

Emission Factors for Greenhouse Gas Inventories

Last Modified: 12 September 2023

Blue text indicates an update from the 2022 version of this document.

Typically, greenhouse gas emissions are reported in units of carbon dioxide equivalent (CO₂e). Gases are converted to CO₂e by multiplying by their global warming potential (GWP). The emission factors listed in this document have not been converted to CO₂e. To do so, multiply the emissions by the corresponding GWP listed in the table below.

Gas	100-Year GWP
CH ₄	25
N ₂ O	298

Source: Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), 2007. See the source note to Table 11 for further explanation.

Table 1 Stationary Combustion

Fuel Type	Heat Content (HHV) mmBtu per short ton	CO ₂ Factor kg CO ₂ per mmBtu	CH ₄ Factor g CH ₄ per mmBtu	N ₂ O Factor g N ₂ O per mmBtu	CO ₂ Factor kg CO ₂ per short ton	CH ₄ Factor g CH ₄ per short ton	N ₂ O Factor g N ₂ O per short ton
Coal and Coke							
Anthracite Coal	25.09	103.69	11	1.6	2,602	276	40
Bituminous Coal	24.93	93.28	11	1.6	2,325	274	40
Sub-bituminous Coal	17.25	97.17	11	1.6	1,676	190	28
Lignite Coal	14.21	97.72	11	1.6	1,389	156	23
Mixed (Commercial Sector)	21.39	94.27	11	1.6	2,016	235	34
Mixed (Electric Power Sector)	19.73	95.52	11	1.6	1,885	217	32
Mixed (Industrial Coking)	26.28	93.90	11	1.6	2,468	289	42
Mixed (Industrial Sector)	22.35	94.67	11	1.6	2,116	246	36
Coal Coke	24.80	113.67	11	1.6	2,819	273	40
Other Fuels - Solid							
Municipal Solid Waste	9.95	90.70	32	4.2	902	318	42
Petroleum Coke (Solid)	30.00	102.41	32	4.2	3,072	960	126
Plastics	38.00	75.00	32	4.2	2,850	1,216	160
Tires	28.00	85.97	32	4.2	2,407	896	118
Biomass Fuels - Solid							
Agricultural Byproducts	8.25	118.17	32	4.2	2,022	264	35
Peat	8.00	111.84	32	4.2	895	256	34
Solid Byproducts	10.39	105.51	32	4.2	1,096	332	44
Wood and Wood Residuals	17.48	93.80	7.2	3.6	1,640	126	63
	mmBtu per scf	kg CO ₂ per mmBtu	g CH ₄ per mmBtu	g N ₂ O per mmBtu	kg CO ₂ per scf	g CH ₄ per scf	g N ₂ O per scf
Natural Gas							
Natural Gas	0.001026	53.06	1.0	0.10	0.05444	0.00103	0.00010
Other Fuels - Gaseous							
Blast Furnace Gas	0.000092	274.32	0.022	0.10	0.02524	0.00002	0.00009
Coke Oven Gas	0.000599	46.85	0.48	0.10	0.02806	0.000288	0.00060
Fuel Gas	0.001388	59.00	3.0	0.60	0.08189	0.004164	0.000833
Propane Gas	0.002516	61.46	3.0	0.60	0.15463	0.007548	0.001510
Biomass Fuels - Gaseous							
Landfill Gas	0.000485	52.07	3.2	0.63	0.025254	0.001552	0.000306
Other Biomass Gases	0.000655	52.07	3.2	0.63	0.034106	0.002096	0.000433
	mmBtu per gallon	kg CO ₂ per mmBtu	g CH ₄ per mmBtu	g N ₂ O per mmBtu	kg CO ₂ per gallon	g CH ₄ per gallon	g N ₂ O per gallon
Petroleum Products							
Asphalt and Road Oil	0.158	75.36	3.0	0.60	11.91	0.47	0.09
Aviation Gasoline	0.120	69.25	3.0	0.60	8.31	0.36	0.07
Butane	0.103	64.77	3.0	0.60	6.67	0.31	0.06
Butylene	0.105	68.72	3.0	0.60	7.22	0.32	0.06
Crude Oil	0.138	74.54	3.0	0.60	10.29	0.41	0.08
Distillate Fuel Oil No. 1	0.139	73.25	3.0	0.60	10.18	0.42	0.08
Distillate Fuel Oil No. 2	0.138	73.96	3.0	0.60	10.21	0.41	0.08
Distillate Fuel Oil No. 4	0.146	75.04	3.0	0.60	10.96	0.44	0.09
Ethane	0.068	59.60	3.0	0.60	4.05	0.20	0.04
Ethylene	0.058	65.96	3.0	0.60	3.83	0.17	0.03
Heavy Gas Oils	0.148	74.92	3.0	0.60	11.09	0.44	0.09
Isobutane	0.099	64.94	3.0	0.60	6.43	0.30	0.06
Isobutylene	0.103	68.86	3.0	0.60	7.09	0.31	0.06
Kerosene	0.135	75.20	3.0	0.60	10.15	0.41	0.08
Kerosene-Type Jet Fuel	0.135	72.22	3.0	0.60	9.75	0.41	0.08
Liquefied Petroleum Gases (LPG)	0.092	61.71	3.0	0.60	5.68	0.28	0.06
Lubricants	0.144	74.27	3.0	0.60	10.69	0.43	0.09
Motor Gasoline	0.125	70.22	3.0	0.60	8.78	0.38	0.08
Naphtha (<401 deg F)	0.125	68.02	3.0	0.60	8.50	0.38	0.08
Natural Gasoline	0.110	66.88	3.0	0.60	7.36	0.33	0.07
Other Oil (>401 deg F)	0.139	76.22	3.0	0.60	10.59	0.42	0.08
Pentanes Plus	0.110	70.02	3.0	0.60	7.70	0.33	0.07
Petrochemical Feedstocks	0.125	71.02	3.0	0.60	8.88	0.38	0.08
Propane	0.091	62.87	3.0	0.60	5.72	0.27	0.05
Propylene	0.091	67.77	3.0	0.60	6.17	0.27	0.05
Residual Fuel Oil No. 5	0.140	72.93	3.0	0.60	10.21	0.42	0.08
Residual Fuel Oil No. 6	0.150	75.10	3.0	0.60	11.27	0.45	0.09
Special Naphtha	0.125	72.34	3.0	0.60	9.04	0.38	0.08
Unfinished Oils	0.139	74.54	3.0	0.60	10.36	0.42	0.08
Used Oil	0.138	74.00	3.0	0.60	10.21	0.41	0.08
Biomass Fuels - Liquid							
Biodiesel (100%)	0.128	73.84	1.1	0.11	9.45	0.14	0.01
Ethanol (100%)	0.084	68.44	1.1	0.11	5.75	0.09	0.01
Rendered Animal Fat	0.125	71.06	1.1	0.11	8.86	0.14	0.01
Vegetable Oil	0.120	81.55	1.1	0.11	9.79	0.13	0.01
Biomass Fuels - Kraft Pulping Liquor, by Wood Furnish							
North American Softwood		94.4	1.9	0.42			
North American Hardwood		93.7	1.9	0.42			
Basswood		95.5	1.9	0.42			
Bamboo		93.7	1.9	0.42			
Straw		95.1	1.9	0.42			

Source:

Federal Register EPA: 40 CFR Part 98; e-CFR, (see link below), Table C-1 and Table C-2 (78 FR 71950, Nov. 29, 2013, as amended at 81 FR 89252, Dec. 9, 2016), Table AA-1 (78 FR 71965, Nov. 29, 2013), <https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98>

Notes:

Emission factors are per unit of heat content using higher heating values (HHV). If heat content is available from the fuel supplier, it is preferable to use that value. If not, default heat contents are provided. The factors represented in the table above represent combustion emissions only (tank-to-wheel) and do not represent upstream emissions or well-to-wheel emissions.

Table 2 Mobile Combustion CO₂

Fuel Type	kg CO ₂ per unit	Unit
Aviation Gasoline	8.31	gallon
Biodiesel (100%)	9.45	gallon
Compressed Natural Gas (CNG)	0.05444	scf
Diesel Fuel	10.21	gallon
Ethanol (100%)	5.75	gallon
Kerosene-Type Jet Fuel	9.75	gallon
Liquefied Natural Gas (LNG)	4.50	gallon
Liquefied Petroleum Gases (LPG)	5.68	gallon
Motor Gasoline	8.78	gallon
Residual Fuel Oil	11.27	gallon

Source: Federal Register EPA: 40 CFR Part 98, e-CFR, (see link below), Table C-1 (78 FR 71950, Nov. 29, 2013, as amended at 81 FR 89252, Dec. 9, 2016)
<https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98>

Notes: The factor was developed based on the CO₂ factor for Natural Gas factor and LNG fuel density from GREET1_2022.xlsx Model, Argonne National Laboratory (Fuel_Specs worksheet). The factors represented in the table above represent combustion emissions only (tank-to-wheel) and do not represent upstream emissions or well-to-wheel emissions.

Table 3 Mobile Combustion CH₄ and N₂O for On-Road Gasoline Vehicles

Vehicle Type	Year	CH ₄ Factor (g / mile)	N ₂ O Factor (g / mile)
Gasoline Passenger Cars	1973-1974	0.1696	0.0197
	1975	0.1423	0.0443
	1976-1977	0.1406	0.0458
	1978-1979	0.1389	0.0473
	1980	0.1326	0.0499
	1981	0.0802	0.0626
	1982	0.0795	0.0627
	1983	0.0782	0.0630
	1984-1993	0.0704	0.0647
	1994	0.0617	0.0603
	1995	0.0531	0.0560
	1996	0.0434	0.0503
	1997	0.0337	0.0446
	1998	0.0240	0.0389
	1999	0.0215	0.0355
	2000	0.0175	0.0304
	2001	0.0105	0.0212
	2002	0.0102	0.0207
	2003	0.0095	0.0181
	2004	0.0078	0.0085
	2005	0.0075	0.0067
	2006	0.0076	0.0075
2007	0.0072	0.0052	
2008	0.0072	0.0049	
2009	0.0071	0.0046	
2010	0.0071	0.0046	
2011	0.0071	0.0046	
2012	0.0071	0.0046	
2013	0.0071	0.0046	
2014	0.0071	0.0046	
2015	0.0068	0.0042	
2016	0.0068	0.0038	
2017	0.0054	0.0018	
2018	0.0052	0.0016	
2019	0.0051	0.0015	
2020	0.0050	0.0014	
Gasoline Light-Duty Trucks (Vans, Pickup Trucks, SUVs)	1973-1974	0.1908	0.0218
	1975	0.1634	0.0513
	1976	0.1594	0.0555
	1977-1978	0.1614	0.0534
	1979-1980	0.1594	0.0555
	1981	0.1479	0.0660
	1982	0.1442	0.0681
	1983	0.1368	0.0722
	1984	0.1294	0.0764
	1985	0.1220	0.0806
	1986	0.1146	0.0848
	1987-1993	0.0813	0.1035
	1994	0.0646	0.0982
	1995	0.0517	0.0908
	1996	0.0452	0.0871
	1997	0.0452	0.0871
	1998	0.0412	0.0787
	1999	0.0333	0.0618
	2000	0.0340	0.0631
	2001	0.0221	0.0379
	2002	0.0242	0.0424
	2003	0.0221	0.0373
2004	0.0115	0.0088	
2005	0.0105	0.0084	
2006	0.0108	0.0080	
2007	0.0103	0.0061	
2008	0.0095	0.0036	
2009	0.0095	0.0036	
2010	0.0095	0.0035	
2011	0.0096	0.0034	
2012	0.0096	0.0033	
2013	0.0095	0.0035	
2014	0.0095	0.0033	
2015	0.0094	0.0031	
2016	0.0091	0.0029	
2017	0.0084	0.0018	
2018	0.0081	0.0015	
2019	0.0080	0.0013	
2020	0.0079	0.0012	
Gasoline Heavy-Duty Vehicles	1980-1984	0.4804	0.0497
	1981-1984	0.4492	0.0538
	1985-1986	0.4090	0.0515
	1987	0.3675	0.0849
	1988-1989	0.3492	0.0933
	1990-1995	0.3246	0.1142
	1996	0.1278	0.1980
	1997	0.0924	0.1726
	1998	0.0655	0.1750
	1999	0.0648	0.1724
	2000	0.0630	0.1660
	2001	0.0577	0.1468
	2002	0.0634	0.1673
	2003	0.0602	0.1563
	2004	0.0298	0.0164
	2005	0.0297	0.0083
	2006	0.0299	0.0241
	2007	0.0322	0.0015
	2008	0.0340	0.0015
	2009	0.0339	0.0015
	2010	0.0320	0.0015
	2011	0.0304	0.0015
2012	0.0313	0.0015	
2013	0.0313	0.0015	
2014	0.0315	0.0015	
2015	0.0332	0.0021	
2016	0.0321	0.0061	
2017	0.0329	0.0084	
2018	0.0328	0.0082	
2019	0.0330	0.0091	
2020	0.0328	0.0098	
Gasoline Motorcycles	1960-1995	0.0070	0.0083
	1996-2005	0	0
	2006-2020	0.0070	0.0083

Source: EPA (2022) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020 (Annexes). All values are calculated from Tables A-84 through A-88.

Notes: Emission factor updates due to a methodology change. The factors represented in the table above represent combustion emissions only (tank-to-wheel) and do not represent upstream emissions or well-to-wheel emissions.

Table 4 Mobile Combustion CH₄ and N₂O for On-Road Diesel and Alternative Fuel Vehicles

Vehicle Type	Fuel Type	Vehicle Year	CH ₄ Factor (g / mile)	N ₂ O Factor (g / mile)
Passenger Cars	Diesel	1960-1982	0.0006	0.0012
		1983-2006	0.0005	0.0010
		2007-2020	0.0302	0.0192
Light-Duty Trucks	Diesel	1960-1982	0.0011	0.0017
		1983-2006	0.0009	0.0014
		2007-2020	0.0290	0.0214
Medium- and Heavy-Duty Vehicles	Diesel	1960-2006	0.0051	0.0048
		2007-2020	0.0095	0.0431
Light-Duty Cars	Methanol		0.0150	0.0040
	Ethanol		0.0150	0.0040
	CNG		0.1460	0.0040
	LPG		0.0150	0.0040
	Biodiesel		0.0300	0.0190
				0.0160
Light-Duty Trucks	Ethanol		0.1580	0.0050
	CNG		0.1580	0.0050
	LPG		0.0160	0.0050
	LNG		0.1580	0.0050
	Biodiesel		0.0290	0.0210
Medium-Duty Trucks	CNG		1.8290	0.0010
	LPG		0.0090	0.0180
	LNG		1.8290	0.0010
	Biodiesel		0.0090	0.0430
	Methanol		0.0750	0.0280
Heavy-Duty Trucks	Ethanol		0.0750	0.0280
	CNG		0.9210	0
	LPG		0.0030	0.0070
	LNG		0.9210	0
	Biodiesel		0.0090	0.0430
Buses	Methanol		0.1020	0.0470
	Ethanol		0.1020	0.0470
	CNG		2.7870	0.0010
	LPG		0.0100	0.0110
	LNG		2.7870	0.0010
	Biodiesel		0.0090	0.0430

Source: EPA (2022) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020 (Annexes). All values are calculated from Tables A-88 through A-90.
<https://www.epa.gov/gheissions/inventory-us-greenhouse-gas-emissions-and-sinks>

Notes:
Emission factor updates due to a methodology change.
The factors represented in the table above represent combustion emissions only (tank-to-wheel) and do not represent upstream emissions or well-to-wheel emissions.

Table 5 Mobile Combustion CH₄ and N₂O for Non-Road Vehicles

Vehicle Type	Fuel Type	CH ₄ Factor (g / gallon)	N ₂ O Factor (g / gallon)
Ships and Boats	Residual Fuel Oil	1.11	0.32
	Gasoline (2 stroke)	4.61	0.08
	Gasoline (4 stroke)	2.25	0.01
	Diesel	6.41	0.17
Locomotives	Diesel	0.80	0.26
Aircraft	Jet Fuel	0	0.30
	Aviation Gasoline	7.06	0.11
Agricultural Equipment ^a	Gasoline (2 stroke)	6.92	0.47
	Gasoline (4 stroke)	1.93	1.20
	Gasoline Off-Road Trucks	1.93	1.20
	Diesel Equipment	1.27	1.07
	Diesel Off-Road Trucks	0.91	0.56
Construction/Mining Equipment ^b	LPG	0.33	0.94
	Gasoline (2 stroke)	7.98	0.12
	Gasoline (4 stroke)	2.85	1.47
	Gasoline Off-Road Trucks	2.85	1.48
	Diesel Equipment	1.01	0.94
Lawn and Garden Equipment	Diesel Off-Road Trucks	0.91	0.56
	LPG	0.59	0.50
	Gasoline (2 stroke)	7.28	0.31
	Gasoline (4 stroke)	2.99	1.49
Airport Equipment	Diesel	0.67	0.49
	LPG	0.41	0.63
	Gasoline	1.03	1.07
Industrial/Commercial Equipment	Diesel	1.88	1.16
	LPG	0.35	0.89
	Gasoline (2 stroke)	7.12	0.50
	Gasoline (4 stroke)	2.74	1.54
Logging Equipment	Diesel	0.41	0.60
	LPG	0.45	0.64
	Gasoline (2 stroke)	9.68	0
Railroad Equipment	Gasoline (4 stroke)	3.24	2.05
	Diesel	0.48	1.27
	Gasoline	3.24	1.81
Recreational Equipment	Diesel	0.38	0.95
	LPG	1.98	0.01
	Gasoline (2 stroke)	17.61	0.11
	Gasoline (4 stroke)	2.87	1.50
	Diesel	0.73	0.66
	LPG	0.43	0.60

Source: EPA (2022) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020 (Annexes). All values are calculated from Tables A-91 through A-92.
<https://www.epa.gov/gheissions/inventory-us-greenhouse-gas-emissions-and-sinks>

Notes:
Emission factor updates due to a methodology change.
The factors represented in the table above represent combustion emissions only (tank-to-wheel) and do not represent upstream emissions or well-to-wheel emissions.
^a Includes equipment, such as tractors and combines, as well as fuel consumption from trucks that are used off-road in agriculture.
^b Includes equipment, such as cranes, dumpers, and excavators, as well as fuel consumption from trucks that are used off-road in construction.

Table 6 Electricity

eGRID Subregion Acronym	eGRID Subregion Name	Total Output Emission Factors			Non-BaseLoad Emission Factors		
		CO ₂ Factor (lb / MWh)	CH ₄ Factor (lb / MWh)	N ₂ O Factor (lb / MWh)	CO ₂ Factor (lb / MWh)	CH ₄ Factor (lb / MWh)	N ₂ O Factor (lb / MWh)
AKGD	AKGD (ASCC Alaska Grid)	1,067.7	0.091	0.012	1,229.6	0.120	0.016
AKMS	AKMS (ASCC Miscellaneous)	482.2	0.025	0.004	1,331.3	0.066	0.016
AZNM	AZNM (WECC Southwest)	819.7	0.052	0.007	1,227.6	0.067	0.009
CAMX	CAMX (WECC California)	531.7	0.031	0.004	1,047.5	0.049	0.006
ERCT	ERCT (ERCOT All)	813.6	0.054	0.008	1,177.4	0.065	0.009
FRCC	FRCC (FRCC All)	832.9	0.053	0.007	1,016.5	0.054	0.007
HIMS	HIMS (HICC Miscellaneous)	1,134.4	0.135	0.021	1,649.4	0.176	0.027
HIOA	HIOA (HICC Oahu)	1,633.1	0.176	0.027	1,784.0	0.172	0.027
MROE	MROE (MRO East)	1,582.1	0.148	0.022	1,555.9	0.133	0.019
MROW	MROW (MRO West)	995.8	0.107	0.015	1,808.3	0.183	0.028
NEWE	NEWE (NPCC New England)	539.4	0.072	0.009	900.5	0.073	0.009
NWPP	NWPP (WECC Northwest)	634.6	0.058	0.008	1,545.7	0.139	0.020
NYCW	NYCW (NPCC NYC/Westchester)	816.8	0.019	0.002	930.8	0.020	0.002
NYLI	NYLI (NPCC Long Island)	1,210.9	0.126	0.016	1,317.3	0.040	0.005
NYUP	NYUP (NPCC Upstate NY)	233.1	0.015	0.002	880.7	0.047	0.006
PRMS	PRMS (Puerto Rico Miscellaneous)	1,358.0	0.081	0.013	1,618.1	0.060	0.011
RFCE	RFCE (RFC East)	872.8	0.049	0.007	1,357.3	0.106	0.015
RFCM	RFCM (RFC Michigan)	1,214.1	0.115	0.016	1,717.0	0.160	0.023
FCW	FCW (RFC West)	1,046.1	0.095	0.014	1,798.8	0.172	0.025
RMPA	RMPA (WECC Rockies)	1,158.9	0.109	0.016	1,614.2	0.128	0.018
SPNO	SPNO (SPP North)	991.7	0.108	0.018	1,926.2	0.204	0.029
SPSO	SPSO (SPP South)	1,031.6	0.080	0.012	1,584.6	0.116	0.017
SRMV	SRMV (SERC Mississippi Valley)	775.7	0.040	0.006	1,177.0	0.066	0.009
SRMW	SRMW (SERC Midwest)	1,543.0	0.171	0.025	1,763.2	0.179	0.026
SRSO	SRSO (SERC South)	891.9	0.067	0.010	1,384.6	0.101	0.015
SRTV	SRTV (SERC Tennessee Valley)	931.6	0.087	0.013	1,636.2	0.151	0.022
SRVC	SRVC (SERC Virginia/Carolina)	639.7	0.052	0.007	1,357.0	0.116	0.016
US Average	US Average	852.3	0.071	0.010	1,410.0	0.110	0.016

Source: EPA eGRID2021, February 2023 (Table 1. Subregion Output Emission Rates)

<https://www.epa.gov/eGRID/download-data>

Notes:

Total output emission factors can be used as default factors for estimating GHG emissions from electricity use when developing a carbon footprint or emissions inventory. Annual non-base-load output emission factors should not be used when developing a carbon footprint or emissions inventory, but can be used to estimate GHG emissions reductions on the grid from changes in electricity use.

For technical information, reference the EPA's eGRID Technical Guide

https://www.epa.gov/system/files/documents/2023-01/eGRID2021_technical_guide.pdf

The factors represented in the table above represent combustion emissions only (tank-to-wheel) and do not represent upstream emissions or well-to-wheel emissions.

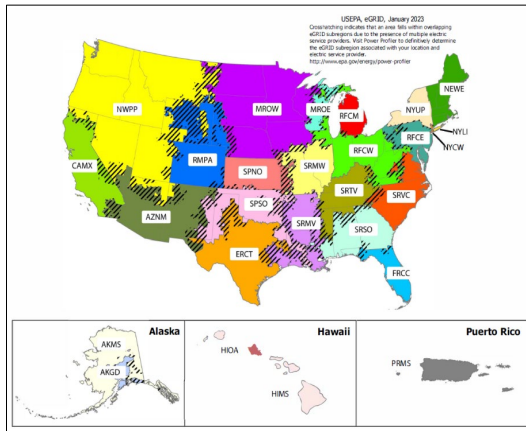


Table 7 Steam and Heat

	CO ₂ Factor (kg / mmBtu)	CH ₄ Factor (g / mmBtu)	N ₂ O Factor (g / mmBtu)
Steam and Heat	66.33	1.250	0.125

Notes:

Emission factors are per mmBtu of steam or heat purchased. These factors assume natural gas fuel is used to generate steam or heat at 80 percent thermal efficiency. The factors represented in the table above represent combustion emissions only (tank-to-wheel) and do not represent upstream emissions or well-to-wheel emissions.

Scope 3 Emission Factors

Scope 3 emission factors provided below are aligned with the Greenhouse Gas Protocol Technical Guidance for Calculating Scope 3 Emissions, version 1.0 (Scope 3 Calculation Guidance). Where applicable, the specific calculation method is referenced. Refer to the Scope 3 Calculation Guidance for more information (<http://www.ghgprotocol.org/scope-3-technical-calculation-guidance>)

Table 8 Scope 3 Category 4: Upstream Transportation and Distribution and Category 9: Downstream Transportation and Distribution

These factors are intended for use in the distance-based method defined in the Scope 3 Calculation Guidance. If fuel data are available, then the fuel-based method should be used, with factors from Tables 2 through 5.

Vehicle Type	CO ₂ Factor (kg / unit)	CH ₄ Factor (g / unit)	N ₂ O Factor (g / unit)	Units
Medium- and Heavy-Duty Truck	1.387	0.013	0.038	vehicle-mile
Passenger Car ^A	0.313	0.008	0.007	vehicle-mile
Light-Duty Truck ^B	0.467	0.013	0.012	vehicle-mile
Medium- and Heavy-Duty Truck ^C	0.170	0.0016	0.0047	ton-mile
Rail	0.021	0.0016	0.0005	ton-mile
Waterborne Craft	0.044	0.0254	0.0011	ton-mile
Aircraft	0.698	0	0.0215	ton-mile

Source:

CO₂, CH₄, and N₂O emissions data for road vehicles are from Table 2-13 of the EPA (2022) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020.

Vehicle-miles and passenger-miles data for road vehicles are from Table VM-1 of the Federal Highway Administration Highway Statistics 2020.

CO₂e emissions data for non-road vehicles are based on Table A-107 of the EPA (2022) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020, which are distributed into CO₂, CH₄, and N₂O emissions based on fuel/vehicle emission factors.

Freight ton-mile data are from Table 1-50 of the Bureau of Transportation Statistics, National Transportation Statistics for 2021 (2020 data).

Notes:

Vehicle-mile factors are appropriate to use when the entire vehicle is dedicated to transporting the reporting company's product. Ton-mile factors are appropriate when the vehicle is shared with products from other companies.

The factors represented in the table above represent combustion emissions only (tank-to-wheel) and do not represent upstream emissions or well-to-wheel emissions.

^A Passenger car: includes passenger cars, minivans, SUVs, and small pickup trucks (vehicles with wheelbase less than 121 inches).

^B Light-duty truck: includes full-size pickup trucks, full-size vans, and extended-length SUVs (vehicles with wheelbase greater than 121 inches).

^C Medium- and Heavy-Duty Truck: includes Combination Trucks and single frame trucks that have 2-Axes and at least 6 tires or a gross vehicle weight rating exceeding 10,000 lbs.

Table 9 Scope 3 Category 5: Waste Generated in Operations and Category 12: End-of-Life Treatment of Sold Products

These factors are intended for use in the waste-type-specific method or the average-data method defined in the Scope 3 Calculation Guidance for category 5 and category 12. Choose the appropriate material and disposal method from the table below. For the average-data method, use one of the mixed material types, such as mixed MSW.

Material	Metric Tons CO ₂ e / Short Ton Material					
	Recycled ^d	Landfilled ^b	Combusted ^c	Composted ^d	Anaerobically Digested (Dry Digestate with Curing)	Anaerobically Digested (Wet Digestate with Curing)
Aluminum Cans	0.06	0.02	0.01	NA	NA	NA
Aluminum Ingot	0.04	0.02	0.01	NA	NA	NA
Steel Cans	0.32	0.02	0.01	NA	NA	NA
Copper Wire	0.18	0.02	0.01	NA	NA	NA
Glass	0.05	0.02	0.01	NA	NA	NA
HDPE	0.21	0.02	2.80	NA	NA	NA
LDPE	NA	0.02	2.80	NA	NA	NA
PET	0.23	0.02	2.05	NA	NA	NA
LLDPE	NA	0.02	2.80	NA	NA	NA
PP	NA	0.02	2.80	NA	NA	NA
PS	NA	0.02	3.02	NA	NA	NA
PVC	NA	0.02	1.26	NA	NA	NA
PLA	NA	0.02	0.01	0.17	NA	NA
Corrugated Containers	0.11	0.90	0.05	NA	NA	NA
Magazines/Third-class mail	0.02	0.42	0.05	NA	NA	NA
Newspaper	0.02	0.35	0.05	NA	NA	NA
Office Paper	0.02	1.25	0.05	NA	NA	NA
Phonebooks	0.04	0.35	0.05	NA	NA	NA
Textbooks	0.04	1.25	0.05	NA	NA	NA
Dimensional Lumber	0.09	0.17	0.05	NA	NA	NA
Medium-density Fiberboard	0.15	0.07	0.05	NA	NA	NA
Food Waste (non-meat)	NA	0.58	0.05	0.15	0.14	0.11
Food Waste (meat only)	NA	0.58	0.05	NA	0.14	0.11
Beef	NA	0.58	0.05	0.15	0.14	0.11
Poultry	NA	0.58	0.05	0.15	0.14	0.11
Grains	NA	0.58	0.05	0.15	0.14	0.11
Bread	NA	0.58	0.05	0.15	0.14	0.11
Fruits and Vegetables	NA	0.58	0.05	0.15	0.14	0.11
Dairy Products	NA	0.58	0.05	0.15	0.14	0.11
Yard Trimmings	NA	0.33	0.05	0.19	0.11	NA
Grass	NA	0.26	0.05	0.19	0.09	NA
Leaves	NA	0.26	0.05	0.19	0.13	NA
Branches	NA	0.53	0.05	0.19	0.16	NA
Mixed Paper (general)	0.07	0.02	0.05	NA	NA	NA
Mixed Paper (primarily residential)	0.07	0.77	0.05	NA	NA	NA
Mixed Paper (primarily from offices)	0.03	0.75	0.05	NA	NA	NA
Mixed Metals	0.23	0.02	0.01	NA	NA	NA
Mixed Plastics	0.22	0.02	2.34	NA	NA	NA
Mixed Recyclables	0.09	0.68	0.11	NA	NA	NA
Food Waste	NA	0.58	0.05	0.15	NA	NA
Mixed Organics	NA	0.48	0.05	0.17	NA	NA
Mixed MSW	NA	0.52	0.43	NA	NA	NA
Carpet	NA	0.02	1.68	NA	NA	NA
Desktop CPUs	NA	0.02	0.40	NA	NA	NA
Portable Electronic Devices	NA	0.02	0.89	NA	NA	NA
Flat-panel Displays	NA	0.02	0.74	NA	NA	NA
CRT Displays	NA	0.02	0.64	NA	NA	NA
Electronic Peripherals	NA	0.02	2.23	NA	NA	NA
Hard-copy Devices	NA	0.02	1.92	NA	NA	NA
Mixed Electronics	NA	0.02	0.87	NA	NA	NA
Clay Bricks	NA	0.02	NA	NA	NA	NA
Concrete	0.01	0.02	NA	NA	NA	NA
Fly Ash	0.01	0.02	NA	NA	NA	NA
Tires	0.10	0.02	2.21	NA	NA	NA
Asphalt Concrete	0	0.02	NA	NA	NA	NA
Asphalt Shingles	0.03	0.02	0.70	NA	NA	NA
Drywall	NA	0.02	NA	NA	NA	NA
Fiberglass Insulation	0.05	0.02	NA	NA	NA	NA
Vinyl Flooring	NA	0.02	0.29	NA	NA	NA
Wood Flooring	NA	0.18	0.08	NA	NA	NA

Source: EPA, Office of Resource Conservation and Recovery (February 2016) Documentation for Greenhouse Gas Emission and Energy Factors used in the Waste Reduction Model (WARM). Factors from tables provided in the Management Practices Chapters and Background Chapters. WARM Version 15, November 2020 Update. Additional data provided by EPA, WARM-15 Background Data.

Notes: These factors do not include any avoided emissions impact from any of the disposal methods. All the factors presented here include transportation emissions, which are optional in the Scope 3 Calculation Guidance, with an assumed average distance traveled to the processing facility. AR4 GWPs are used to convert all waste emission factors into CO₂e.

^a Recycling emissions include transport to recycling facility and sorting of recycled materials at material recovery facility.

^b Landfilling emissions include transport to landfill, equipment use at landfill and fugitive landfill CH₄ emissions. Landfill CH₄ is based on typical landfill gas collection practices and average landfill moisture conditions.

^c Combustion emissions include transport to combustion facility and combustion-related non-biogenic CO₂ and N₂O.

^d Composting emissions include transport to composting facility, equipment use at composting facility and CH₄ and N₂O emissions during composting.

Table 10 Scope 3 Category 6: Business Travel and Category 7: Employee Commuting

These factors are intended for use in the distance-based method defined in the Scope 3 Calculation Guidance. If fuel data are available, then the fuel-based method should be used, with factors from Tables 2 through 5.

Vehicle Type	CO ₂ Factor (kg / unit)	CH ₄ Factor (g / unit)	N ₂ O Factor (g / unit)	Units
Passenger Car ^a	0.313	0.008	0.007	vehicle-mile
Light-Duty Truck ^b	0.467	0.013	0.012	vehicle-mile
Motorcycle	0.178	0.111	0.019	vehicle-mile
Intercity Rail - Northeast Corridor ^c	0.058	0.0055	0.0007	passenger-mile
Intercity Rail - Other Routes ^c	0.150	0.0117	0.0038	passenger-mile
Intercity Rail - National Average ^c	0.113	0.0092	0.0026	passenger-mile
Commuter Rail ^d	0.135	0.0109	0.0027	passenger-mile
Transit Rail (i.e. Subway, Tram) ^e	0.096	0.0080	0.0011	passenger-mile
Bus	0.055	0.0063	0.0011	passenger-mile
Air Travel - Short Haul (< 300 miles)	0.207	0.0064	0.0066	passenger-mile
Air Travel - Medium Haul (>= 300 miles, < 2300 miles)	0.129	0.0006	0.0041	passenger-mile
Air Travel - Long Haul (>= 2300 miles)	0.163	0.0006	0.0052	passenger-mile

Source: CO₂, CH₄, and N₂O emissions data for highway vehicles are from Table 2-13 of the EPA (2022) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2020.

Vehicle-miles and passenger-miles data for highway vehicles are from Table VM-1 of the Federal Highway Administration Highway Statistics 2020.

Fuel consumption data and passenger-miles data for rail are from Tables A.14 to A.16 and C.9 to C.11 of the Transportation Energy Data Book: Edition 40. Fuel consumption was converted to emissions by using fuel and electricity emission factors presented in the tables above.

Intercity Rail factors from communication with Amtrak, March 2020. These are based on 2019 values.

Air Travel factors from 2022 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting. Version 2.0 June 2022.

Notes:

The factors represented in the table above represent combustion emissions only (tank-to-wheel) and do not represent upstream emissions or well-to-wheel emissions.

CH₄ and N₂O emission factor updates for motorcycle and bus due to a methodology change.

^a Passenger car: includes passenger cars, minivans, SUVs, and small pickup trucks (vehicles with wheelbase less than 121 inches).

^b Light-duty truck: includes full-size pickup trucks, full-size vans, and extended-length SUVs (vehicles with wheelbase greater than 121 inches).

^c Intercity rail: Amtrak long-distance rail between major cities. Northeast Corridor extends from Boston to Washington D.C. Other Routes are all routes outside the Northeast Corridor.

^d Commuter rail: rail service between a central city and adjacent suburbs (also called regional rail or suburban rail).

^e Transit rail: rail typically within an urban center, such as subways, elevated railways, metropolitan railways (metro), streetcars, trolley cars, and trams.

Global Warming Potentials

Table 11 Global Warming Potentials (GWPs)

Gas	100-Year GWP
CO ₂	1
CH ₄	25
N ₂ O	298
HFC-23	14,800
HFC-32	675
HFC-41	92
HFC-125	3,500
HFC-134	1,100
HFC-134a	1,430
HFC-143	353
HFC-143a	4,470
HFC-152	53
HFC-152a	124
HFC-161	12
HFC-227ea	3,220
HFC-236cb	1,340
HFC-236ea	1,370
HFC-236fa	9,810
HFC-245ca	693
HFC-245fa	1,030
HFC-365mfc	794
HFC-43-10mee	1,640
SF ₆	22,800
NF ₃	17,200
CF ₄	7,390
C ₂ F ₆	12,200
C ₃ F ₈	8,830
c-C ₄ F ₈	10,300
C ₆ F ₁₀	8,860
C ₆ F ₁₂	9,160
C ₈ F ₁₄	9,300
C ₁₀ F ₁₈	>7,500

Source: 100-year GWPs from IPCC Fourth Assessment Report (AR4), 2007. IPCC AR4 was published in 2007 and is among the most current and comprehensive peer-reviewed assessments of climate change. AR4 provides revised GWPs of several GHGs relative to the values provided in previous assessment reports, following advances in scientific knowledge on the radiative efficiencies and atmospheric lifetimes of these GHGs and of CO₂.

Factors in the 2023 Emission Factors update are based on AR4 GWPs, but EPA recognizes that Fifth Assessment Report (AR5) GWPs have been published and used in the Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2021 report (published February 2023). However, this 2023 Emission Factors Hub and the GHG Reporting Program continue to use AR4 GWPs. EPA plans to incorporate AR5 GWPs into the 2024 Emission Factors Hub update.

Table 12 Global Warming Potentials (GWPs) for Blended Refrigerants

ASHRAE #	100-year GWP	Blend Composition
R-401A	16	53% HCFC-22, 34% HCFC-124, 13% HFC-152a
R-401B	14	81% HCFC-22, 28% HCFC-124, 11% HFC-152a
R-401C	19	33% HCFC-22, 52% HCFC-124, 15% HFC-152a
R-402A	2,100	38% HCFC-22, 6% HFC-125, 2% propane
R-402B	1,330	60% HCFC-22, 38% HFC-125, 2% propane
R-403B	3,444	56% HCFC-22, 39% PFC-218, 5% propane
R-404A	3,922	44% HFC-125, 4% HFC-134a, 52% HFC 143a
R-406A	0	55% HCFC-22, 41% HCFC-142b, 4% isobutane
R-407A	2,107	20% HFC-32, 40% HFC-125, 40% HFC-134a
R-407B	2,804	10% HFC-32, 70% HFC-125, 20% HFC-134a
R-407C	1,774	23% HFC-32, 25% HFC-125, 52% HFC-134a
R-407D	1,627	15% HFC-32, 15% HFC-125, 70% HFC-134a
R-407E	1,552	25% HFC-32, 15% HFC-125, 60% HFC-134a
R-408A	2,301	47% HCFC-22, 7% HFC-125, 46% HFC 143a
R-409A	0	60% HCFC-22, 25% HCFC-124, 15% HCFC-142b
R-410A	2,088	50% HFC-32, 50% HFC-125
R-410B	2,229	45% HFC-32, 55% HFC-125
R-411A	14	87.5% HCFC-22, 11% HFC-152a, 1.5% propylene
R-411B	4	94% HCFC-22, 3% HFC-152a, 3% propylene
R-413A	2,053	88% HFC-134a, 9% PFC-218, 3% isobutane
R-414A	0	51% HCFC-22, 28.5% HCFC-124, 16.5% HCFC-142b
R-414B	0	5% HCFC-22, 39% HCFC-124, 9.5% HCFC-142b
R-417A	2,346	46.6% HFC-125, 5% HFC-134a, 3.4% butane
R-422A	3,143	85.1% HFC-125, 11.5% HFC-134a, 3.4% isobutane
R-422D	2,729	83.1% HFC-125, 31.5% HFC-134a, 3.4% isobutane
R-423A	2,280	47.5% HFC-227ea, 52.5% HFC-134a
R-424A	2,440	50.5% HFC-125, 47% HFC-134a, 2.5% butane/pentane
R-426A	1,508	5.1% HFC-125, 93% HFC-134a, 1.9% butane/pentane
R-428A	3,607	77.5% HFC-125, 2% HFC-143a, 1.9% isobutane
R-434A	3,245	63.2% HFC-125, 16% HFC-134a, 18% HFC-143a, 2.8% isobutane
R-500	32	73.8% CFC-12, 26.2% HFC-152a, 48.8% HCFC-22
R-502	0	48.8% HCFC-22, 51.2% CFC-115
R-504	325	48.2% HFC-32, 51.8% CFC-115
R-507	3,985	5% HFC-125, 5% HFC-143a
R-508A	13,214	39% HFC-23, 61% PFC-116
R-508B	13,396	46% HFC-23, 54% PFC-116

Source: 100-year GWPs from IPCC Fourth Assessment Report (AR4), 2007. See the source note to Table 11 for further explanation. GWPs of blended refrigerants are based on their HFC and PFC constituents, which are based on data from <http://www.epa.gov/ozzone/snap/refrigerants/reblend.html>.