Stockholm Environment Institute

Looking beyond the average Swedish household carbon footprint

Initial findings from the Klimatkalkylatorn dataset with self-reported data from 800 000 people

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Contents

Key messages

- **The online footprint calculator Klimatkalkylatorn has gathered over 800 000 user responses from across Sweden, which testifies to the broad interest among the public to understand personal carbon footprints.**
- **The first analysis of the collected dataset shows that the average carbon footprint varies significantly between households and across postcodes and municipalities, depending on factors such as level of urbanization, household size and income level, giving a more detailed understanding of households' footprint, beyond national statistics.**
- **We also note many similarities among municipality groups in Sweden, especially the more urban and rural households, connected to car travel, air travel, eating out and clothing.**
- **Air travel is responsible for the largest differences in household carbon emissions. Sweden should start monitoring the full effect of air travel, as part of official statistics to support the identification of effective policy measures to decrease consumption emissions.**
- **The differences evident between Swedish households and postcodes can serve as an entry point to understanding how to tailor policies, as well as find other ways to encourage and support sustainable levels of consumption in a fair way across the many types of household groups.**

1. Introduction

Launched in March 2017, Klimatkalkylatorn (the Climate Calculator) is a Swedish online footprint calculator tool developed by SEI in collaboration with WWF Sweden. The tool is designed to support the general public's understanding of the climate impact associated with their personal lifestyle, as a first step to finding engagement for a more "climate-smart" lifestyle. In January 2023, the tool had reached more than 800 000 individual users (i.e. valid responses), a significant share of Sweden's population of 10.5 million (Statistics Sweden, 2023a).

The dataset collected over the past five years represents a trove of knowledge about Swedish households' carbon footprints (for a definition of carbon footprints, see e.g. Wiedmann & Minx, 2007). Here we share some of the early findings from this rich dataset, which illustrate the variations and similarities in carbon footprints among the Swedish population, tied to goods and services produced abroad and nationally. The results break down household carbon footprints at a more detailed level than national statistics do. Our preliminary findings can serve as valuable insights for policymakers as they craft focused policy measures aimed at addressing household consumption patterns. Furthermore, these findings enable us to pinpoint opportunities for our continued research concerning the carbon footprints of Swedish households.

In Sweden, households are responsible for about 60% of Sweden's consumption-based greenhouse gas emissions, often referred to as footprints or carbon footprints (meaning carbon dioxide equivalent or CO_2e); emissions from the public sector and investments make up the remaining 40% (Swedish EPA, 2022). In 2020, official statistics suggest that the average carbon footprint in Sweden was 4.6 metric tons (tons) CO_2e per capita from households' consumption, or 7.7 tons per capita if consumption related to public sector emissions and investments is also included (Swedish EPA, 2022). This is far from the long-term targets recommended under the Paris Agreement, at 1 ton CO_2e per capita (IPCC, 2023; Swedish EPA, n.d.).

However, hidden behind the average is a diverse array of household footprints, which can differ widely even within the same Swedish municipality. In different postcode areas, average values can differ as much as 14 tons CO_2e per capita (Axelsson et al., 2022b). Household income levels are known to be an important driver of differences in carbon footprint size (eg. Minx et al., 2013; Salo et al., 2021). From 1990 to 2015, the wealthiest 10% of Sweden's population was responsible for 24% of Sweden's total consumption-based emissions, more than double their proportional share. The top 1% contributed 6% of emissions, while the bottom 50% with the lowest incomes contributed slightly over 30% (Oxfam, 2020).

Factors other than income also influence carbon footprints: socio-economic and socio-demographic factors, such as a household's geographical context, work ability, family size, education level and age also have influence (e.g. Minx et al., 2013; Ottelin et al., 2018). The results from the Klimatkalkylatorn data can help tease out these other factors' importance and generate knowledge to help policymakers designed targeted policy responses that help achieve a just transition to low-carbon consumption patterns.

2. Method

The Klimatkalkylatorn tool is set up as an online questionnaire that poses questions to the respondent about their household size, lifestyle and consumption patterns. The questionnaire covers consumption areas such as the energy used in the home, food habits and travelling, as well as consumption of clothes, furniture and other goods and services. After having completed the questionnaire, the respondent is presented with an estimate of their household's average annual carbon footprint (CO_2e) per person, as well as breakdowns for different categories of consumption and comparisons with the Swedish and global averages.

One important approach taken in the model is to apply Statistics Sweden's so-called household factor (2016) for estimating expenditure for households of different sizes. We estimate the footprint for all members of the household but present the results per person. The logic for asking about all members of the household is that we recognize that many consumption items are shared with several members of the household (i.e. housing, furniture, insurance, car, etc.) and also that parents have some influence over the products and services consumed for their children. For a summary in Swedish of the methodologies and data used, see the working paper by Axelsson (2022).

The user data are anonymous but collected per postcode to allow analysis of how consumption pressures can be related to households' geographical location. The data are self-reported without quality assurance of the responses. This means that there is a risk of self-reporting bias, i.e. that the user under- or overestimates how much they spend on various consumption items or how often they perform their different habits. Hence, the results should be understood as how respondents perceive or want to convey their own consumption habits and not as objective data.

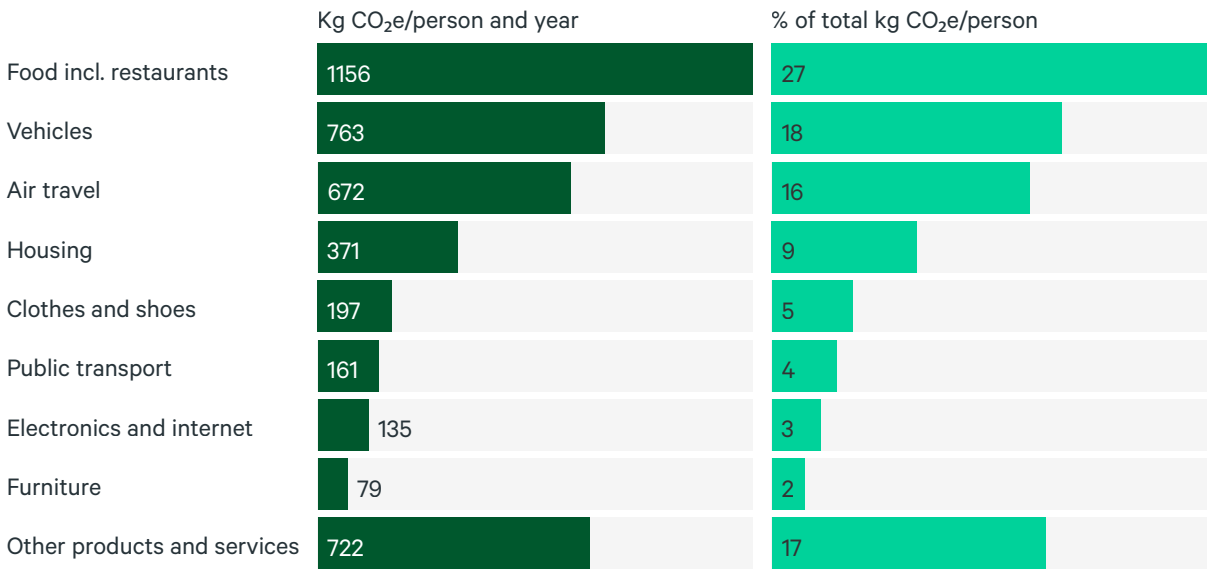
Data were cleaned following a set of rules covering repeat entries, incorrect values, and extremes, meaning the exclusion of anything below 0.5 metric tons (tons) CO_2e or above 50 tons CO_2e per person. The cleaning resulted in the removal of about 200 000 user profiles. There are 10 059 residential postcodes in Sweden with a range of 1 to 6088 inhabitants. The dataset includes responses from across Sweden, with responses from 94% of all Sweden's residential postcodes.

3. Average household carbon footprint

An analysis of Klimatkalkylatorn's dataset reveals that on average, the carbon footprint is 4.3 tons CO_2e per person (excluding impact from the public sector and investments). Among the tool's users, "food" generates the most greenhouse gas emissions (27% of the total), followed by "vehicles" and "air travel" (18% and 16%, respectively). Also notable is the consumption of "other products and services" (17%), which includes sports and leisure activities, pets, toys, gardening, insurance and hygiene products (see Figure 1).

Respondents' total footprints can differ substantially at the postcode level, from 0.5 tons CO_2e per person or close to 50 tons (which were the cut-off values used in the data cleaning process; see previous section). Air travel is the category where consumption differs the most between households. Some households never travel by air, whereas others travel by air several times per year.

Figure 1. Average footprint (kg CO_2e) per person among all users of the Klimatkalkylatorn tool plus share of total emissions.



Source: Klimatkalkylatorn

Note: Other products and services include sports and leisure activities, pets, toys, gardening, insurance, hygiene products, and more.

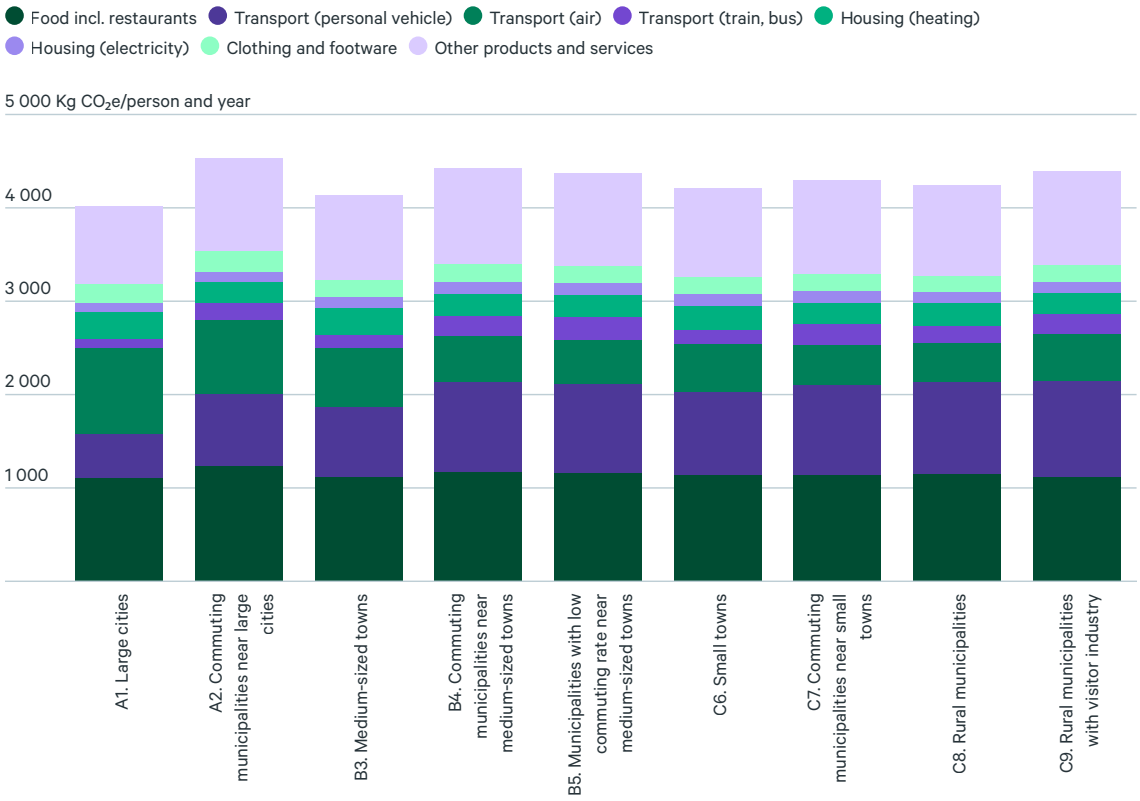
4. Differences in footprints across Sweden

All of Sweden's municipalities are represented in the dataset. Participation rates range from 5% (Högsby) to 36% (Knivsta) of the municipalities' total populations. The Swedish municipalities are classified in three main groups (A–C) and nine subgroups (1–9; see Figure 2) on the basis of parameters such as population size, vicinity to a larger city, and commuting patterns (SALAR, 2016; e.g. A1 Large cities or C8 Rural municipalities). Analysing how footprints differ across the municipality groups can help us understand the extent to which these parameters influence footprints.

When analysing responses from the nine groups, we find that overall, consumption patterns show many similarities among them all, especially between the more urban and rural municipality groups. Respondents living in A2, "Commuting municipalities near large cities", have the highest overall footprint per person. Respondents from this group have a high carbon footprint in connection with many different consumption categories, such as air travel, food, eating out, gardening, clothes and shoes, and sports.

Large cities (group A1) have the lowest overall footprint per person. While they have the highest air travel footprint per person, and are high also in their consumption of clothes, culture and restaurant meals, they are lower than all other groups for car travel and several other categories that have high carbon impacts (see Figure 2). This finding is contrary to past SEI research (Axelsson et al., 2022b), which suggested that the population from A1 has the highest footprint. A review of other research (see e.g. Bhoyar et al., 2014; Muñoz et al., 2020) also suggests that there is no conclusive evidence on the role of density in influencing footprints. The result needs to be further analysed for the Swedish context but can perhaps partly be explained by the tool's high response rates from municipalities in group A2, which also have high average income levels (see Table 1 for examples).

Figure 2. Average footprint per person in Sweden's nine municipality groups



Source: Klimatkalkylatorn; municipality classification according to SALAR (2016).

Note: Other products and services include sports and leisure activities, pets, toys, gardening, insurance, hygiene products, and more. Response rates from the different groups varied between 5.4% (C7) and 9.0% (A1).

Food is the consumption category that generates the highest footprint in all nine groups. Only minor differences are noted between the nine groups, apart from "Eating out/Restaurants", where respondents living in large cities (A1) have almost double the footprint compared to respondents in the more rural municipality groups (e.g. C8). This rural/urban difference is as expected, as urban residents have a larger selection of restaurants in their vicinity. "Mainly meat" is the most common diet among all the respondents (33%), followed by "flexitarian" (half meat, half vegetarian; 30%) and "vegetarian" (12%).

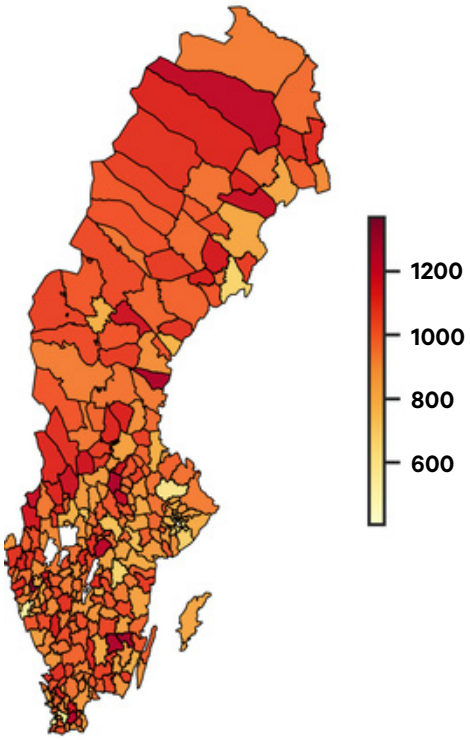
Air travel is the consumption category where footprint differs the most between municipality groups. Respondents in large cities (A1) have an air travel footprint that is twice as high as respondents in rural municipalities (especially C8). Different explanations include higher average income levels in cities; more single-person households (SCB 2022), composed of individuals who travel more by air (see next section); and closer access to airports, making air travel more accessible.

As expected, footprints associated with personal vehicles are smallest in the largest cities (A1 and B3) and largest in the more rural areas (C8 and C9), where distances are greater and public transport is limited (see Figure 3). An unexpected finding is that the large cities (A1) have the lowest footprints from public transport, such as bus and train travel, despite having public transport systems that are more developed. These results need to be explored further but emphasize that the results are dependent on users' self-reported data and that the sample of respondents is not always representative for the geography.

With regard to energy used in the home, district heating is the most common heating source (35%), followed by heat pumps (27%). Respondents living in the larger cities (A1 and B3) have a higher heating footprint than respondents from all the other municipality groups. This is probably due to the larger share of these households being located in cities that are connected to district heating systems, which typically have a higher emission factor than most other common heating sources in Sweden, such as electrical heating or heat pumps (Energiföretagen Sverige, 2022; Swedish Energy Authority, 2022).

The consumption of the different products and services in the "Other" category is also a significant category in all municipality groups (see Figure 1 and 2). The category includes everything from leisure activities to hygiene products, as noted above.

Figure 3. Emissions related to use of personal vehicles (cars, motorcycles, mopeds, microcars, "EPA or A-tractor" (kg CO_2e/person) per municipality.



Source: Klimatkalkylatorn

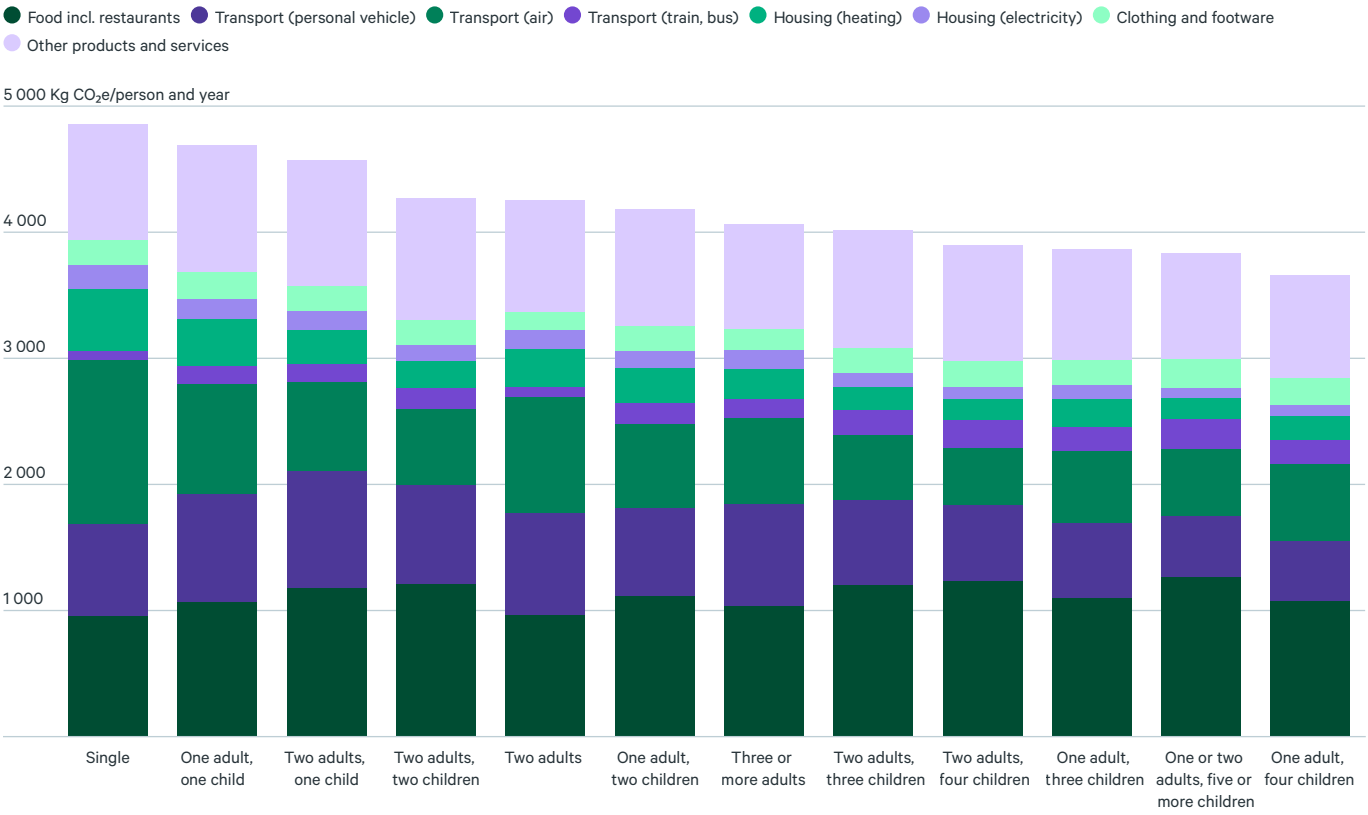
5. Family size influences footprint levels

An analysis of how the footprint per person differs between households of different sizes reveals that single-person households have the highest footprint, followed by households composed of a single adult with one child. Households composed of one adult with four children have the lowest footprint per person.

Single-person households have a much higher per person footprint for air travel than families, and almost double that of the lowest emitting households. As can be expected, single-person households also have high footprints from consumption categories such as furniture, electronics, electricity, hygiene articles, culture and eating out. Individuals in single-person households do not share the consumption burden with anyone; we hypothesize that many are still young and engaged in setting up a new home and hence need to buy more products to get a functioning home. They are also more likely to have more time for cultural activities. Some of the single-person households could be single elderly people that already have all the furniture they need but consume more culture and eat out more, as reflected in the data. Optional age reporting was added to the tool in 2022 but has not been included in this analysis due to the smaller sample collected to date. An analysis of this data will eventually help clarify this picture.

The “food” footprint is the highest in households composed of two adults with two to five children. This category includes “eating out”, which is highest in single-person households. Emissions associated with vehicles are the highest in households consisting of one adult with one child. This is probably a reflection of the fact that the vehicle footprint is shared with fewer people in these households. See Figure 4 for breakdowns of the relationship of footprint to household size.

Figure 4. Average footprint per person in relation to household size.



Source: Klimatkalkylatorn

Note: Other products and services include sports and leisure activities, pets, toys, gardening, insurance, hygiene products and more.

6. Income and vehicle use drive footprint size

Klimatkalkylatorn does not include questions about household income levels. However, postcode data make it possible to match the footprint results to the municipality; as shown in Table 1, we can see that respondents living in municipalities with the highest average emissions per person also live in areas recognized for having the highest average income levels (Statistics Sweden, 2023b). Even without knowing the average income of the respondents, their geographic locations point to income levels being a likely driver of higher footprint levels.

Our data show that when averaging across municipalities, air travel generates most emissions in high income areas. In these same areas, the consumption category that generates the next highest emissions per capita is food, followed by clothing, hygiene, sports, electronics and electricity.

The three municipalities with the lowest footprints all have well under the Swedish median income level. They have a low footprint for categories such as food, activities and electricity. Lund and Umeå have substantially lower vehicle footprints, and Vilhelmina has the lowest air travel footprint of all municipalities. Lund and Umeå both have a high share of (low-income) residents who are students and many cyclists, which probably explains why the municipalities' respondents have low footprints related to vehicles, as well as many other categories. Vilhelmina, located in northern Sweden, is one of Sweden's smallest municipalities by population; households' highest footprints here are from car travel, likely a reflection of the municipality's rural setting.

Table 1. The three municipalities with the highest and lowest average emissions (kg CO_2e/person)

Municipality (municipality group)	Average emissions (kg CO_2e/capita)	Annual average (median) income, thousand SEK, (age 20–64)	Number/Share of population using tool
The three municipalities with highest average footprint			
Danderyd (A2)	5719	1100 (433)	3821/30%
Vellinge (A2)	5583	530 (375)	3020/21%
Lidingö (A2)	5253	645 (378)	5505/28%
The three municipalities with lowest average footprint			
Lund (B3)	3826	317 (274)	15 050/26%
Umeå (B3)	3769	301 (278)	17 632/29%
Vilhelmina (C8)	3751	266 (258)	563/17%

Source: Klimatkalkylatorn data compared with average and median income levels for the year 2021; the average income for the whole of Sweden was 335 800 SEK (Statistics Sweden, 2023c).

7. Overall findings

The results from Klimatkalkylatorn suggest that households' average footprints (4.3 tons CO_2e) are somewhat lower than the official statistics, estimated at 4.6 tons CO_2e (Swedish EPA, 2022). This is surprising, considering that the estimates from the Swedish EPA do not include the climate impact from long-distance air travel (Lee et al., 2010).

Considering this, the average figure from Klimatkalkylatorn could be expected to show a higher footprint per person, but several reasons could explain the lower average. For instance, the majority of the users of Klimatkalkylatorn might be living a more sustainable lifestyle than the average Swede, and citizens less engaged in climate-smart lifestyles may be less likely to respond to a tool like Klimatkalkylatorn. Another reason could be that users estimate their consumption incorrectly (see Method section above about self-reporting bias), or that the calculator omits detailed questions about a household's full consumption. Users could also enter incorrect information, or we may have made incorrect assumptions during data cleaning.

We will continue to explore these possible reasons as part of our continued refinement of Klimatkalkylatorn and our research connected to the tool's findings, with the intention to increase the public's understanding of climate impacts associated with their personal lifestyle choices and to support the development of policies aimed to mitigate carbon footprints. Research plans also include combining these data with other datasets and continuing the analysis of how footprints are influenced by different socio-economic and socio-demographic factors. We also plan to complement the collected data with qualitative studies such as interviews and focus groups.

8. Summary and policy implications

Sweden's current average footprint levels illustrate the country still has a long way to go to reach net-zero emissions by 2045. To mitigate current emission levels and facilitate low-carbon lifestyles as the norm, radical change needs to come from society as a whole, from systems of production to consumption, infrastructure and culture.

The early findings from Klimatkalkylatorn, presented here, show that the average values presented at the national level through Sweden's official statistics in fact differ widely between Swedish households. While the majority of respondents are close to the average emissions per person in Sweden, there are examples of households with footprints of up to 50 tons CO_2e per person. Klimatkalkylatorn's results indicate that 25% of the respondents have a footprint per person below 2.5 tons CO_2e, and 25% have above 5.3 tons CO_2e.

This more detailed picture behind the national-level data shows that each household, no matter which group, will be impacted differently in shifts towards more sustainable consumption patterns. Different policy measures, therefore, must target different categories of consumption, while at the same time recognizing the differences in household consumption patterns and needs (Dawkins et al., 2023; e.g. Gong & Maltais, 2022), in order to achieve a fair and effective reduction of Sweden's consumption-based emissions.

Klimatkalkylatorn provides valuable insights into household consumption patterns across Sweden, and the results, despite being based on self-reported data, can help policymakers to design targeted policy responses that help mitigate carbon footprints. The initial analysis presented here reveals that food consumption is the main driver of greenhouse gas emissions among Swedish households, followed by transport (vehicles and air travel). The consumption of other products and services connected to leisure, sports and culture also represents a significant proportion of the average household footprint. These initial results show stark differences in consumption patterns across households, which are often found to be strongly connected to a municipality's average income levels, as well as to household size.

The consumption of air travel is the most significant factor leading to differences in carbon footprints among households. Given this finding, Sweden should begin monitoring the full impact of travel by air and develop policies and measures to support mitigation of the associated emissions [see e.g. Gössling and Dolnicar (2023), who offered compelling recommendations on how to address air travel behaviour].

The urban/rural context also influences which consumption categories come out high and low with respect to household footprints in their respective context. These results are well aligned with other SEI research findings about how carbon footprints are influenced by income and density (e.g. Axelsson et al., 2022a; Dawkins et al., 2023). This first glimpse of Klimatkalkylatorn's rich dataset requires continued research, to explore what we can learn from the correlation between the many different variables touched upon in this working paper, as well as which policy responses would be necessary to drive forward the necessary shifts in consumption.

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