Carbon Footprint

"A carbon footprint is the total greenhouse gas (GHG) emissions caused directly and indirectly by an individual, organization, event or product."[1] It is calculated by summing the emissions resulting from every stage of a product or service's lifetime (material production, manufacturing, use, and end-of-life). Throughout a product's lifetime, or lifecycle, GHGs may be emitted, such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), each with a greater or lesser ability to trap heat in the atmosphere. These differences are accounted for by the global warming potential (GWP) of each gas, resulting in a carbon footprint in units of mass of carbon dioxide equivalents (CO_2e). See the Center for Sustainable Systems "Greenhouse Gases Factsheet" for more information on GWP. A typical U.S. household has a carbon footprint of 48 metric tons (t) CO_2e/yr.[2]

Sources of Emissions

Food

- Food accounts for 10-30% of a household's carbon footprint, typically a higher portion in lower-income households.[2] Production accounts for 68% of food emissions, while transportation accounts for 5%.[4]
- Food production emissions consist mainly of CO_2, N_2O, and CH_4, which result primarily from agricultural practices.[5]
- Meat products have larger carbon footprints per calorie than grain or vegetable products because of the inefficient conversion of plant to animal energy and due to CH_4 released from manure management and enteric fermentation in ruminants.[5]
- Livestock emitted 195 million metric tons (Mt) CO_2e of methane in 2021 from enteric fermentation, 139 Mt (71%) of it from beef cattle.[6]
- In an average U.S. household, eliminating the transport of food for one year could save the GHG equivalent of driving 1,000 miles, while shifting to a vegetarian meal one day a week could save the equivalent of driving 1,160 miles.[5]
- A vegetarian diet greatly reduces an individual's carbon footprint, but switching to less carbon intensive meats can have a major impact as well. For example, beef's GHG emissions per kilogram are 7.2 times greater than those of chicken.[7]
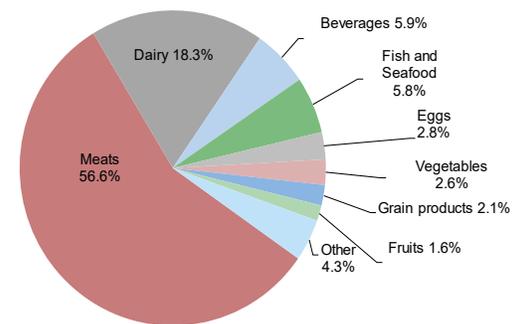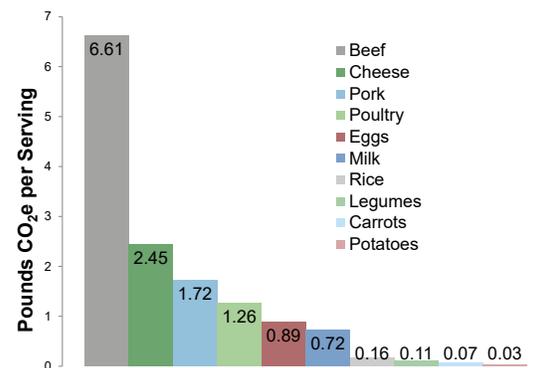
Household Emissions

- For each kWh generated in the U.S., an average of 0.857 pounds of CO_2e is released at the power plant.[8] Coal releases 2.2 pounds, petroleum releases 2.0 pounds, and natural gas releases 0.9 pounds. Nuclear, solar, wind, and hydroelectric release no CO_2 when they produce electricity, but emissions are released during upstream production activities (e.g., solar cells, nuclear fuels, cement production).[6,9]
- Residential electricity use in 2021 emitted 578.3 Mt CO_2e, 9.1% of the U.S. total.[6]
- Space heating and cooling are estimated to account for 44% of energy in U.S. residential buildings in 2023.[10]
- Refrigerators are one of the largest users of household appliance energy; in 2021, an average of 718 lbs CO_2e per household was due to refrigeration.[8,11]
- 26 Mt CO_2e are released in the U.S. each year from washing clothes. Switching to a cold water wash once per week can reduce household GHG emissions by over 70 lbs annually.[12]
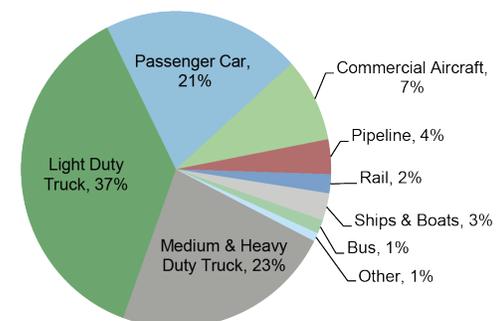
Personal Transportation

- U.S. fuel economy (mpg) declined by 12% from 1988-2004, then improved by 32% from 2004-2021, reaching an average of 25.4 mpg in 2021.[14] Annual per capita miles driven increased 9% since 1995 to 9,937 miles in 2019.[15]
- Cars and light trucks emitted 1.05 billion metric tons (Gt) CO_2e or 16.5% of the total U.S. GHG emissions in 2021.[6]
- Of the roughly 66,000 lbs CO_2e emitted over the lifetime of an internal combustion engine car (assuming 93,000 miles driven), 84% come from the use phase.[16]
- Gasoline releases 19.4 pounds of CO_2 per gallon when burned, compared to 22.5 pounds per gallon for diesel.[17] However, diesel has 11% more BTU per gallon, which improves its fuel economy.[18]
- The average passenger car emits 0.77 pounds of CO_2 per mile driven.[14]
- Automobile fuel economy can improve 7-14% by simply observing the speed limit. Every 5 mph increase in vehicle speed over 50 mph is equivalent to paying an extra $0.25-$0.50 per gallon.[19]

Greenhouse Gases Contribution by Food Type in Average Diet[3]

- Dairy 18.3%
- Meats 56.6%
- Beverages 5.9%
- Fish and Seafood 5.8%
- Eggs 2.8%
- Vegetables 2.6%
- Grain products 2.1%
- Fruits 1.6%
- Other 4.3%

Pounds of CO_2e per Serving[13]
(4 oz. meat, 1/2 c. asparagus & carrots, 8 oz. liquids)

- Beef: 6.61
- Cheese: 2.45
- Pork: 1.72
- Poultry: 1.26
- Eggs: 0.89
- Milk: 0.72
- Rice: 0.16
- Legumes: 0.11
- Carrots: 0.07
- Potatoes: 0.03

Transportation Greenhouse Gases, 2021[6]

- Passenger Car, 21%
- Light Duty Truck, 37%
- Medium & Heavy Duty Truck, 23%
- Commercial Aircraft, 7%
- Pipeline, 4%
- Rail, 2%
- Ships & Boats, 3%
- Bus, 1%
- Other, 1%

- Commercial aircraft GHG emissions vary according to aircraft type, trip length, occupancy, and passenger and cargo weight, and totaled 120 Mt CO_2e in 2021.[6] In 2021, the average domestic commercial flight emitted 0.75 pounds of CO_2e per passenger mile.[6,20]
- Domestic air travel fuel efficiency (passenger miles/gallon) had increased 115% from 1990-2019 largely due to increased occupancy. The Covid-19 pandemic decreased this improvement to a 20% increase in fuel efficiency from 1990-2021.[20] Emissions per domestic passenger-mile decreased 44% from 1990-2019, but increased 47% from 2019-2021 due to Covid restrictions.[6,20]
- In 2021, rail transportation emitted 35.2 Mt CO_2e, accounting for 2% of transportation emissions in the U.S.[6]

Solutions and Sustainable Actions

Ways to Reduce Carbon Footprint

- Reduce meat in your diet and avoid wasting food.
- Walk, bike, carpool, use mass transit, or drive a best-in-class vehicle.
- Ensure car tires are properly inflated. Fuel efficiency decreases by 0.2% for each 1 PSI decrease.[21]
- Smaller houses use less energy. Average household energy use is highest in single-family houses (80.85 million BTU), followed by mobile homes (61.3 million BTU), apartments with 2-4 units (53.5 million BTU), and apartments with 5+ units in the building (33.7 million BTU).[11]
- Whether you hand wash dishes or use a dishwasher, follow recommended practices to decrease water and energy use and reduce emissions.[22]
- Energy consumed by devices in standby mode accounts for 5-10% of residential energy use, adding up to $100 per year for the average American household. Unplug electronic devices when not in use or plug them into a power strip and turn the power strip off.[23]
- Choose energy-efficient lighting. Switching from incandescent to LED light bulbs saves an average household more than $200/year.[24,25]
- Reduce what you send to a landfill by recycling, composting, and buying products with minimal packaging.
- Purchase items with a comparatively low carbon footprint. Some manufacturers have begun assessing and publishing their products' carbon footprints.
- Covering 80% of roof area on commercial buildings in the U.S. with solar reflective material would conserve energy and offset 125 Mt CO_2 over the structures' lifetime, equivalent to turning off 34 coal power plants for one year.[26,27]
- Replacing the global fleet of shipping containers' roof and wall panels with aluminum would save $28 billion in fuel.[28]

U.S. Greenhouse Gas Emissions, 2020[29]
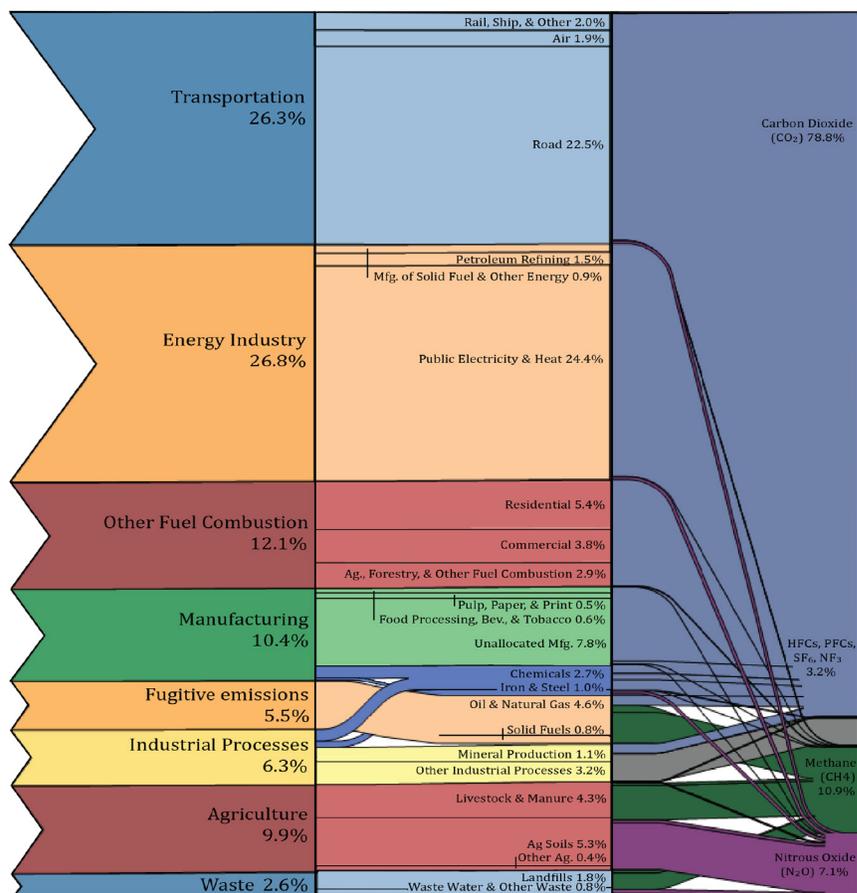
Carbon Footprint Calculator

Estimate your personal or household greenhouse gas emissions and explore the impact of different techniques to lower those emissions:
- U.S. Environmental Protection Agency: www3.epa.gov/carbon-footprint-calculator/
- The Nature Conservancy: www.nature.org/greenliving/carboncalculator/
- Global Footprint Network: https://www.footprintcalculator.org/

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