energy Data Table Worksheet

The energy consumption data entered in the “Default State Energy Data Table” worksheet feed into the calculation worksheets for each sector. Modifying the consumption data in this worksheet will change the consumption estimates on each sector calculation sheet. The default data will automatically be populated in the yellow cells by sector and fuel type for the selected state. On the bulk data worksheet, presented as an example in Figure 4, the yellow cells indicate where the required energy activity data are entered either manually or automatically from default data. Default data in the yellow cells on this worksheet can be overwritten with state-specific data. To revert to default data for all sectors and fuel types, click on the “Refresh Default Data” button at the top of the worksheet. Click on the “Proceed to Calculation Worksheet” to begin/continue estimating emissions or click on the “Return to Control” button to return to the control worksheet.

³ Variations in petroleum are most often expressed in terms of specific gravity at 15 degrees Celsius. The API gravity, where $\text{API gravity} = 141.5 / \text{specific gravity} - 131.5$, is an indication of the molecular size, carbon/hydrogen ratio, and hence carbon content of a crude oil.

Figure 4. Example of the Required Energy Consumption Data in the Default State Energy Data Table Worksheet

State Inventory Tool - CO₂FFC Module 12.10.2010v1.xls

File Edit Module Options

Default Energy Consumption in Arkansas, billion btu (Bbtu)

The energy consumption data entered in the table below feeds into the calculation worksheets for each sector. Modifying the consumption data below will change the consumption estimates on each sector calculation sheet. To modify the inputs below:

1. Overwrite default data provided in the yellow cells with available state-specific data.
2. To revert back to default data for all sectors and fuel types, click on the "Refresh Default Data" button below.
3. Click on the "Proceed to Calculation Worksheet" to begin/continue estimating emissions.

Go to the Control Sheet

Refresh Default Data Proceed to Calculation Worksheet

Sector and Fuel	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Commercial Coal	4	9	42	16	7	-	-	1	1	1
Commercial Distillate Fuel	1,738	1,501	1,858	2,074	2,225	1,754	1,692	1,575	2,086	1,617
Commercial Kerosene	8	11	29	29	24	26	-	-	-	-
Commercial LPG	468	1	-	-	-	1,187	-	-	-	-
Commercial	745	-	-	-	-	151	150	148	149	148
Commercial	321	26	-	-	-	29,724	31,823	29,852	28,759	28,397
Commercial Residual Fuel	-	-	-	-	-	-	1	-	-	-
Commercial Wood	345	361	380	650	623	628	653	392	343	360
Commercial Other	-	-	-	-	-	-	-	-	-	-
Electric Power Coal	208,863	209,095	213,578	192,682	213,561	229,550	251,704	239,806	247,654	259,094
Electric Power Distillate Fuel	818	742	553	732	711	547	568	584	1,043	974
Electric Power Natural Gas	32,657	28,456	27,891	21,790	25,574	33,377	34,795	25,425	41,357	41,082
Electric Power Petroleum Coke	-	-	-	-	-	-	-	-	-	-
Electric Power Residual Fuel	92	7	0	33	338	97	511	169	627	581
Electric Power Wood	-	-	-	-	-	-	-	-	-	-
Electric Power Other	-	-	-	-	-	-	-	-	-	-
Industrial Asphalt and Road Oil	3,288	3,540	7,793	9,642	7,072	8,266	6,470	6,716	5,702	6,787
Industrial Aviation Gasoline Blending Components	1	0	1	1	26	22	30	38	16	24
Industrial Coal	5,839	6,639	7,076	7,748	8,599	7,784	8,356	6,980	7,004	7,927
Industrial Coking Coal	-	-	-	-	-	-	-	-	-	-
Industrial Crude Oil	-	-	-	-	-	-	-	-	-	-
Industrial Distillate Fuel	13,120	11,743	18,274	18,487	18,380	23,541	19,764	23,285	22,228	20,553
Industrial Feedstocks, Naphtha less than 401 F	575	592	747	695	789	739	8,640	9,669	10,527	9,051
Industrial Feedstocks, Other Oils greater than 401 F	1,246	1,639	1,614	1,673	1,662	1,587	13,153	15,525	14,758	14,622
Industrial Kerosene	94	114	52	76	97	115	52	56	98	76
Industrial LPG	4,358	4,560	4,304	5,048	4,690	5,132	4,760	4,233	3,305	7,069
Industrial Lubricants	1,664	1,489	1,518	1,548	1,616	1,588	1,541	1,628	1,704	1,722
Industrial Misc. Petro Products	228	302	198	188	210	192	1,605	1,762	2,145	2,017
Industrial Other	2,470	2,276	2,304	2,063	2,330	2,330	2,365	2,460	2,376	2,060

Control Default State Energy Data Table Residential Commercial Transportation Electric Power Bunker Fuels Industrial Summary-MMTCO₂E Summary-MMTCE Uncertainty FF

Step (4) through Step (7) View Emission Estimates on Individual Sector Worksheets (Excluding International Bunker Fuels and Industrial Sector)

With the exception of the industrial sector, the worksheets for each sector have the same basic set-up. On the residential sector worksheet, presented as an example in Figure 5, the cells in the first column indicate where the required energy activity data were entered from the bulk data worksheet. These activity data are converted into CO₂ emissions using the factors entered on the control worksheet, the energy consumption data entered on the bulk data worksheet, and the formula presented in Equation 1. Click on the orange "Click here for the bulk data worksheet." button to return to the energy consumption data entry worksheet.

The activity data used to populate the energy consumption input cells is annual fuel consumption based on *primary fuel type* (e.g., coal, petroleum, and natural gas) and *secondary fuel type* (e.g., gasoline, residual oil, natural gas, etc.) by *sector* (e.g., residential, commercial, industrial, transportation, and electric utilities). A list of potential fuel types consumed in each sector is provided in Table 1 and is included in the CO₂FFC module.

The CO₂FFC module calculates emissions for each sector by multiplying consumption by the carbon content and the combustion efficiency to obtain the total carbon oxidized. Then, the total tons of

carbon oxidized are converted into MMTCO₂E, by multiplying by the ratio of metric tons per short ton (0.9072) to obtain metric tons and dividing by 10⁶ and multiplying by 44/12 to express emissions in MMTCO₂E (Equation 1).

Figure 5. Example of the Required Energy Data Applied in the Residential Worksheet

State Inventory Tool - CO₂ Emissions from Combustion of Fossil Fuel

File Edit Module Options

3. Residential Consumption and CO₂ Emissions in Colorado

Click here for possible data sources.

Click here for the bulk data worksheet.

Go to the Control Sheet

Go to the Commercial Sheet

Clear All Data

CO₂ emissions from fossil fuel combustion in the residential sector are calculated by multiplying energy consumption (in the residential sector) by carbon content coefficients for each fuel. These quantities are then multiplied by fuel-specific percentages of carbon oxidized during combustion ("combustion efficiency"). The resulting fuel emission values, in pounds of carbon, are then converted to short tons of carbon and million metric tons of carbon equivalent (MMTCE), then to million metric tons of carbon dioxide equivalent (MMTCO₂E), and summed. Note that default emission factors are available through 2008. To facilitate emission calculations for later years, the tool utilizes 2008 emission factors as proxies for emission factors in subsequent years (2009 through 2020). Emission factors for 2009 and beyond will be updated as soon as new data become available. For further detail on this method, refer to the CO₂FCC Chapter in the User's Guide. Click on the orange "Click here for the bulk data worksheet." button to return to the energy consumption data entry worksheet.

According to the methods developed by the International Panel on Climate Change, CO₂ emissions from the combustion of biogenic sources (e.g., fuel wood) are not counted in greenhouse gas inventories, provided that those sources are harvested on a sustainable basis. The carbon in wood fuel was originally removed from the atmosphere by photosynthesis, and under natural conditions, it would cycle back to the atmosphere eventually as CO₂ due to degradation processes. For processes with CO₂ emissions, if the emissions are from biogenic materials and the materials are grown on a sustainable basis, then those emissions are considered to close the loop in the natural carbon cycle.

Residential Sector 1990						
Fuel Type	Consumption (Billion Btu)	Emission Factor (lbs C/Million Btu)	Combustion Efficiency (%)	Emissions (short tons carbon)	Emissions (MMTCE)	Emissions (MMTCO ₂ E)
Coal	249	57.93	100.0%	7,880	0.007	0.024
Distillate Fuel	180	44.43	100.0%	3,958	0.003	0.012
Kerosene	127	43.97	100.0%	2,782	0.003	0.009
LPG	6,136	27.86	100.0%	14,081	0.012	0.379
Natural Gas	92,991	31.87	100.0%	1463,057	1.233	4.987
Other	-	-	-	-	0.000	0.000

Residential Sector 1991						
Fuel Type	Consumption (Billion Btu)	Emission Factor (lbs C/Million Btu)	Combustion Efficiency (%)	Emissions (short tons carbon)	Emissions (MMTCE)	Emissions (MMTCO ₂ E)
Coal	251	57.93	100.0%	7,263	0.007	0.024
Distillate Fuel	127	44.43	100.0%	2,811	0.003	0.009
Kerosene	136	43.97	100.0%	3,000	0.003	0.010
LPG	6,840	27.86	100.0%	127,098	0.105	0.423
Natural Gas	100,394	31.87	100.0%	1,596,349	1.450	5.371
Other	-	-	-	-	0.000	0.000

Residential Sector 1992						
Fuel Type	Consumption (Billion Btu)	Emission Factor (lbs C/Million Btu)	Combustion Efficiency (%)	Emissions (short tons carbon)	Emissions (MMTCE)	Emissions (MMTCO ₂ E)
Coal	220	57.95	100.0%	6,341	0.006	0.021
Distillate Fuel	104	44.43	100.0%	2,304	0.002	0.008
Kerosene	209	43.97	100.0%	4,601	0.004	0.015
LPG	6,119	27.86	100.0%	15,671	0.013	0.379
Natural Gas	96,440	31.87	100.0%	1,536,779	1.294	5.102
Other	-	-	-	-	0.000	0.000

Click here to begin Default State Energy Data Table Residential Commercial Transportation Electric Power Bunker Fuels Industrial Summary-MMTCO₂E Summary-MMTCE Uncertainty

Step (8) View Estimates on Bunker Fuels Worksheet

Emissions from international bunker fuels are calculated in step 7. Consumption data for international bunker fuels comes from EIA SEDS (EIA 2025a). International bunker fuels are fuels used in marine and aviation transport originating in the United States with international destinations. According to the IPCC Guidelines, emissions from international transport should be reported separately as a memo item, instead of allocating them to a particular country.

Step (9) Complete Non-Energy Use Activity Data on the Industrial Sector Worksheet

The industrial worksheet is unique because both total energy consumption and total non-energy consumption are required as inputs to calculate CO₂ emissions, shown in Figure 6 (input cells are shown in green). Including activity data on non-energy use allows calculation of the amount of carbon from these fuels that is stored in non-energy products for a significant period of time (i.e., more than 20 years). The CO₂FCC module estimates carbon stored in non-energy uses for each state by multiplying the total number of Btu consumed by the default percent of that fuel type that is used for non-energy

purposes, and then by a storage factor (i.e., the amount of carbon in non-energy uses that typically remains stored for longer than 20 years, entered in Step 2). This non-energy consumption is then subtracted from the total consumption to yield the net combustible consumption. From this point forward, the industrial worksheet functions in the same manner as the other sector worksheets. The net combustible consumption is multiplied by the carbon content and the combustion efficiency to obtain the total carbon oxidized. Then, the total tons of carbon oxidized are converted into MMTCO₂E, by multiplying by the ratio of metric tons per short ton (0.9072) to obtain metric tons and dividing by 10⁶ and multiplying by 44/12 to express emissions in MMTCO₂E (Equation 2). Click on the orange "Click here for the bulk data worksheet." button to return to the energy consumption data entry worksheet.

Figure 6. Example of Energy and Non-Energy Consumption Data Applied in the Industrial Worksheet

State Inventory Tool - CO₂ Emissions from Combustion of Fossil Fuel

File Edit Module Options

A B C D E F G H I J K L M N O P Q R S

8. Industrial Consumption and CO₂ Emissions in Colorado

Click here for possible data sources.

Click here for the bulk data worksheet.

CO₂ emissions from fossil fuel combustion in the industrial sector are calculated by first subtracting non-energy consumption multiplied by carbon storage factors from the energy consumption for each fuel type. The resulting combustible consumption for each fuel is then multiplied by a carbon content coefficient and by the percentage of carbon oxidized during combustion ("Combustion efficiency"). The resulting fuel emissions, in pounds of carbon, are then converted to short tons of carbon and million metric tons of carbon equivalent (MMTCE), then to million metric tons of carbon dioxide equivalent (MMTCO₂E), and summed. Note that default emission factors are available through 2008. To facilitate emission calculations for later years, the tool utilizes 2008 emission factors as proxies for emission factors in subsequent years (2009 through 2020). Emission factors for 2009 and beyond will be updated as soon as new data become available. For further detail on this method, refer to CO₂FFC Chapter in the User's Guide. Click on the orange "Click here for the bulk data worksheet." button to return to the energy consumption data entry worksheet.

Go to the Control Sheet

Go to the MMTCO₂E Summary Sheet

Check All Boxes

Clear All Data

Industrial Sector 1990

☒ Default Non-Energy Consumption Data?

	Total	Non-Energy		Net combustible					
	Consumption (Billion Btu)	Consumption (Billion Btu)	Storage Factor (%)	Consumption (Billion Btu)	Emission Factor (lbs C/Million Btu)	Combustion Efficiency (%)	Emissions (short tons carbon)	Emissions (MMTCE)	Emissions (MMTCO ₂ E)
7 Fuel Type									
8 Coking Coal	-	-	100%	-	0.00	100.0%	-	0.000	0.000
9 Other Coal	15,383	77	0%	15,383	57.82	100.0%	444,709	0.403	1,479
10 Asphalt and Road Oil	21,614	21,614	100%	-	45.27	100.0%	-	0.000	0.000
11 Aviation Gasoline Blending	-	-	0%	1	41.56	100.0%	25	0.000	0.000
12 Crude Oil	-	-	0%	-	44.42	100.0%	-	0.000	0.000
13 Distillate Fuel	15,739	101	50%	15,749	44.43	100.0%	349,867	0.317	1,184
14 Feedstocks, Naphtha less than 40°F	-	-	50%	-	40.86	100.0%	-	0.000	0.000
15 Feedstocks, Other Oils greater than 40°F	-	-	50%	-	44.43	100.0%	-	0.000	0.000
16 Kerosene	103	-	0%	103	43.97	100.0%	2,262	0.002	0.008
17 LPG	3,533	2,459	50%	2,096	37.46	100.0%	29,260	0.036	0.131
18 Lubricants	1,481	1,481	5%	1,347	43.97	100.0%	29,625	0.027	0.099
19 Motor Gasoline	2,115	-	0%	2,115	42.82	100.0%	45,728	0.041	0.152
20 Motor Gasoline Blending	-	-	-	-	42.83	100.0%	-	0.005	0.019
21 Components	273	-	0%	273	44.42	100.0%	-	0.000	0.000
22 Misc. Petro Products	-	-	-	-	41.34	100.0%	-	0.000	0.000
23 Petroleum Coke	1,732	206	50%	1,689	63.34	100.0%	51,793	0.047	0.172
24 Pentanes Plus	-	-	50%	-	42.86	100.0%	-	0.000	0.000
25 Residual Fuel	79	-	50%	79	45.0	100.0%	1,775	0.002	0.006
26 Sulfur Gas	7,445	108	80%	7,338	40.08	100.0%	149,281	0.134	0.493
27 Special Naphtha	398	374	0%	398	43.47	100.0%	8,643	0.008	0.029
28 Unfinished Oils (1,075)	-	-	0%	(1,075)	44.42	100.0%	(41,636)	-0.038	-0.138
29 Vares	-	-	50%	-	43.60	100.0%	-	0.000	0.000
30 Natural Gas	66,493	2,263	50%	65,160	21.97	100.0%	1,038,319	0.942	3,454
31 Other	-	-	-	-	-	-	-	0.000	0.000

Industrial Sector 1991

☒ Default Non-Energy Consumption Data?

	Total	Non-Energy		Net combustible					
	Consumption (Billion Btu)	Consumption (Billion Btu)	Storage Factor (%)	Consumption (Billion Btu)	Emission Factor (lbs C/Million Btu)	Combustion Efficiency (%)	Emissions (short tons carbon)	Emissions (MMTCE)	Emissions (MMTCO ₂ E)
32 Fuel Type									

Step (10) Review Summary Information

The steps above provide estimates of total carbon in fossil fuels consumed, carbon stored in non-energy products, and amount of carbon oxidized to CO₂. Total carbon emissions are equal to the total carbon content in fuel, minus carbon stored in non-energy uses, adjusted for the carbon not oxidized during combustion, and summed over all fuel types and sectors, for each year. The information is collected on the summary worksheet, displaying results in MMTCO₂E. Figure 7 shows the summary worksheet that sums the emissions from all sectors in the CO₂FFC module. In addition, the results are displayed in graphical format at the bottom of the summary worksheets.

Figure 7. Example of the Emissions Summary Worksheet in the CO₂FFC Module

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	10. Alabama Emissions Summary (MMTCO₂E)															
2																
3																
4		Aggregated Summary Table														
5		MMTCO ₂ E	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
6		Residential	3.10	3.03	3.21	3.43	3.31	3.33	3.74	3.36	3.12	3.33	3.68	3.55	3.26	3.09
7		Coal	0.05	0.01	0.04	0.02	0.00	0.00	0.01	0.02	0.00	0.01	0.01	0.00	0.00	0.00
8		Petroleum	0.58	0.51	0.47	0.61	0.59	0.62	0.63	0.66	0.55	0.98	1.04	0.85	0.72	0.55
9		Natural Gas	2.48	2.51	2.70	2.81	2.72	2.71	3.10	2.68	2.56	2.34	2.63	2.70	2.54	2.54
10		Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11		Commercial	2.44	2.00	2.11	2.06	2.06	1.97	2.17	2.43	1.91	2.20	2.26	2.17	2.00	2.11
12		Coal	0.20	0.03	0.17	0.08	0.02	0.01	0.09	0.15	0.02	0.05	0.11	0.03	0.01	0.01
13		Petroleum	0.92	0.68	0.57	0.58	0.64	0.52	0.49	0.49	0.47	0.63	0.73	0.70	0.63	0.72
14		Natural Gas	1.32	1.29	1.37	1.41	1.39	1.43	1.59	1.79	1.42	1.52	1.42	1.44	1.37	1.38
15		Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16		Industrial	16.14	16.61	19.22	18.12	19.02	19.89	20.52	20.24	19.10	19.64	19.37	17.14	17.40	18.49
17		Coal	5.08	5.53	7.07	5.12	5.56	5.56	5.82	6.02	5.63	5.61	5.40	5.34	4.99	4.90
18		Petroleum	3.20	2.83	2.98	3.13	3.64	3.32	3.81	3.46	2.88	3.01	2.90	3.22	3.58	4.69
19		Natural Gas	7.86	8.25	9.17	9.86	9.81	11.00	10.88	10.76	10.60	11.03	11.07	8.58	8.83	8.89
20		Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21		Transportation	26.69	26.94	27.84	27.97	29.37	30.83	30.27	29.96	30.96	31.39	32.61	30.91	32.46	31.90
22		Coal	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23		Petroleum	25.89	26.04	26.82	27.12	28.56	29.73	29.22	28.81	29.86	30.17	31.35	29.82	31.26	30.87
24		Natural Gas	0.80	0.90	1.02	0.85	0.82	1.10	1.05	1.15	1.10	1.22	1.26	1.10	1.19	1.04
25		Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26		Electric Power	51.40	55.39	58.24	64.01	59.93	65.57	70.84	69.04	71.10	72.39	77.42	74.55	78.19	79.09
27		Coal	51.04	55.04	57.92	63.62	59.54	65.01	70.30	68.29	69.39	70.89	74.91	70.52	71.92	74.19
28		Petroleum	0.06	0.07	0.06	0.06	0.09	0.08	0.13	0.10	0.20	0.13	0.20	0.23	0.16	0.20
29		Natural Gas	0.30	0.28	0.26	0.33	0.30	0.48	0.41	0.65	1.51	1.38	2.30	3.80	6.11	4.69
30		Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31		International Bunker Fuels	1.46	1.79	1.59	1.44	1.26	1.31	1.27	1.20	0.80	0.74	1.16	0.65	1.07	0.90
32		Petroleum	1.46	1.79	1.59	1.44	1.26	1.31	1.27	1.20	0.80	0.74	1.16	0.65	1.07	0.90
33		TOTAL	99.77	103.97	110.63	115.59	113.70	121.58	127.54	125.02	126.19	128.94	135.34	128.33	133.31	134.68
34		Coal	56.37	60.62	65.20	68.84	65.13	70.60	76.23	74.48	75.03	76.55	80.44	75.89	76.92	79.10
35		Petroleum	30.64	30.13	30.90	31.49	33.53	34.27	34.28	33.52	33.96	34.91	36.23	34.82	36.34	37.03
36		Natural Gas	12.76	13.23	14.52	15.26	15.04	16.71	17.03	17.02	17.19	17.48	18.67	17.62	20.04	18.55
37		Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38																
39																
40		Summary Table by Fuel														
41		MMTCO ₂ E	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
42		Residential	3.10	3.03	3.21	3.43	3.31	3.33	3.74	3.36	3.12	3.33	3.68	3.55	3.26	3.09
43		Coal	0.05	0.01	0.04	0.02	0.00	0.00	0.01	0.02	0.00	0.01	0.01	0.00	0.00	0.00
44		Distillate Fuel	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.02	0.00	0.00	0.01	0.02	0.02	0.00
45		Kerosene	0.02	0.03	0.01	0.02	0.01	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.02
46		Hydrocarbon Gas Liquids	0.55	0.47	0.45	0.59	0.57	0.59	0.60	0.62	0.53	0.96	1.01	0.82	0.69	0.53
47		Natural Gas	2.48	2.51	2.70	2.81	2.72	2.71	3.10	2.68	2.56	2.34	2.63	2.70	2.54	2.54
48		Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-
49		Commercial	2.44	2.00	2.11	2.06	2.06	1.97	2.17	2.43	1.91	2.20	2.26	2.17	2.00	2.11
50		Coal	0.20	0.03	0.17	0.08	0.02	0.01	0.09	0.15	0.02	0.05	0.11	0.03	0.01	0.01
51		Distillate Fuel	0.32	0.32	0.33	0.33	0.40	0.28	0.24	0.23	0.24	0.25	0.33	0.36	0.34	0.47
52		Kerosene	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.01
53		Hydrocarbon Gas Liquids	0.21	0.18	0.17	0.23	0.22	0.22	0.23	0.24	0.20	0.37	0.39	0.31	0.27	0.22
54		Motor Gasoline	0.10	0.06	0.05	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	<	>	Control	Default State Energy Data Table	Residential	Commercial	Transportation	Industrial	Electric Power	Bunker Fuels	Summary-MMT	...	+			

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.

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