Sustainability Science
https://doi.org/10.1007/s11625-023-01435-9

SPECIAL FEATURE: ORIGINAL ARTICLE

Individuals within the Larger System to Support the Energy Transition

How individuals make sense of their climate impacts in the capitalocene: mixed methods insights from calculating carbon footprints

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Received: 3 April 2023 / Accepted: 6 November 2023

Abstract

Many people want to play their part to tackle climate change, but often do not know where to start. Carbon Footprint (CF) Calculators pose potential for helping individuals situate themselves in climate impacting systems of which they are a part. However, little is currently known about whether and how individuals who complete CF calculators understand their CF in the context of climate change. This article explores how people make sense of their CFs and locate themselves in the capitalocene. It draws on theories of social practices, environmental ethics, valuation, and knowledge-use to analyse data from 500+ Danes who completed a CF calculator (https://carbonfootprint.hi.is) and interviews with 30 Danes who were asked to complete the CF calculator. In this article, we describe how Danes' CFs are impacted, looking at how survey respondents rate importance of mitigating climate change, importance of personal actions, and importance of public steering, as well as disposable income, living space, and family type. We also show how interviewees reflect over their consumption activities and possibilities. Those with high income nearly always had high CF but felt like they had little agency to change the system and rather justified their high-emitting practices such as flying, while those with low CF felt they had more agency in the system. The results show that high-CF individuals resist voluntary reduction of their emissions despite the presence of environmental ethics. Thus, we conclude that systemic solutions have the foremost capacity to reduce carbon emissions.

Keywords Individual agency · Carbon footprint calculators · Valuation · Capitalocene · Environmental ethics · Climate concern

Introduction: individual carbon footprints (CFs) in the capitalocene

An increasing focus on people and local contexts is warranted by the hitherto empirical limitations of international science, technology, and market-based solutions in dealing

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with the climate crisis. The most recent IPCC report highlights the importance of engaging social aspects of global systems in meeting climate and biodiversity challenges and attaining the 1.5 °C target (Steffen et al. 2018; IPCC 2022; Whitmarsch et al. 2021). There are increasing calls to include the social sphere 'behavior, practices and cultural' in transitions and disruption planning (Kivimaa et al. 2021, p. 122). Questions arising from this renewed interest in individual agency are thus: how do individuals position themselves within broader systems and make sense of locally relevant actions to best reduce climate impacts of everyday life?

CF calculation is one way for individuals to locate themselves in the global systems of which they are a part and thus make sense of how their everyday lives contribute to climate change. CF calculators estimate a user's carbon emissions in tons of CO_2 equivalent per year (either per consumption unit or per capita) based on individuals' consumption of goods and services (including housing, food, transport, etc.). The global average personal CF was ~ 3.6 in 2021 (Akenji et al. 2021) but needs to come down to 2.5 by 2030 and finally 0.7 by 2050, to reach the Paris Agreement targets and limit global warming to 1.5 °C (Akenji et al. 2021). Carbon calculation helps to reveal differences between countries (e.g., Clarke et al. 2017; Hubacek et al. 2017), and individuals: for example, the most affluent 10% of individuals cause almost 50% of global emissions (Chancel 2022).

As well as describing aggregate emissions, CF calculators have the potential to motivate individuals to identify high-emission practices and try to change them. However, much research has also questioned to what extent more knowledge and information is an important aspect of changing everyday practices, especially within the research tradition of theories of practices (c.f. Boström and Klintman 2019). Individual consumers may not have the power to foster substantial, aggregate changes when faced with battling the power of incumbent infrastructures, industries, and governments (Boström and Klintmann 2019; Shove 2010), especially without active organization (Bååth 2022a). Furthermore, comparably excessive emitters believe themselves to have the privilege of consuming more than others (Cass et al 2023), which is also enabled by the unequal distribution of entitlements to certain resources and practices in a capitalist system (Bååth and Daoud 2023).

Capitalism forms the context for much of modern everyday life and one way of thinking about the system of climate impacts is the *capitalocene:* the new geological epoch in which human economic activity has become the dominant driving force behind changes to the Earth's ecosystems. Contrasting 'anthropocene', the concept capitalocene highlights the fact that it is not just people but foremost the wealthiest people, generally located in the most powerful nations of the global north, and the corporations that operate out of them have the largest share in causing the environmental crisis facing the planet and the unequal distribution of climate consequences (Moore 2016). We use capitalocene to describe the global socio-political–material arrangement of environmentally impacting practices and infrastructures, in which individuals may locate themselves in terms of their own, other people's and different institutions' power and responsibility to act for achieving a net sustainable level of CO_2 emissions.

In this paper, we look at how the calculation of an individual CF enables individuals to make sense of their practices by locating themselves in the capitalocene. Extant studies argue that CF calculators' ability to promote individual behavior change is modest. Partly, because such calculators attract users who are already concerned about their individual impact (Oliani 2021). However, even those individuals' attempts to change are often trumped in everyday life by other factors, such as convenience, cost, lack of infrastructures, and social norms (Oliani 2021; Gram-Hanssen and Christensen 2012). Furthermore, CF calculators have attracted criticism for placing moral responsibility on individuals, effectively diverting attention from the comparably greater power of industries and governments to take responsibility for emissions' reduction (see McManus 2022; Solnit 2021).

CF calculators may, however, still have practical value, for example by helping individuals cultivate conscious reflection (Wilks 2009). There is an emerging literature broadening the conceptualization of individuals as change agents who can have systematic impacts beyond their individual practices as, e.g., investors, role models, organizational participants, and citizens (Upham et al. 2020; Steensen Nielsen et al 2021). This literature suggests that CF calculation might offer previously understudied capacities for promoting ethical concerns for the environment as a means of empowering individual agencies for emissions reduction, laying the foundation for broader systematic changes.

The state of the art suggests that the jury is out on the ability of CF calculation to foster individual change for emissions' reduction. While the critics point to a number of practical difficulties for using CF calculations to foster individual change, the proponents put forward the calculators' role in propelling individual ethical considerations about the environment, climate change in particular, in relation to their everyday lives and how to change it for the better. However, how individuals relate such environmental ethics to CF calculation, and whether and how it allows the individual to foster agency for change, is poorly understood. Therefore, this paper poses the following research question:

> How do individuals relate to carbon calculation in locating their everyday lives and agency for change in the capitalocene?

We answer our question first by outlining our theoretical framework for analyzing human practices of self-location through valuation and environmental ethics. We then conduct our analysis in two steps. First, we analyse quantitative data from the CF calculator to identify how respondents' climate concern relates to the size of their CF. Second, we analyse qualitative interviews with individuals who have used (or refused to use) a CF calculator to examine how they relate CF to ethical concerns about climate change and agency for low-CF lifestyles. Our focus is foremost on understanding how tools like carbon calculators can contribute to shaping the knowledge and meanings that govern different CO_2 intensive practices. We conclude by summarizing our insights for policy makers in thinking about what sort of interventions can best help individuals embedded in the capitalocene participate in transitioning toward sustainability.

Theory: valuations, environmental ethics, and self-location

Individuals can locate themselves in a system by valuating the practices constituting their everyday life. *Valuations* refers to socially shared forms of creating and negotiating norms performed by assessing, ascribing, and appreciating one or more values, including the translation of values into action (Lamont 2012; Thévenot 2001). Valuations can thus formulate plural types of value, such as economic, moral and aesthetic, and negotiate relationships between them. For example, CF calculation valuates an individual's practices in terms of descriptive knowledge of CO_2 emissions, while moral valuation of the CF produces normative knowledge about individual practices. Hacking (1983) describes this duality of knowledge as simultaneously a *representation* of reality and an *intervention* that affects it. An individual may use knowledge about CF both to describe the reality of their practices and to intervene in that same reality. When performed in practice, valuations form ties between, e.g., environmental ethics and the practices' environment. Thus, in its most concrete form, valuations locate the individual in the capitalocene by producing and negotiating the moral values of their CF, and whether and how practices ought to be changed to be (environmentally) ethical.

Since knowledge is both descriptive and intervening, how does descriptive knowledge such as CF (i.e., representations) intervene with the existing practices, locate the individual who performs them in larger socio-material arrangements, and potentially change them? (c.f. Jack 2022). Although (representational) knowledge of environmental effects alone does not necessarily foster substantive pro-environmental change to people's everyday practices. Therefore, we turn to valuations, by focusing on how descriptive and normative knowledge is practically interrelated and negotiated within material infrastructures. To intervene, knowledge of the CF must shape expectations, ambitions, hopes, fears, plans, and other projective dimensions that refer to the change (or continuation) of a practice (Mische 2014; Welch 2020). Ethics is one type of normative knowledge that may intervene and thus provoke variations in individual performances of practices (Askholm and Gram-Hanssen 2022; Gram-Hanssen 2021; Katan and Gram-Hanssen 2021). While there is no simple relation between knowledge about (CO_2 intensive) practices leading to individual change, reflexivity and ethical environmental considerations at an individual level may interact with and shape the meanings, norms, and general understandings that guide practices at the systems' level.

Materials and methods: carbon calculation and interviews

To explore how individuals relate to carbon calculation in locating their everyday lives and agency for change in the capitalocene, we used both quantitative results from a CF calculator as well as qualitative interviews with people who had been asked to complete it. Our study is located in Denmark, an interesting case as, on one hand, it can be seen as a frontrunner in relation to a green transition (see, e.g., Yale EPI 2022), and at the same time is a country with a very high ecological footprint per capita (Larsen et al. 2016; Happy Planet Index 2021; Global Footprint Network 2023). Our quantitative data show how demographic factors and climate concern relate to CF, while the qualitative material gives insights into how people make sense and reflect over their CF and everyday lives in the context of climate change.

Quantitative

CF data and calculations

The CF data consist of 515 responses to a calculator survey (carbonfootprint.hi.is) collected in 2022. The survey, the data, and the calculations are explained and evaluated in detail in Heinonen et al. (2022). The survey was built to measure the consumption-based CFs of the respondents, and to collect rich information about their climate attitudes, engagement in pro-climate behaviors, and their self-reported quality of life. Since the survey is based on participant estimates, outputs are also rough relational figures. The survey was provided in Danish and in English and mainly distributed via Facebook advertisements, and participants sharing the survey in their social networks. Only adults in charge of, or participating in the finances of the household were allowed to take the survey. Representativeness over the whole population was not aimed for, but rather the aim was to collect as many high-quality responses as possible.

Overall, 903 respondents took the survey, 515 of whom filled it in fully and consented to use responses for research purposes. 94% of the respondents chose the Danish language version, and 6% chose the English version. In terms of household types, 29% of the respondents were single adults (Singles), 35% adult households with more than one adult (Sharers), 5% single parent households, and 31% families with two adults and one or more children a total of 36% (Families). 69% were women, 29% men, and 2% non-binary/genderqueer. On the urban–rural axis, 47% of the respondents live in urban areas, 28% in semi-urban settings, and 25% in rural locations (using the Eurostat Degree of Urbanity classification, Eurostat 2018). All respondents fell between 1750 and 100,000 kg footprint thresholds.

Income levels were asked both for the respondents themselves, and for their household. Using tax rate information ([1] in Appendix 2), disposable income for each household was calculated. To effectively depict the purchasing power, using the household's disposable income and information about the household composition, a new variable, Disposable income per Consumption Unit ([2] in Appendix 2), was calculated following the UN definition according to which:

- first adult aged 18 and over = 1.0,
- next adults = 0.7,
- children each = 0.5.

The footprint calculator was split into eight domains: diet, housing, vehicle possession and use, public transport, leisure travel, goods and services, second homes, and pets. In the survey, respondents were asked to report either on behalf of the household, or as an individual depending on the domain in question. Housing, vehicle possession and use, second homes, and pets are typically shared (e.g., Ala-Mantila et al. 2016), and therefore, questions related to these were reported for the whole household, whereas in other domains, reporting was individual. To calculate the footprints per CU, in the domains where a household shares, the emissions were divided by the CUs in the household.

To assess the consumption-based CF, all the (globally induced) emissions were allocated to the individual. In contrast to typical consumption-based accounting (e.g., Heinonen et al. 2020), the assessment in question utilized mainly product and process data, with the input–output (IO) component covering only goods and services or ~ 10–20% of the overall footprint. The Exiobase IO model (Stadler et al. 2018) was used in the IO part, whereas the rest of the different data sources are explained in detail in Heinonen et al. (2022).

After filling in the CF calculator, respondents were asked a series of questions about their climate attitudes and perceptions of responsibility. A factor analysis was utilized to form a single climate concern ([3] in Appendix 2) variable with a scale from 1 = very low concern to 5 = very high concern. The sample was then split into three groups of low, middle, and high concern using 3.25 and 4.25 as the thresholds for low and high. These thresholds were chosen to keep the group sizes large enough, as few respondents had very low concern. The factor analysis and the formulation of the climate concern variable are explained in detail in Abdirova (2022).

In addition, respondents were asked how important they feel climate mitigation is, how strongly they think it is their personal responsibility to reduce the emissions they are causing, how important they think that public steering is, and how climate-sustainable they think their own lifestyle is [Likert scale (1) Not at all, (2) Slightly, (3) Moderately, (4) Very, and (5) Extremely]. The respondents were again grouped into high, medium, and low for both questions similarly as with the climate concern level.

The survey ended with a section about respondents' socio-economic situations. In this study, income level, family type, and living space were utilized to depict the CFs. With income per CU and living space per CU, a similar low–medium–high grouping explained above was used. Income thresholds of €1900 and €3300 per CU per month were used to allocate deciles 1–2 to the low group, deciles 3–7 to the middle group, and deciles 8–10 to the high group. Living space of 40 m^2 per CU was set as the threshold between low and medium, and 80 m^2 as the threshold between medium and high. Family types were split into three groups of one person households (Singles), more than one adult households without children (Sharers), and households with children (Families) was used.

Qualitative

To study how people make sense of their individual CF, we interviewed people living in Denmark who were asked to complete the carbon calculator. These interviews were done during a wider research project comparing the CFs of those living together versus those in shared accommodation, carried out in 2022–2023 (removed for review). The qualitative data include 30 interviewees: 23 living alone and seven living in households with at least five other adults. The interviewees were recruited through the 1.5° lifestyle calculator (Heinonen et al. 2022) and snowballing. The interviewees were aged 26–90 and included 15 females and 15 males. Of the interviewees, 14 lived in suburban and 16 in urban areas (no rural respondents). Their income ranged between €800 and €12,000 per month, and their living spaces between 25 and 380 m^2.

Among the interviewees, seven declined to fill in the calculator. However, we included these interviews, because these seven also extrapolated on their reasons for refusing the flaws of calculating individual CF and discussed their individual role in sustainability efforts. Of the 23 interviewees who filled out the calculator, CF ranged between 4.8 and 27.0, and corresponded to their individual incomes (see Appendix 1, interviewees). There is significant variation in individual CF, yet, even the lowest score, 4.8 per CU, is significantly above the target CF to reach the Paris agreement of 2.5 per capita by 2030 (Akenji et al 2021).

The field researcher conducted interviews with the study participants in their homes (16), in public places (5), or via zoom (9). The interviews were conducted in English and lasted between 25 and 105 min. Interviewees were asked a similar range of questions, but each interview was adapted to explore issues that the interviewee identified as important with using a CF calculator to make sense of their sustainability efforts. Interviewees were supplied with a plain language statement and interviews were recorded with written consent. Recordings were transcribed by NVivo software and reviewed by the field researcher.

We extracted the parts of the interviews where respondents discussed using the calculator and the research team discussed emerging themes. After a first round of thematising our results, we re-discussed and refined our research question and did a second round of analysis leading to illustrations of what we identified as valuations for locating their carbon emitting practices in the capitalocene.

Results: CFs, reflection, demotivation, and scepticism

The results from the carbon calculator's data show how the respondents' CF correlates with variables associated with ethical concerns for the climate. The left-hand side of Fig. 1 presents the CFs for the different sub-samples, divided into the eight consumption domains presented in the previous section. The right-hand side forms a pair with the left-hand side, depicting the perception of the climate-sustainability of one's own lifestyle (gray), the level of climate concern (light green), and the consideration of importance of personal actions (dark green) for the same sub-samples.

The uppermost figure pair shows how perceived importance of mitigating climate change correlates with the respondents' CFs. Those who think that mitigating climate change is of low importance have a relatively high CF close to 14 tons CO_2 e/CU, those in the medium group around 9.5 tons, and the high importance group slightly above 8 tons. The low group also has the highest-domain CF in all the other domains but public transport. On the right-hand side, it can be seen how both the climate concern level and the perception of importance of personal actions increase from the low to the high group. Interestingly, the perception of the climate sustainability of one's lifestyle is the highest among the low group despite their significantly higher CFs, both in total and across all the major domains. They also have the highest CFs across all the groups shown in Fig. 1.

The second pair shows the CFs according to the perception of the importance of personal actions. Again, the low importance group has the highest CF at approximately 11 tons CO_2 e/CU, while both the medium and low groups average at slightly above 8 tons. Similarly to the first comparison, the low importance group has the highest average perceived climate-sustainability of their own lifestyles. Interestingly, also the climate concern level of the three groups varies much less than the perception of personal responsibility. Also, despite the high perception of importance of private action, the high group has the highest-domain CF in the leisure travel domain, whereas the low group has the highest in all the other domains except for public transport.

The third pair, looking at the perceived importance of public steering, shows a similar picture. Those who consider the importance of public steering as low have high footprints at close to 13 tons CO_2 e/CU, while the medium and high groups average at slightly above eight tons. The low group has particularly high vehicle and housing energy footprints, and also a very low climate concern level, but a high perceived climate-sustainability of their lifestyles than the other groups, despite the much higher CF.

The fourth pair shows the very commonly found positive correlation of disposable income and CF (e.g., Heinonen et al. 2020; specifically for Denmark also, e.g., Jack and Ivanova 2021). What is interesting in this figure pair is, however, that climate concern, the perception of importance of personal actions, and the perceived climate-sustainability of one's own lifestyle are very similar across disposable incomes, although there is a mildly increasing pattern from high to low incomes.

Living space is an important factor as shown by the fifth figure pair, particularly via housing energy use. Again it is interesting that the right-hand side variables show relatively equal climate-sustainability and importance of personal action perceptions, and only slight increase in climate concern toward the low living space group, suggesting that few consider housing choices as viable personal actions, and might not relate housing very strongly to their considerations of their own lifestyle climate-sustainability.

The last pair shows how climate concern correlates with living arrangements, which indicates to what extent respondents' CF might be affected by sharing benefits, and whether that is reflected in their climate concern. Families have the lowest CFs, followed by Sharers and Singles, largely driven by the sharing benefit (or the lack of it). Again housing energy is an important factor where the sharing benefit is high. Singles have the lowest domain CFs in many major domains such as diet and vehicles which might indicate conscious actions to reduce their footprints, explaining why the right-hand side of Fig. 1 shows how they have the

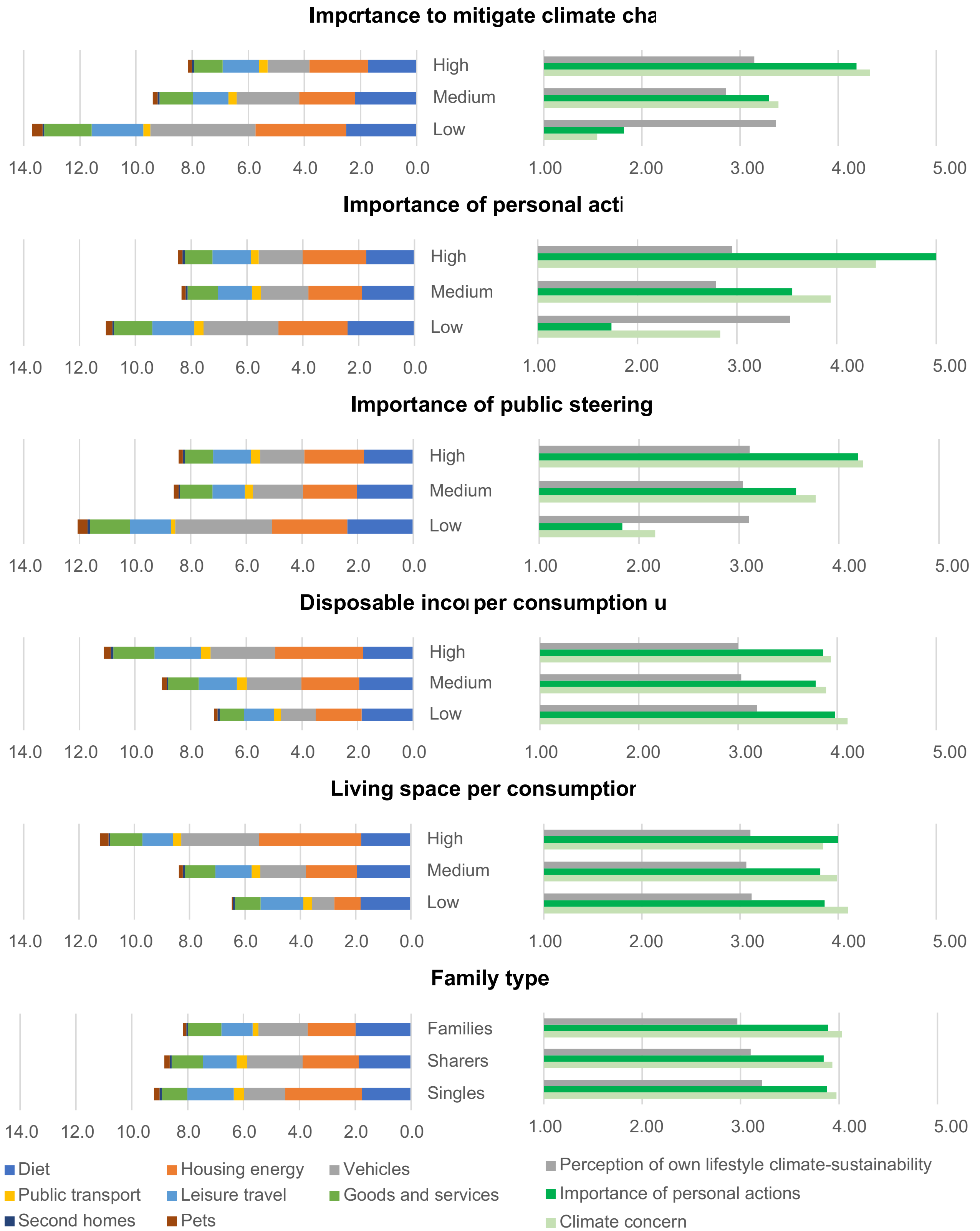

Fig. 1 Left: CFs per consumption unit in tons CO2e/a in eight domains for the sample of Danish respondents divided into three groups according to their opinion on the importance to mitigate climate change, perception of importance of personal actions, disposable income, living space, and family type. Right: perception of the climate sustainability of one's own lifestyle, level of climate concern, and the consideration of importance of personal actions

highest climate-sustainability perception despite the highest CFs. Despite this, Singles also have the highest leisure travel domain CFs. In the end, however, the levels of climate concern and the perception of the importance of personal actions remain high and similar across all family types.

Most strikingly individuals who think the importance of climate mitigation is low, importance of personal action is low, and the importance of public steering is low have the highest CFs. Increasing disposable income and floorspace also increases CF, while family type does not impact CF greatly, possibly since we use CU rather than per capita emissions.

Building on these quantitative findings, we broaden out from climate concern to ethical concerns for the environment, focusing on climate issues. We describe how interviewees who had been asked to complete the 1.5° lifestyle CF calculator make sense of it and their results. None of the interviewees came within the 2.5 limit needed to reach the 1.5° target, even though all of the interviews expressed climate concern and to varying extents of environmental ethics. Responses largely fall into three categories: the calculator as instigating post hoc reflection over one's practices, the calculator as demotivational, and scepticism toward the calculator's relevance for locating one's own lifestyle in the capitalocene.

Reflection

Interviewees with low CFs reflected over actions they were taking to reduce their carbon emissions, referring to both past and current practices as well as ambitions for the future. One example is Ben (m, 59, 4.8) who mentions trying to eat more vegetables, buying food with less packaging, not owning a car, and taking the train instead of flying. He does these things for practical reasons, since he is concerned about his health and thinks that owning a car is foremost a costly nuisance when he lives in the city and can bike everywhere. Ben was "proud" of his comparably low CF, yet he himself explained this as due largely to his low income rather than environmental efforts. Nora (f, 31, declined) emphasized the importance of systemic change, while also being conscious of her individual emissions; "*I'm also in my personal life trying my best to live according to my values and to do the best on my little micro scale*." She does not eat meat, does not have a car, and has quit flying, but places more importance on her political engagement to reduce carbon emissions through policy. Jo (f, 27, 6.1) describes the different routines she has in place to reduce her CF, such as minimising consumption and high emissions transport. However, she also identifies additional actions "*I could probably spend less time on the computer like streaming.*" Similarly, Chris (m, 36, 6.5) describes ambitions to lower his food CF, "*I'm trying to switch over to a vegetarian diet. So I'm also learning to cook again.*" The centrality of trying is also evident in Niels's (m, 59, 8.7) way of making statements, followed by some back peddling, "*I never use a car. Never! I don't own a car… I was part of a car share thing. I almost never fly… I do fly.*" Interviewees with comparatively low CFs reported individual efforts to reduce their consumption and related emissions expressing a greater sense of agency in the capitalocene.

Reflections regarding systemic agency generally identified limitations of the individual's ability to affect their own CF, and many of the interviewees who fell into this category had relatively higher CFs. Linn (f, 36, 12.0), for example, says "*Yes, I could do better. But I'm also aware of the fact that each individual doing a little bit better is not really going to fix anything… it needs to be on a higher level, a higher scale.*" Elias (m, 43, 10.1) drew on his experience from finance, contrasting the "*waste of time … sorting your trash*" with a members-owned pension fund voting through environmentally ambitious targets and '*all of a sudden you have like a hundred and fifty billion kronor working toward (sustainability)*'. Reflections from those with relatively higher CFs point to the insignificance of individual efforts in relation to systemic infrastructures and hence the pointlessness of trying.

Demotivation

Interviewees with higher CFs found the calculator demotivational, fostering negative reactions such as resignation or resistance. One reaction was a general despondency over one's high CF. Linn (f, 36, 12.0) exemplifies this reaction, saying "*…what really hit me was that I'm above average … Yeah, it made me really sad, it made me really sad because I think of myself as someone who does try to choose what I think is green, you know, I don't eat meat, I separate my trash.*" She felt despondent about her individual efforts to lead a sustainable life, which seemed futile when presented with her CF. Such futile views may, however, also be fostered toward the system, rather than the individual themself. Facing his CF, Jon (m, 34, 21.7) expresses a sense of resignation over the lack of sustainability governance, "*… whose responsibility is it to make it easier? I mean, as an individual, you can make your own choices, but it would be nice to be forced into going down the right path.*"

A different kind of demotivation or even resistance is expressed in terms of personal privilege to high-CF practices, especially flying. Linn (f, 36, 12.0) was "surprised" that while she "only" flew once this year, that trip made her CF excessive. Yet, she concludes that "*that's the one thing that's not going to change, it's one of those things that gives me joy in life is doing trips, actual trips. But if I only do one or two a year, I think maybe that's OK.*" Sara (f, 36, 12.0), in turn, explained that her yearly multiple flights was her personal "*guilty conscience*", yet she viewed it as a crucial part of her life and was "*trying not to be too ashamed of it*". Oscar (m, 42, 27), ironically states that flying makes him a "*bad boy*", and moreover hopes that "*people travel more*". Flying, while being a known high-CF practice, is so closely connected to these interviewees' sense of a good life that its effect on their personal CF makes them resist rather than consider change, even while they perform environmental ethics.

Scepticism

Many interviewees were sceptical of the calculator and the CF they were presented with, and seven declined to complete the calculator. Examples of scepticism ranged from questioning why the calculator did not take certain variables or nuances into account, whether there was some error with the calculator, and whether calculating individual CF was meaningful at all. This relates to arguments about systemic agency, for example, Chris (m, 36, 6.5) discovered his transport was a proportionally high part of his CF, due to a 30 km work-commute with the train, but he saw no feasible way of lowering it. More explicit counter arguments referred to the fact that CF-accounting was invented by the fossil fuel industry and thus intrinsically corrupt, for example Nora (f, 31) who declined to complete the calculator saying '*they want us to focus on our individual consumption choices instead of on the fact that their extraction of fossil fuels is driving mass extinction on Earth*.' While another potential interviewee canceled a planned interview when asked to complete the calculator.

Analysis and discussion: what can CF calculation teach us about individual agency in the capitalocene?

Our results show that respondents who are concerned about the climate generally had lower CFs. We also find that interviewees with lower CFs feel more agency, while interviewees with high CFs justify their lifestyles and resist change. This poses further questions about why those with high CFs feel despondent when high CF means greater room for emissions reduction, coupled with (probable) more political sway. We return to valuations and environmental ethics to explore these results considering differences between low and high CF to discuss how knowledge, environmental ethics and trying to reduce climate impacts interact.

Low CF: climate concern, environmental ethics, and trying

The quantitative results showed a correlation between climate concern and CF reduction, even though the utilized bivariate analysis does not allow drawing very strong conclusions. The sharing benefit is not obvious to individuals, illustrated by Singles having the highest CFs with the lowest spending, and the highest perception of the climate-sustainability of their lifestyles. Interestingly, those who found it the least important to reduce their own CFs with personal actions, or public steering to reduce everyone's CF, had the highest perceived climate-sustainability of their own lifestyles. This might hint to an illusion of climate-sustainability of one's own lifestyle based on simply living in a country that is typically held as a forerunner in the global climate mitigation efforts. It might, however, be due to the considered low importance of climate change mitigation in general, leading to the perception that there is nothing wrong with the status quo. Overall, though, even the highest average climate-sustainability perceptions were between 'moderately' and 'very' [climate-sustainable], suggesting that all respondent groups understand that their footprints are high on a global scale. Moreover, even though we saw that high climate concern increases the likelihood of comparably low CF, this correlation does not prove that the high climate concern causes CF reduction. There are other possible explanations that may account for it, e.g., a low-CF lifestyle may foster climate concern and environmental ethics—making a virtue out of necessity.

In the qualitative data, most interviewees expressed environmental ethics to some extent, irrespective of their CF. Those who scored comparably low CFs related to the measure as result of their efforts to improve, while to some extent also affirming their relatively (yet not absolutely) small CF as a part of an ethical conduct and agency in the capitalocene. However, and also indicated by the quantitative results, they do not connect CF reduction with individual actions and sacrifices before systemic change. Nora (f, 31, declined) uses environmental ethics to integrate individual and systemic dimensions of her lifestyle, by simultaneously cultivating low-CF practices and advocating political change. While Jo (f, 27, 6.1) reasons that she can probably do more as an individual to lower her CF, in addition to her current efforts. They connect environmental ethics with CF as a means of valuating both the individual and systemic dimensions of practices in their everyday lives and identifying areas for extra effort.

Jo's valuation is key to how she integrates her environmental ethics' normative knowledge with descriptive knowledge of her CF. Her environmental ethics shape how she judges her CF, followed by how she uses that knowledge-couple to shape the projective dimensions of her practices.

She recurrently says that she "tries" to perform different practices to act ethically. Trying entails ongoing attempts at changing: bridging current and historical practices with future ones. The reflections fostered by CF calculation supplies knowledge about areas for and ways of reducing emissions, including ones which she is currently trying to change. Yet, it also affirms the morality and meaning of trying in terms of a comparably low CF.

Many interviewees who emphasize individual action for CF reduction *also* emphasize the need for system change. Chris (m, 36, 6.5), for example, found out his transport was a proportionally high part of his CF, due to a 30 km work-commute with the train. However, he saw no feasible way of lowering it. Ben (m, 59, 4.8) offers a different example, he cultivates low-CF practices, but for practical reasons, his comparably low CF made him proud, making virtue out of necessity. Ben uses the CF to valuate his lifestyle, and in that process form a relation between environmental ethics (virtue) and the systemic conditions of his lifestyle. To make virtue out of necessity might be seen foremost as pretentious, yet it also acknowledges the morality of a lifestyle which might not be completely voluntary. Thus, the valuation fosters moral pride that might substitute for other negative experiences of necessity and augment trying.

High CF: dismissal and privilege constituting the capitalocene

Dismissal is a strategy commonly employed by higher CF interviewees who were sceptical of the CF, citing reasons such as the inaccuracy of carbon calculation, CF individualizes responsibility or that CF calculation was developed by the fossil fuel industry. These valuations attempt to downplay the relevance of the CF, so that it does not jeopardize interviewees' environmental ethics. The relation formed between CF and environmental ethics in the valuation is one seeking to protect environmental ethics from the CF as a form of moral criticism. Using a valuation that dismisses the CF, the individual may still maintain their view of their everyday life as ethical. Knowledge about CF thus intervenes in the interviewees' practices by provoking continuity in high-carbon practices rather than change.

The dismissal should, however, not be reduced to a simple act of hypocrisy. What is also evident in the data is that dismissal of individual CF, and in effect individual change, is often explained and justified in terms of the need for systemic agency for transformation while painting individual effort as futile. Many CF impacting practices are tied in with material infrastructures, such as energy systems, which the individual has limited power over. Thus, the CF fosters a form of localization of the individual in the capitalocene, yet one where their comparably high emissions can be foremost ascribed to the systemic dimensions encompassing individual efforts. The dismissal is thus simultaneously refusing to accept the individual responsibility for one's location in the capitalocene and re-allocating responsibility to systemic infrastructures that shape possibilities of achieving low individual CF.

Privilege differs from dismissal in that it (to some extent) accepts CF calculation and the individual CF, but questions to what extent one actually has to change to be ethical. Interviewees show privilege when they justify high-emitting practices like flying. Some high-CF interviewees indicate that they are aware of the emissions caused by flying, yet they give themselves the right to fly by 'singularising' themselves (see Bååth 2022a). The CF impacts their ethical reasoning by framing their individual circumstances as more or less unique, and thus exempt from general ethical concerns. Sara (f, 36, 12.0) tries not to feel guilty over flying, while Oscar (m, 42, 27) calls himself a "bad boy". Neither Sara nor Oscar claims not to care for the environment and both are aware that they are doing something wrong from an environmental ethics standpoint, yet they address this wrongdoing by justification and singularization rather than trying to change. The privileged use of CF thus places oneself in a unique location within the capitalocene where general ethical principles do not apply, since they are only following a discourse of the goodlife proffered by the capitalocene. Furthermore, interviewees express collective privilege referring to the fact that everyone else flies so why should not they. For example, Maria's (f, 38, 17.8) partner lives in Italy, so she flies to spend time with him at least once a month, Nick (m, 42, 10.3) justifies flying from Copenhagen to Aalborg (a 4.5 h train ride), and Mette (f, 62, 19.6) expresses pleasure in taking her grandson on international flights. The emerging awareness of the (un)environmental ethics of high-CF practices, such as flying, does not dissuade such practices. Individuals see their circumstances as both unique and collective and thus spurn responsibility, while maintaining a self-image of being environmentally ethical.

The privileged location is not limited to justifications alone. Privilege demands valuations that identify certain performances of excessively emitting practices as, at least formally, justified (Bååth and Daoud 2023). Because capitalism ascribes entitlements to individuals according to their wealth and purchasing power, it, moreover, justifies valuations in which excessive emissions are acceptable if the individual can afford them. Any (legal) practice that the individual can afford is thus justified in the capitalocene, irrespective of environmental ethics. The privilege is, however, compatible with some environmental ethics-based demands for transition, because it assumes that most people are not in such a unique location, and thus, *they* have individual agency and the capacity to change due to systemically driven transition. It is unclear to what extent the identification of one's everyday practices as both individually emitting *and* locked into a system of high-emitting practices motivates political action to battle the capitalocene's organization, or whether it also demotivates collective action.

Ethics, knowledge, and agency for change

Returning to our research question, *How do individuals relate to carbon calculation for locating their everyday lives and agency for change in the capitalocene?* Our analysis shows that CF calculation provokes reflection intervening with the projective dimensions of individual vs systemic agency. Yet, they intervene quite differently depending on how an individual judges their CF, treating it as a normative measurement of morality rather than a descriptive measurement of emissions. Among those with a comparably low CF, it fostered reflection and at least some motivation to continue attempts to lower one's emissions. However, among those with a comparably high CF, their valuations did not seem to influence their projective dimensions toward further attempts to lower CF, but rather provoked justification to exempt either individuals in general or the interviewee in question from having the responsibility or power to change.

Drawing on Hacking's (1983) definition of knowledge as simultaneously representing and intervening, we find that CF intervenes who perform environmental ethics through valuations that assess and justify the relevance of CF in terms of whether the results fit with the interviewee's ethical self-perception. Thus, rather than using the CF to assess and valuate one's ethics, the ethics define to what extent the CF is relevant for one's everyday practices. The CF thus intervenes with the projective dimensions of one's practices only to the extent that it does not challenge one's self-perception as ethical. The foremost role of ethics in making practices more sustainable thus seems to be affirmation and justification of current efforts before evaluation and change orientation—a perverted confirmation bias. While CF calculation might motivate those with environmental ethics who also score a low CF, they at the same time seem to demotivate those who score high CF despite holding environmental ethics.

This finding does not mean that ethics are irrelevant for fostering sustainable practices. Rather, we argue that the role of ethics in practices is dynamic and affected by how they are combined with descriptive knowledge of the practitioners' environment. Furthermore, individuals may actively seek to maintain and foster an experience of themselves as ethical through their practices rather than rationally changing their practices to attain some prescribed moral end. Ethics is thus a form of general understanding that may foster visions and ambitions in practices (Askoholm and Gram-Hanssen 2022; Gram-Hanssen 2021; Katan and Gram-Hanssen 2021). However, such fostering is part of how valuations negotiate and relate different types of knowledge wherein ethics produce justifications of high-CF practices rather than efforts to change. In our understanding, ethics are collectively shared and sits on cross on many different types of everyday practices (Gram-Hanssen 2021). Changes in ethics and in practices are thus co-constitutive, and can go both ways from ethics to practice, and vice versa, the individual performances are part of what constitutes both stability and change in collective practices.

The CF calculation locates the individuals with the most room for net reductions of emissions (i.e., those with the highest emissions) in positions where they do not see individual change as an attainable route for carbon reduction. This 'locked-in' mindset thus justifies high-CF practices because of a perceived lack of agency. CF calculation might be valuable in motivating low emitters to maintain low-emitting everyday practices and find new ways of reducing emissions. While ethics should not be seen as driving individual change, they might provide virtue in necessity and promote low-emitting practices as part of a broader collective change in both the general understandings of environment and ethics and the collective performance of practices. As such ethics may promote not only individuals and their performance but also political and industrial change, such as meat-free days in school lunches or no-fly policies. However, we cannot ignore the fact that CF calculation seems to demotivate those who would have the greatest net climate effect of lowering their emissions. While CF calculation allows the individual to locate themself in the capitalocene, that location only seems to contribute to sustainability efforts if the individual perceives it as an ethically justified location and one offering meaningful space for agency. Moreover, the CF calculations are not exact for any individual, and there might be cases where the average intensities used in the calculator over- or under-estimate the emissions caused by a certain respondent. More detailed and adaptive calculators would be needed for them to allow individuals to truly track the emissions they cause and compare different choices available for them.

Conclusions

Providing individuals with knowledge of their individual emissions might not be an efficient means of encouraging high emitters to voluntarily reduce their emissions. While CF calculators enable individuals to locate themselves, and their high- and low-emitting practices in particular, only achieving low CFs appear to shape intentions to reduce carbon intensive practices further. Conversely, individuals who engage in environmental ethics but have a relatively high CF are demotivated to change by CF calculation and justify their high emissions as a privileged yet moral exception in the capitalocene.

Our core conclusion is therefore that calculation of individual CF has the potential to encourage the maintenance of low-emitting practices and encourage low-CF individuals to continue to further reduce their emissions. Yet, those positive effects are overshadowed by the fact that calculation of individual CF does not motivate high emitters to reduce their emissions. It is, moreover, possible that the valuations fostering their demotivation might stifle individual attempts or perhaps even foster resistance to emissions reduction.

The findings affirm that ethics influence how individuals manage the projective dimensions of their practices (Mische 2014; Welch 2020; Gram-Hanssen 2021). However, influence does not necessarily result in concrete plans or even ambitions for emission reduction. Ties that individuals' valuations create between environmental ethics and individual CF suggest that the influence goes both ways. The example of flight privilege among high-CF interviewees clearly shows how the practice of flying influences their ethics and legitimates flying (see also Gram-Hanssen and Christensen 2012). Furthermore, low-CF interviewees take their low-emitting practices as evidence of ethical conduct. Generally, our findings thus affirm the argument that individual agency is insufficient for CF calculation to foster reduced emissions (Oliani 2021; Gram-Hanssen and Christensen 2012), if the infrastructural conditions do not also empower such reduction (Boström and Klintman 2019; Shove 2010; see also Bååth, 2018, 2022b).

There are, however, limitations to our results. The CF calculator, interview method, and presence of the interviewer may have been experienced as judgmental by participants. The interview method, furthermore, heightens reflexivity, possibly resulting in higher awareness and sense of agency. We also did not test how the results of the calculator shaped respondents' *future* efforts to reduce their CF. The carbon calculator itself also has limitations in that it attracts people who are interested in reducing carbon and, therefore, averages will be lower than the broader population, possibly demotivating those who use the calculator and find that they are higher than the average in their categories. Finally, the calculator is inherently liable to mislead attention from the fact that overall spending is the true driving force behind CF.

Despite its limitations, the study has clear policy implications. Foremost, the results suggest that individuals who routinely perform high-emitting practices cannot be expected to reduce their emissions on a voluntary basis given the right kind of knowledge and personal encouragement. Thus, systemic solutions are likely the most efficient way of reducing emissions. That is, policies which cap income, tax, ban, or otherwise limit individuals from emitting excessively and to use wealth to circumvent or ignore such policies. Furthermore, policies which make emission reduction more widely accessible, such as targeted subsidies and investment in cleaner infrastructure and energy systems. While individuals can locate themselves using CF calculation, due to limited perceived agency in the capitalocene, efforts for change can most effectively be encouraged at the systems' level.

Appendix 1: interview respondents

	Age	Income	Gender	Occupation	Years at current residence	Years living alone	House m^2	Location	CO_2 footprint	Interview location	Dwelling	Ownership	Number of housemates	Recruitment	Sample
Ben	59	11,600	Male	Spinning Instructor	30	40	60	Urban	4.8	Home	Apartment	Owned	NA	Snow balling	Live alone
Linn	36	41,000	Female	Designer	1	8	65	Urban	12.0	Home	Apartment	Rented	NA	Snow balling	Live alone
Jon	34	60,000	Male	Forensic Banker	0	5	80	Urban	21.7	Cafe	Apartment	Rented second- hand	NA	Snow balling	Live alone
Pia	78	14,000	Female	Retired Teacher	4	12	73	Suburban	Declined	Home	Terrace	Rented	NA	Snow balling	Live alone
Maria	38	45,000	Female	Associate Professor	8	1	64	Urban	17.8	Work	Apartment	Rented	NA	Snow balling	Live alone
Hanna	44	60,000	Female	Quality Assurance	0	5	69	Urban	Declined	Home	Apartment	Rented	NA	Snow balling	Live alone
Niels	59	75,000	Male	Senior Researcher	28	24	114	Urban	8.7	Home	Apartment	Owned	NA	Snow balling	Live alone
Mads	34	19,300	Male	Early Retiree	4.5	15	63	Suburban	6.0	Zoom	Terrace	Owned	NA	Snow balling	Live alone
Emma	34	11,500	Female	Artist	2	5	60	Urban	9.5	Home	Apartment	Rented second- hand	NA	Snow balling	Live alone
Tove	37	35,000	Female	Cultural Communication	2	0	350	Suburban	Declined	Zoom	House	Owned	13—6 adults 7 kids	Snowballing	Share
Chris	36	15,000	Male	Student	11	9	46	Suburban	6.5	Home	Apartment	Owned	NA	Snow balling	Live alone
David	48	37,000	Male	Data Specialist	26	26	51	Suburban	15.9	Zoom	Apartment	Owned	NA	Snow balling	Live alone
Nick	42	43,000	Male	Technician	15	Whole adult life	65	Suburban	10.3	Home	Apartment	Owned	NA	Snow balling	Live alone
Lina	33	31,000	Female	Special needs teacher	4	0	380	Suburban	24.1	Home	House	Owned	10	Snow balling	Share
Oscar	42	87,000	Male	Designer	4	4	85	Urban	27.0	Another participants' home	Apartment	Rented	NA	Snow balling	Live alone
Carl	59	37,500	Male	Cultural Broker	23	4	54	Urban	13.7	Home	Apartment	Owned	NA	Snow balling	Live alone
Otto	38	18,000	Male	Office Manager	4	10	25	Suburban	8.4	Zoom	Apartment	Rented	6	Snow balling	Share
Noah	26	6000	Male	Student	0	5	250	Urban	6.5	Zoom	House	Rented	6	1.5 degree	Share
Mette	62	50,000	Female	Administrator	7	7	85	Suburban	19.6	Home	Apartment	Owned	NA	Snow balling	Live alone
Elias	43	55,000	Male	Fund Manager	6	1	250?	Suburban	10.1	Home	House	Owned	10	Snow balling	Share
Ida	29	21,000	Female	Artist	0	0	200?	Suburban	Declined	Zoom	House	Rented	6	Snow balling	Share
Jo	27	41,000	Female	Climate Coordinator	0	1	40	Urban	6.1	Zoom	Apartment	Rented	NA	1.5 degree	Live alone
Lily	31	11,000	Female	Office Worker	3.5	3.5	65	Urban	6.1	Zoom	Apartment	Rented	NA	1.5 degree	Live alone

	Age	Income	Gender	Occupation	Years at current residence	Years living alone	House m^2	Location	CO_2 footprint	Interview location	Dwelling	Ownership	Number of housemates	Recruitment	Sample
Birgitte	90	14,000	Female	Retired Florist	70	20?	120	Suburban	Declined	Home	House	Owned	NA	Snow balling	Live alone
Hugo	43	55,000	Male	Middle Manager	2	15	72	Suburban	11.7	Home	Apartment	Rented	NA	Snow balling	Live alone
Saga	54	49,000	Female	Lecturer	3	5	74	Suburban	14.2	Work	Terrace	Owned	NA	Snow balling	Live alone
Sara	36	39,000	Female	Researcher	17	4	66	Urban	12.0	Cafe	Apartment	Rented	NA	Snow balling	Live alone
Mattias	56	69,500	Male	Associate Professor	14	19	100	Urban	Declined	Park	Apartment	Owned	NA	Snow balling	Live alone
Nora	31	12,500	Female	Personal helper	3	1	300?	Urban	Declined	Home	House	Rented	8	Snow balling	Share

Footnotes

[1] https://skat.dk/data.aspx?oid=2035568&lang=us

[2] Consumption Units reduce CF differences between households of different sizes compared to per capita emissions, flattening out sharing benefits.

[3] Of 10 climate change attitudes-related questions, the following 5 were found to load the same factor, forming the Climate Concern variable [(1) Not at all, (2) Slightly, (3) Moderately, (4) Very, and (5) Extremely]:

1. How worried are you about climate change?
2. How much do you think climate change will harm future generations of people?
3. How much do you think climate change will harm you personally?
4. How important is the issue of climate change to you personally?
5. How important is it to mitigate climate change?

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11625-023-01435-9.

Acknowledgements Tullia Jack and Kirsten Gram-Hanssen would like to acknowledge funding from the European Union's Horizon 2020 research and innovation program under Marie Sklodowska-Curie Grant Agreement, under Grant No. 891223. Jukka Heinonen acknowledges funding from The Icelandic Centre for Research RANNIS, under Grant no. 207195-053, and all those researchers who participated in collecting and operationalizing the quantitative data. The authors would like to thank the SCEP (Sustainable Cities and Everyday Practices) research group at Aalborg University for suggestions and improvements of the paper, at a PUB lunch seminar.

Author contributions TJ designed the study, conducted the interviews, and led the writing of the paper. JB provided the theory, wrote the qualitative results and analysis sections, and commented on all sections of the paper. JH contributed the quantitative results, helped recruit interviewees, and commented on all sections. KG-H contributed to coauthor discussions and commented on all sections.

Funding Open access funding provided by Lund University.

Data availability The data will be made available by the authors upon request based on reasonable justification.

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