Climate Protection Northwest

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United States 2022 Greenhouse Gas Emissions Inventory

A Sample Report

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Preface

Climate Protection NW provides this report as an example of a greenhouse gas (GHG) inventory. An inventory for a smaller jurisdiction or organization would also include the first two sections of this report. Those sections are required by the IPCC (2019). They are 1) emissions by greenhouse gas, and 2) emissions by the IPCC's list of economic sectors. A local inventory would also include the section below reporting emissions by the alternate economic sectors, and a section on any opportunities specific to the jurisdiction or organization.

While the primary purpose of this report is to illustrate what a GHG inventory report contains, the findings deserve attention in themselves. The United States has committed to net zero GHG emissions by 2050 (White House 2021). Americans should keep an eye on how we're doing.

Second, the findings for the United States serve as a quality check for findings in local jurisdictions. For example, in the U.S. overall, HPCs (chemicals used in air conditioners) produce about 3% of GHG emissions[1]. If results for a local jurisdiction indicated that 50% of the emissions were HPCs, that 50% should be examined closely. Chances are it is mistaken.

Finally, the results reported here can be used in the *scaling* inventory methodology (GHGP 2014). The scaling method estimates emissions in a location from emissions in a larger surrounding region by multiplying the larger region's emissions by the portion of the larger region's population who live in the location. For example, in 2019, 328 million Americans emitted 6.6 gigatons of greenhouse gases (EPA 2024, table ES-2). In 2019, 7.6 million people lived in Washington State: 2.3% of the U.S. population. The scaling method estimates that 2.3% of the nation's 6.6 gigatons of GHG were emitted by Washington State. That is 153 megatons. More careful methods estimated Washington State 2019 emissions to be 102 megatons (WA Ecology, 2022). For a question like total emissions, being off by 50% is a big deal. For a question like what portion of emissions come from HPCs, being off by 50% would estimate 4.5% rather than 3%, and make little difference to the total estimated emissions.

If a prior inventory is available, work should capitalize on the prior inventory. Auditing and updating should focus on the elements in the prior inventory that are most likely to yield the largest accuracy improvements, given the limits of available resources.

This inventory is based mostly on the Environmental Protection Agency's *Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2022* (2024a). In this report, analysis focuses on the key findings of the EPA report, and the largest opportunities for reducing U.S. emissions.

The IPCC Inventory Guidelines (IPCC 2019) distinguish between within-boundary "scope 1" emissions; electricity "scope 2" emissions; and out-of-boundary "scope 3" emissions. Within-boundary scope 1 emissions are emissions created within the boundaries of the analysis. The boundaries of this report are the United States in 2022. Electricity scope 2 emissions are emissions

[1] Table 1 below

from generation of electricity consumed within the boundary. Out-of-boundary scope 3 emissions are emissions that were 1) unrelated to electricity, 2) released out of the boundary, and 3) caused by decisions within the boundary. An example of out-of-boundary scope 3 emissions would appear if a steel manufacturer moved operations from the U.S. to Mexico. That relocation would move emissions from in-boundary scope 1 to out-of-boundary scope 3.

Like the EPA report, this report does not include out-of-boundary scope 3 emissions.

IPCC Core Reporting

This greenhouse gas inventory report starts with reporting required by the United Nations Framework Convention on Climate Change (IPCC 2019).

In 2022, the United States emitted 6.3 gigatons[2] of greenhouse gases (in terms of carbon dioxide equivalent, CO_2e[3]). Land use decisions drew down 854 megatons.[4] Altogether, the U.S. added a net total of 5.5 gigatons of CO_2e to the global atmosphere.

Table 1 shows U.S. 2022 emissions by greenhouse gas.

Table 1

2022 U.S. Emissions by Greenhouse Gas[5]

Greenhouse Gas	Megatons of Gas	Megatons CO_2e	% of Greenhouse Gas Emissions
Carbon Dioxide (CO_2)	5,053	5,053	80%
Methane (CH_4)	25	702	11%
Nitrous Oxide (N_2O)	1.5	390	6%
Hydrofluorocarbons (HFCs)	0.048	183	3%
Sulfur Hexafluoride (SF_6)[6]	0.00034	8	0.1%
Perfluorocarbons (PFCs)	0.00070	7	0.1%
Nitrogen Trifluoride (NF_3)	0.000062	1	0.02%
	Total	6,343	100%

[2] A gigaton is a billion metric tons. A metric ton is 1,000 kilograms, which equals 2,205 pounds, or 1.1 American ("short") tons.

[3] CO_2e is a measure of the global heating in the next 100 years caused by a gas's release. CO_2e is the amount of CO_2 that would produce the equivalent heating. For example, a ton of methane produces 28 times as much global warming as CO_2. The CO_2e of a ton of methane is 28.

[4] A megaton is a million metric tons.

[5] Data from table ES-2 of the EPA's *2024 US Greenhouse Gas Emissions Inventory for 1990-2022*, excluding Land Use, Land Use Change, & Forestry (LULUCF) emissions (EPA 2024a).

[6] SF_6, PFCs, and NF_3 are included in table 1 to comply with the IPCC direction to aim for completeness. Part of the reason for completeness is to make sure small emissions sources stay small.

Table 2 shows U.S. emissions by economic sectors required by the IPCC.

Table 2

2022 U.S. Emissions by IPCC Economic Sector[7]

Sector	Megatons CO_2e	% of Greenhouse Gas Emissions
Energy	5,200	82%
Agriculture[8]	593	9%
Industrial Processes and Product Use	383	6%
Waste[9]	167	3%
Total Emissions	6,343	100%
Land Use, Land Use Change, and Forestry (LULUCF)	-854	
Total Emissions Net LULUCF	5,489	

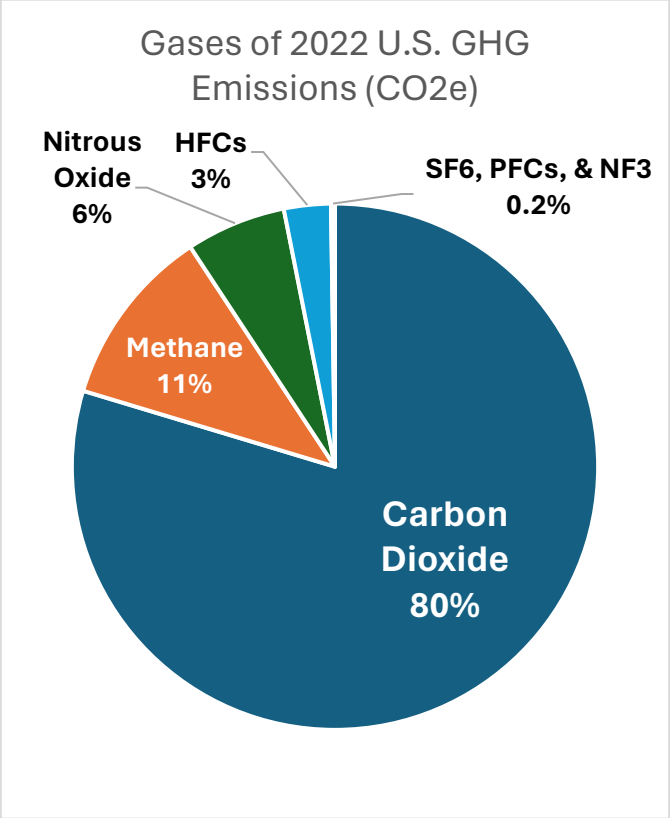
[7] Table 2 data is from table ES-3 of EPA (2024a)

[8] As directed by IPCC guidelines (2019), the agricultural emissions category does not include emissions from fuel combustion. Emissions from agricultural fuel combustion (for example, burning gasoline in tractors) are here classified as "Energy". Agricultural emissions also do not include negative emissions (carbon sinks) such as carbon dioxide captured by forests. Greenhouse gas emissions from forestry and land use changes are classified as *Land Use, Land Use Change, and Forestry (LULUCF)*.

[9] Waste does not include trash incineration power plant emissions. As directed by IPCC (2019) guidelines, emissions from powering electricity generation by burning waste are classified as Energy emissions.

What the IPCC Core Findings Show Us

Figure 1



Carbon Dioxide

80% of the warming of 2022 U.S. greenhouse gas emissions was created by carbon dioxide. Most carbon dioxide comes from burning fossil fuels. Every fossil fuel creates carbon dioxide. In the U.S., small amounts of carbon dioxide were released making cement and steel.

Methane

Fossil fuel industries and fossil fuel use were the largest sources of methane in the U.S. Natural gas, coal, and oil released 40%[10] of the methane emitted in 2022: 4%[10] of the total U.S. GHG emissions.

Another 3%[10] of total emissions were methane from cattle – mostly burped results of the enteric fermentation that cattle use for digestion. About 193 megatons of methane CO_2e were released by cattle: 27% of methane releases.

The remaining 32% of methane releases (4% of total emissions) came from a variety of sources, including farming, rotting trash, and sewage.

[10] Table 8 below

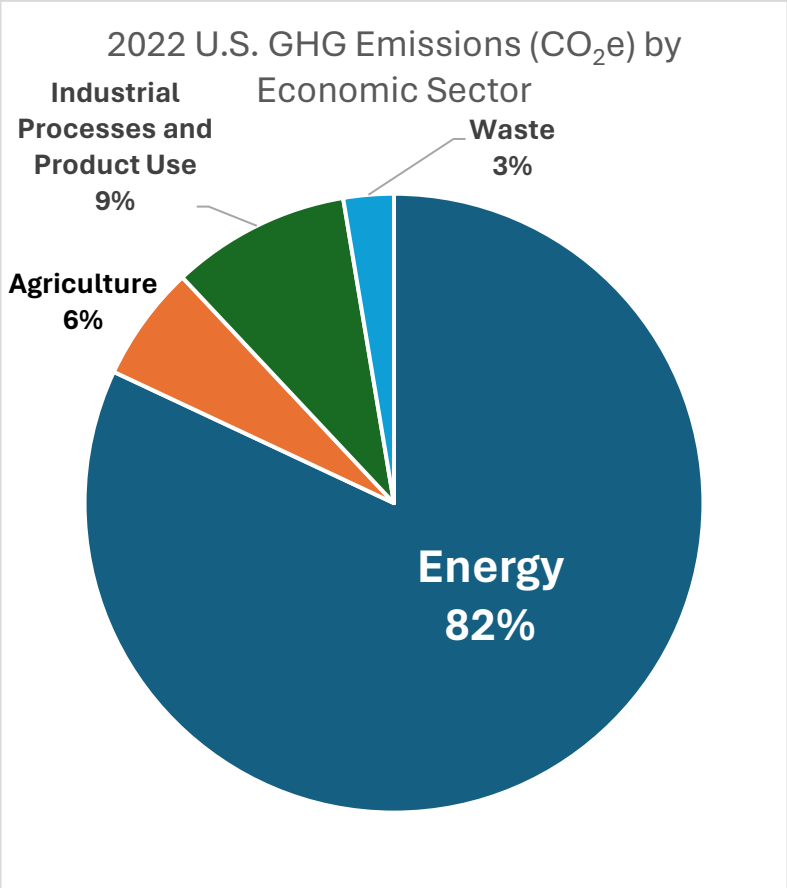
Nitrous Oxide and HFCs

Together, nitrous oxides and HFCs were 9%[11] of U.S. 2022 greenhouse gases. 75% of nitrous oxide emissions (4% of total emissions) came from farmland soils. Most HFCs are used to move heat in refrigerators, air conditioners, and heat pumps.

Emissions by IPCC Economic Sector

The Paris Agreement and the UN Framework Convention on Climate Change (IPCC 2019) require greenhouse gas emissions reported by five economic sectors: Energy, Agriculture, Industrial Processes and Product Use (IPPU), and Waste. Figure 2 depicts greenhouse gas emissions by the UNFCCC sectors shown in table 2.

Figure 2



Energy

The IPCC Energy sector in figure 2 mostly overlaps with the carbon dioxide category in figure 1. The Energy sector includes all the carbon dioxide released by fossil fuel burning and all the methane released during fossil fuel extraction, processing, and delivery.

[11] Table 8 below

Agriculture

The methane from cattle gas and rotting manure shows up in the 9% Agriculture sector, along with the nitrous oxide from farmland.

Industrial Processes and Product Use (IPPU)

The carbon dioxide from making cement and steel is part of the 6% Industrial Processes and Product Use sector.

Waste

The methane from rotting trash and sewage is accounted for in the Waste sector.

Conclusions from IPCC Core Reporting

The major sources of greenhouse gas emissions from the United States are burning gasoline, natural gas, and coal, and the fossil fuel industries that provides them.

Alternate Economic Sector Categories

Many greenhouse inventories include a breakout by an alternate set of economic categories: Transportation, Electricity Generation, Industry (including energy used by industry directly), Agriculture, Commercial, and Residential. That breakout is shown in table 3 and figure 3.

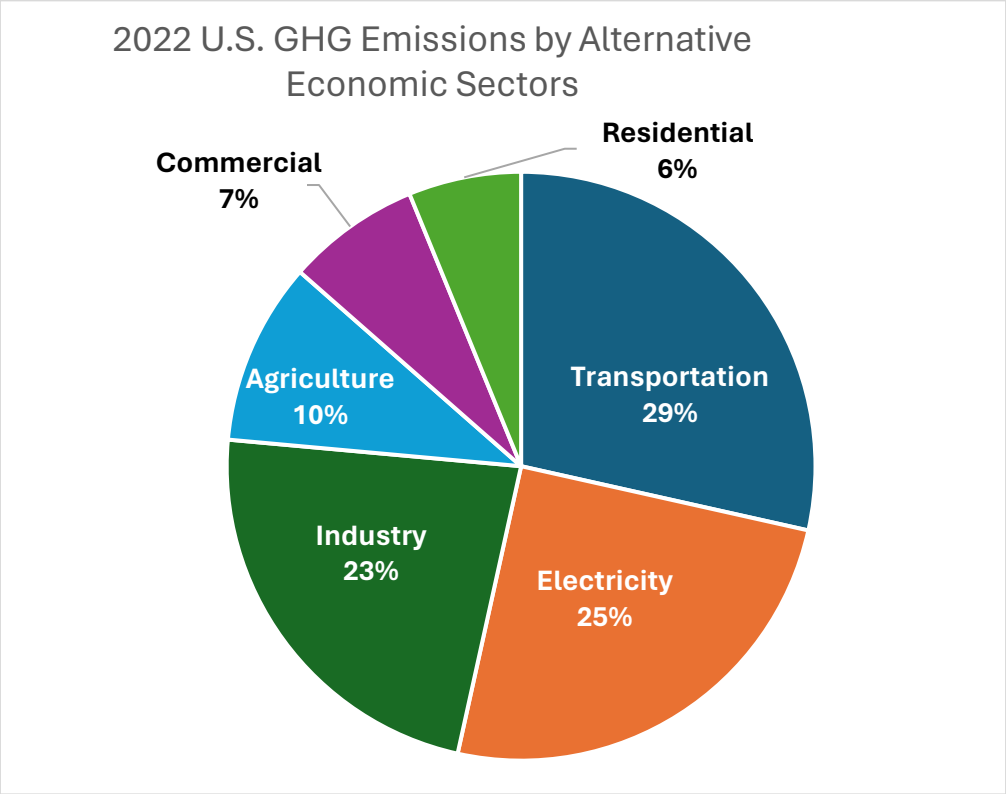
Table 3[12]

U.S. Greenhouse Gas Emissions by Alternative Economic Sector Categories

Economic Sector	Megatons CO_2e	Percent of CO_2e
Transportation	1,808	29%
Electricity Generation	1,583	25%
Industry	1,458	23%
Agriculture	636	10%
Commercial	465	7%
Residential	393	6%
Total	6,343	100%

[12] Data from table ES-5 of EPA (2024a) factored up to include U.S. Territory emissions in economic sectors. Calculations shown below.

Figure 3



There are four major sources of U.S. energy U.S. that emit greenhouse gases. Gasoline, coal, and natural gas create GHG emissions directly. The fourth energy source, electricity, emits greenhouse gases when it is generated by burning fossil fuels. In figure 3, all emissions from electricity are represented in the lower-right orange slice, whether they were released by transportation, industry, commercial, or residential systems. Emissions from solar, wind, hydroelectric, and nuclear generation are not represented in figure 3, because those technologies do not create GHG emissions.

The change from the IPCC categories (shown in figure 2) to the figure 3 categories makes little difference to Agriculture (9% in the IPCC categorization, 10% in figure 3). In the IPCC categorization, Industry (Industrial Processes and Product Use) does not include Industry's use of energy. Adding Industry's use of gasoline, coal, and natural gas raises Industry's emissions from 6% to the 23% shown in figure 3. Industry burns enough in fossil fuels to create 17% of U.S. greenhouse gas emissions.

Conclusions from the Alternative Categorization

Conclusions from the alternative categorization are not different from the IPCC categorization. Transportation produces 29% of the greenhouse gas emissions. Almost all U.S. transportation runs on oil products. Cars, trucks, buses, trains, airplanes, ships, and boats all mostly run on gasoline and diesel.

The 25% orange Electricity slice in figure3 is emissions from power plants that burn natural gas or coal. Hydroelectric dams, nuclear power plants, wind farms, and solar collectors emit hardly any greenhouse gases as they generate electricity.

In figure 3, the green, Industry, wedge summarizes two parts. One part is emissions from industrial processes – about 6% of the total emissions. The other 17% is due to burning coal, gasoline, and natural gas in factories.

The 7% of emissions that are categorized as "Commercial" are mostly the result of burning natural gas and oil to heat spaces and water in commercial buildings. The 6% that is "Residential" comes mostly from burning natural gas and oil to heat homes.

Altogether, combining the 29% of Transportation, the 25% of Electricity, the 17% of Industry that is from fossil fuel burning, and the 7% and 6% from natural gas in commercial and residential spaces, we get that about 84% of U.S. emissions come from burning gasoline, natural gas, and coal for one reason or another. That's roughly what was revealed in the IPCC Energy sector in figure 2.

Opportunities

Breakouts for Opportunity Discovery

In addition to the standard GHG reporting, this report includes breakouts that reveal more about what is happening in the U.S. and what can be done to stop U.S. greenhouse gas emissions.

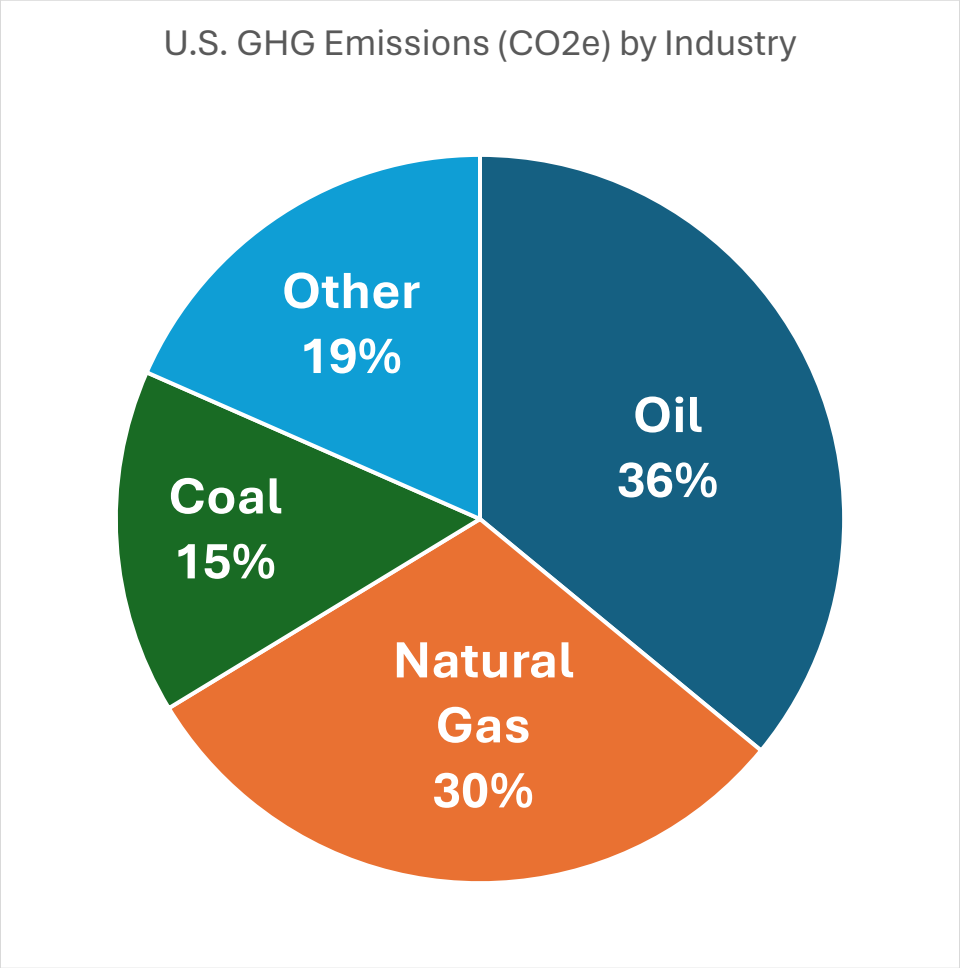
Fossil Fuels (including extraction, processing, and delivery)

Table 4

U.S. 2022 Greenhouse Gas Emissions by Industry

Industry	CO2e Million Metric Tons	Percent of Emissions
Oil	2,281	36%
Natural Gas	1,925	30%
Coal	970	15%
Other	1,167	19%
Total	6,343	100%

Figure 4



In table 4 and figure 4, “Other” includes emissions from farming; cement and steel manufacturing; refrigerants; and rotting trash and sewage.

Figure 4 can be roughly summarized as Oil and Natural Gas each create a third of U.S. emissions, and Coal now creates half as much in emissions as either Oil or Natural Gas.

Oil

Figure 5 drills into the Oil category of figure 4. Figure 5 shows what comes from each activity. For example, 44% of GHG emissions from Oil come from burning fuel in cars, SUVs, and pickup trucks.

Figure 5

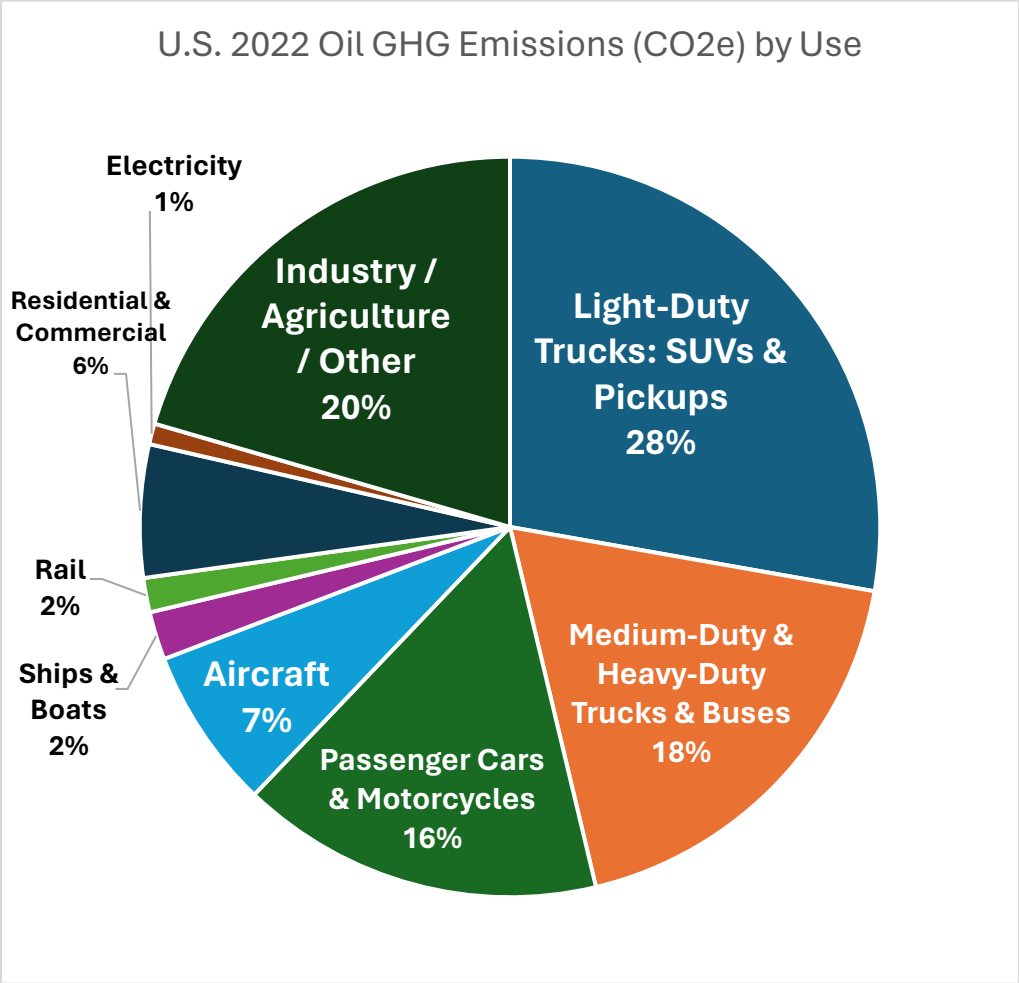


Table 5

U.S. 2022 Oil GHG Emissions (CO_2e) by Use

Source	Megatons CO_2e	Percent
Light-Duty Trucks (SUVs & Pickups)	634	28%
Medium-to-Heavy Duty Trucks (incl. Tractor Trailers & Buses)	422	18%
Passenger Cars & Motorcycles	362	16%
Aircraft	161	7%
Ships and Boats	48	2%
Rail	34	2%
Residential & Commercial Heating	132	6%
Electricity Power Plants	21	1%
Industry / Agriculture / Other	468	20%
Total	2,281	100%

In table 5 and figure 5, 66% of emissions from oil come from on-land and on-water transportation. Technology to replace that petroleum burning is already widely adopted and has been incentivized by the federal government.

Stopping emissions from Jet fuel requires very different interventions, and would stop 3% of total U.S. emissions. 7% is aviation. So far, electric aviation technology is not yet well developed. An important available alternative for Western Hemisphere travel is electric rail, which would consume less power than aviation or transportation on roads.

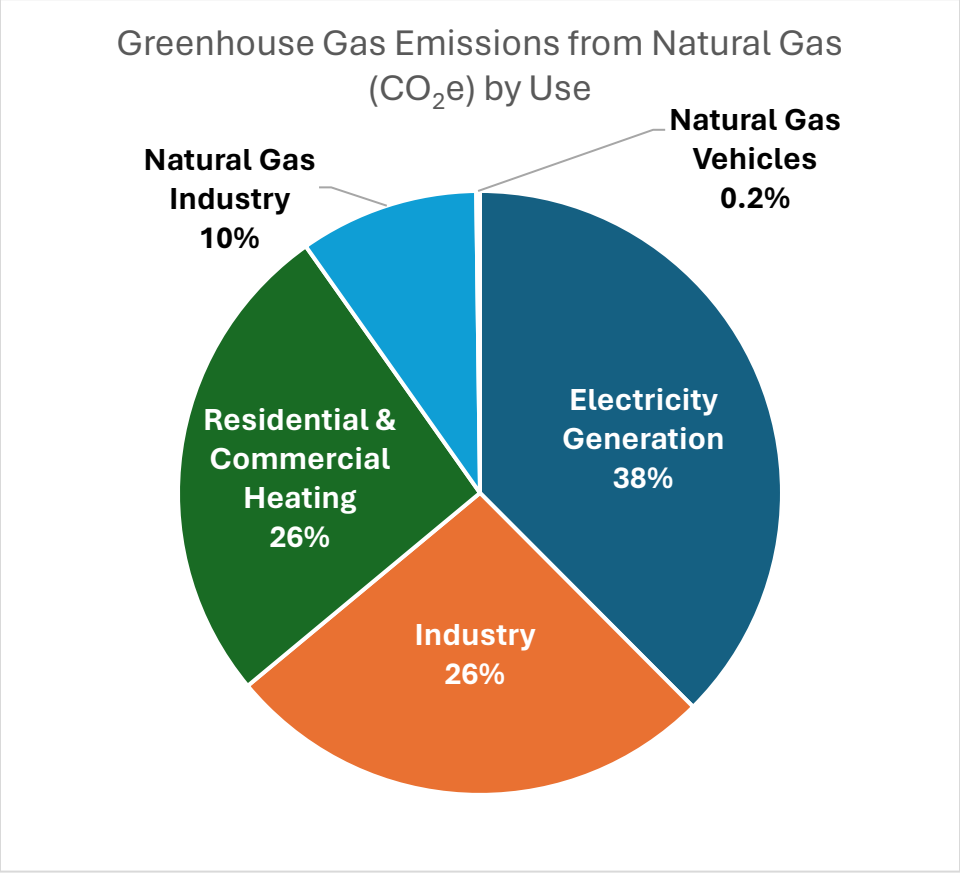
Stopping emissions from heating oil (residential and commercial) would stop 6% of Oil emissions and 2% of total U.S. emissions.

Stopping emissions from industry and agriculture has a larger impact, 20%, but would require a many different new technologies.

Natural Gas

Figure 6 shows a breakout of emissions from natural gas.

Figure 6



In 2022, natural gas generated 30% of U.S. greenhouse gas emissions. The largest use of natural gas was in electricity power plants (38%; 12% of total U.S. emissions). Industrial use accounts for another 26%. Heating, hot water, and cooking in residences and businesses account for another 26%.

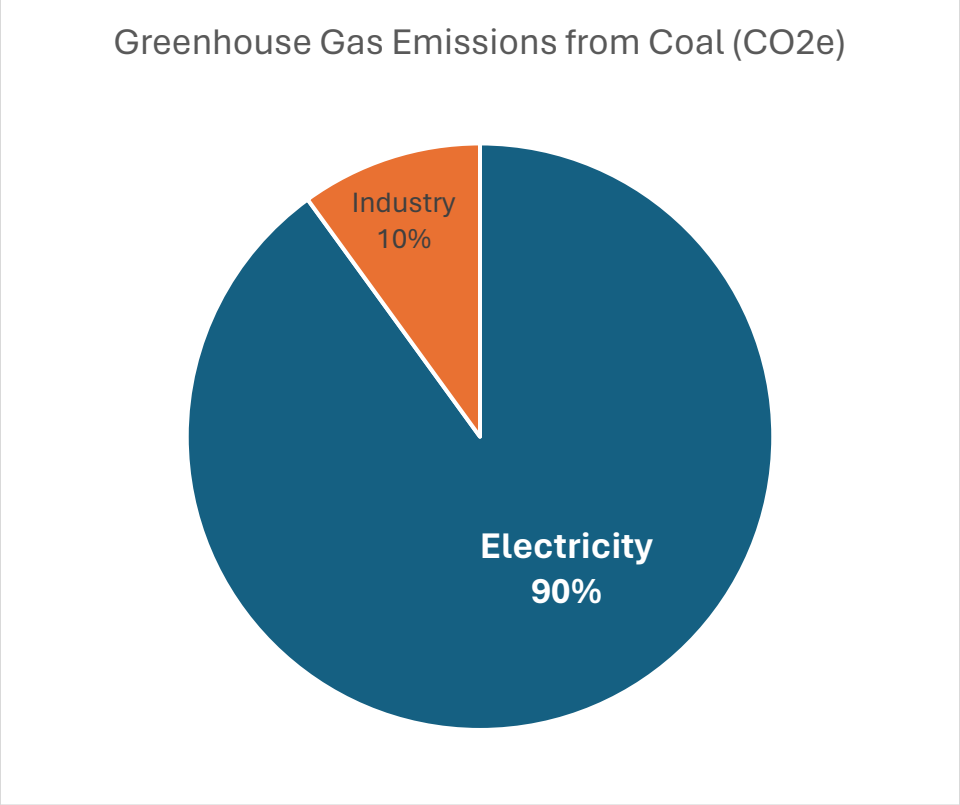
Natural gas vehicles use 0.2% of U.S. natural gas.

The natural gas industry itself generates 10% of the emissions from natural gas (3% of U.S. GHG). The Industry slice at the bottom of figure 6 does not include that 10%.

Coal

In America, there is almost no remaining use of coal to heat homes or businesses. There is some Industrial use (10% of coal use, and 1% of total U.S. emissions). 90% of greenhouse gas emissions from coal use within the U.S. in 2022 was for electricity generation (EIA 2024b). That was 14% of total U.S. emissions.

Figure 7



As the U.S. considers how to stop greenhouse gas emissions, there are questions about the size of the opportunities. For example, currently, the U.S. is investing in adding wind and solar generation; batteries to handle low-wind nights; electric vehicles; heat pumps; and weatherization. If we build out enough wind, solar, and batteries to replace natural gas and coal in electricity generation, how

much does that help? If we replace gasoline-powered vehicles with electric vehicles, how much does that help? What if we replace natural gas heating with heat pumps and weatherization?

There has been some interest in gas from cattle. Cattle digest grass by enteric fermentation, which creates methane gas that the cattle burp. This cattle gas can be avoided by feeding cattle seaweed containing bromoform. How much would that help? Attention on agriculture has also considered tilling practices. Traditional tilling releases a lot of nitrous oxide. Newer soil management techniques can prevent those emissions. What are the opportunities in soil management?

Figure 8 helps quantify opportunities in different strategies.

Figure 8

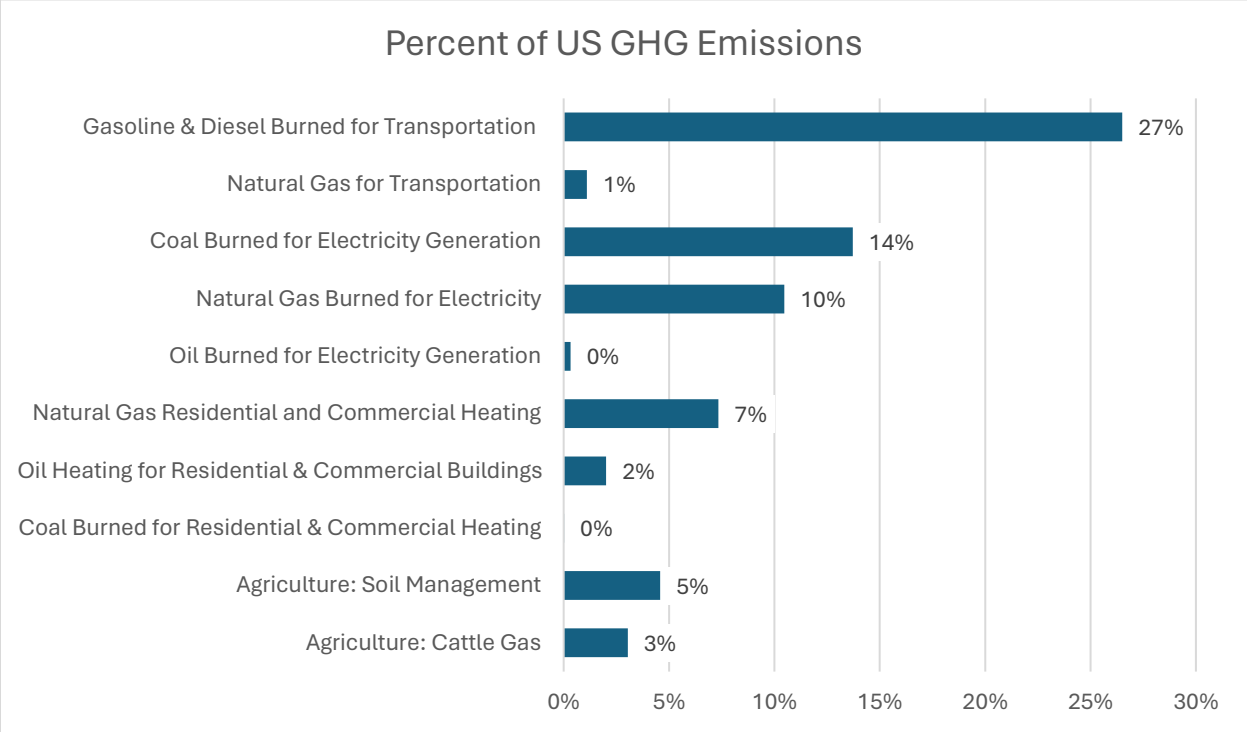


Figure 8 does not show 39% of U.S. emissions created in Industry, waste disposal, or agriculture (other than soil management and cattle gas).

Table 6

2022 U.S. Emissions by Use Related to Specific Solutions

Source	Emissions Megatons CO_2e	Percent of Emissions
Gasoline & Diesel Burned for Transportation	1,681	27%
Natural Gas for Transportation	70	1%
Coal Burned for Electricity Generation	870	14%
Natural Gas Burned for Electricity	664	10%
Oil Products Burned for Electricity Generation	21	0.3%
Natural Gas for Residential & Commercial Heating	466	7%
Oil Heating for Residential & Commercial Buildings	128	2%
Coal Burned for Heating Buildings	1	0.02%
Agriculture: Soil Management	291	5%
Agriculture: Cattle Gas	193	3%
Other (Other Agriculture & Industry)	1,953	31%
Total	6,343	100%

Burning oil products in cars, SUVs, trucks and other on-land and on-water vehicles produced 27% of the greenhouse gases released by the United States. Swapping out gasoline-powered and diesel-powered transportation for electric vehicles would have the largest impact of these strategies.

Emissions from electricity generation are almost entirely from burning coal and natural gas. Replacing coal and natural gas in electricity generation would eliminate another 24% of U.S. emissions.

Other strategies considered here address small portions of the U.S. greenhouse gas emissions. Once fossil fuels are removed from transportation and electricity generation, natural gas for heating would become a larger portion of the remaining emissions.

Uncertainty

For the estimates of emissions, the stated amounts are the most likely actual counts, given the available data. Actual amounts could be anywhere between 5% lower and 5% higher. It is unlikely that the actual amounts are more than 5% lower or 5% higher.

There is much more uncertainty about the greenhouse gases absorbed by land use and forestry. The range of possible actual emissions that should be considered plausible is from 19% lower to 27% higher. The result of combining these uncertainties is that, for total emissions, emissions from 5% lower to 6% higher should all be considered plausible.

Comparisons of these results to results reported elsewhere are likely to show differences of as much as 10%. Differences will come from differences in what is included and what is not included.

Early reviews of this report pointed out that a global inventory looks different. And decisions were made in creating this report (described below) that may not match what went into other inventories. For example, this report tries to account for fuel for aircraft that start their trips in the U.S. and land outside the U.S. The EPA (2024a) inventory accounts for those international flights separately.

Data & Calculations Transparency

Table 1 Data and Calculations

The CO_2e counts in table 1 are from table ES-2 of the EPA inventory (EPA 2024a). Table 7 shows the calculations to translate from the CO_2e amounts to tons of gases.

Table 7

2022 U.S. Emissions by Greenhouse Gas[1]

Greenhouse Gas	Megatons CO_2e	Global Warming Potentials (GWP)	Megatons of gas = Megatons CO_2e / GWP
Carbon Dioxide (CO_2)	5,053	1	5,053
Methane (CH_4)	702	28	25
Nitrous Oxide (N_2O)	390	265	1.5
Hydrofluorocarbons (HFCs)	183	3,779	0.048
Sulfur Hexafluoride (SF_6)[2]	8	23,500	0.00034
Perfluorocarbons (PFCs)	7	10,000	0.00070
Nitrogen Trifluoride (NF_3)	1	16,100	0.000062
	6,343		Total

Pages 1-9 & 1-10 of the EPA inventory include global warming potentials of CO_2, CH_4, N_2O, SF_6, and NF_3. Those GWP's are reported in table 7. Page 1-10 of the EPA's inventory includes GWP's for nine HFC's. For an estimate of overall HFC GWP, the nine HFC GWP's were averaged. That averaging does not reflact that some HFC's are more common than others.

A footnote at the bottom of p. 4-144 (EPA 2024a) indicates that many PFCs have GWPs near 10,000 and that the EPA uses 10,000 as a GWP for many PFCs.

Methane, Nitrous Oxide, & HFC Calculations

Table 8

Top Sources of Methane Emissions with Nitrous Oxide & HFCs Emissions[13]

Source	Megatons Methane CO_2e	Percent	Percent of Total
Methane			
Enteric Fermentation	193	27%	3%
Fossil Fuel Industry			
Natural Gas Systems	173	25%	3%
Coal Mining	44	6%	1%
Petroleum Systems	40	6%	1%
Stationary Combustion	9	1%	0.1%
Abandoned Oil & Gas Wells	9	1%	0.1%
Abandoned Coal Mines	6	1%	0.1%
Mobile Combustion	3	0.4%	0.04%
Fossil Fuel Industry Total	282	40%	4%
Other Methane	228	32%	4%
Methane Total	702	100%	11%
Nitrous Oxide	390		6%
HFCs	183		3%
U.S. Total	6,343		

Table 2

Table 2 megatons of CO_2e are from table ES-3 of the EPA (2024a) inventory.

Table 3

Table 3's data comes from table ES-5 of the EPA's Inventory (2024a). Table ES-5 reports emissions from U.S. Territories separately. That results in a mixture of economic sectors listed with a geographic sector.

Rather than continue the mixture of different types of emissions sources, table 3 in this report counts the territorial emissions in the economic sectors.

Table 9 shows the calculations to spread the territorial data across the economic sectors.

[13] Data from EPA 2024a, table 2-1

Table 9

Economic Sector	2022 Megatons CO_2e	Percent of Economic Sectors	Percent X 6,343
Transportation	1,802	29%	1,808
Electric Power	1,578	25%	1,583
Industry	1,453	23%	1,458
Agriculture	634	10%	636
Commercial	464	7%	465
Residential	391	6%	393
Total Economic Sector Reporting	6,321	100%	6,343
U.S. Territories (Geographic Category)	23		
Total	6,343		

The territorial emissions are 0.4% of the total emissions. Spreading them across the economic categories does not make a big difference.

Table 4

Table 4 includes emissions from international bunker fuels. International bunker fuels are fuels used in ships and aircraft that start their journeys inside the U.S. and complete their journey outside. Table 10 shows data collected from EPA (2024a) Table 3-8 and calculations of total CO2e emissions from international bunker fuels.

Table 10
Data and Calculations of Total CO_2e Emissions from International Bunker Fuels
(Megatons CO_2e)

	Marine	Aviation
CO_2	31.6	66.6
Methane	0.1	0.0
Nitrous Oxide	0.2	0.6
Total	31.9	67.2

Table 11 shows data, data sources, and calculations to calculate CO2e megatons for methane and nitrous oxides from the fossil fuel industries.

Table 11
Data and Calculations of Methane and Nitrous Oxide Emissions from Fossil Fuel Industries
(Megatons CO_2e)

	Oil	Natural Gas	Coal	Data Source
Stationary Methane				
Electricity Generation	0	1	0.2	Table 3-8: Methane from Stationary Combustion
Industrial	0.2	0.3	0.1	
Commercial	0.3	0.5	0	
Residential	0.3	0.7	0	
Territories	0	0	0	
Stationary Nitrous Oxide				
Electricity Generation	0	3.4	18.2	Table 3-9: Nitrous Oxide from Stationary Combustion
Industrial	0.3	0.2	0.2	
Commercial	0.1	0.1	0	
Residential	0.1	0.1	0	
Territories	0	0	0	
Mobile Methane	2.6	0	0	Table 3-14: Methane from Mobile Combustion
Mobile Nitrous Oxide	16.7	0	0	Table 3-15: Nitrous Oxide, Mobile Combustion
Total	20.6	6.3	18.7	

Table 12 combines the data from tables 10 and 11 to calculate industry totals.

Table 12
Emissions by Industry: Data, Data Sources, and Calculations
(Megatons CO_2e)

Source	Oil	Natural Gas	Coal	Data Source
Emissions before end-use[14]	62	210	46	EPA (2024a)
CO2	2,093	1,707	899	Table 3-5
Methane & Nitrous Oxide	21	6	19	Table 11 above
Abandoned Wells CO_2	0	0		EPA (2024a) Tables 3-
Abandoned Wells Methane	7	2	6	109 & 2-1
Marine International Bunker Fuel	32			Table 10 above
Aviation International Bunker Fuel	67			
Total	2,281	1,925	970	
Percent	36%	30%	15%	

This report is based on decisions about what to include in each category in tables 12 and 4. Other analyses may be based on other decisions. The result could be that other analyses report numbers that are 5% or 10% different. For example, another report might not include international bunker

[14] Emissions before end-use combustion, including exploration, extraction, transportation, and refining, processing, leaks, venting, and flaring

fuels, or might not include abandoned wells. The general pattern is likely to show up in any analysis: Oil and Natural Gas about 1/3rd each, and Coal about 1/6th.

Table 5

Table 13 shows data, data sources, and calculations to generate the reporting in Table 5.

Table 13

Data, Data Sources, & Calculations for Table 5

Gas/Vehicle Type	Megatons CO2e	Sources
Light-Duty Trucks	660.2	
Medium-Duty & Heavy-Duty Trucks	413.1	
Buses	26.3	
Medium-Duty & Heavy-Duty Trucks & Buses	439.4	
Passenger Cars	369.5	
Motorcycles	7.6	
Passenger Cars & Motorcycles	377.1	EPA (2024a)Table 2-13
Commercial Aircraft	130.8	
Other Aircraft	37.0	
Aircraft	167.8	
Ships & Boats	49.9	
Rail	35.6	
Transportation Total	1,807.8	
Oil Residential	62.1	
Oil Commercial	65.1	
Oil Transportation	1,681.1	
Oil Electric Power	20.5	EPA (2024a) Table 3-5
Oil Territories	17.0	
Oil Total	2,093.4	
Natural Gas Transportation	70.2	
Factors for Calculations		
Natural Gas Portion of Transportation Factor[15]	96%	
CO_2e/CO_2 Oil Factor[16]	103%	
Territories Factor[17]	101%	
Gas/Vehicle Type	**Megatons CO2e**	
Light-Duty Trucks: SUVs & Pickups	634	
Medium-Duty & Heavy-Duty Trucks & Buses	422	
Passenger Cars & Motorcycles	362	
Aircraft	161	
Ships & Boats	48	
Rail	34	
Residential & Commercial Heating	132	
Electricity Power Plants	21	
Industry / Other	468	
Total	2,281	

[15] In terms of CO2, natural gas emissions for transportation are 4% of transportation emissions (70.2/(70.2+1,681.1). Oil Transportation emissions are estimated by multiplying transportation CO_2e by 96%.

[16] Emissions from oil heating and oil electricity generation are estimated by multiplying CO_2 emissions from Table 3-5 by the ratio of CO_2e to CO_2 (103%).

[17] Table 3-5 reports territory emissions separately. Total emissions are 1% higher than emissions without territories. Residential and commercial heating and electricity generation are estimated by multiplying estimates derived from Table 3-5 by 101%.

Figure 6

Table 14 shows the data and calculations for figure 6. The data is from the U.S. Energy Information Administration (EIA 2024a). The calculations applied the percentage of natural gas in each use to the total natural gas emissions from table 4 above.

Table 14

Calculations of Natural Gas Emissions by Use

	Consumption by End Use in 2022 (Million Cubic Feet)	Percent
Electric Power	12,117,975	38%
Industrial Consumers	8,536,882	26%
Residential Consumers	4,964,165	15%
Commercial Consumers	3,509,075	11%
Field and Processing	1,882,802	6%
Pipeline & Distribution Use	1,212,338	4%
Vehicle Fuel	64,994	0.2%
Total	32,288,231	100%
Total Natural Gas Industry	3,095,140	10%
Residential & Commercial	8,473,240	26%

Use	Natural Gas CO_2e by Use	Percent
Electricity Generation	722.4	38%
Industry	508.9	26%
Residential & Commercial Heating	505.1	26%
Natural Gas Industry	184.5	10%
Natural Gas Vehicles	3.9	0.2%
Total	1,924.7	100%

Figure 8 & Table 6

Table 15 shows the data and data sources along with calculations for the findings shown in Figure 8 and table 6.

Table 15: Data, Data Sources, & Calculations for Specific Breakouts in Figure 8

	Megatons CO2e	Source
Coal Burning for Residential Heat CO2	0.0	EPA Table 3-5
Coal Burning for Commercial Heat CO2	1.4	EPA Table 3-5
Coal Burning for Residential & Commercial Heat Methane	0.0	EPA Table 3-8
Coal Burning for Residential & Commercial Heat Nitrous Oxide	0.0	EPA Table 3-9
Coal Burned for Heating Residential & Commercial Buildings	1.4	
Residential Oil CO2	62.1	EPA Table 3-5
Commercial Oil CO2	65.1	EPA Table 3-5
Residential Oil Methane	0.3	EPA Table 3-8
Commercial Oil Methane	0.3	EPA Table 3-8
Residential Oil Nitrous Oxide	0.1	EPA Table 3-9
Commercial Oil Nitrous Oxide	0.1	EPA Table 3-9
Total Oil for Residential & Commercial Heating	128.0	
Residential Natural Gas CO2	272.0	EPA Table 3-5
Commercial Natural Gas CO2	192.3	EPA Table 3-5
Residential Natural Gas Methane	0.7	EPA Table 3-8
Commercial Natural Gas Methane	0.5	EPA Table 3-8
Residential Natural Gas Nitrous Oxide	0.1	EPA Table 3-9
Commercial Natural Gas Nitrous Oxide	0.1	EPA Table 3-9
Total Natural Gas Residential and Commercial Heating	465.7	
Oil for Electricity CO2	20.5	EPA Table 3-5
Oil for Electricity Methane	0.0	EPA Table 3-8
Oil for Electricity Nitrous Oxide	0.0	EPA Table 3-9
Total Petroleum Products Burned for Electricity Generation	20.5	
Natural Gas for Electricity CO2	659.3	EPA Table 3-5
Natural Gas for Electricity Methane	1.0	EPA Table 3-8
Natural Gas for Electricity N2O	3.4	EPA Table 3-9
Total Natural Gas Burned for Electricity	663.7	
Coal for Electricity CO2	851.5	EPA Table 3-5
Coal for Electricity Methane	0.2	EPA Table 3-8
Coal for Electricity N2O	18.2	EPA Table 3-9
Total Coal Burned for Electricity	869.9	
Source	**Emissions MMT CO2e**	
Gasoline & Diesel Burned for Transportation	1,681.1	EPA Table 3-5
Natural Gas for Transportation	70.2	EPA Table 3-5
Coal Burned for Electricity Generation	869.9	
Natural Gas Burned for Electricity	663.7	
Petroleum Products Burned for Electricity Generation	20.5	
Natural Gas Burned for Heating in Residential and Commercial Buildings	465.7	
Oil Heating for Residential & Commercial Buildings	128.0	
Coal Burned for Heating Residential & Commercial Buildings	1.4	
Agriculture: Soil Management	290.8	EPA Table 2-1
Agriculture: Cattle Gas	192.6	EPA Table 2-1
Other (Industrial & Other Ag)	1,952.6	
Total	6,343.2	

Quality Control

Throughout the development of this inventory report, data were reconciled from multiple sources within the EPA's (2024a) Inventory Report and with other federal government reporting, such as EPA (2024b), and EIA (2023, 2024a, 2024b).

Quality Assurance

The IPCC guidelines for greenhouse gas emissions inventories require that inventories be reviewed by experts who were not involved in creating the inventories. This inventory is provided as an illustration of what an inventory report provides. This section would include information about the quality assurance review. No quality assurance review was hired for this report.

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