Summary of CBEI Methodology and Key Findings

CBEI Methodology

The consumption-based emissions inventory (CBEI) methodology follows the flow of dollars through the economy to track production and consumption of goods and services. The CBEI includes GHG emissions related to five basic sectors of consumption by Bay Area households:

- **Transportation** sector includes GHG emissions embedded in motor vehicle production and maintenance, refining of gasoline and diesel, fuel combustion in motor vehicles, air travel, and public transportation. Note: Emissions related to shipping or freight movement for a given product are included as a component of the emissions attributed to that product (either the housing, food, goods, or services sector, as appropriate).
- **Housing** sector includes the GHG emissions embedded in construction and maintenance of homes, residential energy use, water use and treatment, and waste disposal.
- **Food** sector includes the GHG emissions embedded in the production, processing, and distribution of food consumed both inside and outside the home.
- **Goods** sector includes the GHG emissions embedded in the production of the full range of consumer products, including home furnishings, clothing, personal care products, electronics, toys, books, etc.
- **Services** sector includes the GHG emissions embedded in the full range of services consumed by Bay Area households, including information and communication, financial services, health care, and education.

Key Categories of Consumption

Transportation:

- Motor vehicle production
- Vehicle maintenance
- Motor vehicle fuel consumption
- Public transportation
- Air travel

Housing:

- Construction
- Maintenance
- Residential energy use
- Water
- Waste

Food:

- Grains & cereals
- Fruits & vegetables
- Dairy
- Meat
- Other

Goods:

- Clothing
- Furniture & appliances
- Personal care products
- Books, newspapers, CDs

Services:

- Health care
- Education
- Financial services
- Communication
- Entertainment

In order to develop a detailed expenditure profile to analyze how the residents of a given area spend their income on the full range of goods and services, the sectors shown above are further broken down into several hundred product categories.

For the purpose of the Bay Area CBEI, the neighborhood is defined as a US Census block group. (There are more than 4,700 block groups in the nine-county Bay Area; the average block group includes 500-600 households.) The emissions for each specific category are then calculated by multiplying the average household expenditures for that category times the appropriate GHG emission factor.

The GHG emission factors are based on a full life-cycle analysis of all the emissions embedded in the production (extraction of raw materials, production and assembly, shipping), the use, and the disposal of each category of goods or service. For example, in estimating the motor vehicle emissions for a given household, the inventory considers the greenhouse gases emitted in the production of all the individual parts that go into the vehicle; vehicle assembly; transporting the vehicle to the dealer; maintenance of the vehicle during its useful life; plus the emissions from refining the fuel used to propel the vehicle, and the direct combustion of the fuel as a function of the miles driven per year and the fuel economy of the vehicle.

After calculating the emissions on a category-by-category basis, the emissions for each product category are then added together to calculate the total GHG footprint for the average household within a given block group. The individual block group results can then be aggregated to city, county and regional scale by multiplying the GHG footprint for each block group times the number of households in the block group.

Additional explanation of the methodology used to develop the CBEI can be found in the final project report on the Air District's CBEI web page as well as several journal articles that can be accessed via the Cool Climate Network website.

Findings

When calculated on a consumption basis, the Air District's GHG emissions inventory is larger than the District's traditional (production-based) inventory, with the CBEI exceeding production-based emissions by approximately 35%. The CBEI is larger than the production-based inventory due to the fact that a significant portion of the goods and services consumed by Bay Area residents are produced outside the region, and that the CBEI emission factors are based on a full life-cycle analysis. It should be noted that the two emission inventories overlap in the case of goods and services that are both produced and consumed within the Bay Area, as well as personal motor vehicle use that occurs within the boundaries of the region.

Average Bay Area GHG Footprint compared to the National Average: The GHG footprint of the average Bay Area household is smaller than that of the average American household (the US as a whole), as shown in Figures 1 and 2. (The blue portion of each bar shows direct emissions; i.e. emissions from combustion of fuel in motor vehicles, and combustion of natural gas for space heating and water heating in the home. The green portion of each bar represents emissions embedded in the production, shipping, and disposal of the various goods and services. The gray portion of the right-hand bars represents the $C0_2$ credit for recycling.)

Figure 1. Average SF Bay Area Household GHG Footprint (44.3 metric tons per year)

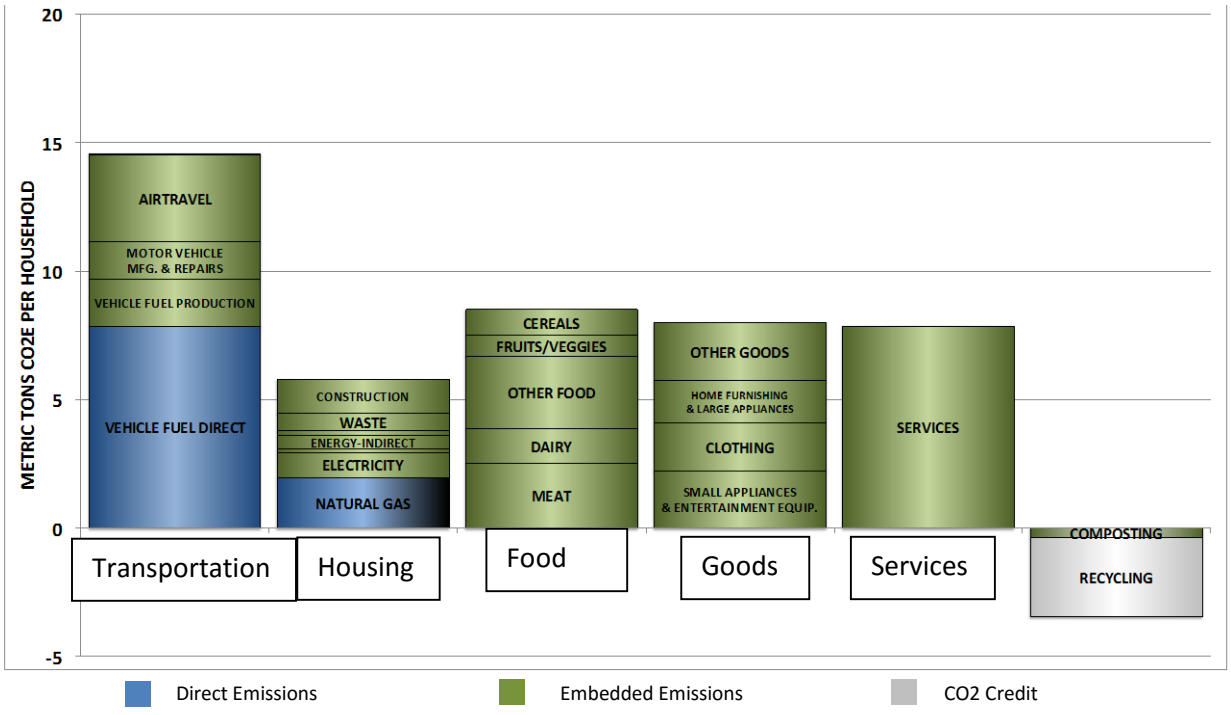
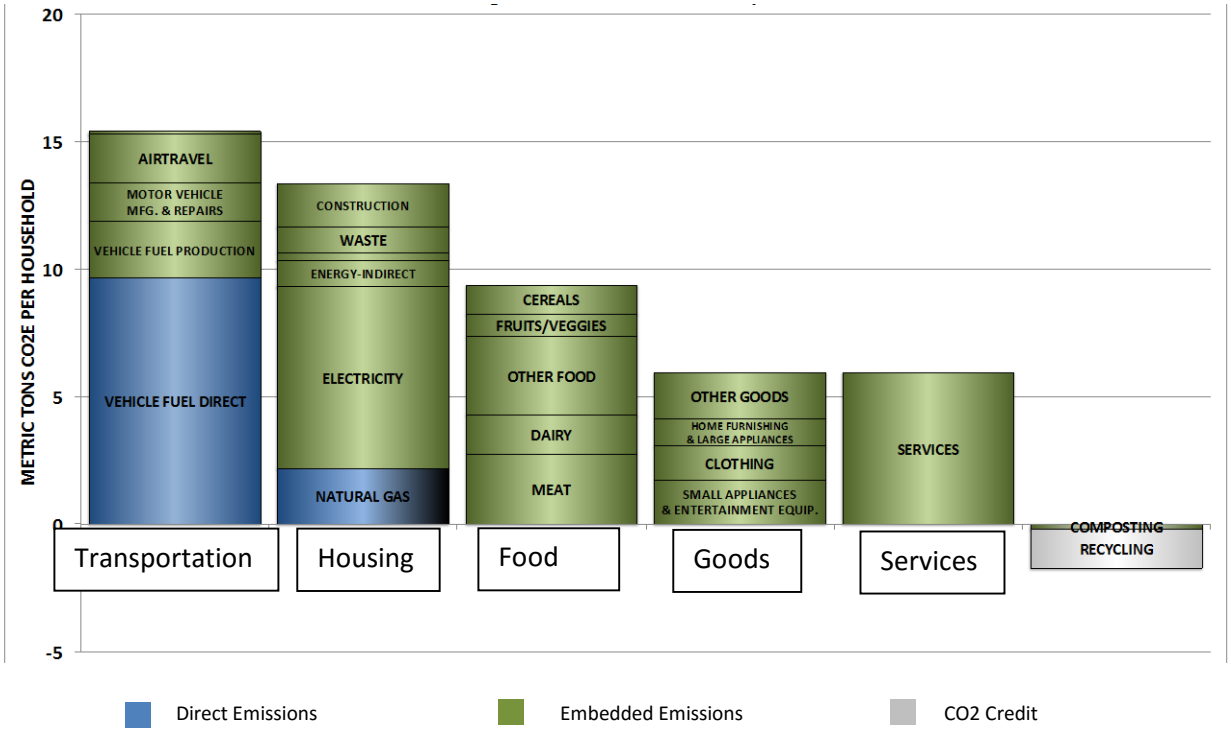


Figure 2. Average American (Nation-wide) Household GHG Footprint (49.8 metric tons per year)



Even though Bay Area residents have significantly higher average income than the national or statewide average, consumption-based GHG emissions for the average Bay Area household (44.3 metric tons per year) are less than the average American household (49.8 metric tons per year) and the average California household (45.7 metric tons per year). A major reason for this is that residential electricity consumption in the Bay Area is well below the national average, as well as slightly less than the statewide average. This is because (1) the electricity consumed in the Bay Area is generated by cleaner sources, and (2) the moderate climate reduces the need for home heating and cooling in the Bay Area. The lower GHG intensity of electricity consumed in the Bay Area reflects the State of California's efforts to promote renewable energy sources and phase out coal-fired power plants though policies such as the Renewable Portfolio Standard, as well as local efforts to promote clean energy such as Community Choice Aggregation programs.

On the other hand, due to the fact that many Bay Area households earn a high income, the average Bay Area household has higher GHG emissions from air travel and from consumption of goods and services than the national or statewide average. This partially offsets the lower emissions from residential electricity use discussed above. The bottom line is that, thanks to factors such as the low carbon intensity of electricity consumed in the region, Bay Area residents enjoy a higher standard of living, with a smaller GHG footprint, than the average American. However, it is important to bear in mind, that even though per-household GHG emissions in the Bay Area are already lower than the state and national average, our emissions will still need to decrease by 80% or more on a per-household basis in the coming decades in order to achieve the GHG reductions targets adopted by the State of California and the Air District.

Variation in the size and composition of GHG footprints emissions within the Bay Area: Although the average Bay Area GHG footprint is smaller than the national or statewide average, it is important to note that there is significant variation in both the size and the composition of per-household GHG emissions within the region. On the whole, the average GHG footprint is smaller in urban core areas (such as San Francisco and East Bay cities west of the hills) than in more suburban communities. The GHG footprint varies by a factor of seven in comparing the US Census block group with the highest emissions in the region to the block group with the lowest emissions. Within larger cities that have a wide variation in demographics and income between neighborhoods, the GHG footprint can vary by a factor three or four from one block group to the next. When comparing the per-household GHG footprint among Bay Area cities, most cities fall within plus or minus 20% of the mean. However, in comparing the high and low ends of the spectrum, there is a three-fold difference between the highest GHG and lowest GHG footprint cities.

Key factors that influence the size of composition of GHG footprint: The CBEI methodology includes more than 30 input factors relating to household demographics and income; the size, age, and location of housing; personal travel and motor vehicle use; food consumption; residential energy consumption of natural gas, heating oil and electricity; and the carbon intensity of electricity based on the mix of power sources. However, six of these factors have the greatest impact, collectively accounting for 92% of the variation in the size and composition of the GHG footprint.

- Household size (# of people)
- Household income
- Size of the home (square footage of the dwelling unit)
- Household vehicle ownership rate
- Population density of the neighborhood
- Carbon intensity of the electricity consumed in the home

Household income has a major impact on both the size and composition of GHG footprint. Higher income correlates with higher GHG emissions from the transportation, housing, goods, and services sectors. In terms of transportation, households with higher incomes tend to own more motor vehicles and drive more. They often commute longer distances, and they make more discretionary trips for shopping and pleasure. There is a strong correlation between household income and air travel, which is one of the most GHG-intensive activities. As income rises, people fly much more and their GHG footprint grows accordingly.

Household income also influences GHG emissions related to the housing, goods, and services sectors. As income rises, so does the average size (square feet) of the home. Likewise, more affluent households have more disposable income to spend on discretionary goods and services.

Since lower-income households have less money to spend, they have smaller GHG footprints. The composition of their footprint also differs from that of more affluent households, since low-income households spend a larger share of their income on the essentials of food and shelter. Therefore, the food and housing sectors account for a larger proportion of the total GHG footprint among low-income households.