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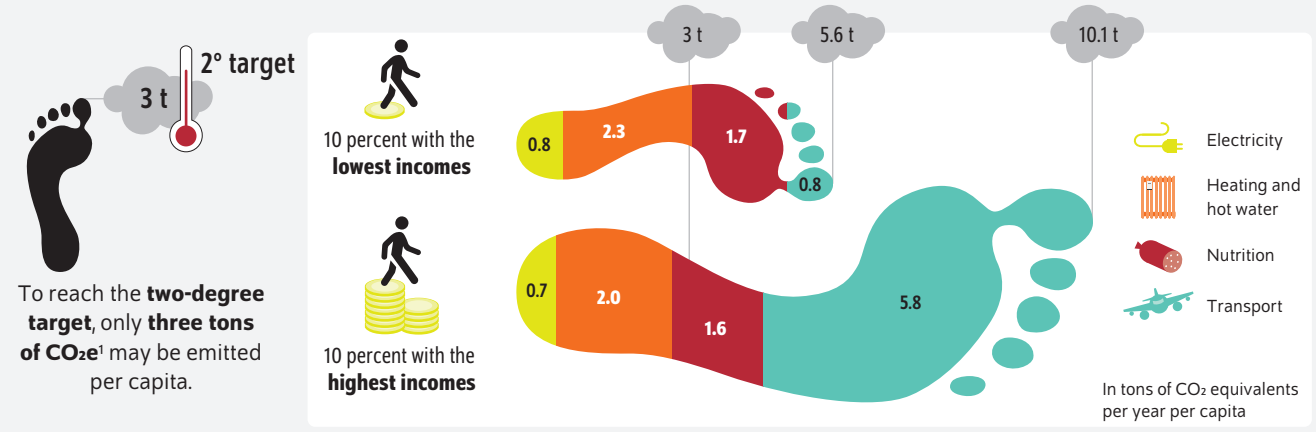
AT A GLANCE

High-income households emit more greenhouse gases, primarily due to transport behavior

By Sandra Bohmann, and Merve Kücük

- Study using 2023 SOEP data analyses the per capita carbon footprint in Germany in the areas of residential energy use, nutrition, and transport
- At 6.5 tons of carbon emissions per capita per year, emissions in these areas are twice as high as required to achieve the two-degree target
- High-income households cause twice as many emissions as low-income households
- Main drivers of emissions are meat consumption, the number of people living in a household, per capita living space, and particularly air travel
- In addition to individual efforts, politicians should set the course by introducing an animal welfare levy, a ban on short flights, and simplifying housing swaps

Regardless of income, the carbon footprint of private individuals is definitely too large



1 Emissions of greenhouse gases other than CO_2 are converted into CO_2 equivalents according to their global warming potential.
Source: Authors' calculations using preliminary data from the 2023 SOEP survey (v40), weighted with preliminary weights from the v39 wave (2022).

FROM THE AUTHORS

"Air travel in particular increases an individual's carbon footprint and is one of the main reasons why higher-income households have a carbon footprint that is twice as high as lower-income households. A single long-haul flight causes more emissions per capita than housing and food-related emissions in an entire year combined."
— Sandra Bohmann —

MEDIA

Audio Interview with Merve Kücük (in German)
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ABSTRACT

Greenhouse gas emissions must be reduced by 65 percent compared to 1990 by 2030 to achieve national climate targets. Nearly one third of greenhouse gas emissions in Germany are caused by private household consumption. Using Socio-Economic Panel (SOEP) data, this Weekly Report calculates the amount of CO_2 equivalents emitted by households due to residential energy use, nutrition, and transport in Germany. Consumption in these three areas alone results in average emissions that exceed the emissions budget targeted for private individuals more than twofold, with transport and residential energy-related emissions accounting for the largest share of emissions. Emissions increase as income increases, especially in the area of transport, with air travel as the main driver. Meat consumption is the main contributor to nutrition-related emissions, and household size and building type contribute the most to residential energy-related emissions. By identifying the most significant driver of emissions in each of the three areas, targeted political instruments can be identified, such as simplifying housing swaps and the energy-efficient renovation of residential buildings, banning short-haul flights, and introducing an animal welfare levy.

Human emissions of greenhouse gases such as carbon dioxide (CO_2), nitrous oxide, and methane are the main driver of climate change.[1] According to the Federal Environment Agency (*Umweltbundesamt*, UBA), around 673 million tons of greenhouse gases were emitted in Germany in 2023, ten percent less than in 2022.[2] However, the Federal Climate Change Act stipulates that emissions must be reduced by at least 65 percent compared to 1990 levels by 2030. However, as of 2022, only 40 percent of this reduction had been achieved.[3]

To reduce greenhouse gas emissions more effectively, it is important to understand their primary driver. Policymakers should consider both the reduction potential in industry as well as in private households: After all, around one third of emissions in Germany can be attributed to private household consumption.[4] This Weekly Report calculates and analyzes the average per capita residential energy consumption (housing), nutrition, and transport-related emissions in Germany using individual and household information.

The analyses are based on unpublished preliminary data from the 2023 Socio-Economic Panel (SOEP) survey.[5] We calculate per capita residential energy, nutrition, and transport-related carbon footprint[6] of private households based on respondents' information on their consumption behavior (Box). First, the carbon footprint of the entire household is calculated. In a second step, the household's total

1 To be able to compare the effects of the various climate-active gases on the climate, they are converted into CO_2 equivalents. For this purpose, emissions of greenhouse gases other than CO_2 are converted into CO_2 equivalents according to their global warming potential.

2 Umweltbundesamt, *Treibhausgasemissionen sinken deutlich* (2024) (in German; available online; accessed on June 11, 2024. This applies to all other online sources in this report).

3 Bundesregierung, *Ein Plan fürs Klima* (2024) (in German; available online); Umweltbundesamt, *Treibhausgasminderungsziele Deutschlands* (2023) (in German; available online).

4 Statistisches Bundesamt, *CO2-Emissionsintensität der deutschen Wirtschaft 2020 weiterhin rückläufig* (2022) (in German; available online).

5 The Socio-Economic Panel (SOEP) is an annual representative survey of private households. It began in West Germany in 1984 and expanded its scope to include the new federal states in 1990; cf. Jan Goebel et al., "The German Socio-Economic Panel (SOEP)," *Journal of Economics and Statistics* 239, no. 29 (2018): 345-360.

6 Carbon footprints indicate how many tons of CO_2 equivalents (tCO_2e) one person generates per year. It is a measure of one individual's impact on the climate, see the DIW Berlin Glossary on the carbon footprint (in German; available online).

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emissions are divided by the number of household members, including children.

Greenhouse gas emissions of private households exceed climate thresholds twofold

According to the SOEP survey data, annual per capita emissions in the three areas (residential energy consumption, nutrition, and transport) are around 6.5 tons of CO_2 equivalents (tCO_2e). Each person in Germany emits an annual average of 0.7 tCO_2e through the use of electricity in their home (Figure 1). A further 2.2 tCO_2e are due to heating and hot water preparation. Nutrition has an average impact of 1.6 tCO_2e, while 2.0 tCO_2e can be attributed to transport. Calculations using SOEP data are thus very close to the UBA's calculations, which are calculated using a different methodology.[7] The values in both calculations are significantly higher than the one to three tons that are—depending on the specific calculation—climate-compatible according to climate experts and the UBA.[8]

Greenhouse gas emissions increase with income

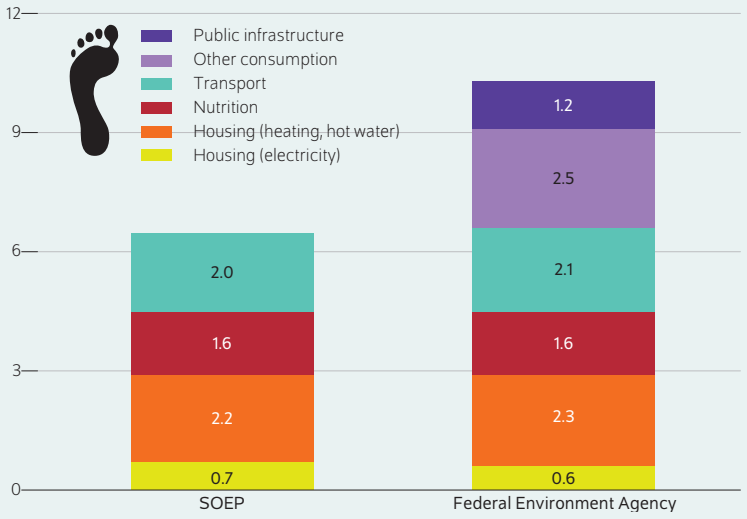
Our calculations confirm that households' carbon footprint increases as equivalized income rises,[9] primarily due to more transport-related emissions (Figure 2). In terms of nutrition and heating, higher-income households tend to have slightly lower per capita emissions. The following sections take a closer look at the composition of emissions in the areas of residential energy, nutrition, and transport, and explain the differences between the income groups using information on all households for which an area-specific carbon footprint was calculated.

Living with others reduces CO_2 emissions

Emissions from residential use of electricity, heating, and hot water preparation are considered together below. On average, 2.9 tons of residential energy-related CO_2e are emitted per person per year. As people who live together share the use of electricity and heat, the number of people living in a household is decisive for the emissions caused per person

Figure 1

Greenhouse gas emissions in Germany per capita and year
In tons of CO_2 equivalents

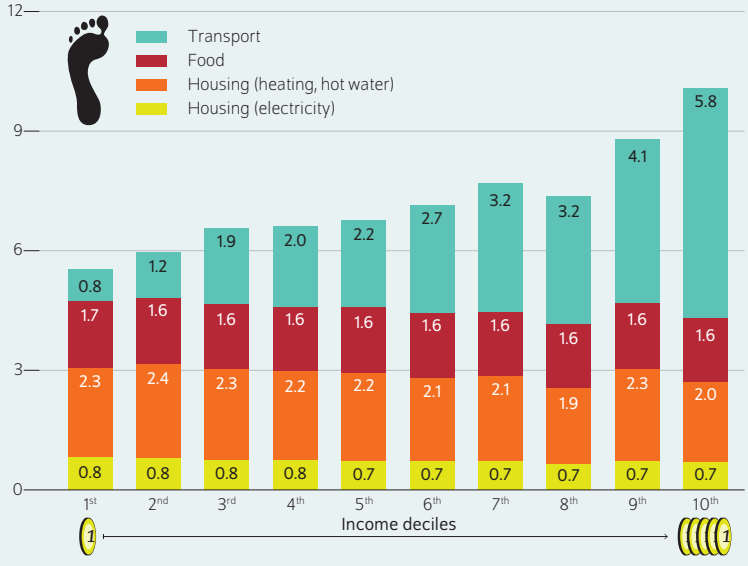


Source: Federal Environment Agency (UBA); authors' calculations using preliminary data from the 2023 SOEP survey (v40), weighted with preliminary weights from wave v39 (2022).

Emissions from the areas of housing, food, and transport surveyed in the SOEP cover around two thirds of the total carbon footprint.

Figure 2

Per capita carbon footprint in Germany by income decile
In tons of CO2 equivalents, annual average



Source: Authors' calculations using preliminary data from the 2023 SOEP survey (v40), weighted with preliminary weights from wave v39 (2022).

Higher emissions in the upper income deciles are primarily due to their transport behavior.

7 Cf. the website of the Federal Environment Agency, *Durchschnittlicher CO_2-Fußabdruck pro Kopf in Deutschland* (Stand: 2024) (in German; available online).

8 Federal Environment Agency, *Wie hoch sind die Treibhausgasemissionen pro Person?* (2024) (in German, online verfügbar). Hans Joachim Schellnhuber, a climate researcher at the Potsdam Institute for Climate Impact Research (PIK), calculated a carbon footprint of around three tons per year and per person for Germany, which would have to be achieved in order to comply with the Paris Climate Agreement—an individual CO_2 budget, so to speak, cf. Dirk Messner et al., "The Budget Approach: A Framework for a Global Transformation toward a Low-Carbon Economy," *Journal of Renewable and Sustainable Energy* 2, no. 3 (2010) (available online). How exactly this figure of three tons per year and per person was calculated is explained very well on the website of the ARD program Panorama (FAQ: *Wer verursacht wie viele Treibhausgase?*) (in German; available online).

9 The income situations of households of different sizes and compositions are made comparable using equivalized income. To calculate the equivalized income, the incomes of all persons living in the household are added together and converted using a needs scale appropriate to the household structure. For more information, see the DIW Berlin Glossary entry on equivalized income (in German; available online). For more on the carbon footprint of German households, cf. Gilang Hardadi, Alexander Buchholz, and Stefan Pauliuk, "Implications of the distribution of German household environmental footprints across income groups for integrating environmental and social policy design," *Journal of Industrial Ecology* 25, no. 1 (2021): 95–113.

Box

Data and methodology

The carbon footprint of households in Germany due to residential energy consumption, nutrition, and transport are calculated using preliminary data from 2023 from the Socio-Economic Panel (SOEP). As no weighting factors are currently available for 2023, preliminary weights from the 2022 survey are used, which take into account the households lost since the last published survey in 2021. People who first participated in the survey in 2023 are thus not included. Furthermore, all refugee samples are not taken into account. Due to these restrictions, the sample is reduced to 7,304 respondents.

The calculations are based on individual and household information taken from household and personal surveys. A similar approach is followed in each of the three areas analyzed: Information provided by respondents on how much they spend on and how much they consume of goods whose production results in greenhouse gases emissions is converted into CO_2 equivalents using the corresponding emission factors per unit of consumption. Emission factors from official sources are used, as the value chains in the individual countries differ and the use of national sources is thus the most suitable and exact for calculating emissions.[1]

Emissions from specific areas were calculated as follows: Emissions caused by energy consumption in private households are calculated via the type of resource used (electricity, gas, district heating, heating oil, solar energy, ambient heat, wood, coal, biomass, and liquefied gas) and the amount of energy used for each of the resources from the household survey that are used. Transport emissions were calculated using data on car ownership, the type of fuel used, transport expenditure, and the frequency of long and short-haul trips via bus, train, tram, and airplane. Nutrition emissions were calculated using the information provided by respondents on gender, age, weight, and frequency of meat and fish consumption.

Missing information on the type of heating is imputed logically, meaning it is assumed that a household uses the same type of heating as they did in the previous survey as long as they have not moved. Missing information on housing expenditure or consumption are not imputed. When calculating emissions relating to nutrition, we assume that the average diet profile of the adults in the household applies for the children as well. In the area of transport, the top and bottom one percent are replaced by percentile boundaries.[2]

For each of the three areas, the analyses include all households for which the area-specific information was available. This means the number of cases vary between the individual areas.

Data cleaning took place in several phases of the area-specific emission calculations. In a similar way, we confirmed that all outliers for each individual area are taken into account. These processes can lead to less pronounced differences in emissions by income.

1 Emissions factors from the Federal Office for Economic Affairs and Export Control (*Bundesamt für Wirtschaft und Ausfuhrkontrolle*) were used for electricity in the area of housing, natural gas, liquefied gas, local and district heating, coal (average value from hard coal and lignite), heating oil, biogas, liquefied petroleum gas, and wood: Bundesamt für Wirtschaft und Ausfuhrkontrolle, *Informationsblatt CO_2-Faktoren* (2022) (in German; available online). Emissions factors from the Federal Environment Agency are used for diesel and gas: Umweltbundesamt, *CO_2-Emissionsfaktoren für fossile Brennstoffe* (2022) (in German; available online).

2 To calculate the percentiles, a data set sorted by size is divided into 100 equal parts. Outliers with values larger than the 99th percentile of the sample and smaller than the bottom first percentile are replaced with limit values.

due to residential energy consumption. A four-person household generates an average of 1.5 tCO_2e per person and year, whereas a single-person household generates just under 4.0 tCO_2e per year (Figure 3).

Using a linear regression model, we investigate the correlation between various household characteristics and residential energy-related emissions per person (Table). The decisive factor is therefore the number of people in the household. In addition, the living space available per person has a significant, albeit smaller, influence on emissions: For each additional square meter of space, emissions per person rise by 0.022 tCO_2e per year. These two factors alone explain nearly half of the observed differences in residential energy-related emissions per capita. In contrast, the income available per person has no significant effect when the factors of people and space per person are taken into account.

The type and age of residential buildings also plays a role: People living in multiple-family residential buildings with more than four housing units create around half a ton fewer emissions per person than people living in detached single or two-family homes or farming infrastructure (Figure 4). In addition, the carbon footprint of people living in newer buildings is lower.[10] Calculations also show that the use of solar energy decreases the per capita carbon footprint in a household by around 0.7 tCO_2e on average.

Meat consumption affects nutrition-related emissions

Around one quarter of global greenhouse gas emissions can be attributed to food production, in particular from livestock farming, fisheries, and land use.[11] Compared to livestock

10 Cf. Sections 10 through 45 of the Buildings Energy Act (*Gesetz zur Einsparung von Energie und zur Nutzung erneuerbarer Energien zur Wärme- und Kälteerzeugung in Gebäuden*, GEG) (in German; available online).

11 Hannah Ritchie, "Food production is responsible for one-quarter of the world's greenhouse gas emissions," Our world in data (2019) (available online).

Table

Influence of household characteristics on housing-related greenhouse gas emissions
In tons of CO_2 equivalents

	Average	95-percent confidence interval	
Reference: single-person household			
Two-person household	−0.82	−0.91	−0.738
Three-person household	−1.15	−1.28	−1.02
Four-person household	−1.33	−1.49	−1.18
Five+ person household	−1.52	−1.76	−1.28
Equivalized income (in thousands of euros)	0.01	−0.004	0.02
Square meter per person	0.022	0.021	0.023
Constant[1]	2.16	2.03	2.29
Observations	4,056		

1 The constant shows the average emissions of a single-person household. Adding the estimated value of the other household sizes to the constant results in the average per capita emissions of each household size.

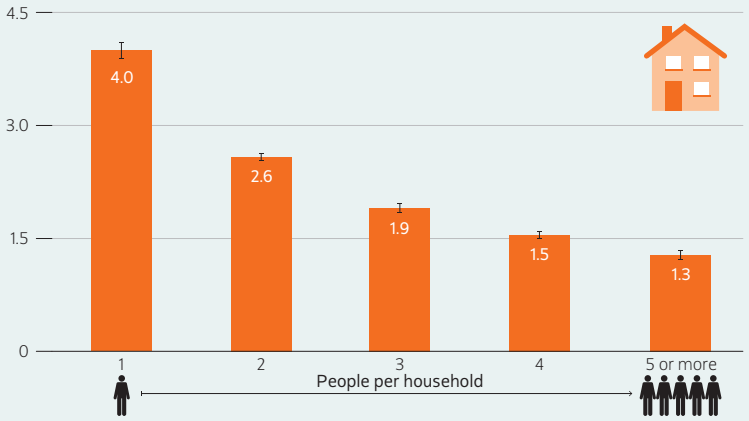
Note: Linear regression model. The 95 percent confidence interval means that the unknown actual value is within this interval in 95 percent of cases. Therefore, the probability of error is five percent. The narrower the interval, the more accurate the estimated effect. The estimates of the influence of household characteristics are based on information from 4,056 households.

Legend: A two-person household emits 0.82 tons of CO2 equivalents less than a single-person household. Each square meter of living space leads to 0.02 tons more CO2 equivalents being emitted per year and per capita.

Source: Authors' calculations using preliminary data from the 2023 SOEP survey (v40), weighted with preliminary weights from wave v39 (2022).

Figure 3

Greenhouse gas emissions from residential energy consumption per person by household size
In tons of CO_2 equivalents, annual average



Notes: The height of the columns corresponds to the average per capita emissions due to heating, electricity consumption, and hot water preparation. The vertical black lines show the confidence intervals. This means that the unknown actual value is within this interval in 95 percent of cases. Therefore, the probability of error is five percent. The narrower the interval, the more accurate the estimated average.

Source: Authors' calculations using preliminary data from the 2023 SOEP survey (v40), weighted with preliminary weights from wave v39 (2022).

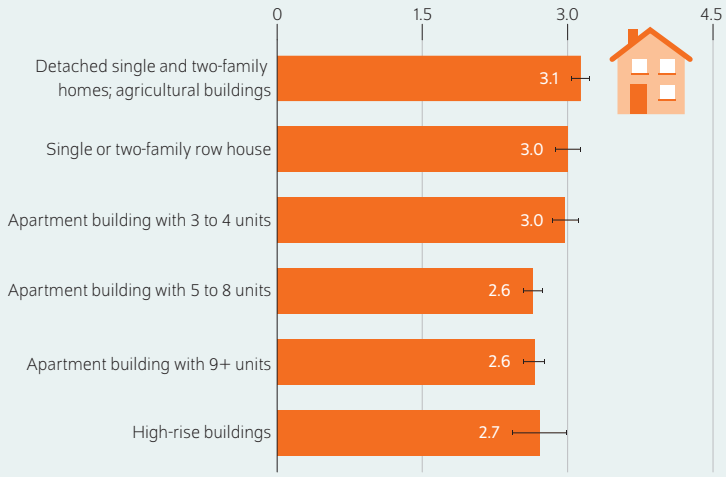
People living alone cause more than twice as many greenhouse gas emissions as people in three-person households.

farming and animal feed production, plant-based foods have a significantly lower carbon footprint. Therefore, the frequency of animal product consumption is an important factor in individual nutrition-related emissions. Studies show that the origin of the food we eat is less important than where our food comes from, as transportation emissions are significantly lower than production-related emissions.[12]

Based on the respondents' information on their dietary preferences and weekly frequency of beef, pork, poultry, and fish consumption, nutrition-related emissions are calculated in combination with gender and age as indicators for the respondents' necessary caloric intake.[13] The diet profiles are assigned to five categories in accordance with the UBA's CO_2 calculator: vegan, vegetarian, low-meat, a mix of meat and plant-based foods, and high-meat diet. A low-meat diet corresponds to average meat consumption of 50 grams per day, while a balanced meat and plant-based foods diet and a meat-heavy diet refer to daily meat consumption of 165 grams

Figure 4

Greenhouse gas emissions per person due to heating and electricity consumption by building type
In tons of CO_2 equivalents, annual average



Note: The horizontal black lines show the confidence intervals. This means that the unknown actual value is within this interval in 95 percent of cases. Therefore, the probability of error is five percent. The narrower the interval, the more accurate the estimated average.

Source: Authors' calculations using preliminary data from the 2023 SOEP survey (v40), weighted with preliminary weights from wave v39 (2022).

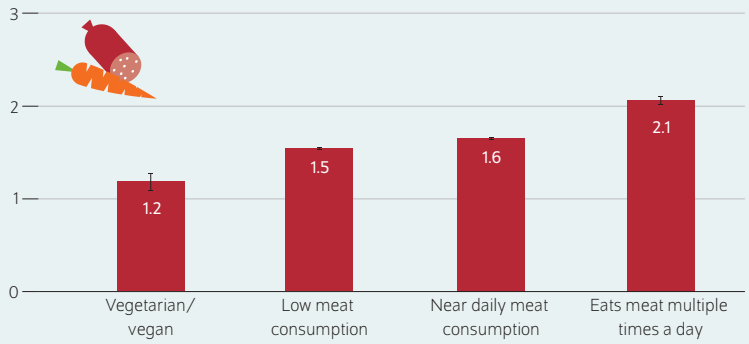
People living in detached or semi-detached homes have a larger housing-related carbon footprint than people living in buildings with multiple residential units.

12 Christopher L. Weber and H. Scott Matthews, "Food-miles and the relative climate impacts of food choices in the United States," *Environmental Science & Technology* 42, no. 10 (2008): 3508–3513 (available online); Hannah Ritchie, "You want to reduce the carbon footprint of your food? Focus on what you eat, not whether your food is local," Our world in data (2020) (available online).

13 Age and gender-specific average weights are used to estimate the calorie requirements of the household members, cf. Statista, *Mittelwerte von Körpergröße, -gewicht und BMI bei Männern in Deutschland nach Altersgruppe im Jahr 2021* (2021) (in German; available online); Statista, *Mittelwerte von Körpergröße, -gewicht und BMI bei Frauen in Deutschland nach Altersgruppe im Jahr 2021* (2021) (in German; available online); Robert Koch Institut, *Körpermaße bei Kindern und Jugendlichen in Deutschland* (2007) (in German; available online).

Figure 5

Food-related greenhouse gas emissions per capita by diet
In tons of CO_2 equivalents, annual average



Note: The vertical black lines show the confidence intervals. This means that the unknown actual value is within this interval in 95 percent of cases. Therefore, the probability of error is five percent. The narrower the interval, the more accurate the estimated average.

Source: Authors' calculations using preliminary data from the 2023 SOEP survey (v40), weighted with preliminary weights from wave v39 (2022).

Vegans and vegetarians have the smallest food-related carbon footprint.

and 290 grams, respectively.[14] According to the statistics by the Federal Office for Agriculture and Food (*Bundesanstalt für Landwirtschaft und Ernährung,* BLE), a declining trend in average meat consumption has been observed in recent years.[15] In 2023, the largest decline was observed in beef consumption, which is particularly harmful to the climate.[16]

One percent of SOEP respondents indicate they follow a vegan diet, while 12 percent report following a vegetarian diet.[17] A high number of the latter nonetheless report eating meat or fish occasionally (less than once a month and less than two to three times a week, respectively). The large majority of the German population follows a low-meat diet (47 percent) or a diet with a mix of meat and plant-based foods (42 percent). Around one in ten respondents reports to eating meat products several times a day.

Per capita (including children), the average nutrition-related emissions in Germany are 1.6 tCO_2e. A vegetarian diet results in an average of only 1.2 tCO_2e per year (Figure 5). People who eat meat less than once a week emit around 1.5 tCO_2e on average per year, while people who eat meat multiple times a day emit around 2.1 tCO_2e per year.

One intercontinental flight emits more CO_2 than one year of residential energy and nutrition-related emissions

Transport-related emissions are calculated using household information on car ownership, the fuel type used, use of public transport (short-distance commuting with all public transport types as well as long-distance commuting with trains and buses) as well as the number of domestic, European, and intercontinental flights and cruises taken.

On average, the per capita transport-related emissions are around 2.0 tCO_2e per year, about half of which come from car trips. The greatest share of transport-related emissions is due to flights. Emissions from car trips average 1.0 tCO_2e per capita. An average round-trip flight within Germany causes 0.24 tCO_2e; for the same amount, a person could travel 8,000 kilometers by train.

According to the UBA, a domestic or European round-trip flight emits 0.2 or 0.5 tCO_2e, respectively, while an intercontinental round-trip flight emits 4.7 tCO_2e.[18] Therefore, there are major differences in transport-related emissions per person depending on if and where they fly. While each person in Germany only flies once a year on average, frequent fliers fly ten or more times per year. People who do not fly at all have a transport-related carbon footprint of around 1.0 tCO_2e (Figure 6), while people who take flights within Europe emit around 2.3 tCO_2e per year according to the calculations. For people who have taken one or more intercontinental round-trip flights, their transport-related emissions are 9.3 tCO_2e on average.

People in the highest income decile (the ten percent with the highest household incomes) emit seven times as much CO_2e as people in the lowest income decile in the area of transport (Figure 7). Emissions from car trips vary between 0.3 tCO_2e for people in the lowest income decile and 1.4 tCO_2e for people in the higher income deciles. At 4.1 tCO_2e, flight-related emissions in the highest income decile are around ten times higher than in the lowest income decile at 0.4 tCO_2e. The frequency at which individuals in the highest income decile fly intercontinentally results in their emissions being 40 percent higher than the emissions of the ninth income decile.

Conclusion: Greatest emissions inequality is in transport

Calculating the greenhouse gas emissions of German households that can be attributed to residential energy consumption, nutrition, and transport showed that there are clear main drivers in each area: For residential energy, it is

14 This description is based on the definitions from the UBA, cf. Umweltbundesamt, *Mein CO_2-Schnellcheck* (in German; available online). The SOEP survey asked about the frequency of meat consumption per week or month. The data was converted into grams for this evaluation.

15 Bundesanstalt für Landwirtschaft und Ernährung, "Pro-Kopf-Verzehr von Fleisch sinkt auf unter 52 Kilogramm," press release from April 4, 2024 (in German; available online).

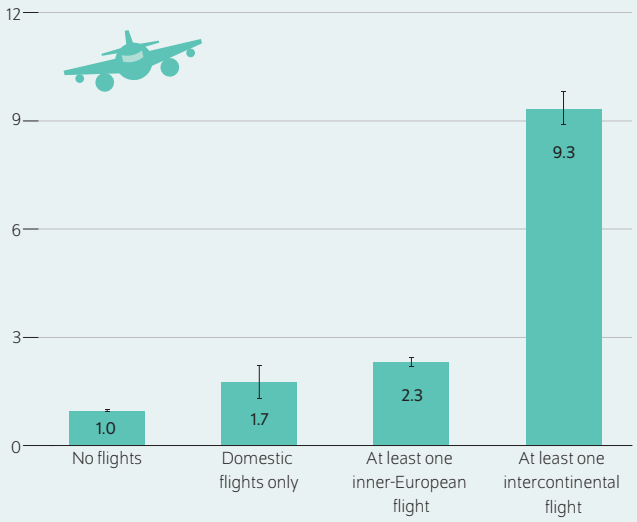
16 Different types of meat differ in their emissions intensitiy: the production of beef causes more than twice as many emissions per kilogram as lamb and more than six times the emissions of poultry meat, cf. Statista, *Ökologischer Fußabdruck von Fleisch, Fisch und Fleischalternativen in Deutschland im Jahr 2019* (2020) (in German; (available online).

17 Other representative studies come to similar results, cf. Forsa, *Ernährungsreport 2023. Ergebnisse einer repräsentativen Bevölkerungsbefragung* (2023) (in German; available online). Thus, the share of vegans and vegetarians in Germany is around two and eight percent, respectively.

18 Umweltbundesamt, *Flugreisen möglichst vermeiden und Alternativen nutzen* (2022) (in German; available online).

Figure 6

Transport-related greenhouse gas emissions per capita by air travel behavior
In tons of CO_2 equivalents, annual average



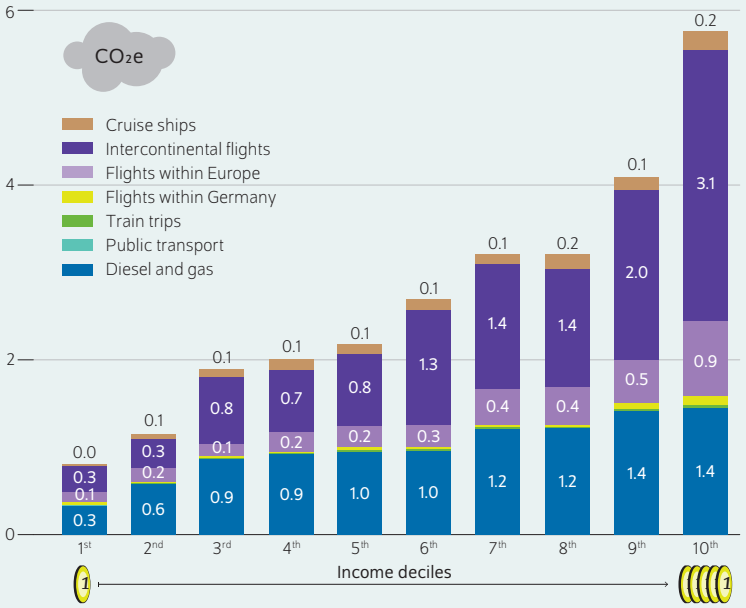
Note: The vertical black lines show the confidence interval. This means that the unknown actual value is within this interval in 95 percent of cases. Therefore, the probability of error is five percent. The narrower the interval, the more accurate the estimated effect.

Source: Authors' calculations using preliminary data from the 2023 SOEP survey (v40), weighted with preliminary weights from wave v39 (2022).

People who take intercontinental flights cause nearly ten times as many emissions as people who do not fly.

Figure 7

Transport-related greenhouse gas emissions per capita by income decile
In tons of CO_2 equivalents, annual average



Source: Authors' calculations using preliminary data from the 2023 SOEP survey (v40), weighted with preliminary weights from wave v39 (2022).

The highest-income group causes seven times as many greenhouse gas emissions through their transport behavior as the poorest ten percent.

primarily the number of people living in a household that is crucial for the individual carbon footprint. Frequent meat consumption is the main driver of nutrition-related greenhouse gas emissions and flying is the main contributor to transport-related emissions. While the income-related differences are small and higher income groups tend to have lower per capita emissions in the areas of residential energy consumption and nutrition, people from higher-income households cause significantly more emissions than people from lower-income households in the area of transport.

To achieve the goal of carbon neutrality by 2045 as laid out in the Federal Climate Change Act, massive individual as well as political efforts are required: Policymakers must implement and support measures that increase energy efficiency in residential energy consumption, promote environmentally-friendly eating habits, and expand sustainable transport options while reducing the emissions-intensive options. In addition to promoting climate-friendly technologies, their research, and piloting, as well as the economic incentives and accompanying social compensation measures, regulation-based policy instruments also are needed in the transition to a low-carbon economy.

The analyses in this Weekly Report point to a number of policy measures that foster the ecological transition while taking social justice into account. For example, a thermal insulation strategy for the most inefficient buildings could result in the most emissions savings and make low-income households less vulnerable from energy price fluctuations.[19] In addition, using existing housing more efficiently could create major savings in the building sector. One instrument to achieve this would be to simplify housing swaps, as was discussed in the *Bundestag* in 2023 and as has been enshrined in Austrian tenancy law since 1982.[20] This would not only combat the housing shortage, but also reduce greenhouse gas emissions due to residential energy consumption.

Reducing the number of flights offers the greatest potential for reducing transport-related emissions. The air traffic tax increase effective May 1, 2024, which, if passed on in full to customers, will increase the price of short-haul flight tickets by 15 euros and long-haul tickets by 70 euros, is likely to only have a minor impact on flight demand, especially among the higher income groups that fly more frequently. The French ban on domestic flights over distances that can be reached in 2.5 hours by train, which was implemented at the beginning of 2023 using an environmental protection

19 Sophie Behr et al., "Thermal retrofitting of worst performing buildings mitigates risk of high heating costs," *DIW Weekly Report*, no. 19/20 (2024) (available online).

20 Jusline, *Gesamte Rechtsvorschriften MRG* (2021) (in German; available online).

clause in European law, [21] goes much further in this respect and also provides positive incentives for the expansion of rail transport.[22] Although short-haul flights only make up a small share of flight-related emissions, they are particularly damaging, as the most greenhouse gases are emitted during takeoff and landing.[23] From a climate policy perspective, it would be even more important to limit the number of long-haul flights via international agreements.

Policy measures aimed at changing eating habits can be viewed skeptically by the public, as cultural habits play an important role in dietary choices. However, according to studies, reducing heavy meat consumption is beneficial to the both climate and our health.[24] The animal welfare levy that was endorsed by the *Bundesrat* as well as farmers' associations at the beginning of 2024 would be a step in the right direction.[25] Studies show that quite high approval rates (50 to 70 percent) can be achieved with lower price increases of around 19 cents per kilogram of meat, especially when the increases are linked to animal welfare.[26] Possible slight regressive effects could at least be mitigated by lowering the value-added tax on plant-based foods.[27] Overall, a variety of different measures will be required to reduce the amount of greenhouse gases produced by private households.

21 Cf. Article 20 of EU Regulation no. 1008/2008 (available online).

22 Zentrum für Europäischen Verbraucherschutz e.V., *Frankreich verbietet kurze Inlandsflüge* (2023) (in German; available online). Studies show that emissions can be reduced by 95 percent without sacrificing travel time by replacing short-haul flights of up to 400 km with rail travel. The introduction of bans on short-haul flight also reduces the time that a newly built high-speed rail line has to be operated before the greenhouse gas emissions generated during construction are amortized from sixty to ten years. Cf. Anne de Bortoli and Adélaïde Féraille, "Banning short-haul flights and investing in high-speed railways for a sustainable future?" *Transportation Research Part D: Transport and Environment*, vol. 128, (2024) (available online).

23 D.M.M.s. Dissanayaka, Varuna Adikariwattage, and H.R. Pasindu, "Evaluation of CO_2 Emission at Airports from Aircraft Operations within the Landing and Take-Off Cycle," *Transportation Research Record* (2020): 444–456; Paola Di Mascio et al., "Optimization of Aircraft Taxiing Strategies to Reduce the Impacts of Landing and Take-Off Cycle at Airports," *Sustainability* 14, no. 15 (2022): 9692 (available online).

24 Wenming Shi et al., "Red meat consumption, cardiovascular diseases, and diabetes: a systematic review and meta-analysis," *European Heart Journal* 44, no. 28 (2023): 2626–2635; Huifeng Zhang et al., "Meat consumption and risk of incident dementia: Cohort study of 493888 UK Biobank participants," *The American Journal of Clinical Nutrition* 114, no. 1 (2021): 175–184; Tian-Shin Yeh, Deborah Blacker, and Alberto Ascherio, "To meat or not to meat? Processed meat and risk of dementia," *The American Journal of Clinical Nutrition* 114, no. 1 (2021): 7–8.

25 Bundesrat, *Drucksache 105/21* (2021) (in German; available online).

26 Grischa Perino and Henrike Schwickert, "Animal Welfare Is a Stronger Determinant of Public Support for Meat Taxation than Climate Change Mitigation in Germany," *Nature Food* 4, no. 2 (2023): 160–169 (available online).

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