



# Carbon Footprint

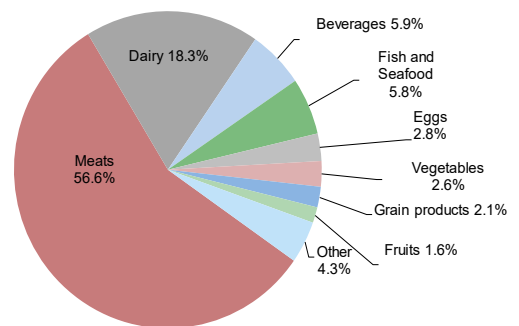
“A carbon footprint is the total greenhouse gas (GHG) emissions caused directly and indirectly by an individual, organization, event or product.”<sup>1</sup> It is calculated by summing the emissions resulting from every stage of a product or service’s lifetime (material production, manufacturing, use, and end-of-life). Throughout a product’s lifetime, or lifecycle, different GHGs may be emitted, such as carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O), 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<sub>2</sub>e). 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 CO<sub>2</sub>e/yr.<sup>2</sup>

## Sources of Emissions

### Food

- Food accounts for 10-30% of a household's carbon footprint, typically a higher portion in lower-income households.<sup>2</sup> Production accounts for 68% of food emissions, while transportation accounts for 5%.<sup>4</sup>
- Food production emissions consist mainly of CO<sub>2</sub>, N<sub>2</sub>O, and CH<sub>4</sub>, which result primarily from agricultural practices.<sup>5</sup>
- 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<sub>4</sub> released from manure management and enteric fermentation in ruminants.<sup>5</sup>
- Ruminants such as cattle, sheep, and goats produced 175 million metric tons (mmt) CO<sub>2</sub>e of enteric methane in the U.S. in 2020.<sup>6</sup>
- 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.<sup>5</sup>
- 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.<sup>7</sup>

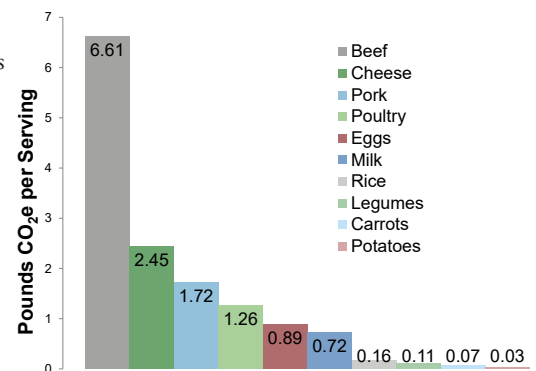
Greenhouse Gases Contribution by Food Type in Average Diet<sup>3</sup>



### Household Emissions

- For each kWh generated in the U.S., an average of 0.822 pounds of CO<sub>2</sub>e is released at the power plant.<sup>8</sup> Coal releases 2.3 pounds, petroleum releases 2.1 pounds, and natural gas releases 0.9 pounds. Nuclear, solar, wind, and hydroelectric release no CO<sub>2</sub> when they produce electricity, but emissions are released during upstream production activities (e.g., solar cells, nuclear fuels, cement production).<sup>6,9</sup>
- Residential electricity use in 2020 emitted 561.1 mmt CO<sub>2</sub>e, 9.4% of the U.S. total.<sup>6</sup>
- Space heating and cooling are estimated to account for 43% of energy in U.S. homes in 2022.<sup>10</sup>
- Refrigerators are one of the largest users of household appliance energy; in 2020, an average of 621 lbs CO<sub>2</sub>e per household was due to refrigeration.<sup>8,11</sup>
- 26 mmt CO<sub>2</sub>e 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.<sup>12</sup>

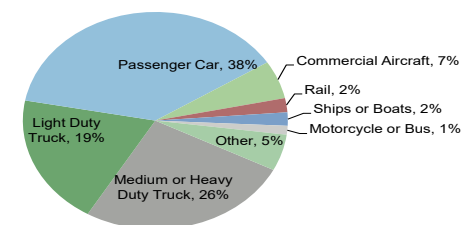
Pounds of CO<sub>2</sub>e per Serving<sup>13</sup>  
(4 oz. meat, 1/2 c. asparagus & carrots, 8 oz. liquids)



### Personal Transportation

- U.S. fuel economy (mpg) declined by 12% from 1988-2004, then improved by 32% from 2004-2020, reaching an average of 25.4 mpg in 2020.<sup>14</sup> Annual per capita miles driven increased 9% since 1995 to 9,937 miles in 2019.<sup>15</sup>
- Cars and light trucks emitted 0.9 billion metric tons CO<sub>2</sub>e or 16% of the total U.S. GHG emissions in 2020.<sup>6</sup>
- Of the roughly 66,000 lbs CO<sub>2</sub>e emitted over the lifetime of an internal combustion engine car (assuming 93,000 miles driven), 84% come from the use phase.<sup>16</sup>
- Gasoline releases 19.4 pounds of CO<sub>2</sub> per gallon when burned, compared to 22.5 pounds per gallon for diesel.<sup>17</sup> However, diesel has 11% more BTU per gallon, which improves its fuel economy.<sup>18</sup>
- The average passenger car emits 0.77 pounds of CO<sub>2</sub> per mile driven.<sup>14</sup>
- 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 \$0.28-\$0.57 per gallon.<sup>19</sup>

Transportation Greenhouse Gases, 2020<sup>6</sup>



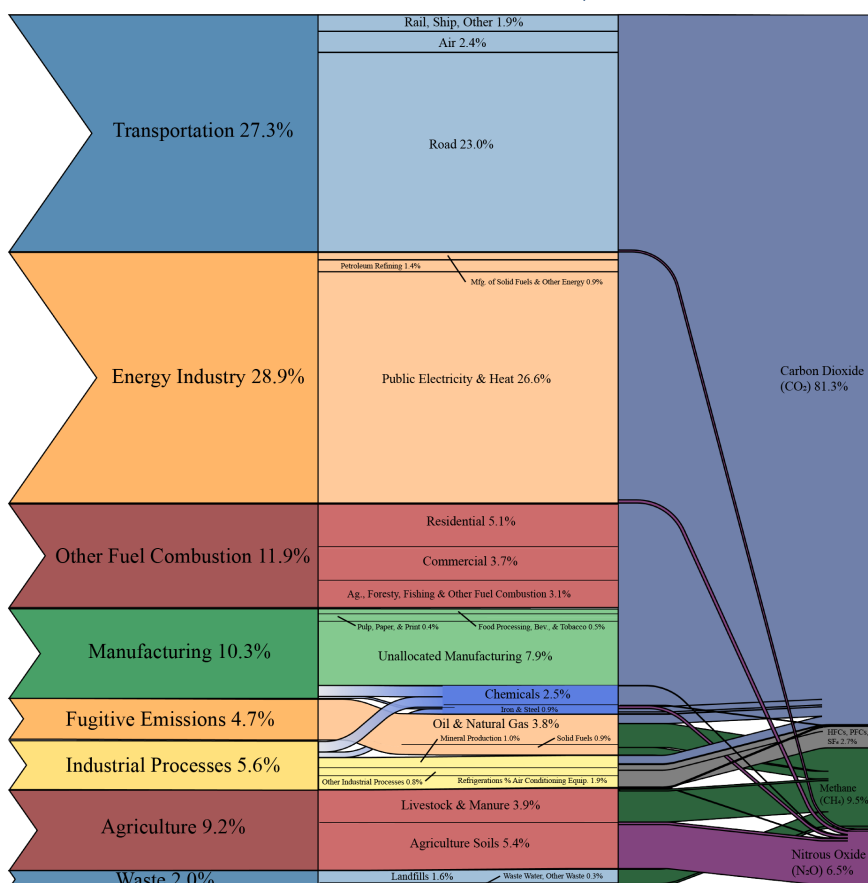
- Commercial aircraft GHG emissions vary according to aircraft type, trip length, occupancy rates, and passenger and cargo weight, and totaled 92.1 mmt CO<sub>2</sub>e in 2020.<sup>6</sup> In 2020, the average domestic commercial flight emitted 0.87 pounds of CO<sub>2</sub>e per passenger mile.<sup>6,20</sup>
- Domestic air travel fuel efficiency (passenger miles/gallon) rose by 115% from 1990 to 2019, largely due to increased occupancy.<sup>20</sup> Emissions per domestic passenger-mile decreased 45% from 1990-2019, but increased 55% from 2019-2020 due to COVID.<sup>6,20</sup>
- In 2020, rail transportation emitted 34.2 mmt CO<sub>2</sub>e, accounting for 2% of transportation emissions in the U.S.<sup>6</sup>

## 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.<sup>21</sup>
- Smaller homes use less energy. Average household energy use is highest in houses (82.3 million BTU), followed by mobile homes (59.8 million BTU), apartments with 2-4 units (53.5 million BTU), and apartments with 5+ units in the building (34.2 million BTU).<sup>11</sup>
- Whether you hand wash dishes or use a dishwasher, follow recommended practices to decrease water and energy use and reduce emissions.<sup>22</sup>
- 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.<sup>23</sup>
- Choose energy-efficient lighting and transition away from incandescent light bulbs.<sup>24</sup>
- 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 mmt CO<sub>2</sub> over the structures' lifetime, equivalent to turning off 34 coal power plants for one year.<sup>25,26</sup>
- Replacing the global fleet of shipping containers' roof and wall panels with aluminum would save \$28 billion in fuel.<sup>27</sup>

U.S. Greenhouse Gas Emissions, 2018<sup>28</sup>



### 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/](http://www3.epa.gov/carbon-footprint-calculator/)
- The Nature Conservancy: [www.nature.org/greenliving/carboncalculator/](http://www.nature.org/greenliving/carboncalculator/)
- Global Footprint Network: <https://www.footprintcalculator.org/>

- The Carbon Trust (2018) Carbon Footprinting.
- Jones C., Kammen D. (2011) "Quantifying Carbon Footprint Reduction Opportunities for U.S. Households and Communities."
- Heller, M.C., et al. (2018). Greenhouse gas emissions and energy use associated with production of individual self-selected US diets. *Environmental Research Letters*, 13(4), 044004.
- Boehm R., et al. (2018) "A Comprehensive Life Cycle Assessment of Greenhouse Gas Emissions from U.S. Household Food Choices."
- Weber, C. and H. Matthews (2008) "Food miles and the Relative Climate Impacts of Food Choices in the United States." *Environmental Science & Technology*, 42(10): 3508-3513.
- U.S. Environmental Protection Agency (EPA) (2022) Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990 - 2020.
- Heller, M., et al. (2020). Implications of Future US Diet Scenarios on Greenhouse Gas Emissions.
- U.S. EPA (2022) "Emissions & Generation Resource Integrated Database (eGRID)."
- U.S. Energy Information Administration (EIA) (2022) Electric Power Monthly with Data from February 2022.
- U.S. EIA (2022) Annual Energy Outlook 2022.
- U.S. EIA (2018) Residential Energy Consumption Survey 2015.
- Mars C. (2016) Benefits of Using Cold Water for Everyday Laundry in the U.S.
- Heller, M. and G. Keoleian. (2014) Greenhouse gas emissions estimates of U.S. dietary choices and food loss. *Journal of Industrial Ecology*, 19 (3): 391-401.
- U.S. EPA (2022) The 2021 EPA Automotive Trends Report: Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975.
- U.S. Department of Energy (DOE), Oak Ridge National Lab (2022) Transportation Energy Data Book: Edition 40.
- Pero, F. et al. (2018) Life Cycle Assessment in the automotive sector: a comparative case study of Internal Combustion Engine and electric car.
- U.S. EIA (2016) "Carbon Dioxide Emissions Coefficients."
- U.S. DOE, Alternative Fuels Data Center (2015) "Fuel Properties Comparison Chart."
- U.S. DOE, Office of Energy Efficiency and Renewable Energy (EERE) (2022) "Driving More Efficiently."
- U.S. Department of Transportation Bureau of Transportation Statistics (2021) National Transportation Statistics 2021.
- U.S. DOE, EERE (2016) "Gas Mileage Tips: Keeping Your Car In Shape."
- Porras, G. (2019) Life Cycle Comparison of Manual and Machine Dishwashing in Households
- U.S. DOE (2012) "3 Easy Tips to Reduce Your Standby Power Loads."
- Liu, L., Keoleian, G. A., & Saitou, K. (2017). Replacement policy of residential lighting optimized for cost, energy, and greenhouse gas emissions. *Environmental Research Letters*, 12(11), 114034.
- Levinson, R. (2012) The Case for Cool Roofs. Lawrence Berkeley National Laboratory, Heat Island Group.
- U.S. EPA (2022) "Greenhouse Gas Equivalencies Calculator."
- Buchanan, C., et al (2018) "Lightweighting shipping containers: Life cycle impacts on multimodal freight transportation." *Transportation Research Part D* 62:418-432.
- U.S. EPA (2020) 2020 Common Reporting Format (CRF) Table.