Using community-based social marketing to identify promising behavioral targets for reducing greenhouse gas emissions among college students

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Abstract

Purpose – The purpose of this paper is to recommend behavioral targets for future interventions to reduce greenhouse gas emissions at college campuses and to advise interventionists on how to choose between many potential behavioral targets.

Design/methodology/approach – The authors used the community-based social marketing (CBSM) methodology over two studies. In Study 1, the authors assessed adoption rates (i.e. penetration) and likelihood of adoption (i.e. probability) for 16 potential behavioral targets. In Study 2, the authors used quantitative and qualitative methods to assess the barriers and benefits of engagement in five of the top-performing behaviors from Study 1.

Findings – The findings suggest that an intervention to promote purchasing green energy credits (GECs) has a high potential to reduce emissions. Purchasing GECs has a small penetration (<7%) and a large impact (1,405 $kgCO_2e$/person/year). Compared to the other four behaviors the authors examined in Study 2, purchasing GECs is also more convenient and requires very little time. Thus, the behavior should be appealing to many individuals interested in reducing emissions or protecting the environment.

Originality/value – The authors performed a holistic evaluation of potential behavioral targets that included a barrier and benefit analysis, in addition to the traditional CBSM method of combining impact, probability and penetration.

Keywords Community-based social marketing, Sustainable behaviors, Climate change mitigation, Greenhouse gas emissions, Behavior change

Paper type Research paper

Introduction

Climate change is an existential threat facing our species. As of 2020, average global temperatures had increased by 1.1°C from preindustrial temperatures, and an increase of at least 1.5°C is likely by 2040 (Intergovernmental Panel on Climate Change [IPCC], 2022). In addition, sea level rise is accelerating, and global economic growth is expected to slow substantially. Moreover, higher temperatures, precipitation extremes and extreme weather will continue to negatively impact infrastructure and human health, and although these effects will be widespread, marginalized groups will be disproportionately impacted.

These changes to our climate are caused by anthropogenic greenhouse gas (GHG) emissions (IPCC, 2022). Although many people around the globe recognize the threat of climate change, this awareness has not translated into action. In fact, climate action failure was perceived as the greatest risk to humanity in a global risk perception survey (World Economic Forum, 2022). While policy-level change and technological advancements are

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necessary for mitigation, these higher-level changes often take much longer to implement than behavioral change. Thus, behavioral change is important for meeting emission reduction goals and reducing emissions more rapidly (Ivanova *et al.*, 2015; Wynes and Nicholas, 2017).

Climate change researchers have identified many high-impact behaviors that can greatly reduce global GHG emissions. For example, Project Drawdown (2022) outlines the impacts of 93 solutions, some of which are behavioral (e.g. eating plant-rich diets). Another such effort, by Wynes and Nicholas (2017), outlines how behavioral interventions traditionally focus on low-impact behaviors with limited ability to reduce emissions, such as recycling and composting, and argues that interventions should instead focus on behaviors that have greater impact on GHG emissions, such as living car free and adopting a plant-based diet.

To mitigate climate change behaviorally, we must focus on behaviors that not only can greatly reduce emissions but that are also feasible targets for intervention. To the authors' knowledge, there have been no studies conducted that test the viability of interventions targeting the behaviors described by Project Drawdown (2022) and Wynes and Nicholas (2017). Thus, the goal of the current research is to determine which high-impact, climate-relevant behaviors have the greatest potential to reduce emissions when targeted through intervention.

Target audience

We chose college students as the target audience for the current study. In 2018, there were almost 20 million people enrolled in colleges and universities in the USA, which represents approximately 6% of the US population (National Center for Education Statistics, 2019; U.S. Census Bureau, 2020). Furthermore, an analysis conducted by Sinha *et al.* (2010) revealed that institutions of higher education in the US emit almost 2% of the total US GHG emissions. This figure is an underestimate because, although it includes direct emissions and several indirect emissions, such as employee and student commuting and landfill waste, it fails to include numerous other indirect emissions, such as food choices. Thus, the true proportion of GHGs, both direct and indirect, emitted from institutions of higher education is likely larger.

In addition to the size of the college student population, another factor which makes students a promising target for behavioral intervention is their concern about the environment. Younger adults born after 1981 are more concerned about climate change and more frequently take actions to address climate change than older adults (Funk, 2021). Many previous interventions have successfully changed college and university students' pro-environmental behavior and behavioral intentions. For instance, Zsóka and Asvanyi (2023) found that, after attending a semester-long sustainability course, students' intentions to act sustainably in the future increased, and some students engaged in more sustainable consumption behaviors. Similarly, an intervention with students conducted by Frantz *et al.* (2016) was able to increase the use of cold water in washing machines and the frequency of lights being turned off in classrooms. Thus, targeting college student behavior leverages a large, GHG-emitting population that might be more responsive to climate-related behavioral interventions.

Community-based social marketing

The current research used the community-based social marketing (CBSM) framework to determine which high-impact, climate-relevant behaviors are the most promising intervention targets. CBSM leverages evidence from the psychological literature to create

interventions that enable behaviors to be adopted more easily. CBSM outlines five steps that inform the creation of successful behavioral interventions (McKenzie-Mohr, 2011):

(1) selecting a behavioral target;
(2) identifying the barriers and benefits of the behavioral target;
(3) developing intervention strategies;
(4) pilot testing the intervention; and
(5) implementing and evaluating the intervention.

In the current research, we sought to inform future interventions about which high-impact behaviors are likely to be successfully adopted by college students; thus, we performed Steps 1 and 2.

Step 1 of CBSM is comprised of several subcomponents that help identify viable behavioral targets based on their potential to achieve the intervention's goal (McKenzie-Mohr, 2011). The interventionist must choose a target audience and a goal state, which is the desired objective to be pursued through intervention. In the current studies, the goal state was reducing GHG emissions on a university campus. After selecting a goal state, the interventionist generates a comprehensive list of relevant behaviors and then selects a single behavioral target with the greatest potential for reaching the goal state.

A behavior's potential is assessed by calculating its impact, probability and penetration. Impact is an estimate of how much a behavior helps to achieve the goal state. For example, in the current studies, we defined impact by how many kilograms of CO_2-equivalent ($kgCO_2e$) per person per year a behavior is predicted to eliminate. Probability refers to how likely the audience is to adopt the behavior and is often rated on a five-point scale (Frantz *et al.*, 2016; Reaves, 2014). Penetration is the percentage of individuals within the audience who already engage in the behavior and is often measured as a proportion (Frantz *et al.*, 2016; McKenzie-Mohr, 2011; Reaves, 2014). To choose a target behavior, McKenzie-Mohr (2011) suggests multiplying impact, probability and one minus penetration (expressed as a proportion) for each behavior, as seen in equation (1). We refer to this product as the "goal state potential" (GSP) [1]:

$$impact \times probability \times (1 - penetration) = GSP \quad (1)$$

Penetration is subtracted from one in this equation to represent the potential audience for the intervention (i.e. the proportion of the population not already engaged in the behavior). According to CBSM, the behavior with the largest GSP should be targeted through intervention, and thus, the ideal behavior has a large impact, a large probability and a small penetration.

In Step 2 of the CBSM methodology, the interventionist assesses the barriers and benefits for the chosen behavioral target to inform the intervention design. An ideal intervention addresses the barriers to behavior adoption and highlights the benefits.

CBSM has been used successfully in many previous interventions, targeting goals ranging from reducing energy consumption to improving lung cancer diagnoses (Allen, 2019; Athey *et al.*, 2012; Cole and Fieselman, 2013; Frantz *et al.*, 2016; Haldeman and Turner, 2009; Kennedy, 2010; McKenzie-Mohr, 2000; Reaves, 2014; Sandoval, 2017; Schuster *et al.*, 2016; Schultz *et al.*, 2015). Despite CBSM's popularity, these studies rarely follow the behavior selection process outlined above; instead, most studies create interventions for preselected behaviors (Athey *et al.*, 2012; Cole and Fieselman, 2013; Haldeman and Turner, 2009). A review of more than 3,000 projects described on the CBSM website (cbsm.com) and

a literature review of published research revealed that only a few studies had included Step 1 (Allen, 2019; Frantz *et al.*, 2016; Reaves, 2014; Sandoval, 2017).

Although the CBSM methodology can be used successfully when a preselected behavior is targeted, skipping Step 1 is problematic because, without assessing the impact, probability and penetration associated with several potential behavioral targets, interventionists cannot be sure they are targeting the behavior likely to have the largest impact on the goal state, and they run the risk of targeting a behavior that is not viable (e.g. the target audience is already engaging in the behavior). Consequently, time, energy and monetary resources might be wasted without proper consideration of the ways in which the target audience views the target behavior, and the intervention might only minimally advance the goal. In addition to highlighting the importance of Step 1, we also sought to demonstrate the synergistic benefits of performing Steps 1 and 2 together.

Modification to community-based social marketing in the current studies. In the current studies, we modified the CBSM process by assessing the barriers and benefits prior to the selection of a single target behavior and audience. Specifically, we used the barriers and benefits to inform the behavior selection process, a procedure not previously included in the CBSM framework. There were three reasons for taking this approach. First, a very low penetration might indicate that there are significant barriers associated with the behavior that ultimately make it very difficult to adopt. Thus, relying solely on the GSP calculation in equation (1), where a low penetration is desirable, could result in intervening on a behavior that fails to achieve the goal state. Second, depending on the resources available for the intervention, some barriers might not be amenable to being addressed through intervention. For example, a behavior with infrastructure barriers, such as a lack of bike lanes, might be a viable target for an intervention conducted by a municipality but not one conducted by a university researcher. Finally, in CBSM, a target audience is usually selected based on impact and penetration. However, taking into account the perceived benefits of the behavior can help identify a target audience that will be more receptive to an intervention that leverages those benefits. Thus, we propose that barriers and benefits should be considered in the behavioral selection process of CBSM, and in the current research, we used Step 1 of the CBSM framework to narrow down the list of possible behavioral targets and Step 2 to select target audience and the final behavior.

The current research. We began this project by compiling a comprehensive list of behaviors that, if adopted, would reduce GHG emissions and by conducting a literature review to determine the impacts of those behaviors. We removed behaviors not relevant to a college student population, such as those that require an individual to own their own home (e.g. installing rooftop solar) and those that were more relevant at the policy-level or for developing countries (e.g. refrigerant management, improving clean cookstoves). Because we focused on high-impact behaviors, we also eliminated most "low-impact actions" defined by Wynes and Nicholas (e.g. running a full dishwasher; 2017, p. 6), although we retained four low-impact behaviors to inform future research by comparing the potential impact of interventions that target high- vs low-impact behaviors. This process culminated in a list of 16 behaviors (shown in Table 1). Appendix 1 includes the behavioral definitions and a description of the impact estimation process.

We then conducted Study 1, in which we administered a survey to undergraduate students to narrow down the list from 16 to 5 behaviors, using the GSP estimates calculated using equation (1). Finally, in Study 2, we administered a survey with open- and closed-ended questions to assess the perceived barriers and benefits associated with these five behaviors. Using the behaviors' impacts, probabilities, penetrations, barriers and benefits,

Behavior	Impact[a]	Probability	Penetration	GSP
Living motor vehicle free	*3,170*	*1.81*	*8*	*5,296*
Living personal vehicle free	2,450	1.79	21	3,477
Purchasing green energy credits (GECs)	*1,405*	*2.45*	*7*	*3,209*
Following a plant-based diet	*841*	*1.95*	*6*	*1,537*
Avoiding a plane flight	*600*	*2.90*	*22*	*1,365*
Following a vegetarian diet	800	2.01	15	1,367
Following a vegan diet	900	1.45	2	1,279
Following a nonruminant diet	276	2.21	28	439
Hanging laundry to dry	210	2.03	9	388
Composting	170	2.21	16	316
Washing laundry in cold water	250	2.70	54	311
Recycling	210	3.42	66	244
Installing CFL/LED bulbs	*170*	*3.63*	*66*	*212*
Having one meatless day/week	114	2.12	73	65
Turning off electronics	34	3.69	81	24
Turning off lights	28	3.46	88	12

Notes: [a]$kgCO_2e$/person/year. Behaviors are sorted by GSP rank. We used nonrounded values to calculate GSP. Behaviors in italic were carried into Study 2
Source: Authors' own creation/work

Table 1.
Impact, probability, penetration and GSP for 16 behaviors

we made recommendations for future interventions aimed at reducing GHG emissions on college campuses and for future uses of the CBSM framework.

Study 1: Calculating goal state potential from impact, penetration and probability

Method

Participants. We recruited 198 undergraduate students from the psychology research pool at Colorado State University (CSU) in Fort Collins, CO. Participants provided informed consent before taking the survey, and they received partial credit toward their course research requirement. The majority of participants were female (68%), White (59%), first-year college students (61%) and lived on-campus (63%).

Materials. Participants completed an online survey that assessed demographic characteristics and the penetration and probability for the 16 behaviors in Table 1, except that on-campus participants were not asked about purchasing green energy credits (GECs) because this behavior is not available to them. Appendix 2 includes the complete survey.

Penetration. We measured penetration for most of the behaviors using Likert-type questions that assessed behavioral frequency (e.g. "How often do you typically compost your compostable food waste?"). There were five response options, ranging from *never* to *always*. We categorized participants as adopters if they reported engaging in the behavior *almost always* or *always* (4 or 5 on the five-point scale); otherwise, they were categorized as nonadopters. There were six behaviors for which the above question format did not apply. To assess purchasing GECs, we gave participants three response options (*yes, no* and *I'm not sure*), with participants who answered *yes* classified as adopters. To assess the nonruminant diet, vegetarianism, a plant-based diet and veganism, participants were asked which (if any) diet they adhered to. Finally, to assess the meatless day behavior, participants were asked to report how many days they typically consume no meat and fish, and we categorized participants as adopters if they consumed no meat and fish at least one day per week. For each behavior, penetration was defined as the proportion of adopters.

Probability. To assess probability, participants indicated how likely they were to engage in each behavior over the next year. For example, for purchasing GECs, we asked participants, "In the next year, how likely are you to purchase renewable energy from your utility?" There were six response options, ranging from *very unlikely* to *very likely*. We estimated probability by calculating a mean of the probability scores across the nonadopters of each behavior.

Results and discussion

Penetration. The behaviors with the lowest penetration (i.e. fewest adopters) were following a vegan diet, following a plant-based diet, purchasing GECs, living motor vehicle free and hanging laundry to dry, each of which had a penetration of 10% or less (see Table 1). The behaviors with the highest penetration were turning off lights when leaving one's residence, turning off electronics when leaving one's residence and having one meatless day/week, each of which had a penetration of 70% or greater.

Probability. The mean probabilities ranged from 1.79 to 3.69 on a six-point scale (see Table 1). Participants reported being most likely to turn off electronics and lights when leaving their residence, install compact fluorescent lamp (CFL)/light-emitting diode (LED) bulbs and recycle, each of which had a probability greater than 3.00. Participants reported being least likely to follow a vegan diet, live personal or motor vehicle free and follow a plant-based diet, each of which had a probability less than 2.00.

GSP calculation. Using the equation (1), we determined that living motor vehicle free, living personal vehicle free and purchasing GECs had the largest GSPs (see Table 1). Avoiding a plane flight and following a plant-based diet, a vegetarian diet and a vegan diet also had relatively large GSPs. Turning off lights, turning off electronics, having one meatless day/week and using cold water for laundry had the smallest GSPs.

We chose five behaviors to examine further in Study 2 (italic in Table 1) based on the GSP calculations. To have a diverse set of behaviors, we chose living motor vehicle free instead of living personal vehicle free because the former subsumes the latter. We also only chose one of the dietary behaviors – a plant-based diet – because it had the largest GSP. We chose purchasing GECs and avoiding a plane flight given their large GSPs. Finally, we chose installing CFL/LED bulbs because, although this behavior had a relatively small GSP, it had a very large mean probability, and thus it served as a comparison point for the other four behaviors with lower probabilities.

Study 2: Assessing barriers and benefits

Method

Participants. We recruited participants from the CSU research pool and from upper-level psychology courses. Students in the research pool were given partial course research credit and students from upper-level courses were offered extra credit by their professors. The majority of participants were female (72%), White (69%) and lived off-campus (67%), and 33% of participants were juniors in college.

Because this study included qualitative data analysis, we used saturation estimates to determine our sample size. Vasileiou *et al.* (2018) found that saturation is typically reached before the 20th interview, especially for studies with relatively homogenous samples and targeted scopes. Therefore, we recruited 303 participants for Study 2, which, based on Study 1 penetration estimates, allowed us to interview at least 20 adopters and 20 nonadopters of each behavior.

Materials. Participants completed an online Qualtrics survey comprised of demographic questions and open- and closed-ended questions assessing the barriers and benefits of the

five behaviors chosen during Study 1. As in Study 1, on-campus participants were not asked about purchasing GECs. To minimize participant fatigue, we did not ask open-ended questions about more than two behaviors. Table 2 lists the total number of participants who responded to each set of open-ended questions.

We also included closed-ended barrier and benefit questions to ensure that participants had reported on all relevant factors and to allow for a more standardized comparison across the behaviors. Participants rated each behavior on five barriers (difficult, time-consuming, stressful, expensive, dangerous) and four benefits (socially acceptable, common, environmentally friendly and healthy) on a five-point scale from *not at all* to *very*. We chose these characteristics based on previous literature and because they applied across all behaviors (Grimes *et al.*, 2020; Markowski and Roxburgh, 2019). Appendix 2 includes the full survey.

Qualitative data analysis. We analyzed a total of 246 behavioral interviews and followed the structural coding method, a content-driven, inductive method in which researchers first categorize data units with broad, structural labels and then apply more specific, content-based codes within the categories (Saldaña, 2016, p. 98). The broad structural labels used for coding the data were barriers and benefits. We created two codebooks [2] which contained a list of possible codes with descriptions, a set of example quotes and counter-example quotes (see Appendix 3). To create the codebooks, the first author and an undergraduate researcher identified themes in the data and created codes based on those themes.

The data were coded using Microsoft Word and Excel. Coders identified both internal factors (e.g. lack of knowledge) and external factors (e.g. lack of infrastructure). Data units were at the question level, and any number of codes could be applied to any given data unit. For each participant, a code was only applied once for each behavior, no matter how many times the participant mentioned the content described by the code. The codebook remained flexible throughout the process; if coders encountered an issue with the codebook or a characterization not yet addressed by the codebook, we incorporated changes. Two additional undergraduate researchers coded the benefits, and the second and third authors coded the barriers. Codes that were agreed upon were finalized, and disagreements were handled collaboratively – the first author and the two coders discussed the disagreements and decided on the final code together.

We calculated intercoder reliability using the kappa (κ) statistic in rStudio, and we assessed saturation using a method proposed by Guest *et al.* (2020). We calculated saturation ten times – once for the adopters and once for the nonadopters of each behavior. We used the following parameters for nine of the saturation calculations – a base size of six interviews, a run length of two interviews and a new information threshold of 0%. To calculate saturation for the adopters of purchasing GECs, we used a more lenient set of parameters given how few adopters participated in the study – a base size of one, a run length of one and a new information threshold of 5%, which Guest *et al.* (2020) also deemed acceptable.

Behavior	Adopters (*n*)	Nonadopters (*n*)
Living motor vehicle free	23	25
Purchasing GECs	3	41
Following a plant-based diet	27	25
Avoiding a plane flight	33	24
Installing CFL/LED bulbs	24	21

Note: There were a total of 246 behavioral interviews
Source: Authors' own creation/work

Table 2. Number of participants who answered open-ended questions

Results and discussion

Qualitative data saturation. The adopter and nonadopter interviews for all but one behavior achieved saturation. Because only three GEC adopters participated in the study, we did not achieve saturation in those interviews. However, our confidence in the data was bolstered by the fact that the GEC adopters did not generate any codes beyond those that had already been generated by the nonadopters. Appendix 4 includes the points at which saturation was achieved for each behavior.

Benefits. We created 17 codes for the "benefit" category (see Table 3 for the codes' frequencies; see Appendix 4 for the frequencies partitioned by adopter status and for the kappa values). The most common codes were environmental benefits, mental benefits and physical benefits, which together accounted for nearly 50% of all codes.

Environmental benefit. Participants often mentioned the environment specifically or they mentioned the planet, nature or pollution. One participant said that their "community would be more eco-friendly" and another mentioned "reduced light pollution" if they were to install CFL/LED bulbs. Environmental benefits were mentioned for all five behaviors; however, the percentage of environmental benefit codes was disproportionately higher for purchasing GECs and disproportionately lower for avoiding a plane flight and installing CFL/LED bulbs.

Mental benefit. Participants often discussed a benefit to their mental health or self-image resulting from a behavior. The mental benefit code was used disproportionately more for avoiding a plane flight because many participants described a fear of flying and a reduction in anxiety when flights are avoided (e.g. avoiding a plane flight would make them "less anxious since I'm not a fan of flying"). Mental benefits were noted for other behaviors as well. Some participants referred to "benefiting from time to slow down" by living motor vehicle free and to "feeling better morally by eating a plant-based diet."

	Overall		Living motor vehicle free		Purchasing GECs		Following a plant-based diet		Avoiding a plane flight		Installing CFL/LED bulbs	
Code	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Environmental benefit	136	22	34	*23*	28	*37*	30	*23*	22	15	22	*19*
Mental benefit	99	16	22	15	12	16	15	11	35	*24*	15	13
Physical benefit	60	10	33	*23*	–	–	25	19	1	1	1	1
Monetary savings	55	9	8	5	4	5	4	3	27	19	12	10
Climate change	50	8	13	9	8	11	10	8	14	10	5	4
Reduced energy use	42	7	7	5	8	11	–	–	6	4	21	18
Vague global benefit	33	5	9	6	10	13	11	8	1	1	2	2
Easy	30	5	–	–	1	1	4	3	9	6	16	14
Vague personal benefit	27	4	6	4	2	3	17	13	2	1	–	–
Convenience	22	4	2	1	–	–	2	2	3	2	15	13
Sets example	11	2	2	1	–	–	4	3	–	–	5	4
Prevents disease	11	2	–	–	–	–	–	–	11	8	–	–
Better for animals	11	2	–	–	–	–	11	8	–	–	–	–
Reduced traffic	9	1	9	6	–	–	–	–	–	–	–	–
Economic benefit	6	1	–	–	2	3	–	–	3	2	1	1
Can pack more	6	1	1	1	–	–	–	–	5	3	–	–
More control	5	1	–	–	–	–	–	–	5	3	–	–

Table 3.
Benefit code frequencies

Notes: The percentages were calculated within each behavior. The *n* columns describe how many times the codes were used. The overall column was calculated across all behaviors. Dash symbols indicate codes not used. The green highlights indicate the code(s) used most frequently for each behavior
Source: Authors' own creation/work

Physical benefit. Some participants mentioned a bodily improvement in relation to behavior engagement. The vast majority of physical benefits were mentioned for living motor vehicle free (e.g. "I'm getting exercise, so that's good for my body since it's a way to stay healthy") and following a plant-based diet (e.g. They reported having "greater energy levels," improved immunity or "better digestion").

Climate change. Climate change was mentioned relatively infrequently but was of particular importance to the current research. The small proportion of adopter codes (8%) and nonadopter codes (9%) that mentioned climate change (see Appendix 4) indicates that concern about climate change is not an important motivator of personal behavior for most people. This underscores the need to use persuasion techniques rather than pure informational messaging in behavior change campaigns.

Closed-ended benefit questions. We used ANOVAs to determine whether the differences in closed-ended question scores between the behaviors were statistically significant (see Table 4 for the ANOVA results; see Appendix 5 for the post hoc analyses). The results converged with some of the patterns observed in the probability, penetration and qualitative data. Living motor vehicle free and following a plant-based diet were perceived as healthier than the other behaviors in the closed-ended questions, which mirrors the open-ended questions. However, living motor vehicle free was rated as significantly more environmentally friendly than the other behaviors, which differs from the qualitative data – in the open-ended questions, participants mentioned environmental benefits proportionally more with purchasing GECs. Participants accurately rated purchasing GECs as the least common behavior and installing CFL/LED bulbs as the most common. However, across all behaviors, participants agreed less with the "common" characteristic than they did with the other characteristics, suggesting that social norms, a common persuasion technique, might not be effective for the behaviors examined in this study.

Barriers. We created 13 codes for the "barrier" category (see Table 5 for the codes' frequencies; see Appendix 4 for the frequencies partitioned by adopter status and for the kappa values). The most common barriers were inconvenience, lack of benefits, expense, lack of control and behavior engagement being unappealing, which together

Benefits and barriers	Living motor vehicle free	Purchasing GECs	Following a plant-based diet	Avoiding a plane flight	Installing CFL/LED bulbs
Benefits					
Socially acceptable***	3.0 (0.9)	3.3 (0.8)	3.0 (0.8)	3.1 (0.9)	3.8 (0.5)
Common***	2.3 (0.8)	1.9 (0.7)	2.4 (0.7)	2.1 (0.8)	3.2 (0.8)
Environmentally friendly***	3.8 (0.5)	3.4 (0.8)	3.4 (0.9)	3.2 (0.9)	3.4 (0.7)
Healthy***	3.7 (0.7)	2.8 (0.9)	3.4 (0.8)	2.5 (0.9)	2.8 (1.0)
AVERAGE***	3.2 (0.9)	2.8 (1.0)	3.0 (0.9)	2.7 (1.0)	3.4 (0.8)
Barriers					
Difficult***	2.7 (0.9)	2.4 (0.9)	2.9 (1.0)	2.6 (1.0)	1.2 (0.4)
Time-consuming***	3.3 (0.7)	1.9 (0.8)	2.3 (1.0)	3.5 (0.9)	1.2 (0.5)
Stressful***	2.6 (0.9)	2.1 (0.9)	2.4 (1.0)	2.6 (1.0)	1.1 (0.3)
Expensive***	1.4 (0.7)	2.7 (0.8)	2.8 (0.8)	2.6 (1.0)	1.8 (0.7)
Dangerous***	2.0 (0.8)	1.1 (0.4)	1.3 (0.5)	1.9 (0.8)	1.1 (0.3)
AVERAGE***	2.4 (1.0)	2.0 (1.0)	2.3 (1.0)	2.6 (1.1)	1.3 (0.5)

Notes: ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; $^{+}p < 0.10$
Source: Authors' own creation/work

Table 4.
Descriptive statistics for the closed-ended benefit and barrier assessment

Code	Overall		Living motor vehicle free		Purchasing GECs		Following a plant-based diet		Avoiding a plane flight		Installing CFL/LED bulbs	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Inconvenient	102	17	27	*27*	4	4	29	*18*	37	*28*	5	6
No personal benefit	84	14	5	5	26	*24*	13	8	19	14	21	25
Expensive	71	12	–	–	22	20	16	10	11	8	22	*27*
No community benefit	68	12	8	8	12	11	9	6	25	19	14	17
Lack of control	62	11	22	22	15	14	4	3	18	14	3	4
Unappealing	57	10	19	19	–	–	26	16	11	8	1	1
Health concern	43	7	12	12	–	–	24	15	6	5	1	1
Low impact	34	6	5	5	9	8	12	8	3	2	5	6
Lack of knowledge	29	5	1	1	18	17	6	4	–	–	4	5
Cultural norms	15	3	1	1	–	–	12	8	1	1	1	1
Lack of interest	12	2	–	–	2	2	3	2	1	1	6	7
Burden for others	6	1	–	–	–	–	5	3	1	1	–	–

Table 5.
Barrier code frequencies across all participants

Notes: The percentages were calculated within each behavior. The *n* columns describe how many times the codes were used. The overall column was calculated across all behaviors. Dash symbols indicate codes not used. The green highlights indicate the code(s) used most frequently for each behavior
Source: Authors' own creation/work

accounted for over 75% of all codes. The least common codes were cultural norms, a lack of interest and being burdensome for others, which together accounted for less than 10% of all codes.

Inconvenient. Participants often described behavior adoption as difficult, time-consuming, tedious or exhausting. The two behaviors pertaining to travel – living motor vehicle free and avoiding a plane flight – received a disproportionate number of inconvenient codes. Participants often said that these behaviors "take too long," and they felt that living motor vehicle free in particular is more physically demanding, saying that "it's tiring having to rely on non-motorized modes of transportation all the time," especially when they "have to go long distances." Inconvenience was mentioned least with purchasing GECs and installing CFL/LED bulbs.

No benefits. When asked how they personally benefit or how society benefits from behavior engagement, many participants said that there were no benefits or that they were unsure of the benefits. Absence of a benefit, either to themselves personally or to their community, was coded as a barrier.

Lack of personal benefit was mentioned proportionally more for purchasing GECs and installing CFL/LED bulbs, with some participants saying that "I don't think it would affect me" or that "I would not benefit personally because not a lot would change for me."

Lack of community benefit was mentioned proportionally more for avoiding a plane flight and installing CFL/LED bulbs. For avoiding a plane flight, some participants noted that "there are still carbon emissions due to traveling by car that may be less than or equal to those created by flying."

Expensive. Expense was most notable for purchasing GECs and for installing CFL/LED bulbs. One participant said that "as a broke college student, I can't always make these choices because they tend to be more costly." The results pertaining to the expensive code, however, are likely biased; we provided cost information in the definitions for purchasing GECs and installing CFL/LED bulbs only, so participants were primed with financial information for those behaviors.

Lack of control. Participants sometimes perceived that they were unable to engage in the behaviors, in which case we applied the lack of control code. This code was particularly relevant to living motor vehicle free (e.g. "when I go to the supermarket, I can't go on foot or bike as it is very far and I have many groceries"). Some participants also noted the need to use a vehicle for work (e.g. "my job, a grocery delivery service, requires a reliable vehicle"). Lack of control was also discussed frequently among nonadopters of purchasing GECs, with participants often noting that their landlords have control over their utilities. One participant lamented that "I live in an apartment building and pay my utilities through them. If I could [purchase GECs], it does sound appealing to me."

Unappealing. Participants often expressed a dislike or discomfort associated with behavior engagement. This code was used most frequently with living motor vehicle free and with following a plant-based diet. For living motor vehicle free, some participants mentioned the challenge of biking or walking in inclement weather (e.g. it's hard to bike in Colorado "when it's cold and the weather shifts"). For following a plant-based diet, some participants expressed distaste for plant-based foods or a preference for animal-based foods (e.g. "I prefer the taste of meat and plant-based imitations usually aren't a good substitution").

Closed-ended barrier questions. The closed-ended barrier results largely converged with the qualitative data (see Table 4 for the ANOVA results; see Appendix 5 for the post hoc analyses). Participants rated living motor vehicle free as the least expensive behavior in the closed-ended questions, which mirrors the open-ended questions in which expensive was never mentioned in regard to living motor vehicle free. The transportation behaviors – living motor vehicle free and avoiding a plane flight – were seen as the most time-consuming, which mirrors the "inconvenient" code. Finally, participants rated living motor vehicle free as more dangerous than most of the other behaviors, which is consistent with the "health concern" code.

General discussion

The goal of this research was to recommend behavioral targets for future interventions aimed at reducing GHG emissions and to advise interventionists on how to choose between many potential behavioral targets proposed by Project Drawdown and others. In this project, we began with a comprehensive list of behaviors that could reduce GHG emissions and, through a series of data collection efforts, identified the most promising targets for interventions with college students (see Table 6 for a summary of our recommendations).

Traditional CBSM recommendations. According to CBSM, a behavioral target should be chosen based on the GSP calculation alone, where the ideal target has large impact, large probability and small penetration. Thus, if strictly following the CBSM methodology, interventionists would target living motor vehicle free, which had the largest GSP in Study 1 given its small penetration (<20%) and exceptionally large impact (3,170 $kgCO_2e$/person/year).

Holistic recommendations. In the current research, we incorporated an element not previously considered in CBSM – we used the barrier and benefit assessment to inform the behavior selection process. Understanding the barriers can inform which behavioral targets are most viable and, thus, most likely to achieve the goal state. Additionally, interventions should leverage the perceived benefits of the target behavior to emphasize the behavior's importance and potential to improve the audience's lives. Whether this message is successful depends on the target audience and their values. For instance, if targeting an environmentally-minded audience, an intervention targeting a behavior perceived as environmentally-friendly might be most successful. Thus, we have made holistic

Holistic behavior rank	Pros	Cons	GSP rank
1. *Purchasing GECs*	• One-time, simple action • Perceived as environmentally- and climate-friendly • "Lack of information" barrier easy to address	• Perceived as expensive with few personal benefits • Lack of control for those who do not pay for their utilities	2
2. *Installing CFL/LED bulbs*	• Perceived as easy with few perceived barriers • Cost-savings over time • Highest willingness to engage	• High penetration, low impact • Vulnerable to forgetfulness • Higher up-front costs than traditional bulbs	5
3. *Living motor vehicle free*	• Perceived as healthy and environmentally-friendly	• Many barriers – inconvenient, unappealing, time-consuming and dangerous • Weather restrictions	1
4. *Following a plant-based diet*	• Perceived as healthy (by some) and environmentally-friendly	• Many barriers – difficult, expensive, unappealing and unhealthy (to some) • Lowest willingness to engage	3
5. *Avoiding a plane flight*	• Mental benefits and monetary savings	• Many barriers – time-consuming, difficult and inconvenient • Impact varies depending on behavior chosen to replace flying (i.e. rebound behaviors)	4

Source: Authors' own creation/work

Table 6. Summary of behavioral target recommendations to reduce GHG emissions

recommendations using the barrier and benefit assessment in addition to the GSP calculations.

Purchasing GECs. An intervention promoting GEC programs would be promising for an environmentally-minded target audience – this behavior was perceived as environmentally- and climate-friendly. Participants also perceived that purchasing GECs was more socially-acceptable and less time-consuming than most of the other behaviors. The behavior had the third largest GSP, the second largest impact (1,405 $kgCO_2e$/person/year), a larger probability than living motor vehicle free and a small penetration (<7%).

Interventions targeting the purchase of GECs will have several barriers to address. Participants perceived the behavior as the least common, and in fact, it was the least common, meaning that social norms messaging might be challenging. Additionally, a quarter of participants reported that there were no personal benefits associated with purchasing GECs which indicates that altruistic motives might be important for adopting this behavior (Panda *et al.*, 2020). Participants also often reported that the behavior was too expensive, that they did not know how to purchase GECs or that their landlords did not give them the option.

Despite these challenges, we recommend this behavior because it had a very large impact, and the challenges of behavior engagement were largely external to the individual rather than internal. If knowledge and accessibility are addressed, the behavior is easy to engage in – once an individual signs up for the Fort Collins GEC program, for instance, no additional action needs to be taken. This could be appealing to a broad range of individuals interested in taking action against climate change but not necessarily ready to significantly alter their lifestyles. Additionally, landlords and apartment complexes could be targeted to access members of the audience without control over their utilities, and if universities allow students living on-campus to sign up for GEC programs, then interventionists could have access to a larger target audience.

Installing CFL/LED bulbs. Although we do not recommend this behavior in most cases, given its large penetration and small impact, interventions targeting audiences who have not yet upgraded to CFL/LED bulbs have strong potential to be successful (Schultz *et al.*, 2015). Interventions targeting this behavior might be well-suited for the fiscally-minded or for those who desire to make a climate-relevant behavior change that requires little effort. Participants felt that installing CFL/LED bulbs was the easiest, most convenient and least stressful behavior while still relevant to reducing energy use. The behavior was also perceived as relatively common and socially-acceptable (in addition to having the highest penetration).

Living motor vehicle free. Living motor vehicle free might be a viable target for health-conscious or environmentally-minded audiences – participants perceived the behavior as the healthiest and most environmentally-friendly behavior. However, these benefits are not easy to come by, and participants expressed a variety of psychological and practical barriers to living motor vehicle free. Almost a quarter of participants asserted that the behavior was impossible to engage in under certain circumstances (e.g. when traveling far or when shopping), which suggests that promoting this behavior would be challenging.

Following a plant-based diet. Following a plant-based diet might also be a worthwhile target for a health-conscious audience – the behavior received the second highest healthy score in the closed-ended questions. The behavior was also generally viewed as environmentally-friendly and, surprisingly, as relatively common, which might bode well for interventions using normative messaging. However, engagement in the behavior had many barriers, including being difficult, expensive, unappealing and socially unacceptable, and many participants had concerns about the negative health impacts of a diet with little to no meat.

Avoiding a plane flight. Avoiding a flight had several perceived personal benefits, including reducing stress and saving money. However, the behavior had several barriers that will be hard to address through intervention, including being difficult, time-consuming and inconvenient. Importantly, many participants also viewed the behavior as not worthwhile and questioned the environmental benefit of avoiding a flight because the main alternative to flying (i.e. driving) could negate the positive climate impacts of avoiding a flight. One potentially promising strategy to avoid some of these challenges could be to encourage an audience to eliminate travel altogether and use virtual meetings instead, which would maximize the impact of this behavior and deliver financial savings to the participants.

Limitations and future directions

The primary goal of this research was to make holistic behavioral recommendations for future interventions aimed at reducing GHG emissions. Future work should test these recommendations to determine whether the criteria we used can indeed produce

interventions more effective at reducing emissions. For recommended ways to overcome the barriers outlined in the current work and for more information about the procedure and our findings, see Ross (2022).

We modified the CBSM methodology in this work by incorporating the perceived barriers and benefits of behavior adoption into the behavior selection process. By doing so, we were able to obtain a more realistic picture of behavior change feasibility. Interventionists using CBSM should test this modification and compare the total impact of targeting two types of behaviors: one with a larger GSP but significant barriers and one with a smaller GSP but less significant barriers. Investigations of this type will establish whether barriers and benefits should be incorporated into CBSM's behavior selection process.

Future researchers should investigate additional modifications to the CBSM framework. The current project employed the traditional CBSM calculation in equation (1). However, this method is problematic because it weights the variables differentially based on the variability within their scales, which is not well-justified. Previous works has suggested rescaling each variable so that their scales match (Reaves, 2014), but this method is also problematic because information is lost when continuous data is transformed to a five- or six-point scale. Future research should determine the best method for calculating GSP – that is, the method which best predicts the effectiveness of an intervention. Additionally, future work should test the consequences of varying penetration sizes on a behavior's ability to yield a productive intervention. Contrary to the CBSM methodology, a small penetration might indicate that a behavior is overly difficult to change through intervention.

In the current studies, we used impact estimates assuming the behaviors would be fully undertaken (e.g. living motor vehicle free), when in practice, individuals are likely to take small steps on their way to achieving the ultimate goal (e.g. eliminating vehicle use for shorter trips). Although we prioritized behaviors with a large impact on GHG emissions, it would nevertheless be environmentally beneficial for participants to take small steps toward behavior engagement if they are unable or unwilling to adopt the full behavior outright. Although the impact of these intermediate steps would be smaller, many barriers would be eliminated and the probability of engagement would be higher. Future work could determine whether targeting full behaviors or intermediate steps yields more productive interventions (Sparkman *et al.*, 2021).

Other limitations to the impact estimates include the geographic location to which the estimates apply – some are specific to the location in which the current study was conducted, while others are not. The implications of this seem to be most apparent in the impact for installing CFL and LED bulbs, which was much larger than the impact for turning lights off when not at home. We calculated the former using local data, whereas the latter was calculated using national data. Thus, the impact for installing CFL and LED bulbs might be overestimated, which could mean that the behavior should rank lower than second place in our holistic recommendations.

Additionally, the small sample size of GEC adopters in Study 2 limits our ability to draw conclusions about the perceived barriers and benefits of that behavior. We did not anticipate having so few adopters because the penetration rate in Study 2 was less than Study 1 due to random variation. Given the small sample size for that behavior in Study 2, a purposive sample of GEC adopters should be interviewed to confirm our findings before undertaking an intervention to increase GEC adoption.

The results we obtained have implications for institutions of higher education and for local governments with GHG reduction goals. The purchase of GECs is likely to expand with campaigns to increase awareness of GEC programs – for instance, most participants

had not heard of Fort Collins Utilities' GEC program, and some expressed interest in enrolling. Universities could give students living on-campus the ability to sign up for GEC programs, which would lead to a larger target audience for GEC interventions, and governments that want to pursue renewable energy portfolios more aggressively might consider GEC programs that require customers to opt out instead of opt in. Additionally, government or university policies to improve bicycle infrastructure, for instance, could address some of the external challenges associated with reducing motor vehicle use.

Conclusion

This project began with a comprehensive list of actions that would help to mitigate the climate crisis. These behaviors are well-documented in the literature, and their potential global impacts are known. What is not known, however, is the actual impact these behaviors might have given the feasibility of their widespread adoption. The current studies used the CBSM methodology to investigate the behaviors' adoption rates and likelihood of being adopted in a college student population. Unlike previous CBSM studies, the current studies incorporated a barrier and benefit assessment in the behavioral target selection process. Our findings suggest that purchasing GECs has a high potential to reduce GHG emissions if targeted through intervention, especially if the intervention includes landlords and university housing services to make purchasing GECs more accessible to college students. Purchasing GECs is easy and takes little time, and its relationship to the environment and climate change is generally known. Given the behavior's large impact and ease of engagement, purchasing GECs should be appealing to many individuals. Interventionists can use the methods and findings outlined in these two studies to develop more productive interventions aimed at reducing GHG emissions and slowing the progression of climate change.

Notes

1. McKenzie-Mohr (2011) uses the term "impact" for the product of the equation and for one of the variables. We chose the term "goal state potential" to avoid confusion.
2. We created a third codebook and coded the data for "ways to overcome the barriers," but these results are not discussed in the current article. See Ross (2022) for more information.
3. *This is likely an overestimate because college students typically have roommates (Statista, 2019) and it is unlikely that each roommate leaves the residence during the same eight-hour period; thus, it is unlikely that the lights would be turned off during the full eight-hour period assumed by this analysis. However*, this was preferrable because the true period of time that the residence is unoccupied is not known, and so we used the full, possible amount.
4. This is likely an overestimate because likely not all members of the target audience own each of the household electronics, but this was preferrable because true household electronic ownership is not known, and so we used the full, possible amount.

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Appendix 1. Impact estimation

We estimated the impacts for 16 behaviors during Study 1. Most impact estimates were taken directly from the review conducted by Wynes and Nicholas (2017), but for certain behaviors, other methods were used and explanations of those methods are in the following paragraphs.

Living motor vehicle free

Wynes and Nicholas (2017) described this behavior as "living car free," which they defined as never using a personal motor vehicle and did not include rebound effects (p. 2). For instance, walking and biking were considered living car free, whereas taking an Uber or a bus was not. We labeled the behavior as living motor vehicle free, which assumes no rebound effects, and included a separate behavior, living personal vehicle free, which does allow for rebound effects in the form of bus transportation.

The impact associated with living motor vehicle free, assuming no rebound effects, is highly dependent on the city in which someone lives and how much the person travels. Thus, we did not use the Wynes and Nicholas (2017) estimate, and instead, we calculated a location-specific estimate using data from Fort Collins, CO, the city in which this research was conducted, whenever possible. Average personal vehicle fuel efficiency, data for which was not available for Fort Collins, is 22.5 mpg in the US (Department of Transportation [DOT], 2019). Gasoline releases 23.2 lbs of CO_2e/gallon (Schlömer *et al.*, 2014), and thus, for each mile traveled, 1.03 lbs of CO_2e is released per car. The average number of adult passengers in car trips in Fort Collins is 1.3 (City of Fort Collins, 2017), which means that 0.79 lbs of CO_2e are released per mile, per person. On average, adults in Fort Collins travel 24.2 miles/day or 8,833 miles/year (City of Fort Collins, 2017). Thus, if all adults in Fort Collins were to stop using personal vehicles, 6,998 lbs or 3,170 kg, CO_2e would be saved per person each year, assuming no rebound effects. This estimate was determined to be plausible given the range of US estimates reported by Wynes and Nicholas (2017; *min* = 970 kgCO_2e, *max* = 4,090 kgCO_2e).

Living personal vehicle free

Similar to living motor vehicle free, we calculated estimates for this behavior using data from Fort Collins, CO when possible. We defined living personal vehicle free as avoiding the use of personal motor vehicles, such as a car, truck or SUV, but we allowed for the rebound effect of using bus transportation, which is available throughout Fort Collins. Average emissions for a bus ride in the US are 0.18 lbs CO_2e/passenger mile (Hodges, 2010). A passenger mile is the distance traveled by one passenger, so this value takes into account the fact that multiple people ride the bus at once (i.e. miles are not double-counted). This value also assumes full bus capacity. Given that 8,833 miles on average are traveled per person per year in Fort Collins (City of Fort Collins, 2017), 1,589.94 lbs CO_2e would be released per person per year if all trips were taken using bus transportation. Assuming that 6,998 lbs CO_2e/person/year would be emitted if personal vehicles were used, as described in the previous section, bus ridership would save 5,408 lbs or 2,450 kg, CO_2e/person/year.

Purchasing green energy credits

Wynes and Nicholas (2017) included purchasing green energy in their list of high impact actions. We used purchasing GECs through Fort Collins Utilities' green energy program as the target behavior. The program uses solar and wind resources from northern Colorado and Wyoming and helps to fund further renewable energy development in the area (City of Fort Collins, 2021). The impact of using green energy varies depending on the local resource mix, and thus, we again used local data instead of the impact estimates reported by Wynes and Nicholas (2017). We assumed that all of a household's electricity is offset by green energy through the program. According to the Platte River Power Authority (2020), which provides energy to Fort Collins Utilities, the resource mix for Fort Collins in 2020 was 55% coal, 39% noncarbon sources (hydropower, wind and solar), 1% natural gas and 5% purchases or other carbon sources. Average residential electricity use in Fort Collins is 640 kilowatt-hours (kWh) per household per month (Fort Collins Utilities, personal communication, November 18, 2020). Thus, in Fort Collins, each household is expected to use an average of 7,680 kWh in 2020. To calculate an individual's share of their household's energy use, we divided that value by the average household size in Fort Collins (2.46 people; United States Census Bureau, 2019). Thus, average electricity use in Fort Collins is 3,122 kWh/person/year as seen in equation (1), and given the resource mix described above, 1,717 kWh comes from coal, 1,218 kWh comes from noncarbon sources, 31 kWh comes from natural gas and 156 kWh comes from purchases or other carbon sources:

$$\frac{640\,\frac{\text{kWh}}{\text{household}*\text{month}}\times 12\,\frac{\text{months}}{\text{year}}}{2.46\,\frac{\text{people}}{\text{household}}}=3,122\,\frac{\text{kWh}}{\text{person}*\text{year}} \quad (1)$$

Coal produces 0.76 $kgCO_2e$/kWh of direct emissions, natural gas produces 0.37 $kgCO_2e$/kWh of direct emissions and renewables directly produce none (Schlömer *et al.*, 2014). Because the Platte River Power Authority did not specify the resource mix included in purchases or other carbon sources, we took an average of the emissions associated with coal and gas, resulting in an emissions estimate of 0.57 $kgCO_2e$/kWh. We multiplied these fuel emissions by the amount of coal, natural gas and purchases used per person in Fort Collins, summed the products for each fuel source and found that 1,405 $kgCO_2e$/person/year of household electricity use could be offset by the purchase of GECs as seen in equation (2), if A equals 3,122 kWh/person/year, as seen in equation (1). This estimate was determined to be plausible given the range of US estimates reported by Wynes and Nicholas (2017; *min* = 1,100 $kgCO_2e$, *max* = 1,600 $kgCO_2e$):

$$(A)\,(.55)\left(0.76\frac{\text{kgCO}_2\text{e}}{\text{kWh}}\right)+(A)(0.01)\left(0.37\frac{\text{kgCO}_2\text{e}}{\text{kWh}}\right)+(A)(0.05)\left(0.57\frac{\text{kgCO}_2\text{e}}{\text{kWh}}\right)=1,405\frac{\text{kgCO\_2 e}}{\text{person}*\text{year}} \quad (2)$$

Following a vegan diet and following a vegetarian diet

Previous literature has reported a wide range of impact estimates for vegan and vegetarian diets (Wynes and Nicholas, 2017) and data were not available for the current study's target audience. Thus, we used the impact estimates that Wynes and Nicholas averaged across several studies – 900 $kgCO_2e$ for a vegan diet and 800 $kgCO_2e$ for a vegetarian diet.

Following a plant-based diet

Plant-based diets are defined differently and often vaguely across scholarly publications (Pohjolainen *et al.*, 2015; Storz, 2022). For instance, a plant-based diet might be used interchangeably with a vegan diet or it might indicate a flexitarian diet that occasionally includes dairy or meat (Cleveland Clinic, 2021). We defined a plant-based diet as less restrictive than a vegan diet but more restrictive than a vegetarian diet, and, for the purposes of calculating impact, we assumed that a plant-based diet consists of following a vegan diet all but two days per month. Using equation (3), we determined that vegan diets reduce 2.5 $kgCO_2e$/person/day, and I then multiplied that value by 24 (i.e. two days per month):

$$900\,\frac{\text{kgCO}_2\text{e}}{\text{person}*\text{year}}-\left(\frac{900\,\frac{\text{kgCO}_2\text{e}}{\text{person}*\text{year}}}{365\,\frac{\text{days}}{\text{year}}}\right)\left(24\,\frac{\text{days}}{\text{year}}\right)=841\,\frac{\text{kgCO}_2\text{e}}{\text{person}*\text{year}} \quad (3)$$

Following a nonruminant diet

A nonruminant diet is one that avoids ruminant animals, which are hooved animals with specialized digestive systems, such as cows and sheep (Parish *et al.*, 2017). We used a systematic review by Aleksandrowicz *et al.* (2016) to estimate the impact of adopting a nonruminant diet, which found that,

in cross-country data, nonruminant diets result in a 21% average decrease in CO_2 from current diets. The current average diet in the US emits 1,314 $kgCO_2e$/person/year (Heller and Keoleian, 2014). Thus, adopting a nonruminant diet can reduce emissions by 276 $kgCO_2e$/person/year.

Having one meatless day per week

We defined this behavior as having one day each week in which no meat is eaten. To calculate the emission reduction associated with having one meatless day per week, we divided the vegetarian estimate by 365 days, which equaled 2.19 $kgCO_2e$/day. Given 52 weeks per year, having one meatless day per week yielded an impact estimate of 114 $kgCO_2e$/person/year.

Avoiding a medium-length plane flight

Wynes and Nicholas (2017) described this behavior as avoiding one medium-length plane flight of 1,697 km (which is approximately 1,000 miles) and considered a flight from Toronto, ON, Canada to Orlando, FL. Because participants were more familiar with US units of measurement, we defined this behavior in miles. Wynes and Nicholas reported an impact of 600 $kgCO_2e$/person for this beharvior.

Washing laundry in cold water and hanging laundry to dry

For both behaviors, we used the impact estimates reported by Wynes and Nicholas (2017) – 250 $kgCO_2e$ for cold-water washing and 210 $kgCO_2e$ for hanging laundry to dry. The estimates assumed 289 laundry loads per year, which is the average in North America (Pakula and Stamminger, 2010).

Recycling

We used an impact estimate of 210 $kgCO_2e$/person/year as reported by Wynes and Nicholas (2017). This estimate includes only household recycling.

Installing compact fluorescent lamps or light-emitting diode bulbs

Wynes and Nicholas (2017) reported an estimate of 170 $kgCO_2e$/person/year for upgrading light bulbs, which they defined as replacing incandescent bulbs with energy-efficient lights. We defined energy efficient lights as light-emitting diode (LED) bulbs and compact fluorescent lamps (CFL).

Composting

Wynes and Nicholas (2017) did not provide a specific impact estimate for composting, and we could not find an impact estimate in the literature. Wynes and Nicholas (2017) categorized the behavior as a "low-impact action" (p. 6). Because upgrading light bulbs was also categorized as a "low-impact action," we instead applied the Wynes and Nicholas (2017) light bulb estimate to composting, which was 170 $kgCO_2e$/person/year.

Turning off lights

We defined this behavior as turning off household lights when leaving one's residence for at least one hour. We estimated the impact using the following process. According to the US Energy Information Administration (EIA), 4% of residential electricity was used for lighting in 2020 (EIA; 2021). On average, individuals in Fort Collins use 3,122 kWh/person/year (see the Purchasing Green Energy Credits section above). Thus, each person used an average of 125 kWh for lighting in 2020 as seen in equation (4). Assuming that an individual sleeps with their lights off for 8 hours/day, this leaves 16 hours/day in which an individual could have their lights on. Assuming, then, that an individual leaves their residence for 8 hours/day, turning lights off during this time can eliminate

Household electronic device	Energy consumption (W)
Television set	97
Video game system	36
Stereo system	30
DVD player	13
Desktop PC	4
Notebook PC	2
Desktop computer monitor	1
AVERAGE	26

Note: Energy consumption estimates for idling were used for each of the electronics, except for the television set, which cannot idle. In that case, the energy consumption estimate for active use was used
Source: Authors' own creation/work

Table A1. Energy use by household electronics

62 kWh/person/year. Finally, given the resource mix in Fort Collins (see the Purchasing Green Energy Credits section above), 28 $kgCO_2e$/person/year [3] can be reduced by turning off lights 8 hours/day as seen in equation (5):

$$B = \frac{\left(3,122\frac{\text{kWh}}{\text{person} * \text{year}}\right)(0.04)}{2} \tag{4}$$

$$(B)(.55)\left(0.76\frac{kgCO_2e}{kWh}\right) + (B)(0.01)\left(0.37\frac{kgCO_2e}{kWh}\right) + (B)(0.05)\left(0.565\frac{kgCO_2e}{kWh}\right) = 28\frac{kgCO_2e}{kWh} \tag{5}$$

Turning off electronics

We defined this behavior as turning off household electronics when leaving one's residence for at least 1 hour. We estimated the impact by first determining how much energy is used by household electronics (see Table A1; Department of Energy [DOE], 2012). Instead of using the total watts across each of these devices, the average amount of watts was used. This is because it is unlikely that all of these devices are owned by every member of the target audience and it is unlikely that every member of the target audience turns on each of these devices every day.

One watt indicates that the device uses 0.001 kWh every hour (DOE, n.d.); thus, an average of 0.026 kWh are consumed across the devices each hour. Assuming that an individual leaves their residence for 8 hours/day, this behavior can eliminate 76 kWh/person/year if the devices are turned off for the full 8 hours. Given the resource mix in Fort Collins (see the Purchasing Green Energy Credits section above), this behavior can reduce 34 $kgCO_2e$/person/year [4] as seen in equation (6), if C equals 76 kWh/person/year:

$$(C)(.55)\left(0.76\frac{kgCO_2e}{kWh}\right) + (C)(0.01)\left(0.37\frac{kgCO_2e}{kWh}\right) + (C)(0.05)\left(0.565\frac{kgCO_2e}{kWh}\right) = 34\frac{kgCO_2e}{\text{person} * \text{year}} \tag{6}$$

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Appendix 2

Survey B.1. **CBSM Questions from the Study 1 Survey**
Note. Wording that changed based on whether participants lived on- or off-campus is marked with brackets. Source: Author's own creation/work

Section 1: Please read each item carefully and select the answer that best represents your **usual** behavior.

In what type of residence do you live?
- o On-campus, residence hall
- o On-campus, apartment
- o Off-campus, rented apartment
- o Off-campus, rented house
- o Off-campus, apartment owned by me/my family/my significant other
- o Off-campus, house owned by me/my family/my significant other
- o Other. Please specify: _____

How often do you typically compost your compostable food waste?
- o Never
- o Rarely
- o Sometimes
- o Almost always
- o Always

In the next year, how likely are you to compost all of your compostable food waste?
- o Very unlikely
- o Moderately unlikely
- o Slightly unlikely
- o Slightly likely
- o Moderately likely
- o Very likely

How often do you typically use the cold water setting when you do your laundry?
- o Never
- o Rarely
- o Sometimes
- o Almost always
- o Always
- o This does not apply to me.

In the next year, how likely are you to use cold water to wash all of your loads of laundry?
- o Very unlikely
- o Moderately unlikely
- o Slightly unlikely
- o Slightly likely
- o Moderately likely
- o Very likely
- o This does not apply to me.

How often do you typically hang dry your laundry?
- o Never
- o Rarely
- o Sometimes
- o Almost always
- o Always
- o This does not apply to me.

In the next year, how likely are you to hang dry all of your laundry?
- o Very unlikely
- o Moderately unlikely
- o Slightly unlikely
- o Slightly likely
- o Moderately likely
- o Very likely
- o This does not apply to me.

Figure 1. A typical CFL light bulb

Figure 2. A typical LED light bulb

When you have to replace light bulbs, how often do you typically install CFL (compact fluorescent) or LED (light-emitting diode) bulbs? (See Figure 1 and Figure 2 for examples.)
- o Never
- o Rarely
- o Sometimes
- o Almost always
- o Always
- o This does not apply to me.

If you need to replace light bulbs in the next year, how likely is it that you will install only CFL or LED bulbs?
- o Very unlikely
- o Moderately unlikely
- o Slightly unlikely
- o Slightly likely
- o Moderately likely
- o Very likely
- o This does not apply to me.

When you leave your residence for at least one hour, how often do you typically turn off the lights before leaving?
- o Never
- o Rarely
- o Sometimes
- o Almost always
- o Always

In the next year, how likely are you to always turn off the lights before leaving your residence for at least one hour?
- o Very unlikely
- o Moderately unlikely
- o Slightly unlikely
- o Slightly likely
- o Moderately likely
- o Very likely

When you leave your residence for at least one hour, how often do you turn off your unused electronics (such as a TV or desktop computer) before leaving?

(*continued*)

o Never
o Rarely
o Sometimes
o Almost always
o Always
o This does not apply to me.

In the next year, how likely are you to always turn off your unused electronics (such as a TV or desktop computer) before leaving your residence for at least one hour?
o Very unlikely
o Moderately unlikely
o Slightly unlikely
o Slightly likely
o Moderately likely
o Very likely
o This does not apply to me.

Figure 3. A 1,000 mile radius around Fort Collins, CO. Note: The black circle indicates a 1,000 mile radius around Fort Collins, CO.

Think back to the times that you've traveled to a destination that is about 1,000 miles from your home (see Figure 3 for an example). When you've traveled a distance of around 1,000 miles in the past, how often have you taken a plane?
o Never
o Rarely
o Sometimes
o Almost always
o Always
o This does not apply to me.

In the next year, how likely are you to avoid flying every time you have to travel a distance of around 1,000 miles?
o Very unlikely
o Moderately unlikely
o Slightly unlikely
o Slightly likely
o Moderately likely
o Very likely
o This does not apply to me.

Please use these guidelines to answer the following questions:

1 Mile = 15-20 minutes of walking, 5-7 minutes of bicycling, or 2 minutes of driving through town
Fort Collins example: Beau Jo's Pizza is about a 1 mile walk from the Oval.
5 Miles = 80-90 minutes of walking, 25-35 minutes of bicycling, 10-15 minutes of driving through town Fort Collins example: Beau Jo's pizza is about 4.5 miles from Harmony Rd.

When you leave [campus OR your apartment or house], how often do you take public transportation, such as a city bus, for trips of up to about 1 mile?
o Never
o Rarely
o Sometimes
o Almost always
o Always

When you leave [campus OR your apartment or house], how often do you use non-motorized travel, such as walking or bicycling, for trips of up to about 1 mile?
o Never
o Rarely
o Sometimes
o Almost always
o Always

In the next year, how likely are you to only use non-motorized travel or take public transportation for trips of up to about 1 mile?
o Very unlikely
o Moderately unlikely
o Slightly unlikely
o Slightly likely
o Moderately likely
o Very likely

In the next year, how likely are you to only use non-motorized travel for trips of up to about 1 mile?
o Very unlikely
o Moderately unlikely
o Slightly unlikely
o Slightly likely
o Moderately likely
o Very likely

When you leave [campus OR your apartment or house], how often do you take public transportation, such as a city bus, for trips that are between about 1 and 5 miles?
o Never
o Rarely
o Sometimes
o Almost always
o Always

(*continued*)

When you leave [campus OR your apartment or house], how often do you use non-motorized travel, such as walking or bicycling, for trips that are between about 1 and 5 miles?
o Never
o Rarely
o Sometimes
o Almost always
o Always

In the next year, how likely are you to only use non-motorized travel or take public transportation for trips that are between about 1 and 5 miles?
o Very unlikely
o Moderately unlikely
o Slightly unlikely
o Slightly likely
o Moderately likely
o Very likely

In the next year, how likely are you to only use non-motorized travel for trips that are between about 1 and 5 miles?
o Very unlikely
o Moderately unlikely
o Slightly unlikely
o Slightly likely
o Moderately likely
o Very likely

When you leave [campus OR your apartment or house], how often do you take public transportation, such as a city bus, for trips that are greater than about 5 miles?
o Never
o Rarely
o Sometimes
o Almost always
o Always

When you leave [campus OR your apartment or house], how often do you use non-motorized travel, such as walking or bicycling, for trips that are greater than about 5 miles?
o Never
o Rarely
o Sometimes
o Almost always
o Always

In the next year, how likely are you to only use non-motorized travel or take public transportation for trips that are greater than about 5 miles?
o Very unlikely
o Moderately unlikely
o Slightly unlikely
o Slightly likely
o Moderately likely
o Very likely

In the next year, how likely are you to only use non-motorized travel for trips that are greater than about 5 miles?
o Very unlikely
o Moderately unlikely
o Slightly unlikely
o Slightly likely
o Moderately likely
o Very likely

At your residence, how often do you typically recycle your recyclable trash?
o Never
o Rarely
o Sometimes
o Almost always
o Always

In the next year, how likely are you to recycle all of your recyclable trash when you're at your residence?
o Very unlikely
o Moderately unlikely
o Slightly unlikely
o Slightly likely
o Moderately likely
o Very likely

[Only asked of off-campus participants] Over the past year, have you purchased renewable energy (such as solar or wind power) from your utility? For example, Fort Collins Utilities sells renewable energy through its Green Energy Program.
o Yes
o No
o I'm not sure.

[Only asked of off-campus participants] In the next year, how likely are you to purchase renewable energy from your utility?
o Very unlikely
o Moderately unlikely
o Slightly unlikely
o Slightly likely
o Moderately likely
o Very likely
o I've already purchased renewable energy from my utility for this next year.

During a typical week, on how many days do you consume no meat and fish?
o 0 o 4
o 1 o 5
o 2 o 6
o 3 o 7

(*continued*)

In the next year, how likely are you to have at least one day each week without meat and fish?
- o Very unlikely
- o Moderately unlikely
- o Slightly unlikely
- o Slightly likely
- o Moderately likely
- o Very likely

The next series of questions will ask you about several dietary habits. Please read each definition carefully, and use these definitions when answering the questions that follow.

Diet A: A diet with no beef, bison, and lamb (i.e., a non-ruminant diet)

Diet B: A diet with no meat and fish, but it regularly contains other animal products such as eggs or dairy (i.e., a vegetarian diet)

Diet C: A diet that rarely includes animal products (i.e., a plant-based diet). This includes vegetarians who rarely eat eggs and dairy. It also includes non-vegetarians who rarely eat meat, fish, eggs, and dairy.

Diet D: A diet with no animal products, such as meat, fish, eggs, and dairy (i.e., a vegan diet)

Do you currently adhere to any of the following diets?
- o None
- o Diet A
- o Diet B
- o Diet C
- o Diet D

In the next year, how likely are you to [adopt OR continue to eat] Diet A (a completely non-ruminant diet)?
- o Very unlikely
- o Moderately unlikely
- o Slightly unlikely
- o Slightly likely
- o Moderately likely
- o Very likely

In the next year, how likely are you to [adopt OR continue to eat] Diet B (a completely vegetarian diet)?
- o Very unlikely
- o Moderately unlikely
- o Slightly unlikely
- o Slightly likely
- o Moderately likely
- o Very likely

In the next year, how likely are you to [adopt OR continue to eat] Diet C (a plant-based diet)?
- o Very unlikely
- o Moderately unlikely
- o Slightly unlikely
- o Slightly likely
- o Moderately likely
- o Very likely

In the next year, how likely are you to [adopt OR continue to eat] Diet D (a completely vegan diet)?
- o Very unlikely
- o Moderately unlikely
- o Slightly unlikely
- o Slightly likely
- o Moderately likely
- o Very likely

Survey B.2. **Demographic Questions included in the Studies 1 and 2 Surveys**
Source: Author's own creation/work

Section 2: Please read each item carefully and select the answer that **best represents you**.

Based on the number of credits you've taken, in what class do you consider yourself to be?
o Freshman
o Sophomore
o Junior
o Senior
o Other. Please specify: _____

Have you declared your major(s) yet?
o Yes
o No

[If so] Please list your major(s) here: _____

[If not] Please list the major(s) you are considering, if any: _____

Have you declared any minors?
o Yes
o No

[If so] Please list your minor(s) here: _____

[If not] Please list the minor(s) you are considering, if any: _____

Do you currently live in Fort Collins?
o Yes
o No

[If not] Have you ever lived in Fort Collins in your adult life (for example, since turning 18)?
o Yes
o No

What is your age? _____

What is your race/ethnicity? [Select all that apply.]
☐ Non-Hispanic/Latinx
☐ Hispanic/Latinx
☐ White
☐ Black or African American
☐ Asian or Asian American
☐ Native American
☐ Native Hawaiian or other Pacific Islander
☐ Prefer not to answer

[Phase 2 only] What is your gender identity? _____

[Phase 3 only] What is your gender?
o Female
o Male
o Other. Please specify: _____
o Prefer not to answer

How do you identify politically? Please choose the response that most closely represents your identity.
o Republican
o Democrat
o Conservative-leaning independent
o Liberal-leaning independent
o Other. Please specify: _____
o No preference
o Prefer not to answer

Survey B.3. **CBSM Questions from the Study 2 Survey**
Note. Wording that changed based on whether participants lived on- or off-campus or whether participants were adopters or non-adopters is marked with brackets. Any instance of 'purchasing green energy credits' was only posed to off-campus participants. Source: Author's own creation/work

In what type of residence do you live?
o On-campus, residence hall
o On-campus, apartment
o Off-campus, rented apartment
o Off-campus, rented house
o Off-campus, apartment owned by me/my family/my significant other
o Off-campus, house owned by me/my family/my significant other
o Other. Please specify: _____

Now, we're going to ask about **CFL and LED light bulbs**. Please read the definition carefully before you move forward.

Definition: CFL bulbs are compact fluorescent bulbs, and LED bulbs are light-emitting diode bulbs (see Figure 1, 2, and 3 for examples). CFL bulbs and LED bulbs can be purchased for around $2.00 per bulb. Incandescent bulbs can be purchased for around $1.00 per bulb.

Figure 1. A typical CFL light bulb

Figure 2. A typical LED light bulb

Figure 3. A typical incandescent light bulb

When you have to replace light bulbs, how often do you typically install CFL or LED bulbs?
o Never
o Rarely
o Sometimes
o Almost always
o Always
o This does not apply to me.

If you need to replace light bulbs in the next year, how likely is it that you will install only CFL or LED bulbs?
o Very unlikely
o Moderately unlikely
o Slightly unlikely
o Slightly likely
o Moderately likely
o Very likely
o This does not apply to me.

Now, we're going to ask about **avoiding a plane flight when you travel 1,000 miles**. Please read the definition carefully before you move forward.

Definition: When you travel around 1,000 miles, you avoid a plane flight and take an alternative form of transportation (see Figure 4 for an example).

Figure 4. A 1,000 mile radius around Fort Collins, CO. Note: The black circle indicates a 1,000 mile radius around Fort Collins, CO.

Think back to the times that you've traveled to a destination that is about 1,000 miles from your home. When you've traveled a distance of around 1,000 miles in the past, how often have you taken a plane?
o Never
o Rarely
o Sometimes
o Almost always
o Always
o This does not apply to me.

In the next year, how likely are you to avoid flying every time you have to travel a distance of around 1,000 miles?
o Very unlikely
o Moderately unlikely
o Slightly unlikely
o Slightly likely
o Moderately likely
o Very likely
o This does not apply to me.

(*continued*)

Next, we're going to ask about **non-motorized modes of transportation**. Please read the definition carefully before you move forward.

Definition: These are modes of transportation that don't have motors, such as walking or bicycling.

When you leave [campus OR your house or apartment], how often do you use non-motorized modes of transportation?
- o Never
- o Rarely
- o Sometimes
- o Almost always
- o Always

In the next year, how likely are you to use non-motorized modes of transportation every time you leave [campus OR your house or apartment]?
- o Very unlikely
- o Moderately unlikely
- o Slightly unlikely
- o Slightly likely
- o Moderately likely
- o Very likely

Now, we're going to ask about a **plant-based diet**. Please read the definition carefully before you move forward.

Definition: A diet that never or rarely includes animal products. This includes: Non-vegetarians who rarely eat meat, fish, eggs, and dairy; Vegetarians who rarely eat eggs and dairy; Vegans

Do you follow a plant-based diet?
- o Yes
- o No

In the next year, how likely are you to [start OR continue] following a plant-based diet?
- o Very unlikely
- o Moderately unlikely
- o Slightly unlikely
- o Slightly likely
- o Moderately likely
- o Very likely

[Only asked of off-campus participants] Now, we're going to ask about **purchasing green energy credits**. Please read the definition carefully before you move forward.

Definition: Purchasing renewable energy, such as wind or solar power, from your utility company. For example, Fort Collins Utilities sells green energy credits for 1.9 cents per kilowatt-hour (kWh) through its Green Energy Program. On average, this would increase an electricity bill by about $13 for an entire household per month.

Over the past year, have you purchased green energy credits from your utility company?
- o Yes
- o No
- o I'm not sure.

In the next year, how likely are you to purchase green energy credits from your utility company?
- o Very unlikely
- o Moderately unlikely
- o Slightly unlikely
- o Slightly likely
- o Moderately likely
- o Very likely
- o I've already purchased renewable energy from my utility for this next year.

The next series of questions will include text boxes where you will write-in your answers.

Please rank order the behaviors according to how likely you are to engage in them over the next year. Simply drag and drop the behaviors, with the behavior that you are most likely to engage in at the top and the behavior that you are least likely to engage in at the bottom. Choose your response carefully - once you move to the next page, you can't change your answers!

_____ Following a plant-based diet
_____ Relying on non-motorized modes of transportation
_____ Avoiding one plane flight when I travel 1,000 miles
_____ Installing CFL or LED light bulbs
_____ Purchasing green energy credits
_____ Attention check - move this option to third place

Please answer these questions fully in the text box below. If you don't have an answer, please say "I'm not sure." If you prefer not to answer, please say "I prefer not to answer."

[Plant-based diet adopter questions:]

You indicated that you follow a plant-based diet.

Please describe your reasons for following a plant-based diet. _____

(*continued*)

How often do you eat meat?
o 5-6 days/week.
o 3-4 days/week.
o 2-3 days/week.
o 1 day/week.
o 2-3 days/month.
o 1 day/month.
o Less than 1 day/month.
o Never.

How often do you eat dairy?
o 5-6 days/week.
o 3-4 days/week.
o 2-3 days/week.
o 1 day/week.
o 2-3 days/month.
o 1 day/month.
o Less than 1 day/month.
o Never.

Please describe what makes it challenging for you to follow a plant-based diet. _____

How do you overcome those challenges? _____

Is there anything else you think might make it challenging for others to follow a plant-based diet?
o No.
o Yes. Please describe: _____

How do you personally benefit from following a plant-based diet? If you don't feel that you benefit, please say so. _____

How does your community or society as a whole benefit from you following a plant-based diet? If you don't feel that your community or society as a whole benefits, please say so. _____

[Plant-based diet non-adopter questions:]

You indicated that you don't follow a plant-based diet.

Please describe what would make it challenging for you to follow a plant-based diet. _____

Please describe what would make it easier for you to follow a plant-based diet. _____

[Only asked of participants who indicated they were slightly unlikely–very likely to start following a plant-based diet in the next year] If you were to follow a plant-based diet in the next year, what's the fewest number of days you would be willing to eat meat and dairy?

"I would be willing to eat meat..."
o 5-6 days/week.
o 3-4 days/week.
o 2-3 days/week.
o 1 day/week.
o 2-3 days/month.
o 1 day/month.
o Less than 1 day/month.
o Never.

"I would be willing to eat dairy..."
o 5-6 days/week.
o 3-4 days/week.
o 2-3 days/week.
o 1 day/week.
o 2-3 days/month.
o 1 day/month.
o Less than 1 day/month.
o Never.

If you were to follow a plant-based diet, how do you think you would personally benefit? If you don't think you would personally benefit, please say so. _____

If you were to follow a plant-based diet, how do you think your community or society as a whole would benefit? If you don't think your community or society as a whole would benefit, please say so. _____

[Living motor vehicle free adopter questions:]

You indicated that you usually use non-motorized modes of transportation when you leave [campus OR your apartment or house].

Please describe your reasons for relying on non-motorized modes of transportation. _____

Please describe what makes it challenging for you to rely on non-motorized modes of transportation. _____

How do you overcome those challenges? _____

Is there anything else you think might make it challenging for others to rely on non-motorized modes of transportation?
o No.
o Yes. Please describe: _____

(*continued*)

How do you personally benefit from relying on non-motorized modes of transportation? If you don't feel that you benefit, please say so. _____

How does your community or society as a whole benefit from you relying on non-motorized modes of transportation? If you don't feel that your community or society as a whole benefits, please say so. _____

[Living motor vehicle free non-adopter questions:]

You indicated that you don't consistently use non-motorized modes of transportation when you leave campus.

Please describe what would make it challenging for you to use non-motorized modes of transportation every time you leave [campus OR your apartment or house]. _____

Please describe what would make it easier for you to use non-motorized modes of transportation every time you leave [campus OR your apartment or house]. _____

If you were to use non-motorized modes of transportation every time you left [campus OR your apartment or house], how do you think you would personally benefit? If you don't think you would personally benefit, please say so. ____

If you were to use non-motorized modes of transportation every time you left [campus OR your apartment or house], how do you think your community or society as a whole would benefit? If you don't think your community or society as a whole would benefit, please say so. _____

[Avoiding a plane flight adopter questions:]

You indicated that you usually don't take a plane when you travel around 1,000 miles.

Please describe your reasons for avoiding a flight when you travel around 1,000 miles. _____

Please describe what makes it challenging for you to avoid a flight when you travel around 1,000 miles. _____

How do you overcome those challenges? _____

Is there anything else you think might make it challenging for others to avoid a flight when they travel around 1,000 miles?

o No.
o Yes. Please describe: _____

How do you personally benefit from avoiding a flight when you travel around 1,000 miles? If you don't feel that you benefit, please say so. _____

How does your community or society as a whole benefit when you avoid a flight when you travel around 1,000 miles? If you don't feel that your community or society as a whole benefits, please say so. _____

If you wanted to avoid a flight of 1,000 miles, which of the following would you consider? Please select all that apply.

☐ Traveling by car/truck/SUV
☐ Traveling by bus
☐ Traveling by train
☐ Traveling by ship
☐ Not traveling (i.e., meeting virtually)
☐ Other. Please specify: _____

How many 1,000-mile trips do you think you'll take in the next year?

o 0
o 1
o 2
o 3
o 4
o 5
o If more than 5, how many? _____

[Avoiding a plane flight non-adopter questions:]

You indicated that you sometimes or usually fly when you travel around 1,000 miles.

Please describe what would make it challenging for you to avoid a flight when you travel around 1,000 miles. _____

Please describe what would make it easier for you to avoid a flight when you travel around 1,000 miles. _____

If you were to avoid a flight when you travel around 1,000 miles, how do you think you would personally benefit? If you don't think you would personally benefit, please say so. _____

If you were to avoid a flight when you travel around 1,000 miles, how do you think your community or society as a whole would benefit? If you don't think your community or society as a whole would benefit, please say so. _____

(*continued*)

If you wanted to avoid a flight of 1,000 miles, which of the following would you consider? Please select all that apply.

- ☐ Traveling by car/truck/SUV
- ☐ Traveling by bus
- ☐ Traveling by train
- ☐ Traveling by ship
- ☐ Not traveling (i.e., meeting virtually)
- ☐ Other. Please specify: _____

How many 1,000-mile trips do you think you'll take in the next year?

- o 0
- o 1
- o 2
- o 3
- o 4
- o 5
- o If more than 5, how many? _____

[Installing CFL/LED adopter questions:]

You indicated that you typically install CFL and LED light bulbs.

Please describe your reasons for installing CFL and LED light bulbs. _____

Please describe what makes it challenging for you to install CFL and LED bulbs. _____

How do you overcome those challenges? _____

Is there anything else you think might make it challenging for others to install CFL and LED bulbs?

- o No.
- o Yes. Please describe: _____

How do you personally benefit from installing CFL and LED bulbs? If you don't feel that you benefit, please say so. _____

How does your community or society as a whole benefit from you installing CFL and LED bulbs? If you don't feel that your community or society as a whole benefits, please say so. _____

[Installing CFL/LED non-adopter questions:]

You indicated that you don't consistently install LED and CFL light bulbs.

Please describe what would make it challenging for you to install only CFL and LED light bulbs. _____

Please describe what would make it easier for you to install only CFL and LED light bulbs. _____

If you were to install only CFL and LED bulbs, how do you think you would personally benefit? If you don't think you would personally benefit, please say so. _____

If you were to install only CFL and LED bulbs, how do you think your community or society as a whole would benefit? If you don't think your community or society as a whole would benefit, please say so. _____

[Purchasing green energy credit adopter questions:]

You indicated that you have purchased green energy credits through your utility company.

Where did you purchase the green energy credits?

- o City of Fort Collins' Green Energy Program
- o A similar program in another city

Please describe your reasons for purchasing green energy credits. _____

Please describe what makes it challenging for you to purchase green energy credits. _____

How do you overcome those challenges?

Is there anything else you think might make it challenging for others to purchase green energy credits?

- o No.
- o Yes. Please describe: _____

How do you personally benefit from purchasing green energy credits? If you don't feel that you benefit, please say so. _____

How does your community or society as a whole benefit from you purchasing green energy credits? If you don't feel that your community or society as a whole benefits, please say so. _____

(*continued*)

[Purchasing green energy credit non-adopter questions:]

You indicated that you have not purchased green energy credits through your utility company.

[For those who had lived in Fort Collins] Had you heard of Fort Collins Utilities' Green Energy Program before taking this survey?
o Yes
o No
o I'm not sure

[For those who had not lived in Fort Collins] Had you heard of any green energy programs in your area before taking this survey?
o Yes
o No
o I'm not sure

Please describe what would make it challenging for you to purchase green energy credits from your utility company.
_____

Please describe what would make it easier for you to purchase green energy credits from your utility company.
_____

If you were to purchase green energy credits, how do you think you would personally benefit? If you don't think you would personally benefit, please say so. _____

If you were to purchase green energy credits, how do you think your community or society as a whole would benefit? If you don't think your community or society as a whole would benefit, please say so. _____

[Closed-ended barrier and benefit questions:]

In the next series of questions, you'll be asked to describe the behaviors based on a set of characteristics. Please select the location on the scale that best describes each behavior. Remember- there are no right or wrong answers! We just want your impression of the behaviors.

Please indicate how **difficult** you think it is to engage in each behavior.
Please indicate how **time consuming** you think it is to engage in each behavior.
Please indicate how **stressful** you think it is to engage in each behavior.
Please indicate how **socially acceptable** you think it is to engage in each behavior.
Please indicate how **expensive** you think it is to engage in each behavior.
Please indicate how **common** you think it is to engage in each behavior (i.e., how frequently others engage in the behavior).
Please indicate how **environmentally friendly** you think it is to engage in each behavior.
Please indicate how **dangerous** you think it is to engage in each behavior.
Please indicate how **healthy** you think it is to engage in each behavior.

	Not at all [characteristic]	Slightly [characteristic]	Moderately [characteristic]	Very [characteristic]
Installing CFL and LED light bulbs	○	○	○	○
Avoiding a plane flight when you travel 1,000 miles	○	○	○	○
Relying on non-motorized modes of transportation	○	○	○	○
Following a plant-based diet	○	○	○	○
Purchasing green energy credits	○	○	○	○

Appendix 3

Table A2.
Benefit codebook

Code	Description	Examples	Counter-examples
Easy	• The participant thinks that engaging in this behavior is easy. They do not see it as challenging, and they think it is a simple behavior to execute	• "This is the simplest thing on the list and something that I can and have easily implemented into my life" • "I don't have any challenges" • "Not applicable"	• Lots of people engage in this behavior. Everyone should be able to engage in this behavior • "I tend to prefer them just because they're what I'm used to, and I know they're more eco-friendly"
Monetary savings	• Engaging in this behavior can save the participant money. This includes short-term and long-term monetary savings	• "I think in the long run it would pay off, like how solar panels are expensive to install but end up saying you a lot of money"	–
Economic benefit	• Engaging in this behavior has economic benefits for the community or for society. It also might increase the number of jobs available	• "I think that there could be benefit in the small businesses who would have more people coming in"	• "I save money, since flying is usually expensive"
Enjoyable	• Engaging in this behavior is enjoyable or fun. The participant might mention something specific that's enjoyable or fun about the behavior or they might be more vague and not mention anything specifically enjoyable. The participant might also say that they "like" or "love" doing something • This code can also be used for CFL/LED lighting – if the participant says that they light the color or brightness of LED/CFL lights	• "I get to take longer from getting to one place and the other. I have this thing where I like listening to music for hours upon end, and this just prolongs it" • "I love riding my bike" • "I get to see landscape" • "We just use LED because they're bright and energy efficient"	–
Mental benefit	• Engaging in this behavior is mentally better for the participant than some alternative. It might reduce stress, anxiety, etc., or it might make them feel happy. It also might make them feel good about themselves because they can think about themselves in a positive way or it might	• "It gets me outside, which is good for my mental health" • "I have anxiety about driving" • "I would benefit by feeling like I am being a productive member of society" • "I think people would benefit from time to slow down"	–

(*continued*)

Code	Description	Examples	Counter-examples
	keep them from feeling negatively. The participant also might mention that the behavior gives them or others time to slow down or that the behavior keeps them grounded	• "being outside keeps me grounded"	
More control	• The participant says that engaging in the behavior gives them more control or flexibility • This is distinguished from the mental benefit code because for this code, the participant does not mention that this is necessarily a mental benefit – simply that they have more control. If having more control is mentally beneficial for the participant, use both codes	• "Control over itinerary"	–
Physical benefit	• Engaging in this behavior is physically beneficial. The participant might mention feeling better physically, getting to exercise, increased physical health, increased energy or improvements to body functioning • Or they might mention how they avoid physical or bodily harm by engaging in the behavior	• "I like moving my legs a lot. I like walking" • "I get headaches when inside a vehicle for prolonged periods" • "I get motion sick on planes" • "I am less prone to disease or getting sick" • "Eating meat and animal products is harmful to your body"	• "It would benefit my health"
Convenience	• The participant mentions that the behavior is more convenient than the alternative. This will look different depending on the behavior in question. See the examples on the right	• "I don't want to take the bus or use Uber/Lyft, so non-motorized modes of transportation are just more convenient for me" • "I don't have to worry about a car payment, car troubles, and the expenses that come with those and I don't have to worry about filling up my gas tank every week or so." (blue text coded as "Convenience") • "I don't have to change lights as often"	• "I think in the long run it would pay off, like how solar panels are expensive to install but end up saying you a lot of money"

(*continued*)

Table A2.

Code	Description	Examples	Counter-examples
Climate change	• The participant specifically mentions climate change or reduced emissions. This could include global warming, greenhouse gas emissions, carbon emissions, CO_2 emissions, methane emissions or something very similar	• "We would benefit more because less bad emissions"	• "My community would be a lot more energy efficient"
Reduced energy use	• The participant mentions that less energy, gas or electricity is used for the behavior. They also could mention that the behavior is more energy efficient • This code also applies if the participant says that others can use the energy that they are no longer using (see third example quote)	• "It seems that I can save more energy by using them" • "My community would be a lot more energy efficient" • "I think my community would benefit from me having less of a carbon footprint because they'd be able to use the energy that I'm not, and I wouldn't be negatively affecting my environment as much as I am now" (coded as climate change, reduced energy use and environmental benefit)	• "Better electricity"
Environmental benefit	• The participant says that engaging in the behavior is beneficial for the environment in some way. They may mention a cleaner or healthier environment • The participant may also mention the planet, the world, ecology, eco-friendliness, sustainability, pollution, resource use, deforestation or waste	• "Just having more sustainable ways to get around" • "Having to change the bulbs less often also means that I don't have to use up as many resources by buying new bulbs all the time" • "If we all made the switch, it would make a difference for the planet"	• "Engaging in this behavior helps to mitigate climate change"
Vague personal benefit	• The participant does not explain the benefit well, but the benefit applies to the individual, their household or their friends/family • They might mention how the behavior is good for them or their family, but they don't explain how it is better • They might mention their health, but they do not explain whether it is mental or physical health	• "This would be beneficial to my family" • "More time outside, less time in a car" • "It would benefit my health"	• "Eating meat and animal products is harmful to your body" • "My immediate community benefits from me being happy!"

Table A2. (*continued*)

Code	Description	Examples	Counter-examples
Vague global benefit	• The participant does not explain the benefit well, but the benefit applies at the community or societal level. They might mention how the behavior is better for society, but they do not explain how it is better	• "Better electricity" • "Better for society" • "My immediate community benefits from me being happy!" • "My immediate community benefits from my increased energy levels because I am able to participate more fully in my community"	• "If we all made the switch, it would make a difference for the planet"
Sets example	• The participant might say that engaging in the behavior is beneficial because it helps to raise awareness about a certain topic or issue. They also might say that when they engage in the behavior, it encourages other people to engage in it as well. They also might say that they are able to influence others to engage in the behavior	• "Me eating plant-based raises awareness around the topic and could potentially encourage others to eat the same way" • "I try to influence others who may be installing the lightbulbs to use CFL and LED instead of regular" • "All it takes is one person to start a chain reaction. If I recommended it to my neighbors and friends, they might switch over" • "I can influence others to purchase and install LED or CFL bulbs" • "It starts with the individual" • "Awareness of what it means to use and invest in clean energy sources – Kinda grows the movement"	• "If I could somehow get my apartment complex to switch as a whole to the green energy project that would be awesome!" (NOT coded as "sets example" because they are not saying that one of the benefits of engaging in the behavior is that it leads to a chain reaction – this is a vague global benefit)
Prevents disease	• Engaging in the behavior can help to prevent the spread of diseases, including COVID-19	• "Prevent the spread of the virus"	–
Can pack more	• The participant mentions that the behavior allows you to bring or pack more items. They might also mention that engaging in the behavior allows them to spend more time with their pets (this would not apply to farm animals, such as horses)	• "I like having more space to carry things that would not fit in a suitcase" • "can bring pets and more luggage"	• "I ride horses a lot so if there was somewhere that I could put my horse and a way that I could take all of my groceries home with me without somewhere to really put a lot of them"

(*continued*)

Table A2.

Code	Description	Examples	Counter-examples
Reduced traffic	• The participant says that the behavior reduces road traffic	• "Reduces traffic"	–
Better for animals	• The participant says that following a plant-based diet is good because it avoids killing or harming animals	• "I do not believe in the mass slaughter of animals"	–
Other	• Use this code if you feel that the particular code you are looking for is not represented in the codebook. After "Other," include a description of the new idea or code	–	–

Table A2. **Source:** Authors' own creation/work

Code	Description	Behavior	Examples	Counter-examples
Lack or unsure of personal benefit	• No personal benefits • Unsure of personal benefits • May list possible benefits, but they express doubts • Markers include don't know, not sure, maybe and "???" • Not "benefit not big enough to make me care/ want to change" [lack of interest]	Plant Bulb GEC Motor Plane	"Probably would not personally benefit, maybe I would feel like I'm making a difference on the environment"	NOT "There is no benefit unless everyone engages in the behavior" [Low Impact]
Lack or unsure of community benefit	• No societal or community benefits • Unsure of societal or community benefits • May list possible benefits, but they express doubts • Markers include don't know, not sure, maybe and "???" • Not "no benefit unless everyone engages in behavior" [Low impact]	Plant Bulb GEC Motor Plane	"I don't really see a benefit to my community, maybe a benefit to the environment"	NOT "There is no benefit unless everyone engages in the behavior" [Low Impact]
Expensive	• Upfront and/or long-term costs are too high • Is not affordable for someone like me	Plant	"Meat alternatives cost more"	NOT "Many Americans would find themselves without jobs" [Burden for Others]
	• Less expensive option(s) available	Bulb GEC Plane	"I can't afford that in my budget" "Driving this long costs lots of money"	–
Lack of knowledge	• Skill-building • Has to learn once, then has necessary knowledge • Not something they need to learn repeatedly (e.g. finding a route in an unfamiliar city) • Not being unsure of benefits [lack of or unsure of benefits]	Plant Bulb GEC Motor Plane	"I don't know any plant-based recipes" "Where do I find these bulbs?" "I had no information about GECs from my utility company" "Inability to ride a bike" "I need to learn how to use GPS"	– NOT "Not sure. I don't understand energy. I think it's better to have renewable energy, but I don't really understand it" [Lack of Benefit] – NOT "It's an unfamiliar city, so I'd need to use my GPS to navigate" [Inconvenient] NOT "Finding my way through a new city is hard" [Inconvenient]

(*continued*)

Table A3.
Barrier codebook

Code	Description	Behavior	Examples	Counter-examples
Inconvenient	• Too difficult or time-consuming • Limited availability • Easier or more convenient option(s) available • "Tedious" triggers inconvenient and unappealing • They don't feel like repeatedly obtaining knowledge (e.g. finding a route in an unfamiliar city)	Plant	"I use meat as a central source of protein"	-
		Bulb	"When they sell out, it's hard to buy them"	
		GEC	"It takes too long to sign up"	
		Motor	"If I have to go long distances it can be tiring, and I sometimes take the bus then"	
		Plane	"A 14 hour car drive can become a 2 hour flight"	
Lack of interest	• No interest in the cause behind or reasons for engaging in the behavior • Includes lack of motivation and lack of attention	Plant	"They don't care about the environment or the animals"	NOT "I don't like plant-based food" [Unappealing]
		Bulb	"I don't account for light bulbs in my budget"	–
		Plane	"There aren't a lot of times that I travel, so it's not something I think about"	
Unappealing	• A dislike or discomfort • Prefer competing behavior/product • "Tedious" triggers unappealing and inconvenient • Not related to functionality (e.g. getting protein)	Plant	"Plant-based meat does not taste good"	NOT "Plant-based meat doesn't have enough protein to support my lifestyle" [Health Concern]
		Bulb	"I don't like the color of LED lights"	NOT "LED hurts my eyes" [Health Concern]
		Motor	"Bad weather could make it difficult to bike"	–
		Plane	"Sitting for long periods of time"	NOT "Driving doesn't get me there fast enough" [Inconvenient]
Health concern	• Unable to engage in the behavior for health reasons (protein acts as a trigger word for the plant-based diet behavior) • Safety concern • "Unnatural" • Can be real or perceived • Not "too difficult" [inconvenient] or "too gross" [unappealing]	Plant	"I feel awful when I eat plant-based" "Humans were made to be omnivores"	NOT "I get protein from meat and dairy" [Inconvenient]
		Bulb	"LED hurts my eyes"	NOT "I don't like the color of LED lights" [Unappealing]
		Motor	"It is not safe to walk"	–
		Plane	"I get carsick, so I can't drive very far" "Driving long distances is dangerous"	

Table A3.

(*continued*)

Code	Description	Behavior	Examples	Counter-examples
Lack of control	• Someone else controls the behavior • Environment blocks performing the behavior • Can be real or perceived • Markers include can't and have to, • Not "too difficult" [inconvenient], "unable for health reasons" [health concern], or "not enough information" [lack of knowledge]	Plant Bulb GEC Motor Plane	"My family cooks dinner for me" "I don't install my own bulbs" "I don't pay for my own electricity" "There are no walking paths, roads with a shoulder, or bike paths" "I don't own a car"	– NOT "Inability to ride a bike" [Lack of Knowledge] –
Low impact	• Impact exists only when everyone engages • Could also say that their behavior alone doesn't make a difference	Plant Bulb GEC Motor Plane	"If we all made the switch, it would make a difference for the environment" "I don't think the community would benefit from just me following a plant-based diet"	NOT "It wouldn't make a difference" [Lack of Benefit]
Cultural norms	• Influenced by others • Behavior passed down through family • Afraid of judgement • Includes religious influence	Plant Bulb	"Toxic masculinity" "My family has always used CFL bulbs"	–
Burden for others	• Hassle for others • Economic burden	Plant	"If everyone was plant-based, many Americans would fine themselves without jobs"	NOT "Friends and family don't follow a plant-based diet" [Cultural Norms]

Source: Authors' own creation/work

Table A3.

Appendix 4

Table A4. Interviews in which saturation was achieved for each behavior

Behavior		Base (1–6)	Number of new codes by interview number: Interview number 7	8	9	10	11	12	13	14	15	16	17	18	19	20
Living motor vehicle free	A	17	2	0	2	0	*0*	–	–	–	–	–	–	–	–	–
	N-A	17	0	*0*	–	–	–	–	–	–	–	–	–	–	–	–
Purchasing GECs	N-A	16	0	1	1	0	*0*	–	–	–	–	–	–	–	–	–
Following a plant-based diet	A	21	0	2	0	1	0	1	0	2	0	*0*	–	–	–	–
	N-A	18	1	1	0	1	1	0	1	0	*0*	–	–	–	–	–
Avoiding a plane flight	A	25	1	0	*0*	–	–	–	–	–	–	–	–	–	–	–
	N-A	15	1	0	1	2	0	1	0	1	0	1	1	0	*0*	–
Installing CFL/LED bulbs	A	14	1	1	1	1	1	1	0	*0*	–	–	–	–	–	–
	N-A	13	1	1	0	2	0	*0*	–	–	–	–	–	–	–	–
Interview number:		Base (1)	2	3	4	5	6	*7*	8	9	10	11	12	13	14	15
Purchasing GECS	A	6	1	1	–	–	–	–	–	–	–	–	–	–	–	–

Notes: "A" signifies adopters, and "N-A" signifies nonadopters. The italic marks the point at which saturation was achieved
Source: Authors' own creation/work

Table A5. Kappa values for the codes in the "benefits" category

Code	Overall	Living motor vehicle free	Purchasing GECs	Following a plant-based diet	Avoiding a plane flight	Installing CFL/LED bulbs
			κ			
Environmental benefit	0.94	0.97	0.85	0.96	0.97	0.97
Mental benefit	0.86	0.88	0.95	0.83	0.78	0.93
Physical benefit	0.95	1.0	–	0.89	0	1.0
Monetary savings	0.95	1.0	0.85	0.85	0.93	1.0
Climate change	0.97	1.0	0.93	0.88	1.0	1.0
Reduced energy use	0.90	0.83	0.88	–	1.0	0.89
Vague global benefit	0.58	0.33	0.33	0.33	0.33	0.79
Easy	0.91	–	1.0	1.0	0.94	0.90
Vague personal benefit	0.80	0.76	0.38	0.90	0	–
Convenience	0.74	0.80	–	0	−0.02	0.92
Sets example	0.80	1.0	–	1.0	–	0.56
Prevents disease	0.90	–	–	–	0.89	–
Better for animals	0.84	–	–	0.83	–	–
Reduced traffic	0.87	0.87	–	–	–	–
Economic benefit	0.77	–	1.0	–	0.85	0
Can pack more	0.73	0	–	–	0.79	–
More control	0.89	–	–	–	0.89	–

Notes: The overall column was calculated across all behaviors. Dash symbols indicate codes not used. Codes are sorted by overall frequency of use
Source: Authors' own creation/work

Code	Overall		Living motor vehicle free		Purchasing GECs		Following a plant-based diet		Avoiding a plane flight		Installing CFL/LED bulbs	
	A (%)	N-A (%)	A (%)	N-A (%)	A (%)	N-A (%)	A (%)	N-A (%)	A (%)	N-A (%)	A (%)	N-A (%)
Environmental benefit	17	29	21	26	50	36	20	30	12	22	*14*	*28*
Mental benefit	18	13	*21*	*9*	17	16	*14*	*3*	24	24	14	12
Physical benefit	9	11	19	26	–	–	17	27	1	–	–	2
Monetary savings	10	7	6	4	–	6	4	–	*22*	*11*	8	14
Climate change	8	9	9	9	17	10	8	7	8	13	6	2
Reduced energy use	4	10	3	7	–	12	–	–	2	9	17	21
Vague global benefit	4	7	6	6	–	14	8	10	1	–	1	2
Easy	7	2	–	–	–	1	4	–	8	2	*19*	*5*
Vague personal benefit	4	5	4	4	–	3	11	20	1	2	–	–
Convenience	5	2	3	–	–	–	2	–	2	2	17	7
Sets example	2	2	–	3	–	–	4	–	–	–	4	5
Prevents disease	2	2	–	–	–	–	–	–	7	9	–	–
Better for animals	3	–	–	–	–	–	10	3	–	–	–	–
Reduced traffic	2	1	8	4	–	–	–	–	–	–	–	–
Economic benefit	1	1	–	–	17	1	–	–	2	2	–	2
Can pack more	1	1	–	1	–	–	–	–	4	2	–	–
More control	1	–	–	–	–	–	–	–	4	2	–	–

Notes: "A" signifies adopters and "N-A" signifies nonadopters. The percentages were calculated within each behavior. The overall column was calculated across all behaviors. Dash symbols indicate codes not used. The green highlights indicate the pairs with the greatest difference between adopter and nonadopters for each behavior (except purchasing GECs given the low number of behavior adopters)
Source: Authors' own creation/work

Table A6. Benefit code frequencies across adopters and nonadopters

Code	Overall	Living motor vehicle free	Purchasing GECs	Following a plant-based diet	Avoiding a plane flight	Installing CFL/LED bulbs
			κ			
Inconvenient	0.80	0.73	1.0	0.80	0.84	0.65
No personal benefit	0.88	0.92	0.88	0.81	0.92	0.88
Expensive	0.89	–	0.86	0.93	0.79	0.94
No community benefit	0.87	0.96	0.86	0.85	0.96	0.88
Lack of control	0.70	0.53	0.92	−0.02	0.83	0.85
Unappealing	0.88	0.89	–	0.91	0.77	1.0
Health concern	0.63	0.61	–	0.55	0.80	1.0
Low impact	0.67	0.33	0.65	0.69	0.85	0.74
Lack of knowledge	0.71	0	0.78	0.92	–	0.19
Cultural norms	0.82	1.0	–	0.95	0	0
Lack of interest	0.63	–	−0.01	0.66	0	0.83
Burden for others	0.60	–	–	0.75	0	–
Other	–	–	–	–	–	–

Notes: The overall column was calculated across all behaviors. Dash symbols indicate codes not used. Codes are sorted by overall frequency of use
Source: Authors' own creation/work

Table A7. Kappa values for the codes in the barriers' category

Code	Overall		Living motor vehicle free		Purchasing GECs		Following a plant-based diet		Avoiding a plane flight		Installing CFL/LED bulbs	
	A (%)	N-A (%)	A (%)	N-A (%)	A (%)	N-A (%)	A (%)	N-A (%)	A (%)	N-A (%)	A (%)	N-A (%)
Inconvenient	24	13	27	27	–	4	23	13	31	24	9	4
No personal benefit	8	19	4	5	25	24	*1*	*16*	*11*	*19*	21	29
Expensive	13	12	–	–	75	18	13	6	7	10	*32*	*22*
No community benefit	10	13	9	7	–	12	–	12	20	17	18	16
Lack of control	10	11	*24*	*20*	–	14	4	1	13	14	3	4
Unappealing	10	9	18	20	–	–	15	18	7	10	–	2
Health concern	8	7	11	13	–	–	11	19	7	2	–	2
Low impact	6	6	2	7	–	9	11	4	3	2	9	4
Lack of knowledge	3	6	2	–	–	17	7	–	–	–	3	6
Cultural norms	4	1	2	–	–	–	10	5	–	2	3	–
Lack of interest	1	3	–	–	–	2	1	3	1	–	3	10
Burden for others	2	1	–	–	–	–	4	3	1	–	–	–
Other	–	–	–	–	–	–	–	–	–	–	–	–

Table A8.
Barrier code frequencies across adopters and nonadopters

Notes: "A" signifies adopters and "N-A" signifies nonadopters. The percentages were calculated within each behavior. The overall column was calculated across all behaviors. Dash symbols indicate codes not used. The green highlights indicate the pairs with the greatest difference between adopter and nonadopters for each behavior (except purchasing GECs given the low number of behavior adopters)
Source: Authors' own creation/work

Appendix 5

Behavior comparisons	Socially acceptable	Common	Environmentally friendly	Healthy
	Difference between the values			
Bulb to GEC	0.52***	1.32***	−0.01	0.05
Bulb to plane	0.76***	1.14***	0.19^{+}	0.34*
Bulb to plant	0.78***	0.80***	−0.01	−0.56***
Bulb to vehicle	0.78***	0.90***	−0.47***	−0.83***
GEC to plane	0.23*	−0.18	0.20^{+}	0.29
GEC to plant	0.25*	−0.52***	0.01	−0.61***
GEC to vehicle	0.26*	−0.42***	−0.45***	−0.89***
Plane to plant	0.02	−0.34***	−0.19*	−0.90***
Plane to vehicle	0.02	−0.24**	−0.66***	−1.18***
Plant to vehicle	0.00	0.10	−0.46***	−0.28**

Notes: GEC: purchasing GECs; bulb: installing CFL and LED bulbs; plane: avoiding a medium-length plane flight; plant: following a plant-based diet; vehicle: living motor vehicle free ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; $^{+}p < 0.10$
Source: Authors' own creation/work

Table A9. Benefit characteristic comparisons using the scheffé post hoc test

Behavior comparisons	Difficult	Time consuming	Stressful	Expensive	Dangerous
	Difference between the values				
Bulb to GEC	−1.21***	−0.66***	−0.97***	−0.96***	0.02
Bulb to plane	−1.48***	−2.25***	−1.50***	−0.83***	−0.79***
Bulb to plant	−1.73***	−1.08***	−1.33***	−1.03***	−0.23***
Bulb to vehicle	−1.55***	−2.03***	−1.53***	0.35***	−0.91***
GEC to plane	−0.27*	−1.59***	−0.53***	0.13	−0.81***
GEC to plant	−0.52***	−0.42***	−0.36***	−0.08	−0.25***
GEC to vehicle	−0.34***	−1.38***	−0.56***	1.31***	−0.93***
Plane to plant	−0.25*	1.17***	0.17	−0.20*	0.56***
Plane to vehicle	−0.08	0.22*	−0.04	1.18***	−0.12
Plant to vehicle	0.18	−0.96***	−0.20^{+}	1.39***	−0.68***

Notes: GEC: purchasing GECs; bulb: installing CFL and LED bulbs; plane: avoiding a medium-length plane flight; plant: following a plant-based diet; vehicle: living motor vehicle free ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; $^{+}p < 0.10$
Source: Authors' own creation/work

Table A10. Barrier characteristic comparisons using the scheffé post hoc test

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