THESIS

REDUCING GREENHOUSE GAS EMISSIONS: USING COMMUNITY-BASED SOCIAL MARKETING TO IDENTIFY TARGETS FOR BEHAVIOR CHANGE

Submitted by

Elizabeth C. Ross

Department of Psychology

In partial fulfillment of the requirements

For the Degree of Master of Science

Colorado State University

Fort Collins, Colorado

Spring 2022

Master's Committee:

Advisor: Patricia Aloise-Young

Jessica Witt
Marilee Long
Sara Anne Tompkins

ABSTRACT

REDUCING GREENHOUSE GAS EMISSIONS: USING COMMUNITY-BASED SOCIAL MARKETING TO IDENTIFY TARGETS FOR BEHAVIOR CHANGE

Greenhouse gas emissions produced by human activities threaten all life on earth. Project Drawdown (2020), Wynes and Nicholas (2017), and other similar efforts have catalogued behaviors that individuals can adopt to stall and mitigate climate change. Thus far, no empirical attempts have been made to determine which of these behaviors make viable targets for behavior change interventions. The current study remedies that gap through the use of community-based social marketing (CBSM), which distinguishes behavioral targets using the behaviors' probability, penetration, impact, and barriers.

Following the CBSM framework, penetration and probability were assessed for 16 low-carbon behaviors to find those with the lowest adoption rates (i.e., penetration) and the highest likelihood of being adopted (i.e., probability). Impact for each behavior was also estimated using Project Drawdown and other similar sources. The perceived barriers and benefits of behavior engagement were then assessed for the five behaviors with the most ideal combination of impact, penetration, and probability: living motor vehicle free, purchasing green energy credits, following a plant-based diet, avoiding a plane flight, and installing compact fluorescent lamp (CFL) and light-emitting diode (LED) bulbs.

Recommendations for future interventions aimed at reducing greenhouse gas emissions were then made based on the findings pertaining to these five behaviors. Among the target audience considered in this work, very few individuals had purchased green energy credits. Additionally, the barriers to purchasing green energy credits had clear solutions for many participants. Given the comparable ease with which participants can engage in this behavior, I recommend that future interventions target the purchasing of green energy credits. Additional recommendations are made for the five behaviors, considering the benefits and challenges associated with each one.

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my committee, Dr. Patricia Aloise-Young, Dr. Jessica Witt, and Dr. Marilee Long, for their patience and guidance in improving this work. I would like to extend a special thank you to my advisor, Dr. Aloise-Young, for your immense support and undying dedication to getting this document through the finish line and for demonstrating how to be resilient when faced with stumbling blocks.

I am also incredibly grateful to the members of my research lab, especially Dr. Aloise-Young and Hannah Curcio, and to our undergraduate research assistants for the long hours they invested in the qualitative coding process.

To Dr. Kristina Quinn and members of the CSU *Writes* community: thank you for your guidance, vulnerability, and community-building in support of graduate student writers.

I am also forever grateful to my fellow graduate students in ASHP for their support in both the pre- and post-pandemic worlds. This would not have been possible without you (and it would have been a lot less fun).

Lastly, but absolutely not least, I cannot begin to express my thanks to my parents, whose unwavering belief in my abilities has been a source of strength and encouragement during the most challenging times. Thank you both so much—I owe you everything. And to my partner, Logan: I know, unreservedly, that I would not have succeeded without your endless supply of love, humor, support, and patience. You've been my biggest cheerleader and my rock, and for that I am forever grateful.

TABLE OF CONTENTS

CHAPTER I: INTRODUCTION

Climate change is an existential threat facing our species. As of 2019, average global temperatures had increased by 1.1°C from pre-industrial era temperatures, and 2015 through 2018 were the warmest years ever recorded (Siegmund et al., 2019). In addition, average sea level on U.S. shores has risen by approximately 9 inches since the early 20th century (Jay et al., 2018). These recent changes to our climate are caused by anthropogenic, or human-driven, greenhouse gas (GHG) emissions (Jay et al., 2018). Among the three major GHGs—carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)—CO_2 is the most well-known, but CH_4 and N_2O have significantly more warming potential than CO_2 (United States Environmental Protection Agency [EPA], 2017). Thus, reducing the emission of all three gases will help to stall global temperature increases.

The climate crisis is a matter of national and global security. Without mitigation, global economic growth is expected to slow substantially (Jay et al., 2018). Moreover, higher temperatures, precipitation extremes, poorer air quality, flooding, and extreme weather events will negatively impact infrastructure and human health (Olsson et al., 2014; Smith et al., 2014). Although these effects will be widespread, marginalized groups will be disproportionately impacted; marginalized groups are more likely to be exposed to hazards and are less likely to be resilient to them, exacerbating pre-existing inequalities (Ebi et al., 2018). For example, low income groups will be less able to pay for rising electricity costs, and areas with existing infrastructure issues will be less able to adapt to environmental changes, such as rising sea levels. Additionally, indigenous groups, who currently face institutional barriers and rely heavily on natural resources, will experience huge economic and cultural losses (Jantarasami et al., 2018).

To mitigate climate change, we must reduce GHG emissions and expand carbon sinks. In the U.S. in 2017, the transportation sector (34%) and electricity production (33%) emitted the most CO_2, and the agricultural industry emitted the most CH_4 and N_2O (EPA, 2020). Changing certain individual-level behaviors related to these sectors can substantially reduce global GHG emissions and mitigate climate

change (Hawken, 2017; Ivanova et al., 2015; Tukker & Jansen, 2006; Wynes & Nicholas, 2017; Vita et al., 2019). While policy-level change and technological advancements must also occur, high-level changes such as those often take much longer to implement than individual-level change, and thus individual-level change is important for meeting emission reduction goals and reducing emissions more rapidly (Wynes & Nicholas, 2017). Therefore, efforts to encourage people to adopt lower-emission behaviors and abandon higher-emission behaviors have the potential to play a major role in climate change mitigation.

Popular programs (e.g., Gershon's *Low Carbon Diet*) and books (e.g., Yarrow's *How to Reduce Your Carbon Footprint: 365 Ways to Save Energy, Resources, and Money*) encourage a variety of options for decreasing one's carbon footprint through individual behavior change, but they often fail to focus on high-emission behaviors. Climate change researchers, however, have identified many high-emission behaviors that have the potential to greatly reduce global GHG emissions. Project Drawdown is one such effort (Hawken, 2017; Project Drawdown, 2020). The organization has identified and recorded the impacts—in gigatons CO_2-equivalent (CO_2e)—of 82 solutions, some of which are relevant to individual behavior change interventions (e.g., driving electric vehicles, eating plant-rich diets, and installing rooftop solar). Another such effort, by Wynes and Nicholas (2017), compares higher-emission behaviors to lower-emission behaviors and describes the impact for each. They argue that there is a lack of attention on behaviors that have a greater impact on CO_2 emissions, such as living car free and adopting plant-based diets, and that behavior change campaigns traditionally focus on behaviors with limited ability to reduce emissions, such as recycling and composting.

Project Drawdown (2020), Wynes & Nicholas (2017), and other similar catalogues of high-emission behaviors have provided crucial starting points for reducing GHG emissions behaviorally (Hawken, 2017; Project Drawdown, 2020; Tukker & Jansen, 2006; Vita et al., 2019; Wynes & Nicholas, 2017). Efforts like these are the culmination of many years of climate science research. According to the American Psychological Association Task Force on the Interface Between Psychology and Global Climate Change, there is now a need for social scientists to develop more effective interventions that

address the structural and psychological barriers to climate action (Swim et al., 2011). To successfully reduce GHG emissions and climate change, we must study behaviors that not only have the potential to significantly reduce emissions but that are also feasible targets for intervention. The goal of the current research is to determine which climate-relevant behaviors are the most promising behavioral targets at a university in the United States. More broadly, this research will inform the creation of more effective climate-relevant behavioral interventions and will begin to assess whether behaviors associated with greater emission reductions are more worthwhile targets to pursue through intervention than behaviors associated with fewer emissions. This study provides strategies for using Project Drawdown (2020), Wynes and Nicholas (2017), and other similar catalogues in a way that maximizes the potential impact of behavior change campaigns and recommends climate-relevant behavioral targets for interventions among college students. To the author's knowledge, there have been no studies conducted that test the viability of interventions targeting the behaviors described by Project Drawdown (2020) and Wynes and Nicholas (2017). Future researchers can apply these techniques to determine worthwhile behavioral targets for populations around the world.

Theories of Behavior Change

The Principle of Compatibility

In past interventions, it was assumed that attitudes and behaviors were consistent, and thus attitude change would lead to and be consistent with behavior change. However, attitudes are often uncorrelated with relevant behaviors, and interventions that rely on attitude change are often ineffective (Ajzen & Fishbein, 2005). The principle of compatibility partially explains why related behaviors and attitudes have historically been uncorrelated. According to the principle of compatibility, the observed or reported behavior needs to be equally as specific or as broad as the target attitude, and the behavior and the attitude must pertain to the same action and target (Ajzen & Fishbein, 2005). For example, an intervention that seeks to decrease meat consumption by targeting attitudes about climate change is unlikely to be successful because it targets a general attitude which is only weakly related to a specific action. In other words, avoiding animal products is not indicative of the attitude as a whole, and there are

many other behaviors that the participant could engage in that would also qualify as climate-friendly (Hawken, 2011; Hedenus & Wirsenius, 2014; Lamb et al., 2016; Wynes & Nicholas, 2017). According to the principle of compatibility, an intervention aimed at reducing meat consumption should instead target attitudes about meat consumption.

The Theory of Planned Behavior

Even if the principle of compatibility is not violated and a specific attitude is changed, it might be insufficient to produce targeted behavior change. The theory of planned behavior (TPB) is a behavior change theory that has been shown to successfully predict pro-environmental behaviors (PEBs) in previous studies (Yuriev et al., 2020). The TPB asserts that attitude change alone is not sufficient to change behavior; instead, intentions to engage in a given behavior predict engagement in the behavior, and attitudes, subjective norms, and perceived behavioral control together predict behavioral intentions (see Figure 1; Ajzen, 1991). Subjective norms, rooted in research on conformity (e.g., Asch, 1955), are the perceived extent to which others approve or disapprove of a behavior, and normative influences have been successfully used to change environmentally sustainable behaviors (Yamin et al., 2019). Perceived behavioral control, which was derived from Bandura's (1977) concept of self-efficacy, is also included to address situations in which people do not have complete control over their behavior (Ajzen, 1991). The TPB can explain why attitudinal interventions so frequently fail to change behavior: interventions solely targeting attitude change might be unsuccessful because subjective norms and perceived behavior control were not considered.

The Value-Belief-Norm Theory

The value-belief-norm (VBN) theory of environmentalism can also explain why attitudes and behaviors are often uncorrelated. The VBN states that identification with biospheric, altruistic, and egoistic values predict when and why social movements are supported (see Figure 2; Stern et al., 1999). It combines findings from environmental psychology with the literature on social movements into one cohesive theory to explain environmental action and has been supported by previous intervention studies (Steg et al., 2005; Stern et al., 1999; Wynveen et al., 2015).

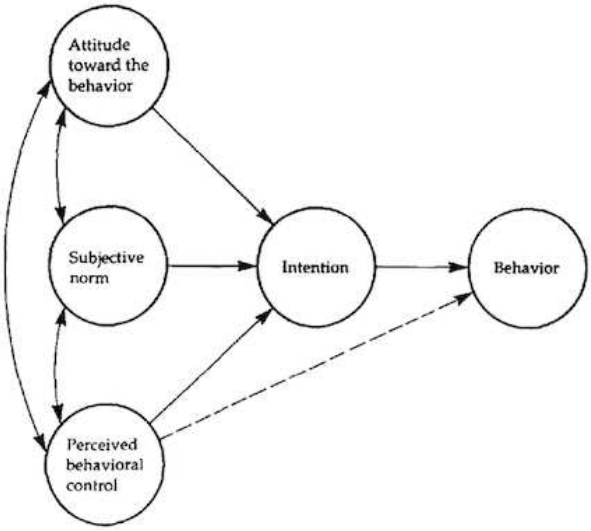

Figure 1. **The Theory of Planned Behavior**
Note. Feedback arrows not shown. Ajzen, 1991.

The VBN theory's development relied heavily on the norm-activation theory, environmental value orientations, and the new ecological paradigm hypothesis (Dunlap et al., 2000; Dunlap & Van Liere, 1978; Dunlap & Van Liere, 1984; Schwartz, 1973; Stern et al., 1993). Specifically, the VBN theory relates personal values to PEB through a series of mediating variables. Among those mediating variables are attitudes about the natural world, which are measured by the new ecological paradigm scale (Dunlap et al., 2000; Dunlap & Van Liere, 1984). These attitudes, then, are proposed to lead to the awareness of the consequences of an environmental issue, assignment of responsibility to oneself, and to the activation of a personal norm or obligation to act (Stern et al., 1999). Having a personal norm regarding an environmental issue, then, leads to PEB, which can manifest in several ways, including activism, policy support, and public and private behaviors. Based on this theory, it is incorrect to assume that attitude change will inevitably lead to behavior change; instead, a series of resulting beliefs and recognitions must occur in favor of the PEB for behavior change to occur.

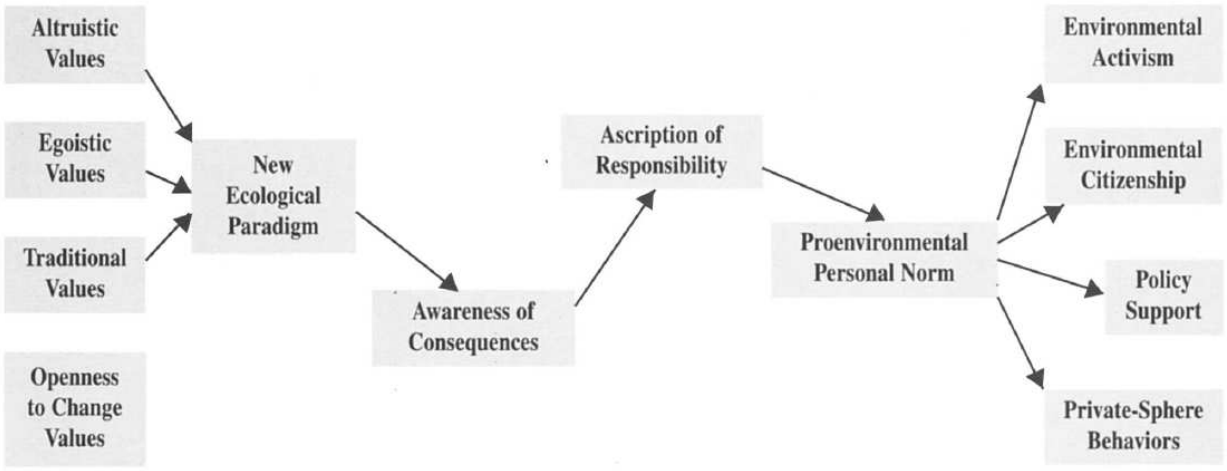

Figure 2. **The Value-Belief-Norm Theory**
Note. Stern et al., 1999

Comparison of the TPB and the VBN Theory

While the VBN theory is much more specific to environmental behavior than the TPB, several comparative studies have found the TPB to be more predictive of environmental behavior than the VBN theory (Kaiser et al., 2005; Aguilar-Luzón et al., 2012; López-Mosquera & Sánchez, 2012). For example, Aguilar-Luzón et al. (2012) compared the ability for the TPB and the VBN theory to predict self-reported recycling behavior. They found that the TPB predicted recycling better and had better overall fit with the data than did the VBN theory. Specifically, attitudes toward recycling, perceived behavioral control, and subjective norms explained 43% of the variance in behavioral intention. Furthermore, behavioral intentions explained 37% of behavior variance, whereas personal norms explained only 7.5% of behavior variance.

The TPB is thus the more parsimonious model, and according to the TPB, attitudes cannot be relied upon to accurately predict and influence behavior; instead, subjective norms and perceived behavioral control need to be taken into account to make predictions more accurately (Ajzen, 1991). Thus, relying on attitude change to encourage behavior change is not sufficient, and interventionists should instead focus on behavior change (Geller, 1992), taking into account perceived norms and self-efficacy. Community-Based Social Marketing (CBSM) is a behavior change approach that leverages

evidence from the psychological literature to create interventions that enable behaviors to be adopted more easily. The approach helps to address perceived behavior control by understanding the barriers to behavior adoption and promotes the use of subjective norms to encourage behavior change. A detailed description of the framework follows in the next section.

Community-Based Social Marketing

Origins of CBSM

The CBSM approach to behavior change has its origins in social marketing. Social marketing was first coined and defined by Kotler and Zaltman (1971) as "the design, implementation, and control of programs calculated to influence the acceptability of social ideas and involving considerations of product planning, pricing, communication, distribution, and marketing research" (p. 5). As Andreasen (1994) pointed out, this definition exemplifies that early social marketers operated under the assumption that changing attitudes leads to behavior change and that typical efforts to change attitudes, such as information dissemination, were sufficient.

Campaigns that use information dissemination often fail, however, because they rely on the false assumption that providing information to a target audience is sufficient to change behavior (Geller, 1992; Andreasen, 1994). Inherent to this strategy is the idea that when given information about the benefits of adopting or abandoning a behavior, an individual will engage with the behavior in a predictable way. Decades of research on behavior change and social marketing have shown that this is often not the case (Geller, 1981; Geller et al., 1983; Midden et al., 1983; Geller, 1989; Dennis et al., 1990; Geller, 1992; Abrahamse et al., 2005; Carrico & Riemer, 2011), perhaps because this strategy targets attitudes and fails to acknowledge the role of perceived behavioral control and subjective norms. For example, an early study examining whether education would increase the installation of water conservation devices found that, at a two-month follow-up, participants enrolled in an education condition had installed statistically the same number of devices as the no education condition (Geller et al., 1983). A study of homeowners in the Netherlands found the same results—providing residents with energy-related information was not effective at reducing residential energy consumption (Midden et al., 1983). A more recent study

compared the ability for feedback and peer education to reduce building energy use (Carrico & Riemer, 2011). Information dissemination using postcards was used as the control condition. The authors found that peer education and feedback significantly reduced building energy use, but energy use actually increased in the information dissemination condition.

In light of this type of evidence, Andreasen (1994) refined the definition of social marketing to the use of commercial marketing techniques to design programs that "influence the voluntary behavior of target audiences to improve their personal welfare and that of the society of which they are a part" (p. 110). This updated definition not only uses a more narrow description of 'social ideas,' but it also focuses on behavior change, highlighting the finding that attitude change does not necessarily equate to behavior change and that information dissemination is largely ineffective at changing behavior (Geller, 1981; Geller et al., 1983; Midden et al., 1983; Geller, 1989; Dennis et al., 1990; Geller, 1992; Carrico & Riemer, 2011).

Having determined that information alone is often ineffective, many social marketers have incorporated empirically-supported persuasion techniques into their behavior change campaigns (Green et al., 2019). CBSM is one such approach. Recognizing the limitations of social marketing campaigns focused solely on information dissemination, Doug McKenzie-Mohr, an environmental psychologist, developed CBSM (McKenzie-Mohr, 2000; McKenzie-Mohr, 2011). The framework stands apart from early social marketing in several ways. First of all, CBSM stresses the importance of targeting behaviors instead of attitudes, which has been shown to be more effective (Abrahamse et al., 2005; Carrico & Riemer, 2011; Dennis et al., 1990; Geller, 1981; Geller et al., 1983; Geller, 1989; Geller, 1992; Midden et al., 1983). Second, it dedicates substantial attention to the behavior selection process. Third, CBSM emphasizes the use of persuasion techniques, such as subjective norms, in addition to commitments, feedback, and prompts, that are empirically-supported and address the perceived barriers and benefits of behavioral targets (McKenzie-Mohr, 2011). Finally, CBSM emphasizes the benefits of small-scale interventions that are geared toward specific audiences and is designed to help individuals overcome structural and psychological barriers. Traditional social marketers, on the other hand, often use large scale

interventions to influence behaviors more broadly (Takahashi, 2009). Larger campaigns use the same solutions for all targeted individuals and are thus unable to address the diverse needs of the group. By focusing on smaller audiences, CBSM interventions are better able to remove barriers that are unique to a given audience and to find solutions that are geared toward the audience's specific needs. Thus, CBSM has been successfully used to promote sustainable and healthy behaviors in many interventions (Allen, 2019; Aronoff et al., 2013; Athey et al., 2012; Cole & Fieselman, 2013; Cooper, 2007; Frantz et al., 2016; Haldeman & Turner, 2009; Kennedy, 2010; McKenzie-Mohr, 2000; Reaves, 2014; Sandoval, 2017; Schuster et al., 2016; Streimikiene & Vveinhardt, 2015; Vigen & Mazur-Stommen, 2012; Withall et al., 2012).

Implementation Process

CBSM outlines five steps intended to inform the creation of successful behavioral interventions (Lynes et al., 2014; McKenzie-Mohr, 2011): 1) selecting behaviors, 2) identifying barriers and benefits, 3) developing strategies, 4) pilot testing, and 5) broad-scale implementation and evaluation (see Table 1). Each step tackles different shortcomings associated with previous interventions. The current study uses CBSM to recommend behavioral targets for future interventions, and thus, only steps 1 and 2 were performed and are the focus of this section.

Table 1. **Overview of the Five CBSM Steps**

Step	Description
1	Selecting behaviors
1a	Selecting a goal state
1b	Deciding which sector(s) to target
1c	Creating an extensive list of non-divisible, end-state behaviors
1d	Narrowing down the list using impact estimates and logical exclusion
1e	Determining the penetration and probability for each behavior
1f	Calculating the goal state potential and retaining only best performing behaviors
2	Identifying barriers and benefits
3	Developing strategies
4	Pilot testing
5	Broad-scale implementation and evaluation

Step 1. The first step of CBSM is comprised of several sub-components that help researchers and practitioners choose viable behavioral targets based on their potential to achieve the researcher's pre-determined goal (see Table 1; McKenzie-Mohr, 2011). During step 1, researchers narrow a wide range of potential behaviors to a small number (typically one to three) promising behavioral targets. The process begins by first deciding on a goal state. A goal state is the desired outcome or the objective that the researcher wants to achieve through intervention. McKenzie-Mohr (2011) emphasizes the importance of focusing initially on goal states instead of specific behaviors because there are often numerous behaviors that have the potential to achieve any given goal state. If a behavior is chosen preemptively, the researcher risks missing an opportunity to achieve the goal state more effectively. For example, a common mistake would be for a researcher to state that 'increasing exercise' is the goal of their intervention. In reality, the intended goal of the intervention is actually improving the health of a population. The researcher has assumed that increasing exercise will achieve the goal, without considering additional behaviors that can improve health (e.g., healthier diets). Instead, the appropriate goal state in this case is a healthier population, and exercise should be one among several behaviors considered.

After selecting a goal state, the researcher must generate a comprehensive list of relevant behaviors. The behaviors should be non-divisible and end-state. Non-divisible behaviors are those that are unambiguous and cannot be reduced. For example, reducing food waste is a divisible behavior because it can be operationalized in several ways. To reduce food waste, one could buy less food at the grocery, save (and eat) leftovers, or compost food waste. Therefore, reducing food waste is a divisible behavior and should not be included in the list. However, composting could be chosen as a target behavior because it can only be operationalized in one way. The behaviors should also be end-state. End-state behaviors are those that correspond directly to the desired outcome. For example, if the desired outcome is to reduce CO_2 emissions, then buying a composter is not an end-state behavior because it alone does not impact the desired outcome; it requires an additional step (i.e., correct utilization) before the desired outcome is reached. Thus, the behavior should be the act of composting itself.

After creating an exhaustive list of potential behavioral targets, the researcher must then determine the impact of each behavior. Impact is an estimate of how much a behavior helps to achieve the goal state. For example, when targeting the goal state of reducing CO_2 emissions, one might measure impact in tonnes of CO_2-equivalent (tCO_2e) per individual per year and calculate how many tCO_2e a behavior is predicted to eliminate each year (Allen, 2019; Reaves, 2014). After estimating the impact for the initial set of potential behaviors, CBSM researchers often narrow down the behaviors under consideration by eliminating behaviors with very small impact estimates (McKenzie-Mohr, 2011; Reaves, 2014).

In the next phase of behavioral selection, the researcher estimates the probability and penetration of each remaining behavior. The probability refers to how likely the audience is to adopt the behavior, and penetration refers to the percentage of individuals within the audience who already engage in the behavior. To assess probability, the researcher can conduct a literature review to determine how successful previous interventions were at changing the behaviors under consideration. The researcher can also survey a selection of the target population for a self-reported estimate of probability. The latter option tends to be inflated while the former option is more accurate. However, assessing probability by conducting a literature review might not accurately reflect the specific audience and context for the planned intervention because previous studies were likely conducted elsewhere (McKenzie-Mohr, 2011). Similarly, there are multiple ways a researcher can estimate the penetration of a behavior in a target population. The researcher can observe individuals engaging in the behavior, which can be challenging because many behaviors are not visible. They can also survey a selection of the target population, which is beneficial because creating a behavioral intervention that is well-suited to a specific target audience is one of the goals of CBSM. Finally, they can use data collected by other researchers/organizations.

To determine the behaviors with the greatest potential for reaching the goal state, probability, penetration, and impact are mathematically combined. The current study calls this product the ‘goal state

potential' (GSP)[1]. McKenzie-Mohr (2011) suggests calculating potential by multiplying impact, probability, and one minus penetration (expressed as a decimal) for each behavior as seen in (1).

$$impact \times probability \times (1 - penetration) = GSP_1 \quad (1)$$

Penetration is subtracted from one in this equation to represent the percentage of the population not already engaged in the behavior (i.e., the potential audience for the behavioral intervention).

The initial list of potential behaviors can then be reduced by choosing the behaviors with the highest GSPs and excluding all others. Thus, according to the CBSM framework, behaviors with high impact, high probability of adoption, and low penetration make the best behavioral targets.

The assessment of probability and penetration is integral to the CBSM process and should not be overlooked. In the case of the current study's goal state of reducing GHG emissions, there are many behaviors that have the potential to reduce emissions, all of which are associated with different impact estimates (Hawken, 2017; Project Drawdown, 2020; Wynes & Nicholas, 2017). For example, according to Wynes and Nicholas (2017), living car free will reduce up to 3.08 tCO_2e per person per year, while avoiding one medium length flight (1697 km) will reduce up to 0.60 tCO_2e per person per year. Thus, because the estimate for living car free is five times greater than that of avoiding a medium length flight, it may seem that car travel should be targeted instead of plane travel. However, this may not be the case for several reasons. First, if probability is low (i.e., the target population is unwilling to accept and engage in behavior change), then buy-in might be too low for the intervention to achieve its goal. Second, the behaviors differ in their penetration, and a campaign to change a behavior that is already largely adopted will result in fewer reduced emissions than a campaign to change a behavior that is largely unadopted. Thus, impact alone should not dictate the target for behavioral intervention and instead these other components should be considered as well.

Step 2. This step involves evaluating the barriers, ways to overcome the barriers, and benefits associated with the behavior, which is crucial to intervention design in the CBSM methodology. Barriers

[1] McKenzie-Mohr (2011) uses the term "impact" for the product of the equation and for one of the variables. I chose the term "goal state potential" to avoid confusion. See the "Modifications to CBSM in the Current Study" section.

need to be assessed because, as stated above, a behavior that is too challenging to adopt will fail to achieve the goal state, even if its GSP is quite high (Aloise-Young, 2012). Moreover, interventions that help audience members to overcome the barriers of behavior adoption are more likely to be successful (McKenzie-Mohr, 2011). Interventions should thus incorporate strategies that help individuals overcome the perceived barriers and help them realize the benefits. Barriers and benefits are usually assessed by conducting focus groups, surveys, or observations with members of the target audience.

Steps 3 through 5. The last three steps of the CBSM framework involve developing strategies and designing an intervention, pilot testing the intervention, and finally broadly implementing the intervention. The strategies often employed in CBSM interventions include using social norms, commitments, and prompts to encourage behavior adoption. After the intervention is designed, a pilot test is used to determine whether the strategies employed are effective at changing behavior, and once pilot testing and intervention refinement are complete, the full intervention can be implemented. The current research focused on the first two steps of the CBSM framework, and thus a more complete discussion of intervention strategies is beyond the scope of this work.

Previous Uses of CBSM

CBSM has been used successfully in a variety of previous interventions, targeting goal states ranging from reducing energy consumption to improving lung cancer diagnoses (Allen, 2019; Aronoff et al., 2013; Athey et al., 2012; Cole & Fieselman, 2013; Cooper, 2007; Frantz et al., 2016; Haldeman & Turner, 2009; Kennedy, 2010; McKenzie-Mohr, 2000; Reaves, 2014; Sandoval, 2017; Schuster et al., 2016; Schultz et al., 2015; Streimikiene & Vveinhardt, 2015; Vigen & Mazur-Stommen, 2012; Withall et al., 2012). However, despite CBSM's popularity, CBSM studies rarely follow the behavior selection process recommended by McKenzie-Mohr (2011). A review of more than 3,000 projects described on the CBSM website (cbsm.com) and a literature review of scientific studies revealed that only a few studies included steps 1 and 2 of the methodology (see Allen, 2019; Frantz et al., 2016; Reaves, 2014; Sandoval, 2017).

Reaves (2014) used CBSM steps 1 and 2 to identify and compare behavioral targets with the potential to reduce energy use among residents of an affordable housing complex. The author began with a list of 200 potential behaviors for reducing residential energy use. Impacts were estimated by conducting a literature review and by obtaining expert input. Behaviors were eliminated if they were associated with very small impacts and if they were not relevant to their target audience. To assess the penetration and probability of the remaining 20 behaviors, residents of an affordable housing complex were asked how often they engaged in a given behavior and how willing they were to adopt a given behavior. Reaves then assessed the barriers and benefits by conducting focus groups regarding the five top-performing behaviors. He found that using open windows for cooling, hanging clothes to dry instead of using a dryer, and replacing light bulbs with compact fluorescent bulbs had the most potential to achieve the goal state in the target population.

Sandoval (2017) used CBSM steps 1, 2, and 3 to make recommendations about the ways that energy use can be reduced among low-income households in a U.S. city. She generated an initial list of 13 behaviors and their associated impact estimates by conducting a literature review of previous, similar interventions. To assess penetration, probability, barriers, and benefits, she conducted a survey and at-home observations with participants. She found that the most promising behaviors for her target audience were cold water washing, drying full loads, hang drying, lowering water heater temperature, and using window coverings.

Frantz et al. (2016) used all five CBSM steps to reduce carbon emissions on a liberal arts college campus in Ohio. They began by identifying the biggest carbon emission sources on their campus using the college's GHG inventory. This resulted in a list of over 30 behaviors. They then used the GHG inventory to assign each behavior a score of zero to four, from the lowest impact behavior to the highest impact behavior, and they used previous research and information from other schools to estimate penetration and probability. To assess barriers and benefits, quantitative, qualitative, and observational methods were used, and a sample of faculty, staff, and students were asked closed- and open-ended questions about what makes it hard to engage in a given behavior and why it might be a good thing to

engage in a given behavior. After implementation of their intervention, the use of cold water in washing machines and instances of lights being turned off in unused classrooms were successfully increased.

Similarly, Allen (2019) used CBSM to determine the optimal behavioral target to reduce GHG emissions and to develop an intervention strategy at the municipal level. Using the CBSM variables of probability, penetration, and impact, the author chose to target a vegetarian diet and piloted an intervention that was ultimately successful at increasing the consumption of vegetarian meals.

However, studies such as those described above are uncommon; most CBSM studies skip the first two steps and instead create interventions for pre-selected behaviors (e.g., Athey et al., 2012; Cole & Fieselman, 2013; Cooper, 2007; Haldeman & Turner, 2009; Streimikiene & Vveinhardt, 2015; Withall et al., 2012). For example, one such intervention successfully increased public transportation use in Washington state (Cooper, 2007). Additionally, recycling behaviors in a neighborhood in Maryland increased after a CBSM intervention improved knowledge about recycling, trained residents on how to recycle, and increase self-efficacy regarding recycling (Haldeman & Turner, 2009). Another CBSM intervention successfully increased recycling and environmentally friendly purchasing while decreasing the use of paper at a university in Oregon (Cole & Fieselman, 2013).

Though the CBSM methodology can be used successfully when a pre-determined behavior is targeted, skipping steps 1 and 2 is problematic for several reasons. As stated previously, without assessing the probability, penetration, and barriers associated with several potential behavioral targets, researchers a) cannot be sure that they are targeting the behavior most likely to have the largest impact on the goal state, b) run the risk of targeting a behavior that is not viable for a behavior change intervention, and c) cannot appropriately address barriers and benefits in the intervention design and thus are less likely to be successful. Consequently, time, energy, and monetary resources might be wasted without proper consideration of the ways in which the target audience views the target behavior. In addition, without systematically comparing alternative behavior options, these efforts might be wasted on a behavior option with that only minimally advances the goal.

Modifications to CBSM in the Current Study

The current study incorporated elements into the CBSM framework not previously described by McKenzie-Mohr.

Barrier Assessment for Behavior Selection. In the current research, barriers were assessed prior to the selection of a single behavioral target and used to inform the behavior selection process. There were two primary reasons for taking this approach, rather than relying solely on the GSP calculation shown in (1). First, a very low penetration might indicate that there are significant barriers associated with the behavior that prevent individuals from adopting it. Thus, relying solely on the GSP calculation, where a low penetration is desirable because it means that there is more room for improvement, could result in selecting a behavior that is very difficult or even impossible to change through intervention and ultimately not aid in achieving the goal state. Second, depending on the resources available for the intervention, some barriers might not be amenable to being addressed in an intervention. For example, infrastructure changes, such as adding bike lanes, could be included in a behavior change program organized by a municipality, but not by a university researcher. If infrastructure limitations are a primary barrier to the behavior, that behavior is not a viable target for the researcher's intervention. Thus, I propose that barriers should be considered in the behavioral selection process of CBSM. In the current study, Step 1 of the CBSM framework was used to narrow down the list of possible behavioral targets and Step 2 was used to select the final behavior.

Terminology. McKenzie-Mohr (2011) uses the term 'impact' in two ways, making it challenging to discuss the methodology in a clear way. First, impact is used to describe how well the behavior helps to achieve the goal state. For instance, in this study, impact describes how much a behavior reduces CO_2 emissions and is measured in $kgCO_2e$/person/year. Second, impact is used by McKenzie-Mohr to describe the product of penetration, probability, and impact. Thus far in this paper, I have used the term 'goal state potential' or GSP to describe the that product. To clarify the behavioral selection process, I will use impact to refer only to the CO_2 savings achieved by the behavior and GSP to refer to the product of

impact, probability, and penetration to allow the reader to more easily identify which portions of the calculation are being referenced.

Calculating Goal State Potential. As described earlier, McKenzie-Mohr proposed calculating (1) to determine the behavioral target with the greatest potential for intervention. Thus, in CBSM, the ideal behavioral target is one with a high impact, low penetration, and high probability. However, the mathematical rationale for the GSP calculation (1) is not well-justified by the CBSM methodology.

$$impact \times probability \times (1 - penetration) = GSP_1 \qquad (1)$$

Moreover, critics have pointed to issues with the way in which the variables are scaled (Reaves, 2014).

Typically, probability is assessed on a discrete scale (e.g., a 6-point scale), penetration is a proportion that ranges from 0 to 1, and impact estimates are raw values with units relevant to the goal state (e.g., 3,170 $kgCO_2e$). Whereas probability and penetration are confined to a finite range of values, the impact estimate can be infinitely large. This means that the impact estimate is more influential in the GSP calculation than either the penetration or probability, and thus a large impact estimate sways the calculation in favor of that behavior, even when the probability and penetration are unfavorable.

McKenzie-Mohr does not discuss this issue, but it seems unlikely that he intended for the variables to be weighted in this manner because it defeats the purpose of assessing probability and penetration. Thus, to remedy this, previous CBSM researchers have rescaled the impact and penetration values. For instance, Frantz et al. (2016) used the same scale from 0–4 to estimate impact, penetration, and probability. This method assumes that each variable is equally important in distinguishing between the behaviors and thus applies equal weights to them. Similarly, Reaves (2014) used the same scale from 1–5 for both penetration and probability, in addition to using a method which placed the impact value on a scale from 0–5. To use the same scale for the impact, probability, and penetration and to compare the original CBSM method with the revised method, I used both the original McKenzie-Mohr GSP estimate (1) and the Frantz et al. (2016) GSP estimate (2), resulting in two GSP estimates per behavior.

$$rescaled\ impact \times probability \times (rescaled\ penetration) = GSP_2 \qquad (2)$$

Predictors of Behavior Adoption. In the current research, surveys were used to measure individual difference characteristics that may predict behavior engagement and impact the messaging used in behavioral interventions. According to McKenzie-Mohr (2013), "barriers to a sustainable behavior may be internal to an individual, such as one's lack of knowledge, non-supportive attitudes, or an absence of motivation" (p. 1). Thus, understanding individual characteristics and cultural norms of the target audience might help inform future interventions. In addition to asking participants about barriers to behavior adoption, the current study assessed participants' scores on several measures that have been shown to be related to PEB in previous research, including commitment to the natural environment, stereotypical masculinity, trust in various authorities as sources of information about climate change, belief about climate change, and political orientation. These measures provide information about participants' psychological barriers that they might not report when asked about barriers to behavior engagement.

Commitment to the Natural Environment. A meta-analysis conducted by Whitburn et al. (2020) examined the relationship between connection to nature and PEB and found that, across studies and measurement scales, connection to nature is strongly correlated with PEB ($r = .42$, $p < .001$). Whitburn et al. (2020) identified 12 connection to nature scales developed between 1999 and 2014, including the commitment to the environment scale (CTE; Davis et al., 2009), the nature relatedness scale (NR; Nisbet et al., 2009), and the connectedness to nature scale (CNS; Mayer & Frantz, 2004). The CTE scale (Davis et al., 2009) was the most strongly related to PEB ($r = .60$, $p < .001$; Whitburn et al., 2020). The focus of the CTE scale is also oriented slightly differently than the other scales. Specifically, the CTE looks at commitment to the natural environment (e.g., "When I make plans for myself, I take into account how my decisions may affect the environment"), in addition to connection to the environment (e.g., "It seems to me that humans and the environment are interdependent"), which could explain why it is more strongly predictive of environmental behavior than the other scales. In fact, the CTE scale was found to be a significant predictor of PEB even when other connection to nature scales, such as the CNS, were included in a regression analysis (Davis et al., 2011). Thus, the CTE was included in the current research.

Stereotypical Masculinity. Gender differences in pro-environmental attitudes and behaviors are also well-documented in environmental psychology and pervasive across cultures and geographic locations, though the effect size is typically weak (Gifford & Nilsson, 2014; Rothgerber, 2013; Zelezny et al., 2000). Recent analyses found that characteristics, such as empathy, social dominance, conscientiousness, agreeableness, and neuroticism, explain the relationship between gender and pro-environmental attitudes and behavior and are generally more strongly associated with PEB than gender (Desrochers et al., 2019; Milfont & Sibley, 2016). The 24-item personal attributes questionnaire (PAQ) is a measure of stereotypical masculinity that addresses some of these characteristics, including aggression, dominance, empathy, and kindness (Helmreich et al., 1981; Spence & Helmreich, 1978). Although gender differences have been declining since the creation of the PAQ and other similar measures (Donnelly & Twenge, 2017; Twenge, 1997), the characteristics assessed by the PAQ might still inform future interventions, regardless of whether the differences fall along gender divisions. Thus, the PAQ was included in the current study.

Additional Variables. The current study also explored participants' beliefs about climate change, whether they trust certain authorities, including elected officials and scientists, as sources of information about climate change, and political identification. These characteristics could represent barriers to behavior adoption and inform future interventions. When developing intervention strategies, CBSM emphasizes the importance of using credible sources for message delivery (McKenzie-Mohr, 2011). In addition, beliefs about climate change, including whether participants believe that climate change is happening and whether it is caused by human activities, could also impact messaging strategies chosen in interventions. Political orientation of the participants was also assessed because political party is predictive of climate change beliefs and PEB (Costa & Kahn, 2013; Ziegler, 2017).

The Current Research

Primary Goal

The primary goals of this research were two-fold: 1) to recommend viable behavioral targets for future interventions at a university in the United States aimed at reducing GHG emissions and 2) to advise

researchers, practitioners, and other interventionists on how to choose between many potential behavioral targets proposed by Project Drawdown and other similar catalogues of GHG emissions. The first two steps of CBSM were used to emphasize the importance of careful behavioral target selection and to preserve the time, energy, and financial resources of future interventions.

This research began with Phase 1, which included the compilation of a comprehensive list of behaviors that, if adopted, would reduce GHG emissions and a literature review to find the impacts of those behaviors. Phase 2 proceeded with a survey distributed to undergraduate students at the university to narrow down the list of behaviors to those with the highest GSPs, calculated using the behaviors' impact estimates, probabilities, and penetrations (i.e., CBSM step 1). Lastly, an additional survey with both open- and closed-ended questions was distributed during Phase 3 to assess the perceived barriers and benefits associated with each of the most promising behaviors (i.e., CBSM step 2). Recommendations for behavioral targets for future interventions and for future uses of the CBSM methodology were then made.

Secondary Goals

The secondary goals of this research were to assess the association of certain individual characteristics (i.e., feelings of connection to nature, stereotypical masculinity, political orientation, trust in authorities for information about climate change, beliefs about climate change, and political orientation) to the probability of engaging in PEB. To assess these characteristics, I included the CTE scale, the PAQ, questions about authorities on climate change, beliefs about climate change, and political orientation. Understanding the relationship between these measures and the CBSM variables within the target audience will help to inform future behavioral interventions by further helping to identify potential intervention barriers and strategies.

CHAPTER II: PHASE 1

Having identified the goal state of reducing GHG emissions, the next step in the CBSM process is to identify the target audience, create a list of possible behavioral targets to help achieve the goal state, and determine the impact of those possible targets. In this chapter, I provide the rationale for the selection of the target audience, and I detail the processes through which behavioral impacts were estimated.

Identifying the Target Audience

College students were identified as the target audience for the current study. In 2018, there were almost 20 million people enrolled in colleges and universities in the United States, which represents approximately 6% of the U.S. population (National Center for Education Statistics, 2019; United States Census Bureau, 2020). Furthermore, an analysis conducted by Sinha et al. (2010) revealed that institutions of higher education in the United States emit almost 2% of the total U.S. GHG emissions. This figure is an underestimate because, although it includes direct emissions and several indirect emissions, such as employee and student commuting and landfilled waste, it fails to include numerous other indirect emissions, such as food choice. Thus, the true proportion of GHGs, both direct and indirect, emitted from institutions of higher education is likely larger. Changing these and other individual-level behaviors can substantially reduce GHG emissions and mitigate climate change (Hawken, 2017; Ivanova et al., 2015; Tukker & Jansen, 2006; Wynes & Nicholas, 2017; Vita et al., 2019). Further, younger adults (i.e., those born after 1981) are more concerned about climate change and take actions to address climate change more frequently than older adults (Funk, 2021). Thus, targeting individual behaviors at universities provides access to a large, GHG-emitting population that might be more responsive to climate-related behavioral interventions and affords the potential to reduce emissions associated with higher education institutions and beyond.

Initial Behavior List

I first generated a list of behaviors relevant to the goal state of reducing GHG emissions using previous literature, primarily Project Drawdown (2020) and Wynes and Nicholas (2017). The list of 101 behaviors, which can be found in Appendix A, included a wide variety of potential targets, many of which were not relevant to a college student population. Behaviors were eliminated if they a) required an individual to own their own home (e.g., installing rooftop solar, buying electric vehicles with associated charging units); b) were more relevant at the policy-level, the industrial-level, or for developing countries (e.g., refrigerant management, improving clean cookstoves); or c) required technological advancements whose implementation college students have little to no control over (e.g., using alternative cement, using bioplastics). Wynes & Nicholas (2017) also included having one fewer child as a high impact behavior, but this behavior was eliminated because of the challenges associated with addressing such a behavior through intervention. Because this project aimed to focus on high impact behaviors, I also eliminated behaviors labeled as "low impact actions" by Wynes and Nicholas (e.g., running a full dishwasher, reducing lawn mowing, and buying ecolabel products; 2017, p. 6). However, four low impact behaviors were retained to inform future research that will compare the efficacy of interventions that target high impact behaviors to those that target low impact behaviors. Two low impact actions, composting and installing CFL and LED bulbs, were retained because they were included in both Wynes and Nicholas (2017) and Project Drawdown (2020). Two additional low impact actions, turning off electronics and turning off lights, were retained because an intervention conducted at the same University in which the current study was conducted included these behaviors. Based on these exclusion criteria, the original list of 101 behaviors was reduced to the 16 behaviors in Table 2.

Impact Estimation

Impact estimates and rescaled values were calculated for the remaining behaviors. 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 sections. Impact estimates are in units of kg CO_2-equivalent ($kgCO_2e$). CO_2e includes measures of relevant GHGs,

such as methane, that have been standardized according to the global warming potential of CO_2 (EPA, 2013).

As described earlier, GSPs were calculated using both the original McKenzie-Mohr formula (1) and the Frantz et al. (2016) method (2), which requires rescaled impact estimates. To calculate the rescaled estimates, I used a scale from one to six, which is the same as the scale used for the probability estimates, as discussed in Chapter III. The impact estimates ranged from 28 to 3,170 $kgCO_2e$/person/year, and thus, I created six thresholds by first dividing the range by six, which equaled 523.67. Thus, each threshold is 523.67 points higher than the last, and I assigned rescaled scores based on those thresholds: 28–552 = 1; 553–1,075 = 2; 1,076–1,599 = 3; 1,600–2,123 = 4; 2,124–2,646 = 5; and 2,647–3,170 = 6. Raw and rescaled impact estimates for each behavior are shown in Table 2.

Table 2. **Impact Estimates for 16 Behaviors Carried into Phase 2**

Behavior	Impact[a]	Rescaled Impact
Living motor vehicle free	3,170	6
Living personal vehicle free	2,450	5
Purchasing green energy credits	1,405	3
Following a vegan diet	900	2
Following a plant-based diet	841	2
Following a vegetarian diet	800	2
Avoiding a medium-length plane flight	600	2
Following a non-ruminant diet	276	1
Washing laundry in cold water	250	1
Hanging laundry to dry	210	1
Recycling	210	1
Installing CFL/LED bulbs	170	1
Composting	170	1
Having 1 meatless day/week	114	1
Turning off electronics	34	1
Turning off lights	28	1

[a]Units of $kgCO_2e$/person/year
Note. Behaviors in bold are those that performed best with Phase 2 data and were taken into Phase 3.

Living Motor Vehicle Free

Wynes and Nicholas (2017) described this behavior as "living car free," which was defined as never using a personal motor vehicle and did not include rebound effects (p. 2). For instance, walking and

biking are considered living car free, whereas taking an Uber or a bus is not. I 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, the Wynes and Nicholas (2017) estimate was not used, and instead, data specific to Fort Collins, CO, the city in which this research was conducted, was used when it was available. Average personal vehicle fuel efficiency, data for which was not available for Fort Collins, is 22.5 mpg in the U.S. (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 .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 U.S. 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, estimates for this behavior were calculated using data specific to Fort Collins, CO when possible. Living personal vehicle free was defined as avoiding the use of personal motor vehicles, such as a car, truck, or SUV, but allowed for the rebound effect of using bus transportation, which is available throughout Fort Collins. Average emissions for a bus ride in the U.S. 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. In the current study, purchasing green energy credits (GECs) through Fort Collins Utilities' green energy program was used as the target behavior. The program uses solar and wind resources form 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, I used local data instead of the impact estimates reported by Wynes and Nicholas (2017) and 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% non-carbon 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, 7,680 kWh/household/year is expected to be used in 2020. To calculate an individual's share of their household's energy use, I 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 (3), and given the resource mix described above, 1,717 kWh comes from coal, 1,218 kWh comes from non-carbon sources, 31 kWh comes from natural gas, and 156 kWh comes from purchases or other carbon sources.

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

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, I took an average of the emissions associated with coal and gas, resulting in an emissions estimate of 0.57

$kgCO_2e/kWh$. I 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 (4), if *A* equals 3,122 kWh/person/year, as seen in (3). This estimate was determined to be plausible given the range of U.S. estimates reported by Wynes and Nicholas (2017; *min* = 1,100 $kgCO_2e$, *max* = 1,600 $kgCO_2e$).

$$(A)(.55)\left(0.76\frac{\mathrm{kgCO_2e}}{\mathrm{kWh}}\right)+(A)(.01)\left(0.37\frac{\mathrm{kgCO_2e}}{\mathrm{kWh}}\right)+(A)(.05)\left(0.57\frac{\mathrm{kgCO_2e}}{\mathrm{kWh}}\right)=1{,}405\ \frac{\mathrm{kgCO_2e}}{\mathrm{person*year}} \quad (4)$$

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 & Nicholas, 2017), and data were not available for the current study's target audience. Thus, I used the impact estimates that Wynes and Nicholas averaged across several—900 $kgCO_2e$ for a vegan diet and 800 $kgCO_2e$ for ra vegetarian diet.

Following a Plant-Based Diet

Plant-based diets are defined differently and often vaguely across scholarly publications (Pohjolainen et al., 2015; Storz, 2012). 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). In the current study, I 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, I assumed that a plant-based diet consisted of following a vegan diet all but two days per month. Using (5), I 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).

$$900\ \frac{\mathrm{kgCO_2e}}{\mathrm{person*year}}-\left(\frac{900\ \frac{\mathrm{kgCO_2e}}{\mathrm{person*year}}}{365\frac{\mathrm{days}}{\mathrm{year}}}\right)\left(24\frac{\mathrm{days}}{\mathrm{year}}\right)=841\ \frac{\mathrm{kgCO_2e}}{\mathrm{person*year}} \quad (5)$$

Following a Non-Ruminant Diet

A non-ruminant diet is one that avoids ruminant animals, which are hooved animals with specialized digestive systems, such as cows and sheep (Parish et al., 2017). I used a systematic review by Aleksandrowicz et al. (2016) to estimate the impact of adopting a non-ruminant diet, which found that, in cross-country data, non-ruminant diets result in a 21% average decrease in CO_2 from current diets. The current average diet in the U.S. emits 1,314 $kgCO_2e$/person/year (Heller & Keoleian, 2014). Thus, adopting a non-ruminant diet can reduce emissions by 276 $kgCO_2e$/person/year.

Having One Meatless Day Per Week

This behavior was defined 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, I 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

This behavior was taken from Wynes and Nicholas (2017), who described the 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 are more familiar with U.S. units of measurement, this behavior was defined in miles. The impact reported was 600 $kgCO_2e$/person if one medium length flight was avoided each year.

Washing Laundry in Cold Water and Hanging Laundry to Dry

The estimates for these two behaviors were also taken directly from 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 & Stamminger, 2010).

Recycling

The estimate of 210 $kgCO_2e$/person/year was taken directly from Wynes and Nicholas (2017) and includes only household recycling.

Installing CFL/LED Bulbs

The estimate of 170 $kgCO_2e$/person/year was taken directly from Wynes and Nicholas (2017), which defined upgrading light bulbs as replacing incandescent bulbs with energy-efficient lights. In the current study, energy efficient lights were defined 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 no impact estimate could be found in the literature. Instead, Wynes and Nicholas (2017) categorized the behavior as being a "low-impact action" (p. 6). Because upgrading light bulbs was also categorized as a "low-impact action," I applied the Wynes and Nicholas (2017) light bulb estimate to the composting behavior, which was 170 $kgCO_2e$/person/year.

Turning Off Lights

This behavior was defined as turning off household lights when leaving one's residence for at least one hour. The impact estimate was calculated using the following process. According to the U.S. 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, 125 kWh/person were used for lighting in 2020 as seen in (6). Assuming that an individual sleeps with their lights off for eight 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 eight hours/day, turning lights off during this time can eliminate 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 can be reduced by turning off lights eight hours/day as seen in (7). 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

preferred because the true period of time that the residence is unoccupied is not known, and so the full, possible amount was used.

$$B = \frac{\left(3{,}122\frac{\text{kWh}}{\text{person}*\text{year}}\right)(.04)}{2} \qquad (6)$$

$$(B)(.55)\left(0.76\frac{\text{kgCO}_2\text{e}}{\text{kWh}}\right) + (B)(.01)\left(0.37\frac{\text{kgCO}_2\text{e}}{\text{kWh}}\right) + (B)(.05)\left(0.565\frac{\text{kgCO}_2\text{e}}{\text{kWh}}\right) = 28\ \frac{\text{kgCO}_2\text{e}}{\text{person}*\text{year}} \qquad (7)$$

Turning Off Electronics

This behavior was defined as turning off household electronics when leaving one's residence for at least one hour. The impact estimate was calculated by first determining how much energy is used by household electronics (see Table 3; 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 1) it is unlikely that all of these devices are owned by every member of the target audience and 2) it is unlikely that every member of the target audience turns on each of these devices every day.

Table 3. **Energy Use by Household Electronics**

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.

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 eight hours/day, this behavior can eliminate 76 kWh/person/year if the devices are turned off for the full eight 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 as seen in (8), if *C* equals 76 kWh/person/year.

This is likely an overestimate because likely not all members of the target audience own each of the household electronics, but this was preferred because true household electronic ownership is not known, and so the full, possible amount was used.

$$(C)(.55)\left(0.76\frac{\mathrm{kgCO_2e}}{\mathrm{kWh}}\right)+(C)(.01)\left(0.37\frac{\mathrm{kgCO_2e}}{\mathrm{kWh}}\right)+(C)(.05)\left(0.565\frac{\mathrm{kgCO_2e}}{\mathrm{kWh}}\right)=34\ \frac{\mathrm{kgCO_2e}}{\mathrm{person*year}} \quad (8)$$

Summary

In Phase 1, the target audience was identified. An exhaustive list of behaviors was then generated using Project Drawdown (2020) and Wynes and Nicholas (2017). Using various criteria, the list was then reduced to 16 initial behaviors, and impact estimates were compiled and calculated. As expected and indicated by Wynes and Nicholas, the transportation behaviors (i.e., living motor and personal vehicle free and avoiding a plane flight), reduced-meat diets (i.e., veganism, plant-based diet, and vegetarianism), and purchasing GECs are estimated to reduce the most GHGs among the 16 behaviors. The impact estimates were highly variable and ranged from 28 to 3,170 $kgCO_2e$/person/year, demonstrating the need to rescale the impact estimates to make them more comparable to that used for the other variables. To make a behavioral target recommendation using CBSM, the probability and penetration for each of the behaviors are also needed; these were assessed in Phase 2.

CHAPTER III: PHASE 2

After narrowing down the initial list of behaviors and determining impact estimates, the next step in the CBSM process is to assess the probability and penetration of each behavior and to calculate the behaviors' GSP estimates. In this chapter, I outline the method used and the results of that process.

Method

Participants

Data collection was conducted at Colorado State University (CSU), a public research and land-grant institution in Fort Collins, CO. Two-hundred participants were recruited from the CSU psychology research pool comprised of undergraduate students who are enrolled in either Introduction to Psychology (PSY 100) or Research Methods I (PSY 250). Phase 2 was approved by CSU's Institutional Review Board (IRB). Participants provided informed consent before taking the survey, and they received 0.5 research credit toward their 6-credit requirement for either Introduction to Psychology or Research Methods I.

A large sample size was desirable because several of the behaviors were believed to have very low penetration in the target audience. For example, only 3% of Americans report being vegan (Reinhart, 2018), and thus, a large sample size increased the probability that vegans and other adopters of low penetration behaviors were represented in the sample.

A power analysis was conducted to determine whether a sample of 200 was large enough to obtain significant results on the exploratory analyses examining the relationships between PEB, the CTE scale, and the PAQ. A meta-analysis found that across 71 studies, the CTE was highly correlated with PEB (r = .60; Whitburn et al., 2020). With an effect size of .60, an alpha of .05, a one-sided test, and a sample size of 200, the statistical power was 1.0. Conducting a power analysis for the PAQ was less straightforward because, at the time the current study was conducted, there were no studies that directly examined the relationship between PEB and the PAQ. Additionally, previous research has reported a wide

range of effect sizes for the relationship between PEB and either gender or characteristics similar to those assessed by the PAQ. For example, gender is weakly but consistently correlated with PEB (r = .10; Zelezny et al., 2000), whereas a recent study found a stronger correlation between certain personality traits similar to those measured by the PAQ (e.g., openness) and PEB (r = .29; Desrochers et al., 2019). The midpoint between these effect sizes (i.e., r = .20) was used in the power analysis for the PAQ in the current study, in addition to an alpha of .05, a one-sided test, and a sample size of 200. This resulted in statistical power of .89, which is viewed as an acceptable level of statistical power (Brysbaert, 2019) and was deemed acceptable in the current study, given that the analyses investigating the PAQ were exploratory.

In Fall Semester 2020, CSU had 27,835 students enrolled, 23,590 of whom were undergraduate students and 4,556 of whom were first-year undergraduate students (CSU, 2021). Because students from across the university, and not just psychology majors, take PSY 100, participants in the research pool tend to mirror the CSU population, with the exception that most are in their first or second year (see Table 4). This was largely true for the participants recruited for Phase 2; however, women and multi-racial students were overrepresented in the sample. Moreover, because of the high percentage of first-year students, the percentage of students living on campus was higher in the sample than in the student body as a whole. Each of the colleges within the university were also represented in the Phase 2 sample, though the College of Natural Sciences, which houses the Department of Psychology, was overrepresented.

Ultimately, 208 students participated in Phase 2. Seven participants were removed because they did not complete the survey and thus did not complete the debriefing required by the IRB for students in the research pool. Participants were also removed if they took less than half the median time to complete the survey in addition to showing signs of inattention, which was determined prior to data analysis. Specifically, three participants who took 5.5 minutes or less and gave all or almost all of the same responses to the CNE, PAQ, and the trust in authority scales were removed from the sample. This resulted in a final sample size of 198 participants for Phase 2. Berinsky et al. (2016) discuss the potential risks to validity caused by participant removal due to inattention. They assert that external validity is threatened if

participant removal results in decreased representativeness of the sample. They also assert that internal validity might be threatened by both the inclusion and the removal of inattentive participants; if participant removal covaries with experimental conditions, then interval validity is harmed, but if inattentive participants are retained, then data noise can distort participants' true scores. Because the CBSM analysis in the current study did not involve experimental conditions with which participant removal could correlate, the participants were removed to reduce noise.

Phase 2 Survey

Participants completed an online Qualtrics survey comprised of a total of 105 questions—48 questions assessed the penetration and probability of the CBSM behaviors carried into Phase 2 (refer to Table 2). Additionally, the CTE consisted of 11 questions, the PAQ consisted of 24 questions, climate change beliefs and trust in authorities consisted of 9 questions, and the demographic characteristics consisted of 13 questions (see Appendices B–F). Most participants answered only a portion of those questions. For example, if a participant indicated that they had not yet declared a major, then they were not asked to list their major in a follow-up question. In addition, some of the questions were worded one way for participants living on-campus and another way for participants living off-campus, and participants only saw one of those two options. Furthermore, off-campus participants were asked about all behaviors, whereas on-campus participants were asked about all behaviors but purchasing GECs because students living on-campus are not able to participate in the GEC program at CSU. The survey was pilot tested before recruitment through the CSU research pool began, and adjustments were made to the survey questions based on the pilot feedback.

Penetration and Probability. Penetration for most of the behaviors (10 out of 16) was measured by posing Likert-type questions that assessed behavioral frequency. For example, on-campus participants were asked "When you leave campus, how often do you use non-motorized travel, such as walking or bicycling, for trips greater than about 5 miles?"[2] to assess penetration for living motor vehicle free. There

[2] Penetration and probability for living motor vehicle free were assessed for distances less than one mile, between one and five miles, and greater than five miles. Because I was unable to calculate different impact estimates for each

Table 4. **Demographic Characteristics of Survey Samples**

	Phase 2	Phase 3	Both Phases	University-wide [a]
n	198	303	501	27,835
Gender				
Female	68%	72%	71%	54%
Male	23%	25%	24%	46%
Other [c]	5%	2%	3%	-
NR [d]	4%	1%	2%	-
Race				
White	59%	69%	65%	69%
Hispanic/Latinx	10%	10%	10%	14%
Asian	5%	2%	3%	3%
Black	2%	2%	2%	2%
Multi-racial	21%	12%	16%	5%
NR	3%	3%	3%	1%
Age				
M (SD)	19.5 (4.2)	20.7 (3.5)	20.2 (3.8)	-
NR	4%	1%	2%	-
Class				
Freshman	61%	24%	39%	19%
Sophomore	21%	25%	24%	-
Junior	12%	33%	25%	-
Senior	7%	16%	12%	-
Other	1%	2%	1%	-
Majors by college [e]				
Declared	85%	93%	90%	-
Natural Sciences	35%	53%	46%	19%
Liberal Arts	8%	12%	10%	19%
Health & Human Sciences	19%	16%	17%	18%
Engineering	4%	3%	3%	10%
Business	2%	3%	2%	9%
University-Wide Instruction	0%	1%	< 1%	8%
Natural Resources	2%	1%	1%	7%
Agricultural Sciences	3%	3%	3%	6%
Veterinary Medicine & Biomedical Sciences	13%	5%	8%	4%
Undeclared	15%	7%	10%	-
Residence				
On-campus	63%	32%	44%	20% [b]
Off-campus	37%	67%	55%	80% [b]
Other	0%	2%	1%	-
Lives in Fort Collins	82%	86%	85%	-
Does not live in Fort Collins	18%	14%	15%	-
Never lived in Fort Collins	12%	5%	8%	-

[a] Most values are sourced from the CSU fact book (2021), which reports fall semester values for all residential instruction (RI) students, including undergraduates (n = 23,590), graduates (n = 3,648), and professionals (n = 597). Items with a dash (-) indicate values not reported.
[b] These values were sourced from U.S. News (2020) and were based on fall 2020 enrollment.
[c] Fill-in responses consisted of trans and non-binary gender identities, or self-reported sexuality mistaken for gender
[d] Both non-responses (NR) and 'prefer not to answer' were included in all NR percentages
[e] Some participants listed two or more majors, in which case all majors were included in the percentages.

of these distances, only the questions pertaining to the greatest distance (i.e., distances greater than five miles) were used to measure living motor vehicle free.

were five response options, ranging from *never* to *always*. Certain behaviors had a sixth response option of *This does not apply to me*. This option was included when it was possible to not have the option to engage in the behavior. For example, this option was included for turning off electronic devices when leaving one's residence but not for turning off lights because it is possible that participants do not own electronics; however, it was assumed that all participants have lights in their residence. For the purpose of calculating the penetration of a behavior within the sample (i.e., the percentage of participants engaging in the behavior), participants were categorized as adopters of a given behavior if they reported engaging in the behavior *almost always* or *always* (4 or 5 on the 5-point scale), otherwise they were categorized as non-adopters.

There were six (out of 16) behaviors for which the above question format did not apply, and for those behaviors, different question formats were used to measure penetration. For example, to assess purchasing GECs, participants were given three response options (*yes, no,* and *I'm not sure*), with participants who answered *yes* classified as adopters. To assess the non-ruminant diet, vegetarianism, a plant-based diet, and veganism, participants were asked to self-identify which diet they adhere to. Finally, to assess the meatless day behavior, participants were asked to report how many days they typically consume no meat and fish. They were categorized as adopters if they consumed no meat and fish on one or more days per week. All other participants were categorized as non-adopters.

To assess probability, participants indicated how likely they were to engage in the behavior in the next year. For example, participants were asked "In the next year, how likely are you to purchase renewable energy from your utility?" to assess the GEC behavior. There were six response options, ranging from *very unlikely* to *very likely*. Again, a seventh option (i.e., *This does not apply to me*) was included with some of the questions. The final probability score for each behavior was calculated by first removing the *This does not apply to me* responses and then by taking a mean of the probability estimates across the non-adopters of the behavior (i.e., adopters were excluded).

The Exploratory Variables. Measures assessing several individual characteristics, including commitment to the natural environmental, instrumentality (i.e., stereotypical masculinity), and climate

change beliefs, were included in the Phase 2 survey; however, these variables were not examined until Phase 3, and thus, the scales will be discussed in Chapter IV.

Results and Selection of Behaviors

Probability

Probabilities ranged from 1.79 to 3.69 on a 6-point scale (see Table 5). Participants reported being most likely to turn off electronics when leaving their residence, install CFL and LED bulbs, turn off lights when leaving their residence, and recycle in the next year, each of which had a mean probability greater than 3. Participants reported being least likely to adhere to a vegan diet, live personal vehicle free, live motor vehicle free, and adhere to a plant-based diet, each of which had a mean probability of less than 2.

Penetration

The behaviors with the fewest adopters, and thus the lowest penetration, were adhering to a vegan diet, adhering to 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. The behaviors with the most adopters and thus the highest penetration were turning off lights when leaving one's residence, turning off electronics when leaving one's residence, and having at least one meatless day/week, each of which had a penetration of 70% or greater. Please note that Table 5 shows '1 – Penetration' (the element included in the GSP_1 calculation) for each behavior, rather than the percentage of adopters. Rescaled penetration estimates were also created and used in the GSP_2 calculation to weight each variable equally on a 6-point scale. Rescaled penetration scores were calculated using the method described earlier (see Chapter II) for the rescaled impact estimates. Specifically, the '1 – Penetration' estimate range was divided by six, which was equal to .1433. Then, rescaled scores were assigned based on the following parameters: .12–.26 = 1, .27–.41 = 2, .42–.55 = 3, .56–.69 = 4, .70–.84 = 5, .85–.98 = 6.

Table 5. **Phase 2 Data: Behaviors' Impact, Probability, and Penetration**

Behavior	Impact [a]	Rescaled impact	Probability *M* (*SD*)	Penetration				
				1 – Penetration	Adopters (*n*)	Non-adopters (*n*)	Does not apply and/or no response (*n*)	Rescaled penetration
Living motor vehicle free	**3,170**	**6**	**1.81 (1.3)**	**.92**	**15**	**183**	**-**	**6**
Living personal vehicle free	2,450	5	1.79 (1.2)	.79	41	157	-	5
Purchasing GECs	**1,405**	**3**	**2.45 (1.4)**	**.93**	**5**	**69**	**124**	**6**
Following a vegan diet	900	2	1.45 (.97)	.98	4	193	1	6
Following a plant-based diet	**841**	**2**	**1.95 (1.4)**	**.94**	**12**	**185**	**1**	**6**
Following a vegetarian diet	800	2	2.01 (1.4)	.85	30	167	1	6
Avoiding a plane flight	**600**	**2**	**2.90 (1.7)**	**.78**	**42**	**153**	**3**	**5**
Following a non-ruminant diet	276	1	2.21 (1.5)	.72	55	142	1	5
Washing laundry in cold water	250	1	2.70 (1.4)	.46	105	91	2	3
Hanging laundry to dry	210	1	2.03 (1.2)	.91	17	179	2	6
Recycling	210	1	3.42 (1.3)	.34	130	67	1	2
Installing CFL/LED bulbs	**170**	**1**	**3.63 (1.8)**	**.34**	**115**	**60**	**23**	**2**
Composting	170	1	2.21 (1.4)	.84	32	166	-	5
Having 1 meatless day/week	114	1	2.12 (1.4)	.27	139	51	8	2
Turning off electronics	34	1	3.69 (1.5)	.19	156	37	5	1
Turning off lights	28	1	3.46 (1.4)	.12	174	24	-	1

[a] Units of $kgCO_2e$/person/year

Note. The behaviors in bold are those that were carried into Phase 3.

Calculating the Goal State Potential

To calculate the GSP for each of the behaviors, I used two GSP calculation methods as described in Chapter II—the traditional method (1) and the method using rescaled impact and penetration estimates (2). Table 6 lists each behavior in order of their GSPs according to the two calculation methods.

$$impact \times probability \times (1 - penetration) = GSP_1 \qquad (1)$$

$$rescaled\ impact \times probability \times (rescaled\ penetration) = GSP_2 \qquad (2)$$

The methods produced largely the same GSP ranks. Both methods yielded living motor vehicle free, living personal vehicle free, and purchasing GECs as the behaviors with the highest GSPs. Avoiding a plane flight, a plant-based diet, a vegetarian diet, and a vegan diet also had relatively large GSPs in both methods. Finally, turning off lights when leaving one's residence, turning off electronics when leaving one's residence, having one meatless day/week, and using cold water for laundry consistently had the smallest GSPs.

Table 6. **Phase 2 Data: Behaviors' GSP Ranks According to the Two Methods**

Behavior	GSP_1 (rank)	GSP_2 (rank)
Living motor vehicle free	**5,296 (1)**	**65.2 (1)**
Living personal vehicle free	3,477 (2)	44.8 (2)
Purchasing GECs	**3,209 (3)**	**44.1 (3)**
Following a plant-based diet	**1,537 (4)**	**23.4 (6)**
Avoiding a plane flight	**1,357 (5)**	**29.0 (4)**
Following a vegetarian diet	1,367 (6)	24.1 (5)
Following a vegan diet	1,279 (7)	17.4 (7)
Following a non-ruminant diet	439 (8)	11.1 (10)
Hanging laundry to dry	388 (9)	12.2 (8)
Composting	316 (10)	11.1 (9)
Washing laundry in cold water	311 (11)	8.1 (11)
Recycling	244 (12)	6.8 (13)
Installing CFL/LED bulbs	**210 (13)**	**7.3 (12)**
Having 1 meatless day/week	65 (14)	4.2 (14)
Turning off electronics	24 (15)	3.7 (15)
Turning off lights	12 (16)	3.5 (16)

Note. The behaviors in bold are those that were carried into Phase 3.

Five behaviors, based on their GSP values, were chosen to be examined further in Phase 3 (in which barriers and benefits of each behavior were assessed). The few differences between the methods were inconsequential to the selection of behaviors for Phase 3. Living motor vehicle free and living

personal vehicle free had the largest GSPs, and because the former subsumes the latter, only the former was included in the next phase of the study. Purchasing GECs was also chosen, given its large GSP values. Avoiding one medium-length plane flight also had relatively large GSP values and was thus carried to Phase 3. In order to have a diverse set of behaviors, only one of the dietary behaviors was carried to Phase 3. Because a plant-based diet had a greater GSP_1 than the rest of the dietary behaviors, a plant-based diet was chosen instead of the others. Finally, a behavior with a low GSP was carried forward to Phase 3 for comparison purposes. Installing CFL and LED bulbs had a relatively small GSP; it had a very large mean probability, a greater penetration, and a lower impact than each of the other chosen behaviors, and thus, installing CFL and LED bulbs was carried to Phase 3 and served as a comparison point for the other four, higher-impact behaviors.

Conclusion

Behaviors were chosen for Phase 3 by considering their GSPs and their degree of similarity to the other behaviors; thus, living motor vehicle free, purchasing GECs, adhering to a plant-based diet, avoiding a plane flight, and installing CFL and LED bulbs were examined further in Phase 3.

CHAPTER IV: PHASE 3

The primary purpose of Phase 3 was to assess the perceived barriers and benefits of the five behaviors chosen based on Phase 2 results (i.e., living motor vehicle free, purchasing GECs, following a plant-based diet, avoiding a 1,000-mile plane flight, and installing CFL and LED bulbs). A secondary goal of this chapter was to explore the relationship between the individual characteristic variables and PEB to aid in barrier identification. The following chapter describes the data collection process, the coding process, and the subsequent results.

Method

Participants

Participants for Phase 3 were recruited from the CSU research pool and from upper-level psychology courses. Three hundred participants were recruited for this phase; 150 participants were recruited through each method. Students in the CSU research pool were given credit in either PSY 100 or PSY 250 for their participation, and students from the upper-level courses were offered extra credit by their professors for their participation. Phase 3 was approved by CSU's IRB. Participants provided informed consent before taking the survey, and they received either 0.5 research credit if they were recruited through the research pool or were offered variable amounts of extra credit determined by their professors if they were recruited from upper-level courses.

More participants were recruited for this phase to ensure that adopters and non-adopters of each behavior were well-represented. Saturation, which is the point at which little to no new information is generated by interviews and is often used as the point at which data collection can cease (Guest et al., 2020; Vasileiou et al., 2018), was also assessed to determine whether an appropriate number of interviews had been conducted per behavior. A systematic analysis of qualitative research found that saturation is typically reached before the 20th interview, especially for studies with relatively homogenous samples and targeted scopes (Vasileiou et al., 2018); thus, I aimed to have at least 20 adopters and 20 non-adopters of

each behavior. Using the penetration estimates from Phase 2, I determined that GECs would be the most difficult behavior for which to identify 20 adopters. This is because, in addition to its low penetration, only students living off-campus are able to purchase GECs. This was one reason why participants were recruited from upper-level psychology courses in addition to the CSU research pool; students in the CSU research pool are more likely to be in their first year and thus live on-campus, while those enrolled in upper-level courses tend to be later in their college careers and thus are more likely to live off-campus, increasing the likelihood of recruiting GEC adopters.

Participants in Phase 3 were demographically similar to those in Phase 2 and to the student body as a whole (see Table 4 in Chapter III). As expected, there were fewer first-year students and more students living off-campus in Phase 3. Additionally, in Phase 3, as in Phase 2, women and multi-racial students and students from the college of natural sciences were overrepresented.

Ultimately, 328 students participated in Phase 3. Twenty-one participants were removed because they did not complete the survey and thus did not complete the debriefing required for students in the research pool. An additional participant was removed for providing nonsensical strings of letters in response to the open-ended questions. As in Phase 2, participants were removed if it took them less than half the median time to complete the survey in addition to showing signs of inattention. This resulted in the removal of two participants who took 10 minutes or less and either gave all or almost all of the same responses to the CNE, PAQ, and the trust in authority scales or failed to answer any of the questions in those scales. An additional participant who took 10 minutes or less to complete the survey was removed because their responses to the open-ended questions were short and incomprehensible. This resulted in a final sample size of 303 participants for Phase 3.

Phase 3 Survey

Participants completed an online Qualtrics survey comprised of open- and closed-ended questions to assess the CBSM variables and the additional variables, including the CNE scale and the PAQ (see Appendices C–G).

CBSM Variables. The CBSM variables were assessed for living motor vehicle free, purchasing GECs, following a plant-based diet, avoiding a plane flight, and installing CFL/LED bulbs. Off-campus participants were asked about all five behaviors; however, on-campus participants were not asked any questions pertaining to purchasing GECs because students living on-campus are not able to participate in the GEC program at CSU. In this survey, participants were provided with more detailed behavioral definitions before completing the probability, penetration, benefit, and barrier questions for each behavior to obtain more thorough descriptions of participants' perceived barriers and benefits. See Table 7 for the definitions provided for each behavior. For example, in Phase 2, GECs were described as "purchasing renewable energy" from a utility, and in Phase 3, they were described specifically as credits for which the participant pays. Also, as noted in Phase 2, I was unable to obtain impact estimates for different driving distances, and consequently, in Phase 3, distance estimates were not included in the measures of living motor vehicle free. To verify the plant-based diet definition, plant-based diet adopters were asked to report how often they consume meat and dairy. Specifically, participants were asked to answer two questions (how often they eat meat and how often they eat dairy), to which they could respond: *5–6 days/week*, *3–4 days/week*, *2–3 days/week*, *1 day/week*, *2–3 days/month*, *1 day/month*, *less than 1 day/month*, or *never*. These data were used to compare behavioral frequency with self-identification.

Phase 3 included both closed-ended probability and penetration questions and open-ended barrier and benefit questions for each of the behaviors. The penetration questions were used to classify the participant as an adopter or non-adopter. In doing so, customized wording of the benefit and barrier questions could be presented to participants based on their status as an adopter or non-adopter (see Figure 3 for an example), and barrier and benefit responses could be examined for differences as a function of their status as an adopter or non-adopter. Participants completed penetration and probability questions for all five (for off-campus participants) or four (for on-campus participants) behaviors; however, to minimize participant fatigue and to ensure that participation in the study took 30 minutes or less, participants were asked open-ended questions about the barriers and benefits of no more than two

Table 7. **Phase 2 Behavioral Definitions**

Behavior	Definition
Living motor vehicle free	Using non-motorized modes of transportation for all travel. Non-motorized modes of transportation are those without motors, such as walking or bicycling
Purchasing GECs	Purchasing renewable energy, such as wind and solar power, from the utility company. For instance, Fort Collins Utilities sells green energy credits for 1.9 cents per kilowatt-hour (kWh) through its Green Energy Credit Program. On average, this would increase an electricity bill by about $13 for an entire household per month.
Following a plant-based diet	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
Avoiding a plane flight	Taking an alternative form of transportation for trips of around 1,000 miles
Installing CFL/LED bulbs	Installing compact fluorescent (CFL) or light-emitting diode (LED) bulbs when replacing light bulbs. 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.

behaviors. The questions asked participants about their perceived barriers, ways to overcome the barriers, and the benefits of engaging in the behaviors. An example set can be found in Figure 3.

I sought to obtain at least 20 adopter and 20 non-adopter responses for all behaviors, and thus, quotas were set in Qualtrics such that once a certain number[3] of adopters and non-adopters had completed the open-ended barrier and benefit question sets for each of the behaviors, the questions were no longer shown to participants. When assigning participants to their two specific behaviors, behaviors with lower levels of penetration (based on Phase 2 data) were prioritized. For instance, if a participant indicated that they were an adopter of a plant-based diet, they were assigned that set of questions first because following a plant-based diet had the lowest penetration among the five behaviors examined in this phase. If a participant indicated that they were an adopter of GECs, they were presented with that set of questions second. Next, non-motorized transportation adopters were assigned that set of questions. The rest of the question sets were randomized. This process proceeded based on participants' adopter status until the

[3] For adhering to a plant-based diet, living motor vehicle free, and installing CFL and LED bulbs, the quota was 25 adopters and 25 non-adopters to account for the potential of obtaining bad data. For purchasing GECs, I obtained very few adopters, so the non-adopter quota was increased to 40. Finally, data monitoring revealed that a few participants were confused about the direction of the avoiding a plane flight behavior (i.e., they responded to the open-ended questions as adopters but indicated that they were non-adopters in the closed-ended questions), and so the quota for avoiding a plane flight was increased to 30.

quotas had been filled and participants had completed two or fewer question sets. Table 8 shows the number of participants who provided barriers and benefits for each behavior.

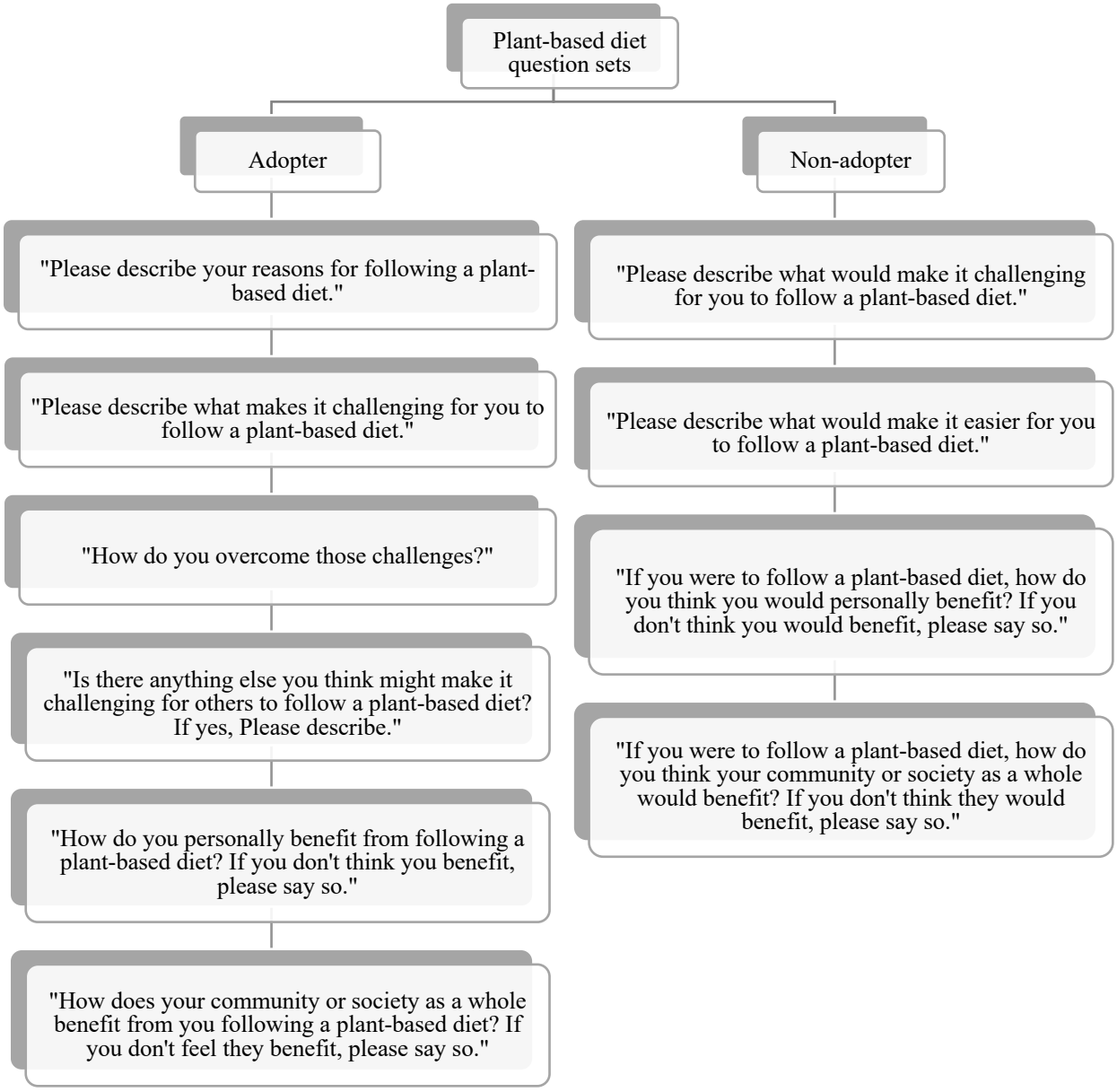

Figure 3. **Example Open-Ended Question Set for Following a Plant-Based Diet**

Table 8. **Number of Participants Who Provided Barriers and Benefits for Each Behavior**

Behavior	Adopters (*n*)	Non-adopters (*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. The values in this table describe the number of participants who provided barriers and benefits after poor quality data was removed as described earlier in Chapter IV.

Closed-ended barrier and benefit questions were also included as a follow-up measure to 1) help ensure that participants had reported on all relevant factors and to 2) allow for a more standardized comparison across the behaviors. Participants rated the extent to which 11 characteristics applied to each behavior on a 4-point scale from *not at all*, *slightly*, *moderately*, and *very*. Eight of the characteristics included: being difficult, time-consuming, stressful, expensive, dangerous, socially acceptable, common, and environmentally friendly. Three additional characteristics, healthy, masculine, and feminine were also rated on the 4-point scale, but with the addition of a 'not applicable' option because it was possible for the participants to think that these characteristics were not relevant to the behaviors. These 11 characteristics were chosen based on previous literature and because they applied across all behaviors considered (Grimes et al., 2020; Markowski & Roxburgh, 2019; Pohjolainen et al., 2015; Rothgerber, 2013). In an additional closed-ended question, participants ranked the behaviors according to how likely they were to engage in them over the next year.

The Commitment to the Environment Scale. The CTE scale is an 11-item, one factor scale that assesses the degree to which respondents feel part of the natural world and tied to its fate (Davis et al., 2009). Davis et al. (2011) report a Cronbach's alpha of .87 for the scale. A meta-analysis found that, across 71 studies, the CTE scale was strongly correlated with PEB ($r = .60$, $p < .001$; Whitburn et al., 2020). On a five-point Likert scale, participants indicate the extent to which they agree or disagree with statements such as, "My personal welfare is independent of the welfare of the natural world" and "I think of the natural world as a community to which I belong." Higher scores on the CTE scale are associated

with stronger feelings of commitment and connection to the natural world, and thus, one question had to be reverse-scored (i.e., “It is unlikely that I’ll feel a connection to the environment in the future”).

The Personal Attributes Questionnaire. The PAQ is one of the most commonly used masculinity and femininity measures (Smiler, 2004; Whorley & Addis, 2006). It assesses the degree to which respondents identify with stereotypically masculine and feminine characteristics (Helmreich et al., 1981; Spence & Helmreich, 1978). The PAQ includes three factors: masculinity, femininity, and masculinity-femininity. The first two factors include characteristics that are desirable for all individuals but are viewed as more stereotypically masculine (e.g., competitive) or feminine (e.g., very helpful to others). The third factor includes characteristics that are only desirable for either masculine or feminine individuals (e.g., very aggressive vs not at all aggressive; Spence & Helmreich, 1978). Gender differences have been declining since the creation of the PAQ and other similar measures (Donnelly & Twenge, 2017; Twenge, 1997). Thus, it might be more accurate to think about the original masculinity factor as instrumentality and the original femininity factor as expressiveness, with which individuals of any gender can identify (Spence, 1993; Ta, 2017; Ward et al., 2006). Thus, I will henceforth refer to the masculine factor as the instrumental factor, the feminine factor as the expressive factor, and the masculine-feminine factor as the instrumental-expressive factor.

The PAQ consists of 24 pairs of contradictory characteristics with a 5-point scale ranging from *A* to *E*. Participants must choose where on the 5-point scale they lie in relation to the two characteristics. For example, one pair of characteristics on the instrumental-expressive factor is “very submissive” and “very dominant” (see Table 9). If a participant selects E, indicating that they are very dominant, their score for that question would be 4. Means are calculated for each of the three factors, where higher scores represent greater endorsement of that characteristic.

Table 9. **Example Question from the I-E Factor in the PAQ**

Very submissive	A	B	C	D	E	Very dominant

Note. I-E denotes the instrumental-expressive factor.

Additional Variables. Participants were also asked about their feelings of trust in authorities regarding information about climate change, their beliefs about climate change, and demographic variables such as political orientation, age, gender, race and ethnicity, and type of residence. Trust in authorities was measured using the question "how much, if at all, do you trust each of the following groups to give full and accurate information about the causes of global climate change?" (on a 4-point scale from *not at all* to *a lot*): elected officials, appointed officials, climate scientists, energy industry leaders, and news media. This question was based on similar, previously used questions (Hamilton et al., 2015; Hmielowski et al., 2014; Pew Research Center, 2016) and was expanded upon to include additional sources of information beyond climate scientists.

Beliefs about climate change were assessed by asking whether participants A) think that global climate change is happening and B) whether they think it is caused by human activities, to which they were able to respond *yes*, *no*, or *I don't know*. If participants answered either question with yes or no, they were asked a follow-up question regarding how sure they were about that position, to which they were able to respond *not at all sure*, *somewhat sure*, *very sure*, or *extremely sure* (Hmielowski et al., 2014). However, if a participant responded to either question (A or B) with *I don't know*, they were assigned an *NA* to the follow-up question to indicate that the question had not been posed to them. Additionally, if a participant responded *no* to the first question (A), they were not asked about whether climate change is caused by human activities—it was assumed that, if participants do not think climate change is happening, they do not think it is caused by human activities. Climate change beliefs were analyzed as a binary variable in the exploratory analyses. Those who responded with *no* or *I don't know* to the question of whether climate change is caused by human activities comprised the first group and those who responded with *yes* comprised the second group (see Table 26).

To assess political orientation, participants responded to "how do you identify politically?" by selecting either *republican, democrat, conservative-leaning independent, liberal-leaning independent, other* with a fill-in box*, no preference,* or *prefer not to answer*. Political orientation was dichotomized because there were few participants who identified in the politically conservative categories (e.g., 16

conservative-leaning independents). To create the binary, I categorized the political orientations as either liberal (i.e., democrats, liberal-leaning independents, or those on the left/far left) or non-liberal (i.e., all others; Costa & Kahn, 2013). This resulted in two groups (62% liberal, 38% non-liberal; see Table 26).

Qualitative Data Analysis

Process. A total of 246 behavioral interviews were analyzed in the current study.[4] The qualitative coding process followed the structural coding method. This is 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 codebooks can be found in Appendix H, and an excerpt from the 'barrier' codebook can be found in Table 10. The broad structural labels used for coding the data were barriers, ways to overcome the barriers, and benefits. Both internal factors (e.g., lack of knowledge) and external factors (e.g., lack of infrastructure) were identified (Lynes et al., 2014). In addition, data units were at the question level, meaning that coders were able to include any number of words relevant to a given code, 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. Microsoft word and excel were used to code the data.

Table 10. **Excerpt from the Barrier Codebook**

Structural code	Code	Description	Example	Counter-example
Barrier	Expensive	• Upfront and/or long-term costs are too high • Isn't affordable for someone like me • Less expensive option(s) available	"Meat alternatives cost more." "I can't afford that in my budget." "Driving this long costs lots of money."	NOT "Many Americans would find themselves without jobs." [coded as Burden for others]

The coding process proceeded in two waves. First, a draft codebook was created by the author and an undergraduate research assistant (URA). We independently read through five[5] sets of adopter

[4] Eighty-nine participants provided two behavioral interviews and 68 provided one behavioral interview.
[5] With the exception of purchasing GECs, which only had three adopters during Phase 3.

questions and five sets of non-adopter questions for each behavior and marked distinct pieces of information provided by the participants. We then compared our lists, identified themes, and created codes based on those themes. These codes were organized by the structural labels, and three draft codebooks were created based on those labels: a 'benefit' codebook, a 'barrier' codebook, and a 'ways to overcome the barriers' codebook. The final codebooks contained a list of the possible codes to be used, a description of the codes, and a set of example quotes. Counter-example quotes (i.e., quotes to which the given code would not apply) were added to the more conceptually challenging codes to help define the codes' boundaries. For the 'barriers' and 'ways to overcome the barriers' codebooks, counter-example quotes also included the name of the code that would apply.[6]

During the next wave of coding, the author and several coders refined the codebooks, and the coders applied the final codes to the data. The codebook remained flexible throughout the process; if coders encountered an issue with the codebook or a characterization not yet addressed by the codebook, changes were incorporated. Two additional URAs, who had not yet seen the data, coded the data for benefits, and two researchers (one faculty member and one graduate student) coded the data for the barriers and ways to overcome the barriers.[7] The coders were initially trained to use the codebooks by coding five question sets from each behavior, including a mixture of both adopter and non-adopter data, and by coding data collected during piloting.[8] After training, the coders independently applied codes to all the data. Codes that were agreed upon were finalized, and disagreements were handled collaboratively—the author and the two coders discussed the disagreements and decided on the final codes together.

Coder Reliability. Intercoder reliability (ICR) was calculated during training and when final codes were applied. Although some researchers have epistemological objectives to the use of ICR, many find it to be beneficial both to external audiences and to the research team; external audiences can

[6] This practice was not adopted by the author until the 'barrier' codebook was finalized, which occurred after the benefits had already been coded.
[7] Initially, two URAs were recruited to code the barriers and ways to overcome. This coding, however, proved to be more challenging than the benefits coding. Thus, two additional researchers were recruited to apply the final barrier and ways to overcome codes, and the initial work performed by the URAs was used to refine the codebook.
[8] The data collected during piloting was not reviewed by the IRB and was thus not included in the final codes.

understand the quality of the coding process more thoroughly and the research team can use ICR to guide coding discussions and to increase self-discipline (O'Connor & Joffe, 2020). Thus, the current study calculated ICR for each code, and every disagreement was discussed and mended by the research team. This helped to ensure consistency across code applications and a thorough understanding of the data. The kappa (κ) statistic was chosen to measure ICR instead of using percent agreement because the latter fails to take into account agreement by chance and is "almost universally rejected by methodologists" (O'Connor & Joffe, 2020, p. 8). Similar to correlation, kappa ranges from -1 to +1, with the midpoint indicating the level of agreement that would be expected by chance (McHugh, 2012). RStudio was used to calculate kappa, and a kappa of .70 was deemed acceptable due to the non-clinical, exploratory nature of the current research (O'Connor & Joffe, 2020). Because the unit of analysis was the question posed to participants, codes were considered agreements when both coders scored the same question as embodying the code, even if the coders differed in the portion of the response (i.e., the exact word or phrase) that was applicable to the code. If, however, coders recorded the same code for different questions in a participant's data, this was considered a disagreement.

Data Saturation. After data was collected and analyzed, saturation was assessed using a method proposed by Guest et al. (2020). The method is beneficial because it does not assume a random sample and can be applied retrospectively after analysis is complete. It relies upon base size (i.e., the number of interviews upon which to establish a baseline amount of information attained), run length (i.e., the number of interviews that will subsequently be assessed for new information), and the new information threshold (i.e., the proportion of new information at which saturation is reached). Guest et al. (2020) concede that it can never truly be known when new information generation has ceased; however, in support of their method, and others' methods, they demonstrate that new information is generated most frequently in earlier interviews.

The current study used the following parameters suggested by Guest et al. (2020)—a base size of six interviews, a run length of two interviews, and a new information threshold of 0%—to mark the point at which saturation was achieved. These parameters were set for all behaviors, except for the adopters of

purchasing GECs because of how few adopters of that behavior were recruited. For purchasing GECs, a more lenient set of parameters was used—a base size of one, a run length of one, and a new information threshold of 5%, which was also deemed acceptable by Guest et al. (2020). In their method, the number of new codes generated in the first six interviews are summed and become the denominator for each subsequent saturation calculation. Then, the number of new codes is summed across each run length and used as the numerator of the saturation calculations. In effect, when a new information threshold of 0% is chosen with a run length of two interviews, saturation is reached once two interviews in a row have no new codes after the base set of six interviews. This process was applied across data categories per behavior and adopter status (i.e., for the adopters and non-adopter of each of the five behaviors across benefit, barrier, and ways to overcome codes) and was thus conducted 10 times. For the analyses, the interviews were ordered by the date and time in which the participant completed the survey.

Results and Discussion

Probability, Penetration, and Goal State Potential

The probability and penetration estimates for the Phase 3 data can be found in Table 11. Penetration was again rescaled in this phase following the same process used for Phase 2. The penetration range was divided by 6, which equaled .112. This resulted in rescaled scores as follows: .32–.43 = 1, .44–.54 = 2, .55–.66 = 3, .67–.77 = 4, .78–.88 = 5, .89–.99 = 6.

As described earlier, the samples for Phase 2 and Phase 3 differed in that half of the Phase 3 sample was recruited from upper division Psychology courses. As intended, this resulted in a higher percentage of the sample living off campus. The Phase 3 CBSM variables were compared to the Phase 2 data using *t* tests and χ^2 as shown in Table 11. The probabilities for living motor vehicle free and purchasing GECs were significantly higher in the Phase 3 sample ($p < .001$ and $p < .05$, respectively). In addition, the penetrations for living motor vehicle free and following a plant-based diet were significantly higher in the Phase 3 sample ($p < .001$ and $p < .01$, respectively), and the difference in the penetration for purchasing GECs was marginally significant ($p < .10$). Despite the differences in the samples and the

resulting differences in mean penetration and probability, the GSP_1 and GSP_2 ranks for the behaviors were consistent between Phases 2 and 3 (see Table 12).

Table 11. **Comparison of Behaviors' Probability and Penetration Between Phase 2 and Phase 3**

Behavior	Impact [a]	Phase 2		Phase 3	
		Probability	Penetration	Probability	Penetration
Living motor vehicle free	3,170	1.81	8%	2.43***	20%***
Purchasing GECs	1,405	2.45	7%	2.87*	1%$^{+}$
Following a plant-based diet	841	1.95	6%	2.14	14%**
Avoiding a plane flight	600	2.90	22%	2.82	16%
Installing CFL/LED bulbs	170	3.63	66%	3.94	68%

[a] Units of $kgCO_2e$/person/year

Note. *T* tests were used to compare the probability, and χ^2 tests were used to compare the penetration.
***$p < .001$; **$p < .01$; *$p < .05$; $^{+}p < .10$

Table 12. **Behaviors' GSP Values Across Both Phases According to the Two Impact Calculation Methods**

Behavior	Phase 2		Phase 3	
	GSP_1 (rank)	GSP_2 (rank)	GSP_1 (rank)	GSP_2 (rank)
Living motor vehicle free	5,296 (1)	65.2 (1)	6,188 (1)	72.9 (1)
Purchasing GECs	3,209 (2)	44.1 (2)	3,970 (2)	51.7 (2)
Following a plant-based diet	1,537 (3)	23.4 (4)	1,544 (3)	21.4 (4)
Avoiding a plane flight	1,365 (4)	29.0 (3)	1,419 (4)	28.2 (3)
Installing CFL/LED bulbs	212 (5)	7.3 (5)	218 (5)	3.9 (5)

Reassessment of the Impact for Following a Plant-Based Diet. As described in Chapter II, the impact for a plant-based diet was estimated by assuming the behavior involved eating meat and dairy two days per month. To generate an empirically-supported description of a plant-based diet and validate this assumption, plant-based diet adopters ($n = 33$) were asked to report how often they eat meat and dairy. On average, participants reported eating dairy one day/week and meat less than one day/month. This suggests that the impact of following a plant-based diet was underestimated in the current study. Future research should use this more restrictive definition of a plant-based diet.

Ranking Questions. In addition to the individual probability questions for each behavior, participants ranked the behaviors in order of likelihood to engage. The ranking results were similar to the results from the probability questions—installing CFL/LED bulbs received the most first-place scores and

had the highest mean probability score, and following a plant-based diet received the most last-place scores and had one of the lowest mean probability scores (see Figures 4 and 5). Interestingly, however, the rankings present a less promising picture for purchasing GECs than do the probability ratings. More than half of the participants ranked purchasing GECs fourth or fifth, and it was ranked in first place by less than 1% of participants, whereas purchasing GECs received the second highest mean probability score (2.87 out of 6).

Data Saturation

All behaviors but one achieved saturation using the method described by Guest et al. (2020; see Table 13). Because only three GEC adopters were recruited, saturation was not achieved in those interviews. However, because of time and logistical constraints, further data was not collected. Specifically, given the low penetration of purchasing GECs in Phase 3 (i.e., 1%) and the interviews needed to achieve saturation for the other behaviors (M = 13), between 1,300–2,000 off-campus participants would need to be recruited to obtain saturation. My confidence in this decision is bolstered by the fact that the GEC adopter data did not generate any codes beyond those that had already been generated by the non-adopter data. That is, there was no new information in the GEC adopter data.

Benefits

Seventeen codes were ultimately created for the 'benefit' structural category. The codes' kappa values can be found in Table 14, and the codes' frequencies can be found in Tables 15 and 16. The most common benefits across all behaviors pertained to environmental benefits, mental benefits, and physical benefits, which together accounted for nearly 50% of all codes. The least common codes across all behaviors pertained to setting an example for others, preventing disease, reducing traffic, benefiting the economy, packing more, and having more control over one's plans, which together accounted for less than 10% of all codes. The focus of the results will be on the codes most frequently mentioned.

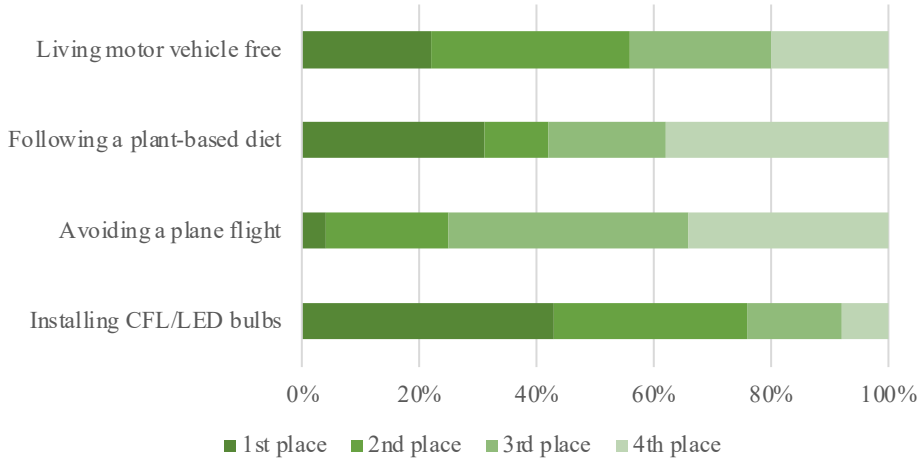

Figure 4. **On-campus Participants' Behavioral Rankings**

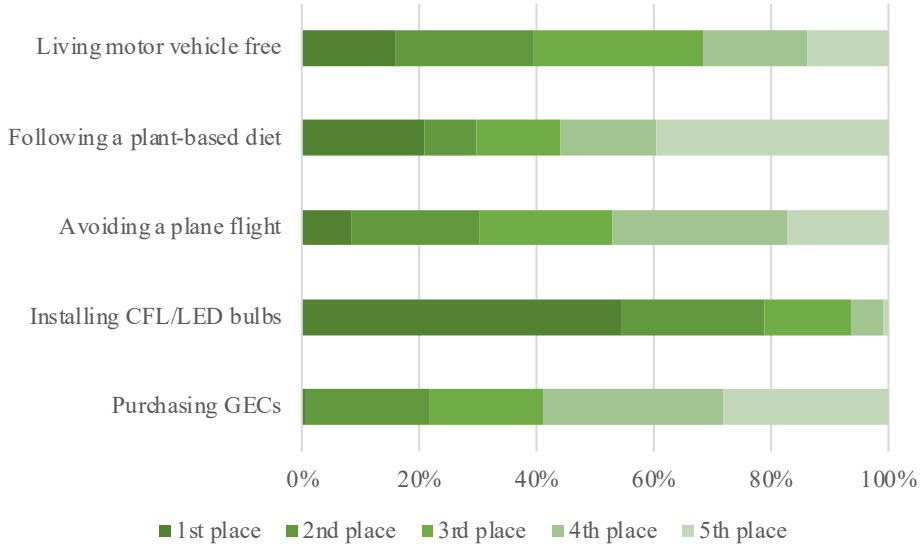

Figure 5. **Off-campus Participants' Behavioral Rankings**

Table 13. **Interviews in Which Saturation was Achieved for Each Behavior**

Behavior		Number of new codes by interview number														
		Interview number														
		Base (1–6)	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	-	-	-	**-**	-	-	-	-	-	-	-	-

Note. "A" signifies adopters, and "N-A" signifies non-adopters. The bold marks the point at which saturation was achieved.

Table 14. **Kappa Values for the Codes in the 'Benefits' Category**

Code [a]	κ					
	Overall	Living motor vehicle free	Purchasing GECs	Following a plant-based diet	Avoiding a plane flight	Installing CFL/LED bulbs
Environmental benefit	.94	.97	.85	.96	.97	.97
Mental benefit	.86	.88	.95	.83	.78	.93
Physical benefit	.95	1.0	-	.89	0	1.0
Monetary savings	.95	1.0	.85	.85	.93	1.0
Climate change	.97	1.0	.93	.88	1.0	1.0
Reduced energy use	.90	.83	.88	-	1.0	.89
Vague global benefit	.58	.33	.33	.33	.33	.79
Easy	.91	-	1.0	1.0	.94	.90
Vague personal benefit	.80	.76	.38	.90	0	-
Convenience	.74	.80	-	0	-.02	.92
Sets example	.80	1.0	-	1.0	-	.56
Prevents disease	.90	-	-	-	.89	-
Better for animals	.84	-	-	.83	-	-
Reduced traffic	.87	.87	-	-	-	-
Economic benefit	.77	-	1.0	-	.85	0
Can pack more	.73	0	-	-	.79	-
More control	.89	-	-	-	.89	-
Other	-	-	-	-	-	-

Note. The overall column was calculated across all behaviors. Dash symbols indicate codes not used.
[a] Codes are sorted by overall frequency of use, details for which can be found in Table 15.

Table 15. **Benefit Code Frequencies Across All Participants**

	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%	-	-
Other	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	613	-	146	24%	75	12%	133	22%	144	23%	115	19%

Note. The *n* column describes how many times the code was used. The overall column was calculated across all behaviors. The total row was calculated across all codes. Dash symbols indicate codes not used. The green highlights indicate the largest value in each row.

Environmental Benefit. The environmental benefit code was distinct from both the climate change and the reduced energy use code in that for the environmental benefit code, participants did not specifically mention the climate, greenhouse gases, energy reduction, or similar concepts. Instead, participants often mentioned the environment specifically. For example, one participant said that purchasing GECs "would be environmentally beneficial." Participants, however, sometimes mentioned the planet, nature, or pollution instead of the environment. For example, 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. Non-adopters tended to mention environmental benefits proportionally more than adopters across all the behaviors, except for purchasing GECs.

Table 16. **Benefit Code Frequencies Across Adopters and Non-Adopters**

	Overall		Living motor vehicle free		Purchasing GECs		Following a plant-based diet		Avoiding a plane flight		Installing CFL/LED bulbs	
Code	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%	-	-
Other	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL (*n*)	356	257	77	69	6	69	103	30	98	46	72	43

Note. The 'A' columns describe codes mentioned by adopters, and the 'N-A' columns describe codes mentioned by non-adopters. For example, 21% of the living motor vehicle free adopter codes (i.e., 16 out of 77 codes) mentioned environmental benefits. The overall column was calculated across all behaviors. The values for the total row were calculated across all codes. Dash symbols indicate codes not used. The green highlights indicate the pairs with the greatest difference between adopter and non-adopters in each row (however, purchasing GECs was not included in this given the low number of behavior adopters).

Mental Benefit. The mental benefit code was used when participants discussed some benefit to mental health or self-image upon engagement in a behavior. This often included either the reduction of stress or anxiety (e.g., "less anxious") or the increase in happiness or comfort (e.g., "more fun"). Other participants referred to mental benefits such as staying "grounded" and "benefiting from time to slow down" by being outside and walking instead of driving and "feeling better morally by eating a plant-based diet." The mental benefit code was particularly relevant to avoiding a plane flight, for which the code was overrepresented, because many participants described a fear of flying and the associated reduction in anxiety when flights are avoided. For instance, one participant said that avoiding a plane flight would make them "less anxious since I'm not a fan of flying." Another echoed a similar sentiment and said that a "fear of flying is definitely a concern for some. I personally do not like to be in such tight spaces." Across most behaviors, adopters and non-adopters tended to refer to mental benefits equally; however, for

living motor vehicle free and following a plant-based diet, adopters mentioned mental benefits proportionally more than non-adopters did.

Physical Benefit. The physical benefit code applied when participants explicitly mentioned a physical (i.e., bodily) improvement or harm reduction in relation to behavior engagement. The vast majority of physical benefits were discussed for living motor vehicle free and following a plant-based diet; very few physical benefits were mentioned for avoiding a plane flight and installing CFL/LED bulbs, and none were mentioned for purchasing GECs. Many participants described the benefit of exercise when discussing living motor vehicle free. For instance, one participant said "I'm getting exercise, so that's good for my body since it's a way to stay healthy." In terms of following a plant-based diet, participants often noted the positive health impacts of reducing meat consumption, commenting on "greater energy levels," improved immunity to illness, "better digestion," and being able to "lose weight" with the diet. For both behaviors, non-adopters mentioned physical benefits proportionally more than adopters.

Climate Change. Climate change, though it was mentioned by participants relatively infrequently, was of particular importance to the current research. It seems that, given the proportion of adopter codes and non-adopter codes that mentioned climate change (8% and 9%, respectively), that awareness of behavioral impacts of climate change does not impact behavior adoption. This provides evidence that information alone is often not sufficient for prompting behavior change and that persuasion techniques might be needed to supplement messaging about climate change. Additionally, using the frequencies of climate change codes as a proxy for estimation of climate change impact, participants incorrectly valued the behaviors. For example, living motor vehicle free has a large impact; however, participants mentioned climate change proportionally more for purchasing GECs and for avoiding a plane flight. Participants generally did seem to understand that installing CFL and LED bulbs had the lowest impact—that behavior had the fewest climate change codes proportionally.

Additional Patterns. Participants also mentioned monetary savings associated with engagement in the behaviors. This code is distinct from the economic benefit code in that it pertains to financial savings for the individual alone, whereas the latter code refers to financial benefit or job creation potential

for the larger community. The monetary savings code was used relatively frequently, whereas economic benefit was discussed infrequently, representing only 1% of all codes used. Monetary savings was mentioned most often and was overrepresented for avoiding a plane flight, especially among adopters of the behavior. For instance, one adopter said "if you can take a road trip rather than a plane flight, you can save quite a bit of money."

Participants also discussed reduced energy use when engaging in the behaviors, and they noted that some of the behaviors are easy to engage in, which together accounted for 12% of all codes. Both codes were overrepresented for installing CFL/LED bulbs—participants recognized that CFL and LED bulbs are energy efficient, with one participant noting that "they reduce the overall power consumption required to light the house." Participants also recognized the ease with which CFL and LED bulbs can be installed, with one participant saying that "I have no difficulty installing these bulbs." The easy code was also applied when participants replied simply with "nothing" or "not sure" when asked what makes it challenging to engage in the behavior.

Closed-Ended Benefit Questions. The following benefits were also assessed using closed-ended questions: socially acceptable, common, environmentally friendly, and healthy. Participants rated the extent to which each characteristic applied to each behavior on a 4-point scale (*not at all, slightly, moderately, and very*). ANOVA tests were used to determine whether the differences between the behaviors were statistically significant, results for which can be found in Table 17. The post-hoc analyses using the Scheffé test can be found in Appendix I. These results converged with some of the patterns observed in the CBSM data. For example, participants accurately reported that purchasing GECs is the least common behavior and that installing CFL/LED bulbs is the most common. Similarly, living motor vehicle free and following a plant-based diet were also seen as healthier than the other behaviors in the closed-ended questions, which follows the same pattern as the qualitative data—in the open-ended questions, participants mentioned health benefits more in relation to these two behaviors. Living motor vehicle free, however, was rated as significantly more environmentally friendly than the other behaviors, which differs from the qualitative data—instead, in the open-ended questions, participants mentioned

environmental benefits proportionally more with purchasing GECs. Finally, across all behaviors, participants agreed less with the common characteristic than they did with the others. This suggests that using social norms, which is a messaging strategy commonly used to promote behavior in college students, might not be effective for these climate-friendly behaviors.

Table 17. **Descriptive Statistics for the Closed-Ended Benefit Assessment**

	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 [a, ***]	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)

[a] For purchasing GECs, 60% of participants said *not applicable*. For avoiding a plane flight, 45% of participants said *not applicable*. For installing CFL/LED bulbs, 58% of participants said *not applicable*. For the remaining behaviors, less than 10% said *not applicable*. These responses were not included in the mean.
***$p < .001$; **$p < .01$; *$p < .05$; $^{+}p < .10$

Barriers

Thirteen codes were ultimately created for the 'barrier' structural category. The codes' kappa values can be found in Table 18, and the codes' frequencies can be found in Tables 19 and 20. The most common barriers across all behaviors pertained to inconvenience, lack of benefits, expense, lack of control, and behavior engagement being unappealing, which together accounted for over 75% of all codes. The least common codes across all behaviors pertained to cultural norms, a lack of interest, and being a burden for others, which together accounted for less than 10% of all codes.

Inconvenient. Participants described barriers such as behavior adoption being difficult, time-consuming, tedious, or exhausting. They also often described options other than the target behavior that are easier or more convenient. In each of these cases, the inconvenient code was applied. The two behaviors pertaining to travel—living motor vehicle free and avoiding a plane flight—received a disproportionate number of inconvenient codes for both adopters and non-adopters. Many participants discussed the greater time commitment required for both behaviors, saying that "taking a non-motorized

Table 18. **Kappa Values for the Codes in the Barriers' Category**

	κ					
Code [a]	Overall	Living motor vehicle free	Purchasing GECs	Following a plant-based diet	Avoiding a plane flight	Installing CFL/LED bulbs
Inconvenient	.80	.73	1.0	.80	.84	.65
No personal benefit	.88	.92	.88	.81	.92	.88
Expensive	.89	-	.86	.93	.79	.94
No community benefit	.87	.96	.86	.85	.96	.88
Lack of control	.70	.53	.92	-.02	.83	.85
Unappealing	.88	.89	-	.91	.77	1.0
Health concern	.63	.61	-	.55	.80	1.0
Low impact	.67	.33	.65	.69	.85	.74
Lack of knowledge	.71	0	.78	.92	-	.19
Cultural norms	.82	1.0	-	.95	0	0
Lack of interest	.63	-	-.01	.66	0	.83
Burden for others	.60	-	-	.75	0	-
Other	-	-	-	-	-	-

Note. The overall column was calculated across all behaviors. Dash symbols indicate codes not used.
[a] Codes are sorted by overall frequency of use, details for which can be found in Table 19.

Table 19. **Barrier Code Frequencies Across All Participants**

	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*	%
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%	-	-
Other	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	583	-	100	17%	108	19%	159	27%	133	23%	83	14%

Note. The *n* column describes how many times the code was used. The overall column was calculated across all behaviors. The total row was calculated across all codes. Dash symbols indicate codes not used. The green highlights indicate the largest value in each row.

Table 20. **Barrier Code Frequencies Across Adopters and Non-Adopters**

	Overall		Living motor vehicle free		Purchasing GECs		Following a plant-based diet		Avoiding a plane flight		Installing CFL/LED bulbs	
Code	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	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL (*n*)	240	343	45	55	4	104	82	77	75	58	34	49

Note. The 'A' columns describe codes mentioned by adopters, and the 'N-A' columns describe codes mentioned by non-adopters. For example, 27% of the living motor vehicle free adopter codes (i.e., 12 out of 45 codes) mentioned inconvenience. The overall column was calculated across all behaviors. The values for the total row were calculated across all codes. Dash symbols indicate codes not used. The green highlights indicate the pairs with the greatest difference between adopter and non-adopters in each row (however, purchasing GECs was not included in this given the low number of behavior adopters).

mode of transport would take too long" and that "flying is the quickest way to get somewhere out of state." Participants also acknowledged that living motor vehicle free is more physically demanding, saying that "it's also 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, which echoes the 'easy' benefit code that was applied to installing CFL/LED bulbs.

No Benefits. When asked how they personally benefit or how society benefits (or would benefit, for non-adopters) from behavior engagement, many participants said that there were no benefits or that they were unsure of the benefits. Absence of a benefit was coded as a barrier to engaging in the behavior. If they said that there were no benefits to them personally, the 'no personal benefit' code was used, and if they said that there were no benefits to society, the 'no community benefit' code was used. Across all behaviors, non-adopters considered there to be no personal benefit of behavior engagement proportionally more than adopters. This could indicate that perceived personal benefits are an important antecedent to

behavioral engagement, or it could mean that adopters reap unanticipated personal benefits from climate-friendly behaviors. Additionally, participants claimed that there were no personal benefits for purchasing GECs and for installing CFL/LED proportionally more than the other behaviors, 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, in contrast, was discussed relatively equally across adopters and non-adopters. The code, however, was mentioned proportionally more for avoiding a plane flight and installing CFL/LED bulbs, and participants often expressed uncertainty about whether community or societal benefits exist (e.g., "I'm not entirely sure how this helps [the community]"). Moreover, for avoiding a plane flight, participants sometimes replied to the benefit question with adverse consequences of the behavior instead of providing benefits. One participant said that they "don't feel there is much benefit to me avoiding flights" and pointed out that "there are still carbon emissions due to traveling by car that may be less than or equal to those created by me flying." Another participant noted that "folks need to make money, plain and simple, and for a lot of folks in urbanized areas, efficient travel is a must."

Expensive. Expense was mentioned by both adopters and non-adopters of every behavior, with the exception of living motor vehicle free. The barrier 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; cost information was only provided for purchasing GECs and for installing CFL/LED bulbs, so participants were primed with financial information for those behaviors.

Lack of Control. Participants often felt that their ability to engage in the behaviors was restricted, and in those cases, we applied the lack of control code. The lack of control code is distinct from the inconvenient code in that an inability to engage in the behavior (e.g., using words such as "can't" or "have to") is inherent to lack of control whereas inconvenience referred to behaviors that were perceived as difficult but still possible to engage in. Lack of control was interpreted from the perspective of the participant; that is, the code was applied regardless of whether the coders believed that the limitations were real. Lack of control was especially relevant for the living motor vehicle free behavior—many

participants noted the impossibility of walking or biking long distances, especially when they run errands. One participant summarized both of these points and said that "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 also noted the need to use a vehicle for work: "my job (a grocery delivery service) requires a reliable vehicle."

Lack of control was also discussed frequently among non-adopters of purchasing GECs, with participants often noting that their landlords have control over their utilities. One participant lamented that "I do not set up my utilities, my landlord does, so I do not have a say in the way in which I receive electricity" and that "I would most likely purchase GECs from my utility company if I took care of my own electricity." Another participant echoed this sentiment and said that "I live in an apartment building and pay my utilities through them. I don't know if there is a way for me to purchase GECs with my current utilities setup. Although, if I could it does sound appealing to me."

Unappealing. Participants often expressed a dislike or discomfort associated with behavior engagement, which was coded as unappealing. The unappealing code was used most frequently with living motor vehicle free and with following a plant-based diet across both adopters and non-adopters, and the sentiment manifested in different ways across the behaviors. If participants discussed challenges associated with the weather, which was frequently the case for living motor vehicle free, the unappealing code was applied. One participant noted the challenges of biking in Colorado "when it's cold and the weather shifts." The unappealing code was applied to following a plant-based diet, often because the participant expressed distaste with plant-based foods or a preference for animal-based foods. One participant said that "I prefer the taste of meat and plant-based imitations usually aren't a good substitution."

Additional Patterns. Other notable patterns emerged from the qualitative data. Health concerns were expressed proportionally more for following a plant-based diet and living motor vehicle free. Dietary health concerns were expressed proportionally more among non-adopters than among adopters. These participants frequently mentioned lack of protein in a plant-based diet, with one participant saying that "I need meat-based proteins to be healthy" and another saying that "I need a lot protein to support my

lifestyle." Some participants mentioned health concerns more broadly, and one participant felt that their "body functions better on meat." Health was also a concern for living motor vehicle free, and many participants felt that driving was safer than non-motorized transportation. One participant noted that "there are no walking paths, roads with a shoulder, or safe places to walk." Another participant elaborated and said that "it (seems) easier to get your bike stolen, to be stranded, get hit by a car (with potentially more fatal consequences), or have more unwanted interactions along the way when walking or biking than in a car."

The lack of knowledge code, although not used often across most behaviors, accounted for 17% of all codes applied to purchasing GECs. This is because many participants expressed confusion over how to engage in the behavior (e.g., "I don't know how to do it"), and some had never heard of GECs. One participant summarized by saying that "the most difficult aspect of purchasing GECs was that I hadn't heard of it and would have to look up how to purchase them from my utility provider."

Closed-Ended Barrier Questions. The following barriers were also assessed using closed-ended questions: difficult, time-consuming, stressful, expensive, and dangerous. Participants rated each behavior on a 4-point scale for each characteristic (*not at all, slightly, moderately, and very*). These are presented in Table 21, along with the ANOVA results. The results from the Scheffé post-hoc test can be found in Appendix I. As was the case for the closed-ended benefit questions, these results largely converged with the traditional CBSM data. Living motor vehicle free was seen as the least expensive behavior in the closed-ended questions, which agrees with the open-ended questions in which expensive was not mentioned by any participant in regards 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 again echoes the sentiments expressed in the open-ended questions in relation to the inconvenient code. Finally, participants rated living motor vehicle free as more dangerous than most of the other behaviors, which is also consistent with the open-ended responses in relation to the health concern code.

Table 21. **Descriptive Statistics for the Closed-Ended Barrier Assessment**

	Living motor vehicle free	Purchasing GECs	Following a plant-based diet	Avoiding a plane flight	Installing CFL/LED bulbs
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)

***$p < .001$; **$p < .01$; *$p < .05$; $^{+}p < .10$

Way to Overcome the Barriers

Twelve codes were ultimately created for the 'ways to overcome' structural category. The codes' kappa values can be found in Table 22, and the codes' frequencies can be found in Tables 23 and 24. When coders applied an overcoming code, they also tagged the barrier itself, if it could be identified in the participant's data. The most common ways to overcome codes across all behaviors were increased affordability, increased accessibility, planning, adjusting one's mindset, increased knowledge, and alternative improvement, which together accounted for nearly 75% of all codes. The least common codes across all behaviors were relocation and social influence, which together accounted for less than 10% of all codes.

Table 22. **Kappa Values for the Codes in the Ways to Overcome Category**

	κ					
Code [a]	Overall	Living motor vehicle free	Purchasing GECs	Following a plant-based diet	Avoiding a plane flight	Installing CFL/LED bulbs
Increased affordability	.86	-	1.0	.75	.44	1.0
Increased accessibility	.70	.65	.71	.72	0	.76
Planning	.84	1.0	-	.87	.76	0
Adjust mindset	.57	.66	.66	.43	.38	.79
Increased knowledge	.74	0	.72	.76	1.0	.74
Alternative improvement	.79	.93	-	.41	.90	1.0
Social assistance	.85	.80	-	.66	.95	-
Sometimes don't engage	.63	.49	-	.80	-	-
Act of nature	.50	.60	-	.40	0	-
Relocate	.70	.70	.66	-	-	-
Social influence	.61	-	1.0	.40	1.0	.66
Other	0	-	0	0	-	0

Note. The overall column was calculated across all behaviors. Dash symbols indicate codes not used.
[a] Codes are sorted by overall frequency of use, details for which can be found in Table 23.

Table 23. **Ways to Overcome Code Frequencies Across All Participants**

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*	%
Increased affordability	31	13%	-	-	14	28%	4	6%	4	8%	9	27%
Increased accessibility	31	13%	4	9%	13	26%	7	11%	1	2%	6	18%
Planning	30	12%	4	9%	-	-	12	19%	13	25%	1	3%
Adjust mindset	29	12%	1	2%	4	8%	7	11%	9	17%	8	24%
Increased knowledge	29	12%	1	2%	14	28%	8	13%	1	2%	5	15%
Alternative improvement	27	11%	8	18%	-	-	7	11%	11	21%	1	3%
Social assistance	15	6%	2	5%	-	-	3	5%	10	19%	-	-
Sometimes don't engage	15	6%	9	20%	-	-	6	10%	-	-	-	-
Act of nature	12	5%	7	16%	-	-	3	5%	2	4%	-	-
Relocate	9	4%	8	18%	1	2%	-	-	-	-	-	-
Social influence	8	3%	-	-	1	2%	4	6%	1	2%	2	6%
Other	5	2%	-	-	3	6%	1	2%	-	-	1	3%
TOTAL	241	-	44	18%	50	21%	62	26%	52	22%	33	14%

Note. The *n* column describes how many times the code was used. The overall column was calculated across all behaviors. The total row was calculated across all codes. Dash symbols indicate codes not used. The green highlights indicate the largest value in each row.

Table 24. **Ways to Overcome Code Frequencies Across Adopters and Non-Adopters**

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
Increased affordability	3%	20%	-	-	33%	28%	5%	9%	-	18%	-	39%
Increased accessibility	2%	21%	-	16%	-	28%	3%	26%	3%	-	-	26%
Planning	26%	3%	16%	4%	-	-	31%	-	37%	9%	-	4%
Adjust mindset	23%	4%	5%	-	67%	4%	13%	9%	27%	5%	70%	4%
Increased knowledge	8%	15%	5%	-	-	30%	13%	13%	3%	-	10%	17%
Alternative improvement	10%	12%	21%	16%	-	-	10%	13%	7%	41%	-	4%
Social assistance	7%	6%	5%	4%	-	-	-	13%	20%	18%	-	-
Sometimes don't engage	15%	-	47%	-	-	-	15%	-	-	-	-	-
Act of nature	-	9%	-	28%	-	-	-	13%	-	9%	-	-
Relocate	-	6%	-	32%	-	2%	-	-	-	-	-	-
Social influence	7%	1%	-	-	-	2%	10%	-	3%	-	20%	-
Other	-	4%	-	4%	-	-	-	6%	-	-	-	4%
TOTAL (*n*)	101	140	19	25	3	47	39	23	30	22	10	23

Note. The 'A' columns describe codes mentioned by adopters, and the 'N-A' columns describe codes mentioned by non-adopters. For example, 28% of the purchasing GEC non-adopter codes (i.e., 13 codes) mentioned increased affordability. The overall column was calculated across all behaviors. The values for the total row were calculated across all codes. Dash symbols indicate codes not used. The green highlights indicate the pairs with the greatest difference between adopter and non-adopters in each row (however, purchasing GECs was not included in this given the low number of behavior adopters).

Increased Affordability. Participants described the need for either decreased costs or increased income in response to behaviors they perceived to be expensive. Thus, living motor vehicle free, which received no expensive barrier codes, also received no increased affordability codes. In contrast,

purchasing GECs received a disproportionate amount of affordability codes from both adopters and non-adopters, and installing CFL/LED bulbs received a disproportionate amount from non-adopters. For example, when considering GECs, participants expressed thoughts such as "if they were able to decrease the price, I would be on board" and "having higher income helps."

Increased Accessibility and Alternative Improvement. These codes were similar but had key differences. Participants often described the need to have better labeling or advertisement to make behavior engagement easier, and they also expressed the need to have better infrastructure in place for behavior engagement. In each of these cases, we applied the increased accessibility code. This code was particularly relevant to purchasing GECs and to installing CFL/LED bulbs. One participant provided a specific recommendation regarding accessibility and said "if my utility company sent me a brochure in the mail, I would be able to read about it and be more inclined to purchase green energy." The increased accessibility code was also applied to purchasing GECs if participants expressed the need to be able to sign up through their apartments or landlords (e.g., "if the rental company gave me the choice to choose how I get my energy"). Similar sentiments regarding accessibility were expressed for installing CFL/LED bulbs, with participants saying that "gaining easier access to" the bulbs or making them "more widely available" would be helpful.

On the other hand, participants also suggested ways to make engaging in the behavior easier through improvements to the behavior itself, such as having a better alternative; in this case, we used the alternative improvement code. This code was used disproportionately for living motor vehicle free and for following a plant-based diet. For instance, participants described the need for a better alternative mode of transportation in order to live motor vehicle free (e.g., needing a bike). They also expressed a willingness to eat a plant-based diet if, for instance, "non-dairy milk options had more protein" or if meat alternatives "tasted better."

Planning. When participants described the need to take steps to engage in a behavior or act differently in order to engage in a behavior, we used the planning code. The planning code was most relevant to avoiding a plane flight and to following a plant-based diet. Some participants explicitly

mentioned planning, but many participants explained the steps necessary to engage in the behavior, including "leaving plenty of time to reach my destination" and "bringing activities and listening to music" to aid in avoiding a plane flight. Planning meals ahead of time was often important for following a plant-based diet, and several participants described needing to eat smaller, more frequent meals, including "having a lot of small meals throughout the day, such as carrots, hummus, apples, and peanut butter," and "mostly eating snacks instead of meals at the dining hall." Another strategy that participants said helps with following a plant-based diet is finding restaurants and grocery stores that sell plant-based options, and one participant said they "suggest places with good plant-based options" when they eat out with their friends. Conversely, some participants described the need to eat at home instead of in restaurants or the dining halls. The vast majority of the planning codes were mentioned by adopters instead of non-adopters; because adopters have engaged in the behavior already, they have a better awareness of the steps necessary to engage successfully. This knowledge could be helpful to incorporate in future interventions.

Adjust Mindset. This code described the need for participants to change their thinking in order to engage in a behavior and was far more common among adopters than non-adopters. Adjust mindset comprised nearly 25% of the installing CFL and LED codes. For instance, participants frequently described the need to simply remember to buy and install CFL and LED bulbs. They also often said that, although the CFL and LED bulbs are more expensive than incandescent bulbs, they focus on the benefits instead, such as reduced energy use and long-term monetary savings. One participant said that you need to "just buy them anyway," and another said that they "weigh the long-term financial benefits."

Increased Knowledge. This code dealt with participants needing to either obtain more information to engage in a behavior or build additional skills. This code was highly relevant to purchasing GECs because participants often made comments about needing more information about both how to sign up for GECs and about the benefits of doing so. For purchasing GECs, this code was often used in conjunction with increased accessibility, as participants often described needing information about the behavior and an easy way to engage in it.

Connection to the Barriers. As previously mentioned, the coders identified the relevant barrier(s) that the coded ways to overcome helped to address. Table 25 shows how often each overcoming code was used to address each barrier. Inconvenient, lack of control, unappealing, and health concern were associated with the largest range of potential ways to overcome. Planning, alternative improvement, and increased knowledge were frequently recommended. Predictably, increased affordability was used exclusively for the expensive barrier, which itself was overcome frequently by several methods, including adjusting one's mindset—participants often discussed a need to engage in the behaviors, regardless of the cost.

Exploratory Analyses

The relationships between PEB and the individual characteristic variables (the CTE, the PAQ, climate change beliefs, political orientation, and trust in authorities) were examined by performing correlations and t-tests. Effect sizes were interpreted using Funder and Ozer (2019), Lovakov and Agadullina's empirically derived interpretations (2021), and by using existing literature on the exploratory variables, as described in Chapter III.

Measurement and Statistical Considerations

For all exploratory analyses, only Phase 3 data were used because the exploratory analyses were used to inform the barrier assessment, which was the main focus of Phase 3. In addition, the probability estimates for two of the behaviors changed significantly between Phase 2 and Phase 3. Given that the sample for Phase 3 was larger and more representative in terms of class composition (i.e., there were more upper-class students), the exploratory analyses were conducted on these data. Finally, it should be noted that for the CBSM analysis, only non-adopters' self-reported probability were used to calculate the GSP estimates. However, for the exploratory analyses, all participants were included.

PEB Probability. The exploratory analyses focused on the relationship between PEB and individual characteristics, such as commitment to the environment and instrumentality. Because the penetration questions for the five behaviors differed in form (behavioral frequency and self-identification), and because of the extremely small number of GEC adopters, it was decided that

Table 25. **Frequencies of Ways to Overcome for Each Barrier**

Way to overcome (total number of codes)	Barrier (total number of codes)								
	Inconvenient (102)	Expensive (71)	Lack of control (62)	Unappealing (57)	Health concern (43)	Low impact (34)	Lack of knowledge (29)	Cultural norms (15)	Lack of interest (12)
Increased affordability (31)	-	34%	-	-	-	-	-	-	-
Increased accessibility (31)	7%	1%	5%	4%	2%	-	14%	7%	8%
Planning (30)	17%	1%	6%	9%	5%	-	-	-	-
Adjust mindset (29)	8%	13%	-	5%	2%	-	-	7%	8%
Increased knowledge (29)	6%	-	2%	2%	7%	-	38%	7%	-
Alternative improvement (27)	5%	3%	11%	14%	5%	-	-	-	-
Social assistance (15)	8%	-	-	4%	5%	-	-	7%	-
Sometimes don't engage (15)	6%	4%	8%	9%	5%	-	-	13%	-
Act of nature (12)	4%	-	5%	7%	5%	-	-	-	-
Relocate (9)	4%	-	2%	5%	2%	-	-	-	-
Social influence (8)	1%	-	2%	-	-	3%	-	-	-
Other (5)	-	-	3%	-	-	-	-	-	-
None used	35%	44%	56%	42%	63%	97%	48%	60%	83%

Note. The percentages describe how many of each barrier code were associated with each way to overcome code. For example, 3% of all low impact barrier codes were addressed with social influence, while 97% of all low impact barrier codes were not addressed with any way to overcome code.

participants' self-reported probability of engaging in the PEBs would be used for these analyses rather than the penetration questions.

To reduce the number of comparisons and thus reduce the Type I error rate, a PEB probability composite variable was created and analyzed in conjunction with the individual characteristic variables. To create the PEB probability composite variable, z-scores were calculated for the probability of each behavior for each participant. Then, the five z-scores were averaged for each participant (Song et al., 2013). In cases where the statistical test performed on the composite variable was significant, follow-up analyses were conducted for each individual behavior. To inform the behaviors' barrier assessments, the individual characteristic variables with a significant relationship to the PEB expectations variable were examined with each of the behaviors independently.

Dichotomized Variables. As previously described, binaries were created for political orientation (liberal vs non-liberal) and climate beliefs (*yes* vs *no*/*I don't know*). Although there were two questions about climate change beliefs included in the survey—one regarding whether climate change is happening and one regarding whether climate change is human-caused—only the human-caused question was used in the exploratory analyses because that question had more variability (see Table 26).

Results

Commitment to the Environment Scale. The CTE was strongly related to PEB probability ($r = .40$, $p < .001$); participants with greater commitment to the environment reported being more likely to engage in PEB (see Tables 27 and 28 for the results for all exploratory analyses). The behaviors were then examined individually. CTE was significantly and positively related to the probability for all five behaviors. This relationship was strongest for following a plant-based diet ($r = .40$, $p < .001$) and also moderately strong for purchasing GECs ($r = .31$, $p < .001$). The effect sizes associated with the other behaviors, however, were smaller than those reported in the literature relating the CTE to PEB (e.g., 95% CI [.37, .76]; Whitburn et al., 2020).

Table 26. **Comparison of Phase 2 and Phase 3 Exploratory Data**

	Phase 2	Phase 3	Both Phases
n	198	303	501
PEB Probability – *M* (*SD*)	0.01 (0.56)	0.00 (0.56)	0.00 (0.57)
CTE – *M* (*SD*)	5.6 (1.5)	5.9 (1.5)	5.8 (1.5)
PAQ – *M* (*SD*)			
Instrumental Factor	19.0 (4.7)	18.6 (4.9)	18.8 (4.8)
Expressive Factor	23.7 (5.0)	24.0 (5.3)	23.9 (5.2)
Instrumental-Expressive Factor	13.7 (4.1)	13.3 (4.6)	13.5 (4.4)
Political orientation			
Democrat	36%	36%	36%
Independent (liberal-leaning)	21%	22%	22%
Republican	13%	8%	10%
Independent (conservative-leaning)	10%	5%	7%
No preference	10%	14%	12%
NR or prefer not to answer	6%	6%	7%
Other	4%	9%	7%
Left/far left [a]	2%	5%	3%
Libertarian [b]	1%	1%	1%
Centrist [c]	< 1%	3%	2%
Unaffiliated	< 1%	0%	< 1%
Climate change beliefs			
Climate change is happening			
Yes	91%	94%	93%
How sure are you? [d] – *M* (*SD*)	3.5 (0.7)	3.5 (0.7)	3.5 (0.7)
No	5%	1%	3%
How sure are you? [d] – *M* (*SD*)	2.7 (0.5)	2.8 (1.0)	2.7 (0.6)
I don't know	4%	4%	4%
NR or prefer not to answer	0%	1%	< 1%
Caused by human activities [e]			
Yes	87%	90%	89%
How sure are you? [d] – *M* (*SD*)	3.4 (0.7)	3.4 (0.8)	3.4 (0.7)
No	6%	4%	5%
How sure are you? [d] – *M* (*SD*)	2.7 (0.6)	2.9 (1.1)	2.8 (1.0)
I don't know	7%	5%	6%
NR or prefer not to answer	0%	1%	1%
Trust in authorities [f], * – *M* (*SD*)**			
Elected officials	2.0 (0.8)	2.0 (0.8)	2.0 (0.8)
Appointed officials	2.2 (0.8)	2.2 (0.8)	2.2 (0.8)
Climate scientists	3.7 (0.7)	3.8 (0.6)	3.7 (0.6)
Energy industry leaders	2.7 (1.0)	2.5 (1.1)	2.6 (1.0)
News media	1.8 (0.8)	1.8 (0.8)	1.8 (0.8)

[a] Fill-in responses included "leftist," "socialist," and "Green Party," among others
[b] Fill-in responses included "libertarian" and "socially left, economically right," among others
[c] Fill-in responses included "centrist," "moderate," and "independent," among others
[d] Response scale of 1 = *not at all sure*; 2 = *somewhat sure*; 3 = *very sure*; 4 = *extremely sure*
[e] Only asked of participants who either indicated that climate change is happening or that they were not sure. Those that indicated that climate change is not happening were automatically assigned a score of *No*.
[f] Response scale of 1 = *not at all*; 2 = *not too much*; 3 = *some*, 4 = *a lot*
***$p < .001$; **$p < .01$; *$p < .05$; $^{+}p < .10$

Personal Attributes Questionnaire. The correlations between the three PAQ factors (i.e., the instrumental, expressive, and instrumental-expressive factors) and PEB probability were negligible (see Table 27), and thus, most of the behaviors were not examined independently with the PAQ. However, given previous literature describing the relationship between masculinity and meat consumption specifically (Rothgerber, 2013), following a plant-based diet was examined further. The probability of following a plant-based diet was positively related to the expressive factor ($r = .10$, $p < .10$) and negatively related to the instrumental-expressive factor ($r = -.14$, $p < .05$), but the effect sizes for both relationships were small. For both factors, expressive individuals tended to report higher probability of adopting a plant-based diet than instrumental individuals or those with low expressive scores. These findings parallel the neutral closed-ended questions (see Table 29); participants perceived following a plant-based diet as the least masculine and most feminine behavior, and thus, the behavior seems to be relevant to masculinity and femininity.

Political Orientation. Political orientation (liberal vs. non-liberal) was moderately related to PEB probability ($d = 0.37$, $p < .01$), with liberal-leaning participants reporting a higher probability of PEB; thus, each behavior was examined independently (see Table 28). Political orientation significantly predicted the probability of following a plant-based diet with a moderate effect size ($d = 0.54$, $p < .001$)—liberal individuals had a higher mean probability for following a plant-based diet ($M = 3.03$, $SD = 1.9$) than non-liberal individuals ($M = 2.04$, $SD = 1.6$). Similarly, liberal individuals had a higher mean probability for installing CFL and LED bulbs ($M = 5.19$, $SD = 1.2$) than non-liberal individuals ($M = 4.84$, $SD = 1.4$; $d = 0.27$, $p < .05$).

Climate Change Beliefs. Beliefs about whether climate change is caused by human activities were also moderately related to PEB probability ($d = 0.47$, $p < .05$; see Table 28). In the analyses reported above, following a plant-based diet was positively related to commitment to the environment, expressive traits, and liberal political orientations. Similarly, in this analysis, I found that the probability for following a plant-based diet was strongly related to climate change beliefs ($d = 0.63$, $p < .001$)—the mean

Table 27. **Correlational Analyses for the Continuous Exploratory Variables**

	PEB Probability	Living motor vehicle free	Purchasing GECs	Following a plant-based diet	Avoiding a plane flight	Installing CFL/LED bulbs
CTE	r = .40*** (.30, .49)	r = .14* (.03, .25)	r = .31*** (.19, .43)	r = .40*** (.30, .49)	r = .12* (.01, .23)	r = .18** (.06, .28)
PAQ						
Instrumental Factor	r = -.04 (-.15, .07)	-	-	r = -.08 (-.19, .04)	-	-
Expressive Factor	r = .04 (-.08, .15)	-	-	r = .10^{+} (-.02, .21)	-	-
Instrumental-Expressive Factor	r = -.03 (-.14, .08)	-	-	r = -.14* (-.25, -.02)	-	-
Trust in Authorities						
Elected Officials	r = -.10^{+} (-.21, .02)	-	-	-	-	-
Appointed Officials	r = .01 (-.10, .13)	-	-	-	-	-
Climate Scientists	r = .06 (-.05, .17)	-	-	-	-	-
Energy Industry Leaders	r = -.16** (-.26, -.04)	r = -.01 (-.12, .10)	r = -.16* (-.29, -.03)	r = -.14* (-.25, -.03)	r = -.06 (-.17, .06)	r = -.07 (-.18, .05)
News Media	r = .11^{+} (-.00, .22)					

Note. Confidence intervals (95%) for the effect size statistic are in parentheses: (*lower, upper*). All analyses were performed using Phase 3 probability data only.
***p < .001; **p < .01; *p < .05; ^{+}p < .10

Table 28. ***T*-test Analyses for the Binary Exploratory Variables**

	PEB Probability	Living motor vehicle free	Purchasing GECs	Following a plant-based diet	Avoiding a plane flight	Installing CFL/LED bulbs
Political Orientation						
Non-liberal – *M* (*SD*)	-0.64 (2.5)	2.81 (1.8)	2.76 (1.5)	2.04 (1.6)	2.95 (1.6)	4.84 (1.4)
Liberal – *M* (*SD*)	0.37 (2.5)	2.72 (1.5)	3.05 (1.6)	3.03 (1.9)	3.22 (1.8)	5.19 (1.2)
Cohen's d	d = 0.37**	d = -0.06	d = 0.19	d = 0.54***	d = 0.16	d = 0.27*
CI (95%)	(0.14, 0.61)	(-0.29, 0.18)	(-0.09, 0.48)	(0.30, 0.78)	(-0.08, 0.40)	(0.03, 0.51)
Human-Caused Climate Change [b]						
No/I don't know – *M* (SD)	-1.15 (2.2)	2.54 (1.7)	2.19 (1.5)	1.58 (1.3)	3.04 (1.6)	4.96 (1.2)
Yes – *M* (*SD*)	0.09 (2.6)	2.77 (1.6)	2.99 (1.5)	2.75 (1.9)	3.15 (1.7)	5.06 (1.3)
Cohen's d	d = 0.47*	d = 0.15	d = 0.53^{+}	d = 0.63***	d = 0.06	d = 0.08
CI (95%)	(0.07, 0.88)	(-0.26, 0.55)	(0.02, 1.05)	(0.23, 1.04)	(-0.34, 0.47)	(-0.33, 0.49)

Note. All analyses were performed using Phase 3 probability data only.
***p < .001; **p < .01; *p < .05; ^{+}p < .10

Table 29. **Descriptive Statistics for the Closed-Ended Assessment of the Neutral Characteristics**

	Living motor vehicle free	Purchasing GECs	Following a plant-based diet	Avoiding a plane flight	Installing CFL/LED bulbs
Neutral					
Masculine [a, ***]	2.1 (1.1)	2.1 (1.0)	1.7 (1.0)	2.2 (1.1)	2.4 (1.1)
Feminine [b, ***]	2.2 (1.1)	2.4 (1.1)	2.9 (1.0)	2.0 (1.1)	2.2 (1.1)

Note. Scores were on a 4-point scale from *not at all, slightly, moderately, and very*. ANOVA tests are reported here, and the Scheffé post-hoc tests can be found in Appendix I.
[a] For all behaviors, between 43–59% of participants said *not applicable*, which was not included in the mean.
[b] For all behaviors, between 39–59% of participants said *not applicable*, which was not included in the mean.
***$p < .001$; **$p < .01$; *$p < .05$; $^{+}p < .10$

probability among those who were unsure of or denied human-caused climate change ($M = 1.58$, $SD = 1.3$) was significantly lower than the mean probability among those who accepted human-caused climate change ($M = 2.75$, $SD = 1.9$). Additionally, the difference in mean probability for purchasing GECs between those who were unsure of or denied human-caused climate change ($M = 2.19$, $SD = 1.5$) and those who accepted human-caused climate change ($M = 2.99$, $SD = 1.5$; $d = 0.53$, $p < .10$) was marginally significant.

Trust in Authorities. Several authoritative sources for information about climate change were considered: elected officials, appointed officials, climate scientists, energy industry leaders, and news media. Each authority was examined independently. An ANOVA test was used to determine whether trust differed between the authorities, results for which can be found in Table 26, and the post-hoc analysis using the Scheffé test can be found in Appendix J. Participants tended to trust climate scientists the most ($M = 3.8$, $SD = 0.6$) and news media the least ($M = 1.8$, $SD = 0.8$). Despite the fact that trust in the news media was low overall, it was positively associated with PEB probability, albeit weakly ($r = .11$, $p < .10$; see Table 27). Among the different sources for climate information, only trust in energy leaders was significantly related to PEB probability. However, the direction of this relationship was negative: as trust in energy industry leaders increased, the probability of PEB decreased ($r = -.16$, $p < .01$). A similar pattern was observed for the individual behaviors of purchasing GECs ($r = -.16$, $p < .05$) and following a plant-based diet ($r = -.14$, $p < .05$), though the effect sizes were small.

Interrelationships Between the Individual Characteristic Variables. There were common trends that emerged across the various predictor variables, most notably in relation to following a plant-

based diet. This raises the question of to what extent CTE, expressive traits, political orientation, climate change beliefs, and trust in authorities are themselves interrelated. Table 30 shows the intercorrelations among these variables. Not surprisingly, the strongest correlations are those between trust in elected and appointed officials ($r = .72$, $p < .001$), the PAQ's expressive and instrumental-expressive factors ($r = -.49$, $p < .001$), the PAQ's instrumental and instrumental-expressive factors ($r = .46$, $p < .001$), and climate change beliefs and trust in climate scientists ($r = .43$, $p < .001$).

Table 30. **Correlation Matrix for the Exploratory Variables**

	PAQ I	PAQ E	PAQ IE	Poli	CC	Trust EO	Trust AO	Trust C	Trust E	Trust M
CTE	.00	.09	-.06	.37***	.32***	.04	.12*	.28***	-.17**	.15*
PAQ I	-	-.01	.46***	-.07	-.05	.01	-.01	-.08	.03	-.06
PAQ E	-	-	-.49***	.15*	.02	.07	.07	.11^{+}	-.02	.04
PAQ IE	-	-	-	-.20***	-.12*	-.05	-.05	-.11^{+}	.08	-.06
Poli	-	-	-	-	.36***	.10^{+}	.14*	.33***	-.11^{+}	.25***
CC	-	-	-	-	-	.15**	.19***	.43***	.06	.16**
Trust EO	-	-	-	-	-	-	.72***	.18**	.17**	.30***
Trust AO	-	-	-	-	-	-	-	.21***	.13*	.21***
Trust C	-	-	-	-	-	-	-	-	.11^{+}	.20***
Trust E	-	-	-	-	-	-	-	-	-	.01

Note. PAQ I = instrumental factor; PAQ E = expressive factor; PAQ IE = instrumental-expressive factor; Poli = political orientation; CC = climate change beliefs; Trust EO = elected officials; Trust AO = appointed officials; Trust C = climate scientists; Trust E = energy industry leaders; Trust M = news media
***$p < .001$; **$p < .01$; *$p < .05$; $^{+}p < .10$

Conclusion

The primary focus of Phase 3 was to examine barriers and benefits for the five behaviors selected in Phase 2. Participants generated a wide range of benefits, barriers, and importantly, ways to overcome the barriers. Participants recognized that several of the behaviors were environmentally friendly, including purchasing GECs, living motor vehicle free, and following a plant-based diet. In addition to the environmental benefits, participants also frequently cited physical and mental benefits associated with performing the behaviors, especially following a plant-based diet and living motor vehicle free. However, participants also expressed concern over many barriers, the most frequent of which was inconvenience. The good news, from an intervention perspective, is that although inconvenience was the top barrier for

several behaviors (living motor vehicle free, following a plant-based diet, and avoiding a plane flight), it was also the barrier with the greatest variety of ways to overcome.

In Phase 3, the results of the qualitative data were augmented with exploratory findings investigating the relationship between the probability of PEB and several individual characteristic variables. CTE was significantly related to the probability of engaging in all five PEBs, which confirms previous findings that commitment to the environment is positively related to environmentally sustainable behavior. In addition, probability of following a plant-based diet was significantly and positively related to liberal political identity, beliefs about human-caused climate change, and expressive traits. In the next chapter, I will synthesize these findings in recommendations for behavioral targets and potential interventions to reduce GHGs on college campuses.

CHAPTER V: GENERAL DISCUSSION

The primary goal of this research was to recommend viable behavioral targets for future interventions at a university in the United States aimed at reducing GHG emissions and to advise researchers, practitioners, and other interventionists on how to choose between many potential behavioral targets proposed by Project Drawdown and other similar catalogues of GHG emissions. In this study, I began with a list of 101 possible behavioral targets and through a series of data collection efforts have been able to identify the most promising targets for a behavioral intervention with college students.

Behavior Promotion Recommendations

In the current study, a variety of measures were used to develop recommendations for behavioral intervention targets, beginning with the CBSM variables of impact, probability, penetration, and their product: the goal state potential, or GSP. A qualitative analysis of perceived benefits and barriers was then incorporated into the behavioral target decision-making process. In addition to these traditional CBSM variables, the current study also included a behavioral ranking question, which was used to make a standardized probability comparison, closed-ended benefit and barrier questions, and characteristic assessments. The following section outlines recommendations based on the traditional CBSM calculations, which is followed by recommendations based on a synthesis of all assessment strategies.

CBSM Recommendations Based on the GSP Calculations

According to CBSM, a behavioral target is chosen based on the GSP calculation alone. Thus, researchers choosing a GHG-reducing behavior based solely on the CBSM criteria collected in the current study would choose to intervene on living motor vehicle free. Living motor vehicle free had the largest GSP in both Phase 2 and Phase 3, despite differences in the sample characteristics and the level of specificity of the question. In CBSM, the ideal behavioral target is one with a high impact, low penetration, and high probability. Living motor vehicle free did have low penetration (< 20%), but the

probability was low to moderate (4th or 5th out of the 5 behaviors). However, this is counterbalanced by the behavior's exceptionally high impact—3,170 $kgCO_2e$ per person each year.

Based on its large GSP, targeting GECs might also yield a fruitful intervention—this behavior has the second highest impact (1,405 $kgCO_2e$ per person each year) and a higher probability of being adopted (3rd out of 5 behaviors). Additionally, only 1–7% of the target audience had engaged in the behavior. The contrast between living motor vehicle free and purchasing GECs illustrates the point made in Chapter I about the GSP calculation. Although the probability and penetration values are favorable for purchasing GECs as compared to living motor vehicle free, the latter comes out on top due to its extremely high impact. Interestingly, however, scaling the impact values did not change the behaviors' ranks.

In contrast to living motor vehicle free and purchasing GECs, the GSP for installing CFL and LED bulbs was very low and would thus be viewed as the least promising behavior to target. Only approximately 30% of the target audience had not adopted the behavior, meaning that the behavior has limited growth potential. That, coupled with the behavior's low impact (only 170 $kgCO_2e$ per person each year, 5% the impact of living motor vehicle free), means that an intervention targeting CFL and LED bulb installation is unlikely to achieve the same level of carbon emission reductions as an intervention targeting motor-free living, according to the CBSM methodology. It is worth noting, however, that installing energy efficient light bulbs was the only behavior whose mean probability of adoption was above the midpoint on the 6-point scale.

Holistic Recommendations Based on the Benefits, Barriers, and GSP Calculations

Interventions using messaging to influence behavior change leverage the perceived benefits of the target behavior to make the case for the behavior's importance and potential to improve the audience's life. Whether the message is successful depends on the target audience and their values. For instance, if a target audience is environmentally minded, an intervention targeting a behavior perceived as environmentally friendly might be most successful. This is why CBSM recommends assessing benefits specific to the target audience. Additionally, the perceived barriers can help inform which strategies should be used to aid the target audience in behavior adoption. Thus, considering the perceived benefits

and barriers of a behavior in conjunction with the target audience and the GSP calculations will be useful to interventionists.

Purchasing Green Energy Credits. An intervention promoting GEC programs might be promising for a target audience that is environmentally minded. Purchasing GECs was perceived as one of the most environmentally- and climate-friendly behaviors—proportionally, it had the highest percentage of environmental benefit and climate change codes, and the probability of purchasing GECs was significantly and moderately correlated with commitment to the environment. Purchasing GECs was also perceived as being more socially acceptable and less time-consuming than most of the other behaviors. The behavior, however, was perceived as the least common, and in fact was the least common, meaning that strategies using social norms would be challenging. Additionally, a quarter of participants reported that there were no personal benefits associated with purchasing GECs. It was also considered to be an expensive behavior, and participants often reported that they did not understand what GECs are and how they can be purchased. Many participants also referenced a lack of control related to purchasing GECs given that many of them did not pay for their own utilities. Finally, participants most frequently ranked the behavior in fourth place in terms of behaviors they would adopt in the next year. Interventions targeting the purchase of GECs will thus have several challenges to address.

Despite these challenges, I recommend this behavior first because it has a very large impact, and the challenges associated with 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, no additional actions need to be taken, which minimizes the effects of fatigue and forgetfulness. This could be appealing for a broad range of individuals interested in taking action against climate change. Although decreasing the cost of GECs is generally not within the control of interventionists, other beneficial intervention strategies can be used. For instance, increasing advertisement and education explaining what GECs are and improving the ease with which individuals can purchase them will help address the barriers mentioned by many participants.

Additionally, to access members of the target audience without control over their utilities, landlords and apartment complexes could also be included in the intervention.

Installing CFL/LED Bulbs. Interventions targeting the use of CFL and LED bulbs 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 helping to reduce energy use. They also felt that it was one of the least expensive behaviors. It also seems that installing CFL/LED bulbs is an uncontroversial behavior because it was perceived as being the most common and socially-acceptable behavior (in addition to having the highest penetration). In terms of which behavior participants were most likely to engage in over the next year, participants ranked installing CFL/LED bulbs first most frequently. Finally, the challenges associated with installing CFL/LED bulbs seem to be relatively easy to overcome.

Although this behavior is not recommended for the target audience considered in the current study given its high penetration and thus limited ability to reduce emissions, interventions conducted for target audiences who have largely not upgraded to CFL/LED bulbs have strong potential to be successful (e.g., Schultz et al., 2015). The ease with which the behavior can be adopted and the cost-savings associated with using CFL/LED bulbs should be appealing across many populations. Interventions could provide reminders, or nudges, and information about how to find the bulbs when shopping to help participants engage in the behavior more frequently. Participants also said that reduced up-front costs would help them engage in the behavior, which is likely out of the control of the interventionists, but reminders about the cost savings associated with reduced energy use might help mitigate the price of the bulbs.

Living Motor Vehicle Free. A viable intervention for a target audience that is health conscious or environmentally minded might be living motor vehicle free. Proportionally, it had the most physical benefit codes and also many environmental benefit codes. Participants rated the behavior as the healthiest and most environmentally-friendly behavior. However, these benefits are not easy to come by—participants noted many challenges associated with engaging in the behavior, and participants'

willingness to engage in the behavior was highly variable, with virtually equal numbers of participants ranking it as their most likely behavior to engage in and their least likely behavior to engage in. Participants expressed a variety of psychological and practical barriers to living motor vehicle free, including that the behavior was inconvenient, unappealing, time-consuming, and stressful, and although the behavior was associated with health benefits, participants perceived it to be dangerous. In the closed-ended questions, it also tied for the lowest score on social acceptability. Further, participants often felt that the behavior was impossible to engage in under certain circumstances (e.g., when traveling far or when shopping).

Interventions can use participants' recommendations to help audience members overcome these challenges. Participants said that, to engage in this behavior most easily, buses or carpooling can be used when walking or biking is impossible. This will maintain audience members' engagement with the behavior but allow the flexibility needed to complete necessary tasks; however, the less consistently participants engage in the behavior, the lower the behavior's impact. Participants also noted that relocating (i.e., living closer to necessities or living in a warmer climate) would make behavior engagement easier. Thus, undertaking an intervention aimed at decreasing motor vehicle use during warmer weather or in areas with warmer climates might be more impactful than those conducted during colder weather or in areas with colder climates.

Following a Plant-Based Diet. Another promising intervention for a health-conscious audience is promoting plant-based diets because the behavior had a disproportionately high number of physical benefit codes and received the second highest healthy score in the closed-ended questions. The behavior was also generally viewed as environmentally friendly, and, surprisingly, the behavior was viewed as relatively common, which might bode well for interventions using normative messaging. However, engagement in the behavior had many barriers. It received the highest difficulty score and was also perceived as being the most expensive in the closed-ended questions. It also tied for the lowest score on social acceptability and was perceived as unappealing. Additionally, although many participants considered a plant-based diet to be healthy, many had concerns about the health impacts of a diet with

little to no meat. Another substantial challenge with promoting plant-based diets is that the behavior was most frequently rated as the last behavior participants were likely to try in the next year.

For audience members to overcome these challenges, they can plan meals ahead of time (e.g., bringing food to gatherings), adjust the way they eat throughout the day (e.g., eating smaller meals more frequently), and learn more about plant-based shopping and cooking. It seems, however, that interventions targeting meat consumption will be most successful with certain populations. Following a plant-based diet was the only behavior to relate significantly, albeit with a small effect size, to the PAQ factors—the probability for following a plant-based diet tended to decrease as instrumentality (i.e., "masculinity") increased. Similarly, in the closed-ended questions that assessed behavioral characteristics, following a plant-based diet was seen as the least masculine and most feminine behavior. Thus, the behavior appears to be gendered, which will pose a unique challenge to interventionists. Interventions targeting feminine individuals or individuals with higher scores on the PAQ's expressive factor might be most successful, whereas targeting masculine individuals might be more challenging. Following a plant-based diet also appears to be politicized—those who identify on the liberal side of the political spectrum tend to be more likely to engage in the behavior than those who identify on the conservative side. Thus, interventions targeting plant-based diets might be most successful with liberal target audiences. However, strategies can be used to appeal to conservative values, which could yield interventions among conservative audiences more successful (Hurst & Stern, 2020).

Avoiding a Plane Flight. Avoiding a plane flight was perceived as having several personal benefits—proportionally, it had the highest number of mental benefit and monetary savings codes. Participants often discussed the joys associated with taking road trips, which they also considered to have less risk of COVID-19 transmission than flying. However, it was most frequently ranked in second-to-last place in terms of behaviors participants were likely to engage in over the next year. In fact, avoiding a plane flight had several barriers which will be hard to address through intervention: it was seen as difficult, time-consuming, and inconvenient. Importantly, it was also viewed as not being a worthwhile behavior, as many noted a lack of community or societal benefit, and participants questioned the

environment benefit of engaging in the behavior. This could be because many of the alternatives to flying (e.g., driving) negate the positive climate impacts of avoiding a flight.

Many of these challenges are out of interventionists' control. If audience members are committed to traveling, an intervention cannot improve alternative forms of travel and reduce the time it takes to use these alternative forms of travel. However, participants did note several strategies for overcoming these barriers, such as thorough planning, adjusting one's mindset to consider the route as part of the excitement of the journey, and enjoying the company of travel companions, all of which can be addressed through intervention. Finally, interventions could attempt to eliminate travel altogether and promote virtual meetings over long-distance flights, perhaps by highlighting the financial savings, to avoid some of the challenges associated with using alternative forms of travel and to maximize the impact of this behavior. However, taken together, these barriers would make this behavior a poor intervention target, which is important to note given its relatively large GSP.

Summary

By considering the GSP calculations in conjunction with the chosen target audience and with the behaviors' barriers and benefits, I have made several behavioral target recommendations (see Table 31 for a summary of the findings). Interventionists interested in reducing GHG emissions should target GEC purchasing, especially if they are able to expand the target audience beyond college students. Behavior engagement is easy and takes little time, and its relationship to the environment and climate change is generally known to audience members. Given the behavior's large impact and ease of engagement, purchasing GECs should be appealing to many individuals. Targeting CFL and LED bulb installation might not be as impactful among audiences with high adoption rates, as was the case in the current study, but the perceived benefits, including the ease of behavior engagement and the associated monetary savings, make it a behavior relatively likely to be adopted. Living motor vehicle free, while perceived as healthy and environmentally friendly, might only be a feasible behavioral target in warm weather. Moreover, a disproportionate number of participants perceived this behavior to be 'impossible' (lack of control code). Plant-based diets might be successfully promoted in interventions with certain populations

(e.g., with more expressive or liberal individuals) but might be harder to promote beyond those populations due to the substantial barriers, including the difficulty and lack of appeal associated with changing dietary habits. Finally, avoiding a plane flight affords audience members certain benefits, but rebound behaviors might negate the associated environmental benefits.

Table 31. **Summary of Behavioral Target Recommendations to Reduce GHG Emissions**

Final Behavior Rank	Pros	Cons	GSP_1 Rank
1. Purchasing green energy credits	• One time, simple action • Perceived as environmentally friendly and impactful for climate • Lack of information barrier easy to address	• Perceived as expensive with few personal benefits • Lack of control for those who don't pay for their utilities	2
2. Installing CFL and LED bulbs	• Perceived as easy to engage in with many perceived benefits and few perceived barriers • Cost-savings over time • Highest willingness to engage compared to the other behaviors	• 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 • Benefits that depend on population (perceived as feminine, politicized) • Perceived as environmentally friendly	• Barriers that depend on population (perceived as feminine, politicized) • Many barriers- difficult, expensive, unappealing, and to some, unhealthy • Lowest willingness to engage compared to the other behaviors	3
5. Avoiding a plane flight	• Mental benefits and monetary savings	• Barriers difficult to address through intervention- time-consuming, difficult, and inconvenient • Varying levels of impact, depending on behavior chosen to replace flying (i.e., rebound behaviors) • Lowest mean benefit score and highest mean barrier score	4

Strengths, Limitations, and Future Directions

Lynes et al. (2014) provided benchmarking criteria that researchers can use to assess CBSM studies. In terms of behavior selection, they recommend a) a clear identification of the target audience; b) a selection of behaviors that are non-divisible and end-state; c) an assessment of impact, probability, and

penetration; and d) a reduction of potential behaviors to five or six of the most feasible. They also recommend that researchers perform an assessment to identify the barriers and benefits, both internal and external, for the behaviors under consideration. All of these benchmarks were met in the current study with the exception of one—not all behaviors were non-divisible. Avoiding a plane flight was a divisible behavior in that participants could perform the behavior in many ways. For example, they could drive to their destination, take a bus, or choose not to travel, each of which would successfully avoid a plane flight. This was deemed acceptable in the current study so that the behaviors that Wynes & Nicholas (2017) proposed could be tested as described. This decision, however, had certain implications, which are described below, along with other impact estimate considerations.

Impact Estimates

The Wynes and Nicholas (2017) impact estimate for avoiding a plane flight did not consider rebound effects, such as driving to a destination instead of flying—if an individual were to drive instead of fly, the impact used in the current study is overestimated. Indeed, participants in the current study typically talked about the benefits of road trips when considering avoiding a plane flight, and participants seemed to understand that avoiding a plane flight does not necessarily result in an environmental benefit because the behavior had relatively few environmental benefit codes. However, if an individual were to stay home instead of fly, the impact estimate would have been appropriate. Future research should thus alter the wording for this behavior with this in mind (i.e., not traveling at all instead of taking a plane *or* a car), unless, of course, electric vehicles or other low-impact forms of travel become more ubiquitous, in which case the impact estimate used in the current study would be more accurate.

Similarly, the impact estimates used for all behaviors in the current study were for undertaking the full behavior (e.g., living completely motor vehicle free) when, in practice, individuals are likely to take small steps, such as eliminating vehicle use for shorter trips, on their way to achieving the ultimate goal. Given that behaviors with a large potential impact on GHG emissions were prioritized in the current study, it would still be environmentally beneficial for participants to take small steps toward behavior engagement if they are unable to adopt the behavior outright. Although the impact of those small steps

would be lower, many barriers would be eliminated and the probability of engagement would likely be higher. Indeed, in Phase 2 of the current study, living motor vehicle free was broken down into trips of up to one mile, trips between one and five miles, and trips over five miles, and participants did report a higher likelihood of eliminating vehicle use for one-mile trips than for five-mile trips. This suggests that a more refined approach to behavior change is warranted, which is a promising avenue for future researchers interested in using CBSM to develop behavior change programs.

For example, future work could calculate the impact of reducing motor vehicle use for various distances and examine the feasibility and overall impact of targeting smaller distances through intervention. As described in Chapter III, this was not possible in the current study. Consequently, penetration and probability for the furthest distance (i.e., distances greater than five miles) were used to calculate GSP in Phase 2, and in the Phase 3 survey, living motor vehicle free was not qualified by distance. These changes in the way that the behavior was defined resulted in significant differences in the behaviors' probability and penetration (see Table 11 in Chapter IV). Despite these differences, however, the GSP rankings remained consistent from Phase 2 to Phase 3.

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. The former was calculated 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 terms of behavioral target recommendations. Additionally, some impact estimates were based on average household size, including the impact for cold water laundry. The average household size in the U.S. is 2.6 people (Fry, 2019), and average-sized households likely generate more laundry than the average college student. This means that the impact estimate for cold water laundry is likely an overestimate (which, it should be noted, would not improve how well this behavior performed in the current analysis).

The impact estimates, however, have many strengths as well. The localized impact estimates calculated by the author were similar to the national estimates reported by Wynes and Nicholas (2017). Additionally, the impact estimate for following a plant-based diet, which considered eating meat and dairy twice per month, was largely supported by the participants—plant-based diet adopters reported eating dairy once per week and eating meat less than once per month. This means that, although similar, the impact included in the current study is likely underestimated because meat has a larger climate impact than dairy. Future work should seek to confirm the description and associated impact of a plant-based diet to calculate a more accurate GSP value for the behavior.

Penetration, Probability, and Barrier Assessment

Penetration, probability, and behavioral barriers were estimated using data collected from undergraduate students at Colorado State University (see Table 4 in Chapter III). Although the Phase 3 participants were generally more representative of the student body than the Phase 2 participants, several demographics were still underrepresented. This includes students enrolled in the Colleges of Engineering, Business, Natural Resources, and Agricultural Sciences. This could have impacted results because these students might have a unique perspective on the behaviors examined in the current study.

Qualitative Coding

The coding of qualitative barriers and benefits was an integral part of Phase 3. Initially, I sought to achieve ICR scores of at least .80 for each code because, while this research is exploratory and does not have sensitive clinical implications (which would require a high ICR score), it was believed that the coding process would be simple and thus an ICR of .80 would have been easy to achieve (O'Connor & Joffe, 2020). During training, however, both pairs of coders struggled to maintain an ICR of .80 across all codes, and thus, an ICR of .70 was deemed acceptable for the final coding process. Additionally, although a few of the ICRs for the final barrier and ways to overcome codes were below .70, this was largely due to small numbers of instances of those codes, and each disagreement was discussed and resolved as a group. This resulted in a collaborative, flexible process in which more codes were retained and thus more information was extracted from the data. This does mean, however, that assumptions based on the codes

with lower ICRs should be made with caution. Additionally, we refined the codebook based on the decisions made by the research team; however, the codebook likely does not represent the full extent of conversation that took place amongst the research team, and thus, it may be difficult for future researchers to replicate our results with different teams of coders.

Finally, the benefits codebook is different from the barriers and ways to overcome codebooks because improvements were made to the latter codebooks to aid in the barrier coding process, which proved to be challenging for coders. For instance, all codebooks included counter-examples to define the codes' boundaries; however, the benefits codebook did not describe which code should be used instead, while the barriers and ways to overcome codebooks did. This could have hindered the benefit codebook's ability to define the codes' boundaries. The benefits codebook was also generally more verbose and less concise than the barriers codebook, likely making it more cumbersome to use. Regardless, the benefits coders, who were undergraduate students without prior experience in qualitative coding, achieved an ICR of at least .70 for all but one 'catch-all' code (i.e., the vague global benefit code), indicating that the differences did not hinder its successful use.

Improving the CBSM Framework

In the current study, I used the CBSM methodology with several modifications. This included incorporating the perceived barriers and benefits of behavior adoption into the behavior selection process. By doing so, I was able to obtain a more realistic picture of behavior change feasibility. Interventionists using CBSM should test this further and compare the total impact of targeting two types of behaviors: one with a higher GSP but significant barriers and one with a lower GSP but less significant barriers. Investigations of this type will confirm whether barriers and benefits should be incorporated earlier in the CBSM process.

Future work can also test the consequences of a high penetration estimate on a behavior's ability to be altered through intervention. Arguably, a low penetration indicates that a behavior might be difficult to change in a target audience, contrary to the CBSM methodology. CBSM researchers should compare

an intervention targeting a higher-penetration behavior to an intervention targeting a lower-penetration behavior to see which type of intervention is most impactful.

Rescaled impact and penetration estimates were used in the current study because the impact and penetration are on vastly different scales than the probability in the traditional CBSM methodology. The current study employed the traditional CBSM calculation (1), in addition to a method (2) in which the variables are weighted equally (Frantz et al., 2016). However, both methods have drawbacks. The original methodology weights the variables differentially based on the variability within their scales, which is not well-justified. Conversely, information is lost in method (2) because, in order to weight the variables equally, refined data is transformed to a 6-point scale. Future research needs to determine the best method for calculating the GSP—that is, the method which best predicts the effectiveness of an intervention for achieving its goal state.

This future research direction could compare the two methods used in the current study, as well as additional methods, such as calculating GSP using a measure of proportional impact. Consider a comparison between installing CFL and LED bulbs and living motor vehicle free. Given these behaviors' impact estimates of 170 $kgCO_2e$/person/year and 3,170 $kgCO_2e$/person/year respectively, 19 people would need to install energy efficient light bulbs in order to achieve a greater impact on GHG emissions than a single person who began living motor vehicle free. However, because installing energy efficient light bulbs has smaller barriers and higher self-reported probability than living motor vehicle free, this scenario is quite possible—there could be 19 times more adopters of CFL and LED bulbs. If this were the case, the GSP for installing CFL and LED bulbs should be larger than that of living motor vehicle free, but this is not the case for the GSP calculations used currently in CBSM. This third, untested method has the additional benefit of retaining more meaningful units for the GSP value, which makes the behavior comparisons easier to conceptualize. Future research should investigate this GSP method, and the others used in the current study, in relation to the results of actual interventions.

Despite the differences between the GSP_1 and GSP_2 calculations in the current study, there was only a slight difference in behavioral ranks. Living motor vehicle free consistently had the largest GSP,

purchasing GECs consistently had the second largest GSP, and installing CFL and LED bulbs consistently had the lowest GSP. For the GSP_1 method, following a plant-based diet had a higher score than avoiding a plane flight, but these ranks were reversed in the GSP_2 method. This is because the differences between the behaviors were minimized with the GSP_2 method. For instance, the impact estimate for following a plant-based diet is 241 $kgCO_2$ smaller than that of avoiding a plane flight. However, when the impact is rescaled, both behaviors receive a score of two. Similarly, although the *1 – penetration* score for following a plant-based diet was 16 points higher than that of avoiding a plane flight (Phase 2 data), the rescaled penetration scores differed by only 1 point. This resulted in a masking of the benefits of following a plant-based diet compared to avoiding a plane flight for GSP_2.

In the current study, the traditional CBSM behavioral selection process was enhanced by examining several individual characteristics and their relationship to PEB probability. The results generally mirrored those from previous work, albeit with smaller effect sizes. It should be noted that the confidence intervals for many of the exploratory relationships had a large range, indicating that replications in similar populations can expect negligible to strong effect sizes for many of the relationships examined here.

One exploratory relationship I examined that had yet to be investigated was the relationship between PEB and the PAQ factors. I found that PEB probability was not significantly related to the PAQ but that the probability of following a plant-based diet was weakly related to expressive traits. Similarly, I found that participants rated following a plant-based diet as significantly less masculine and more feminine than each of the other behaviors, perhaps because Western culture identifies meat-eating as masculine (Rothgerber, 2013). The implications this might have on behavioral interventions targeting meat consumption should be examined in future research.

The results I obtained also have implications for local governments with GHG reduction goals. Policies aimed at improving bicycle infrastructure, for instance, could address some of the challenges associated with reducing motor vehicle use. The purchase of GECs is also likely to expand with campaigns aimed at increasing awareness of GEC programs. The undergraduate students living off-

campus in the current study had often not heard of Fort Collins Utilities' GEC program, and some expressed interest in enrolling. Clear communication about the likely costs and how to enroll would be helpful to these students. Communities that want to more aggressively pursue renewable energy portfolios might also want to consider making GEC programs require that customers opt out, rather than opt in.

The primary goal of this research was to recommend behaviors for future interventions that will be most successful at reducing GHG emissions. Future work should test my recommendations, utilizing the barrier and benefit results, to determine whether the criteria I used can indeed produce interventions more effective at reducing GHG emissions. For instance, I concluded that purchasing GECs would have a greater total impact through intervention than would installing CFL and LED bulbs among college student populations with similar behavioral penetrations to the population examined here. A future investigation could conduct interventions targeting these two behaviors and calculate the GHG emissions savings in each case to test my recommendations.

Conclusion

This study began with a list of 101 actions that will 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 will have given the feasibility of their widespread adoption. The current study used the CBSM methodology to investigate the behaviors' penetration and likelihood of being adopted in a college student population. Unlike previous CBSM studies, the current study also incorporated an assessment of the behaviors' barriers and benefits in the behavioral target recommendation process. These findings suggest that purchasing GECs, with its low-effort adoption among those with control over their utilities, has a high potential to reduce GHG emissions. Ensuring that target audience members are aware of GEC programs, making the behavior more accessible, and lowering the cost should help to increase its adoption. With the methods demonstrated across the three phases of this study and the final behavioral recommendations made as a result, future researchers and practitioners can develop productive interventions for specific target audiences that will ultimately help to reduce GHG emissions and slow the progression of climate change.

REFERENCES

Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2005). A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology, 25*, 273-291. doi:10.1016/j.jenvp.2005.08.002

Aguilar-Luzón, M. D. C., García-Martínez, J. M. A., Calvo-Salguero, & Salinas, J. M. (2012). Comparative study between the theory of planned behavior and the value-belief-norm model regarding the environment, on Spanish housewives recycling behavior. *Journal of Applied Social Psychology, 42*(11), 2797-2833. doi:10.1111/j.1559-1816.2012.00962.x

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*, 179-211.

Ajzen, I., & Fishbein, M. (2005). The influence of attitudes on behavior. In D. Albarracín, B. Johnson, & M. Zanna (Eds.), *The Handbook of Attitudes* (1st ed.) (pp. 173-271). Mahwah, NJ: Lawrence Erlbaum Associates, Inc., Publishers.

Aleksandrowicz, L., Green, R., Joy, E. J. M., Smith, P., & Haines, A. (2016). The impacts of dietary change on greenhouse gas emissions, land use, water use, and health: A systematic review. *PloS ONE, 11*(11), e0165797. doi:10.1371/journal.pone.0165797

Allen, C. (2019). *Community-based social marketing: An investigation of sustainable behavioral change strategies at the municipality level in Sweden* (Publication No. 2019/10) [Master's Thesis, Uppsala University]. Department of Earth Sciences, Uppsala University.

Aloise-Young, P. (2012, February). *The importance of behavioral plasticity for energy/carbon savings* [Presentation]. Climate, Mind, and Behavior Symposium, The Garrison Institute, Garrison, NY, United States. https://www.youtube.com/watch?v=LcVOstgl2n4

Andreasen, A. R. (1994). Social marketing: Its definition and domain. *Journal of Public Policy & Marketing, 13*(1), 108-114.

Aronoff, J., Champion, B., Lauer, C., & Pahwa, A. (2013). Teaching old dogs new tricks: The effectiveness of community-based social marketing on energy conservation for sustainable university campuses. *IEEE Power & Energy Magazine, 11*(1), 30-38. doi:10.1109/MPE.2012.2225234

Asch, S. E. (1955). Opinions and social pressure. *Scientific American, 193*(5), 31-35. https://www.jstor.org/stable/24943779

Athey, V. L., Suckling, R. J., Tod, A. M., Walters, S. J., & Rogers, T. (2012). Early diagnosis of lung cancer: Evaluation of a community-based social marketing intervention. *Thorax, 67*, 412-417. doi:10.1136/thoraxjnl-2011-200714

Berinsky, A. J., Margolis, M. F., & Sances, M. W. (2016). Can we turn shirkers into workers? *Journal of Experimental Social Psychology, 66*, 20-28. http://dx.doi.org/10.1016/j.jesp.2015.09.010

Brysbaert, M. (2019). How many participants do we have to include in properly powered experiments? A tutorial of power analysis with reference tables. *Journal of Cognition, 2*(1), 1-38. https://doi.org/10.5334/joc.72

Carrico, A., & Riemer, M. (2011). Motivating energy conservation in the workplace: An evaluation of the use of group-level feedback and peer education. *Journal of Environmental Psychology, 31*, 1-13. doi:10.1016/j.jenvp.2010.11.004

City of Fort Collins. (2021). *Green energy: Purchasing clean, renewable energy*. Utilities. https://www.fcgov.com/utilities/residential/renewables/green-energy

City of Fort Collins. (2017). *Fort Collins travel diary study: Report of results.* https://www.fcgov.com/transportation/pdf/Fort_Collins_Travel_Diary_Report_2017-07-24.pdf

Cleveland Clinic. (2021). *What is the flexitarian diet? What to know about this semi-vegetarian lifestyle*. Health Essentials. https://health.clevelandclinic.org/what-is-the-flexitarian-diet/

Cole, E. J., & Fieselman, L. (2013). A community-based social marketing campaign at Pacific University Oregon: Recycling, paper reduction, and environmentally preferable purchasing. *International Journal of Sustainability in Higher Education, 14*(2), 176-195. doi:10.1108/14676371311312888

Colorado State University [CSU]. (2021). *FY21 fact book*. http://irpe-reports.colostate.edu/pdf/fbk/2021/Fact_Book_Partial_FY21.pdf

Cooper, C. (2007). Successfully changing individual travel behavior: Applying community-based social marketing to travel choice. *Journal of the Transportation Research Board, 2021*, 89-99. doi:10.3141/2021-11

Costa, D. L., & Kahn, M. E. (2013). Energy conservation "nudges" and environmentalist ideology: Evidence from a randomized residential electricity field experiment. *Journal of the European Economic Association, 11*(3), 680-702. https://doi.org/10.1111/jeea.12011

Davis, J. L., Green, J. D., & Reed, A. (2009). Interdependence with the environment: Commitment, interconnectedness, and environmental behavior. *Journal of Environmental Psychology, 29*, 173-180. doi:10.1016/j.jenvp.2008.11.001

Davis, J. L., Le, B., & Coy, A. E. (2011). Building a model of commitment to the natural environment to predict ecological behavior and willingness to sacrifice. *Journal of Environmental Psychology, 31,* 257-265. doi:10.1016/j.jenvp.2011.01.004

Dennis, M., Soderstrom, E. J., Koncinski, W., & Cavanaugh, B. (1990). Effective dissemination of energy-related information: Applied social psychology and evaluation research. *American Psychologist, 45*(10), 1109-1117.

Department of Energy. (2012). *2011 buildings energy data book*. https://ieer.org/wp/wp-content/uploads/2012/03/DOE-2011-Buildings-Energy-DataBook-BEDB.pdf

Department of Energy. (n.d.). *When to turn off your lights.* Energy saver. https://www.energy.gov/energysaver/save-electricity-and-fuel

Department of Transportation. (2019). *Annual vehicle distance traveled in miles and related data*. https://www.fhwa.dot.gov/policyinformation/statistics/2019/pdf/vm1.pdf

Desrochers, J. E., Albert, G., Milfont, T. L., Kelly, B., & Arnocky, S. (2019). Does personality mediate the relationship between sex and environmentalism? *Personality and Individual Differences, 147*, 204-213. https://doi.org/10.1016/j.paid.2019.04.026

Donnelly, K., & Twenge, J. M. (2017). Masculine and feminine traits on the Bem Sex-Role Inventory, 1993-2012. A cross-temporal meta-analysis. *Sex Roles, 76*, 556-565. doi:10.1007/s11199-016-0625-y

Dunlap, R. E., & Van Liere, K. D. (1978). The new environmental paradigm: A proposed measuring instrument and preliminary results. *Journal of Environmental Education, 9*, 10-19.

Dunlap, R. E., & Van Liere, K. D. (1984). Commitment to the dominant social paradigm and concern for environmental quality. *Social Science Quarterly, 65*, 1013-1028.

Dunlap, R. E., Van Liere, K. D., Mertig, A. G., & Jones, R. E. (2000). Measuring endorsement of the new ecological paradigm: A revised NEP scale. *Journal of Social Issues, 56*, 3, 425-442. doi:10.1111/0022-4537.00176

Ebi, K. L., Balbus, J. M., Luber, G., Bole, A., Crimmins, A., Glass, G., Saha, S., Shimamoto, M. M., Trtanj, J., & White-Newsome, J. L. (2018). Human health. In D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, & B. C. Stewart (Eds.), *Impacts, risks, adaptation in the United States: Fourth national climate assessment* (Vol. 2). (pp. 539-571). U. S. Global Change Research Program. doi:10.7930/NCA4.2018.CH14

Frantz, C. M., Flynn, B., Atwood, S., Mostow, D., Xu, C., & Kahl, S. (2016). Changing energy behavior through community based social marketing. In W. L. Filho & M. Zint (Eds.), *The contribution of social sciences to sustainable development at universities* (pp. 259-272). Springer.

Fry, R. (2019, October 1). *The number of people in the average U.S. household is going up for the first time in over 160 years*. Pew Research Center. https://www.pewresearch.org/fact-tank/2019/10/01/the-number-of-people-in-the-average-u-s-household-is-going-up-for-the-first-time-in-over-160-years/

Funder, D. C., & Ozer, D. J. (2019). Evaluating effect size in psychology research: Sense and nonsense. *Advances in Methods and Practices in Psychological Science, 2*(2), 156-168. doi:10.1177/2515245919847202

Funk, C. (2021, May 26). *Key findings: How Americans' attitudes about climate change differ by generation, party and other factors*. Pew Research Center. https://www.pewresearch.org/fact-tank/2021/05/26/key-findings-how-americans-attitudes-about-climate-change-differ-by-generation-party-and-other-factors/

Geller, E. S. (1981). Evaluating energy conservation programs: Is verbal report enough? *Journal of Consumer Research, 8*(3), p. 331-335.

Geller, E. S., Erickson, J. B., & Buttram, B. A. (1983). Attempts to promote residential water conservation with educational, behavioral, and engineering strategies. *Population and Environment, 6*(2), 96-112.

Geller, E. S. (1989). Applied behavior analysis and social marketing: An integration for environmental preservation. *Journal of Social Issues, 45*(1), 17-36.

Geller, E. S. (1992). It takes more than information to save energy. *American Psychologist, 47*(6), 814-815.

Gifford, R., & Nilsson, A. (2014). Personal and social factors that influence pro-environmental concern and behaviour: A review. *International Journal of Psychology, 49*(3), 141-157. doi:10.1002/ijop.12034

Green, K. M., Crawford, B. A., Williamson, K. A., & DeWan, A. A. (2019). A meta-analysis of social marketing campaigns to improve global conservation outcomes. *Social Marketing Quarterly, 25*(1), 69-87. doi:10.1177/1524500418824258

Grimes, A., Chrisman, M., & Lightner, J. (2020). Barriers and motivators of bicycling by gender among older adult bicyclists in the Midwest. *Health Education & Behavior, 47*(1), 67-77. https://doi.org/10.1177/1090198119879731

Guest, G., Namey, E., & Chen, M. (2020). A simple method to assess and report thematic saturation in qualitative research. *PloS ONE 15*(5), e0232076. https://doi.org/10.1371/journal.pone.0232076

Haldeman, T., & Turner, J. W. (2009). Implementing a community-based social marketing program to increase recycling. *Social Marketing Quarterly*, *15*(3), 114-127. http://dx.doi.org/10.1080/15245000903154618

Hamilton, L. C., Hartter, J., & Saito, K. (2015). Trust in scientists on climate change and vaccines. *SAGE Open, 5*(3), 1-13. doi:10.1177/2158244015602752

Hawken, P. (Ed.). (2017). *Drawdown: The most comprehensive plan ever proposed to reverse global warming*. Penguin Books.

Hedenus, F., & Wirsenius, S. (2014). The importance of reduced meat and dairy consumption for meeting stringent climate change targets. *Climate Change, 124,* 79-91. doi:10.1007/s10584-014-1104-5

Heller, M., & Keoleian, G. A. (2014). Greenhouse gas emission estimates of U.S. dietary choices and food loss. *Journal of Industrial Ecology, 19*(3). doi:10.1111/jiec.12174

Helmreich, R. L., Spence, J. T., & Wilhelm, J. A. (1981). A psychometric analysis of the Personal Attributes Questionnaire. *Sex Roles, 7,* 1097-1108.

Hmielowski, J. D., Feldman, L., Myers, T. A., Leiserowitz, A., & Maibach, E. (2014). An attack on science? Media use, trust in scientists, and perceptions of global warming. *Public Understanding of Science, 23*(7), 866-883. doi:10.1177/0963662513480091

Hodges, T. (2010). *Public transportation's role in responding to climate change*. U.S. Department of Transportation Federal Transit Administration. https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/PublicTransportationsRoleInRespondingToClimateChange2010.pdf

Hurst, K., & Stern, M. J. (2020). Messaging for environmental action: The role of moral framing and message source. *Journal of Environmental Psychology, 68*, 101394. https://doi.org/10.1016/j.jenvp.2020.101394

Ivanova, D., Stadler, K., Steen-Olsen, K., Wood, R., Vita, G., Tukker, A., & Hertwich, E. (2015). Environmental impact assessment of household consumption. *Journal of Industrial Ecology, 20*(3), 526-536. doi:10.1111/jiec.12371

Jantarasami, L. C., Novak, R., Delgado, R., Marino, E., McNeeley, S., Narducci, C., Raymond-Yakoubian, J., Singletary, L., & Powys Whyte, K. (2018). Tribes and indigenous peoples. In D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, & B. C. Stewart (Eds.), *Impacts, risks, adaptation in the United States: Fourth national climate assessment* (Vol. 2). (pp. 572-603). U. S. Global Change Research Program. doi:10.7930/NCA4.2018.CH15

Jay, A., Reidmiller, D. R., Avery, C. W., Barrie, D., DeAngelo, B. J., Dave, A., Dzaugis, M., Kolian, M., Lewis, K. L. M., Reeves, K., & Winner, D. (2018). Overview. In D. R. Reidmiller, C. W. Avery, D. R. Easterling, K. E. Kunkel, K. L. M. Lewis, T. K. Maycock, & B. C. Stewart (Eds.), *Impacts, risks, adaptation in the United States: Fourth national climate assessment* (Vol. 2). (pp. 33-71). U.S. Global Change Research Program. doi:10.7930/NCA4.2018.CH1

Kaiser, F., Hübner, G., & Bogner, F. (2005). Contrasting the theory of planned behavior with the value-belief-norm model in explaining conservation behavior. *Journal of Applied Social Psychology, 35*(10), 2150-2170. doi:10.1111/j.1559-1816.2005.tb02213.x

Kennedy, A. (2010). Using community-based social marketing techniques to enhance environmental regulation. *Sustainability*, 2, 1138-1160. doi:10.3390/su2041138

Kotler, P., & Zaltman, G. (1971). Social marketing: An approach to planned social change. *Journal of Marketing, 35*, 3-12.

Lamb, A., Green, R., Bateman, I., Broadmeadow, M., Bruce, T., Burney, J., Carey, P., Chadwick, D., Crane, E., Field, R., Goulding, K., Griffiths, H., Hastings, A., Kasoar, T., Kindred, D., Phalan, B., Pickett, J., Smith, P., Wall, E., … Balmford, A. (2016). The potential for land sparing to offset greenhouse gas emissions from agriculture. Nature Climate Change, 6, 488-492. https://doi.org/10.1038/nclimate2910

López-Mosquera, N., & Sánchez, M. (2012). Theory of planned behavior and the value-belief-norm theory explaining willingness to pay for a suburban park. *Journal of Environmental Management, 113*, 251-262. http://dx.doi.org/10.1016/j.jenvman.2012.08.029

Lovakov, A., & Agadullina, E. R. (2021). Empirically derived guidelines for effect size interpretation in social psychology. *European Journal of Social Psychology, 51*(3), 485-504. https://doi.org/10.1002/ejsp.2752

Lynes, J., Whitney, S., & Murray, D. (2014). Developing benchmark criteria for assessing community-based social marketing programs: A look into Jack Johnson's "All at Once" campaign. *Journal of Social Marketing, 4*(2), 111-132. doi:10.1108/JSOCM-08-2013-0060

Markowski, K. L., & Roxburgh, S. (2019). "If I became vegan, my family and friends would hate me:" Anticipating vegan stigma as a barrier to plant-based diets. *Appetite, 135*, 1-9. https://doi.org/10.1016/j.appet.2018.12.040

Mayer, F. S., & Frantz, C. M. (2004). The connectedness to nature scale: A measure of individuals' feeling in community with nature. *Journal of Environmental Psychology, 24*, 503-515. doi:10.1016/j.jenvp.2004.10.001

McHugh, M. L. (2012). Interrater reliability: The kappa statistic. *Biochemia Medica, 22*(3), 276-282. https://doi.org/10.11613/BM.2012.031

McKenzie-Mohr, D. (2000). Fostering sustainable behavior through community-based social marketing. *American Psychologist, 55*(5), 531-537. doi:10.1037//0003-066X.55.5.531

McKenzie-Mohr, D. (2011). *Fostering sustainable behavior: An introduction to community-based social marketing* (3rd edition). New Society Publishers.

McKenzie-Mohr, D. (2013). *Quick reference: Community-Based Social Marketing.* https://savetheirl.org/wp-content/uploads/CBSM-Quick-Guide.pdf

Midden, C., Meter, J., Weenig, H., & Zieverink, H. (1983). Using feedback, reinforcement and information to reduce energy consumption in households: A field experiment. *Journal of Economic Psychology, 3*, 65-86.

Milfont, T. L., & Sibley, C. G. (2016). Empathic and social dominance orientations help explain gender differences in environmentalism: A one-year Bayesian mediation analysis. *Personality and Individual Differences, 90*, 85-88. http://dx.doi.org/10.1016/j.paid.2015.10.044

National Center for Education Statistics. (2019, December). *Enrollment in elementary, secondary, and degree-granting post-secondary institutions, by level and control of institution: Selected years, 1869-70 through fall 2029.* https://nces.ed.gov/programs/digest/d19/tables/dt19_105.30.asp

Nisbet, E. K., Zelenski, J. M., & Murphy, S. A. (2009). The nature relatedness scale: Linking individuals' connection with nature to environmental concern and behavior. *Environment and Behavior, 41*(5), 715-740. doi:10.1177/0013916508318748

Olsson, L., Opondo, M., Tschakert, P., Agrawal, A., Eriksen, S. H., Ma, S., Perch, L. N., & Zakieldeen, S. A. (2014). Livelihoods and poverty. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, & L. L. White (Eds.), *Climate change 2014: Impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects. Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate change*. (pp. 793-832). Cambridge University Press.

Pakula, C., & Stamminger, R. (2010). Electricity and water consumption for laundry washing by washing machine worldwide. *Energy Efficiency, 3*, 365-382. https://doi.org/10.1007/s12053-009-9072-8

Parish, J. A., Rivera, J. D., & Boland, H. T. (2017). *Understanding the ruminant animal digestive system*. Mississippi State University Extension. http://extension.msstate.edu/sites/default/files/publications/publications/p2503.pdf

Pew Research Center. (2016, October 1). *1. Public views on climate change and climate scientists.* https://www.pewresearch.org/science/2016/10/04/public-views-on-climate-change-and-climate-scientists/

Platte River Power Authority. (2020). *Who we serve: Our communities*. Retrieved November 21, 2020, from https://www.prpa.org/about-prpa/who-we-serve/

Pohjolainen, P., Vinnari, M., & Jokinen, P. (2013). Consumers' perceived barriers to following a plant-based diet. *British Food Journal, 117*(3), 1150-1167. https://doi.org/10.1108/BFJ-09-2013-0252

Project Drawdown. (2020). *Drawdown 2020*. https://drawdown.org/

Reaves, D. (2014). *Identifying perceived barriers and benefits to reducing energy consumption in an affordable housing complex using the Community-Based Social Marketing Model* (Publication No. 1651621326 [Master's thesis, Colorado State University]. ProQuest Dissertations Publishing.

Reinhart, R. J. (2018, August 1). *Snapshot: Few Americans vegetarian or vegan*. Gallup. https://news.gallup.com/poll/238328/snapshot-few-americans-vegetarian-vegan.aspx

Rothgerber, H. (2013). Real men don't eat (vegetable) quiche: Masculinity and the justification of meat consumption. *Psychology of Men & Masculinity, 14*(4), 363-375. https://doi.org/10.1037/a0030379

Sandoval, P. (2017). *Formative evaluation of the behavior change components within a Colorado weatherization assistance program* (Publication No. 10640689) [Master's thesis, Colorado State University]. ProQuest LLC.

Schlömer, S., Bruckner, L., Fulton, L., Hertwich, E., McKinnon, A., Perczyk, D., Roy, J., Schaeffer, R., Sims, R., Smith, P., & Wiser, R. (2014). Annex III: Technology-specific cost and performance parameters. In: *Climate Change 2014: Mitigation of climate change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge, United Kingdom and New York, NY, USA.*

Schultz, P. W., Colehour, J., Vohr, J., Bonn, L., Bullock, A., & Sadler, A. Using social marketing to spur residential adoption of ENERGY STAR®-certified LED lighting. *Social Marketing Quarterly, 21*(2), 61-78. doi:10.1177/1524500415577429

Schuster, L., Kubacki, K., & Rundle-Thiele, S. (2016). Community-based social marketing: Effects on social norms. *Journal of Social Marketing, 6*(2), 193-210. doi:10.1108/JSOCM-06-2015-0036

Schwartz, S. H. (1973). Normative explanations of helping behavior: A critique, proposal, and empirical test. *Journal of Experimental Social Psychology, 9*, 349-364.

Siegmund, P., Abermann, J., Baddour, O., Canadell, P., Cazenave, A., Derksen, C., Garreau, A., Huss, M., Isensee, K., Kennedy, J., Mottram, R., Nitu, R., Ramasamy, S., Schoo, K., Sparrow, M., Tarasova, O., Trewin, B., & Ziese, M. (2019). *The global climate in 2015-2019*. World Meteorological Association. https://library.wmo.int/doc_num.php?explnum_id=9936

Sinha, P., Schew, W. A., Sawant, A., Kolwaite, K. J., & Strode, S. A. (2010). Greenhouse gas emissions from U.S. institutions of higher education. *Journal of the Air & Waste Management Association, 60*(5), 568-573. doi:10.3155/1047-3289.60.5.568

Smiler, A. P. (2004). Thirty years after the discovery of gender: Psychological concepts and measures of masculinity. *Sex Roles, 50*(1/2), 15-26. doi:10.1023/b:sers.0000011069.02279.4c

Smith, K. R., Woodward, A., Campbell-Lendrum, D., Chadee, D. D., Honda, Y., Liu, Q., Olwoch, J. M., Revich, B., & Sauerborn, R. (2014). Human health: Impacts, adaptation, and co-benefits. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, & L. L. White (Eds.), *Climate change 2014: Impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects. Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate change*. (pp. 709-754). Cambridge University Press.

Song, M.-K., Lin, F.-C., Ward, S. E., & Fine, J. P. (2013). Composite variables: When and how. *Nursing Research, 62*(1). doi:10.1097/NNR.0b013e3182741948

Spence, J. T. (1993). Gender-related traits and gender ideology: Evidence for a multifactorial theory. *Journal of Personality and Social Psychology, 64*(4), 624-635.

Spence, J. T., & Helmreich, R. L. (1978). *Masculinity & femininity: Their Psychological Dimensions, Correlates, and Antecedents.* University of Texas Press.

Statista. (2019). *Living arrangements for undergraduate students in the U.S. in 2018*. Education & science. https://www.statista.com/statistics/914589/us-college-living-arrangements-undergraduate-students/

Stern, P. C., Dietz, T., & Kalof, L. (1993). Value orientations, gender, and environmental concern. *Environment & Behavior, 25*, 322-348.

Steg, L., Dreijerink, L., & Abrahamse, W. (2005). Factors influencing the acceptability of energy policies: A test of VBN theory. *Journal of Environmental Psychology, 25*, 415-425. doi:10.1016/j.jenvp.2005.08.003

Storz, M. A. (2021). What makes a plant-based diet? A review of current concepts and proposal for a standardized plant-based dietary intervention checklist. *European Journal of Clinical Nutrition*. https://doi.org/10.1038/s41430-021-01023-z

Streimikiene, D., & Vveinhardt, J. (2015). Community based social marketing for implementation of energy saving targets at local level. *Amfiteatru Economic Journal, 17*(39), 723-734.

Swim, J., Clayton, S., Doherty, T., Gifford, R., Howard, G., Reser, J., Stern, P., & Weber, E. (2011). *Psychology & global climate change: Addressing a multifaceted phenomenon and set of challenges*. The American Psychological Association Task Force on the Interface Between Psychology and Global Climate Change. https://www.apa.org/science/about/publications/climate-change-booklet.pdf

Ta, V. P. (2017). A meta-analytic review of gender-role dimensions and relationship satisfaction. *Journal of Relationships Research, 8*(e18), 1-14. doi:10.1017/jrr.2017.18

Takahashi, B. (2009). Social marketing for the environment: An assessment of theory and practice. *Applied Environmental Education and Communication, 8*(2), 135-145. doi:10.1080/15330150903135889

Tukker, A., & Jansen, B. (2006). Environmental impacts of products. *Journal of Industrial Ecology, 10*(3), 159-182. doi:10.1162/jiec.2006.10.3.159

Twenge, J. (1997). Changes in masculine and feminine traits over time: A meta-analysis. *Sex Roles, 36*(5/6), 305-235.

United States Census Bureau. (2020, August 15). *U.S. and world population clock.* https://www.census.gov/popclock/

United States Census Bureau. (2019). *QuickFacts: Fort Collins city, Colorado*. https://www.census.gov/quickfacts/fact/table/fortcollinscitycolorado/HSD310218#HSD310218

United States Energy Information Administration. (2021, February 3). *How much electricity is used for lighting in the United States?* Frequently asked questions (FAQS). https://www.eia.gov/tools/faqs/faq.php?id=99&t=3

United States Environmental Protection Agency. (2017, February 14). Understanding global warming potentials. https://www.epa.gov/ghgemissions/understanding-global-warming-potentials

United States Environmental Protection Agency. (2020). *DRAFT inventory of U.S. greenhouse gas emissions and sinks: 1990-2018.* https://www.epa.gov/sites/production/files/2020-02/documents/us-ghg-inventory-2020-main-text.pdf

U.S. News. (2020). *Colorado State University Student Life*. https://www.usnews.com/best-colleges/colorado-state-university-1350/student-life

Vasileiou, K., Barnett, J., Thorpe, S., & Young, T. (2018). Characterising and justifying sample size sufficiency in interview-based studies: Systematic analysis of qualitative health research over a 15-year period. *BMC Medical Research Methodology, 18*, 148. https://doi.org/10.1186/s12874-018-0594-7

Vigen, M., & Mazur-Stommen, S. (2012). *Reaching the "high-hanging fruit" through behavior change: How community-based social marketing puts energy savings within reach.* American Council for an Energy-Efficient Economy. http://www.aceee.org/files/pdf/white-paper/high-hanging-fruit-cbsm.pdf

Vita, G., Lundström, J. R., Hertwich, E. G., Quist, J., Ivanova, D., Stadler, K., & Wood, R. (2019). The environmental impact of green consumption and sufficiency lifestyles scenarios in Europe: Connecting local sustainability visions to global consequences. *Ecological Economics, 164*, 106322. https://doi.org/10.1016/j.ecolecon.2019.05.002

Ward, L. C., Thorn, B. E., Clements, K. L., Dixon, K. E., & Sanford, S. D. (2006). Measurement of agency, communion, and emotional vulnerability with the Personal Attributes Questoinnaire. *Journal of Personality Assessment, 86*(2), 206-216. doi:10.1207/s15327752jpa8602_10

Whitburn, J., Linklater, W., & Abrahamse, W. (2020). Meta-analysis of human connection to nature and proenvironmental behavior. *Conservation Biology, 34*(1), 180-193. doi:10.1111/cobi.13381

Whorley, M. R., & Addis, M. E. (2006). Ten years of psychological research on men and masculinity in the United States: Dominant methodological trends. *Sex Roles, 55*, 649-658. doi:10.1007/s11199-006-9120-1

Withall, J., Jago, R., & Fox, K. R. (2012). The effect of a community-based social marketing campaign on recruitment and retention of low-income groups into physical activity programmes: A controlled before-and-after study. *BMC Public Health, 12*. http://www.biomedcentral.com/1471-2458/12/836

Wynes, S., & Nicholas, K. (2017). The climate mitigation gap: Education and government recommendations miss the most effective individual actions. *Environmental Research Letters, 12*, 074024. https://doi.org/10.1088/1748-9326/aa7541

Wynveen, C. J., Wynveen, B. J., & Sutton, S. G. (2015). Applying the value-belief-norm theory to marine contexts: Implications for encouraging pro-environmental behavior. *Coastal Management, 43*(1), 84-103. doi:10.1080/08920753.2014.989149

Yamin, P., Fei, M., Lahlou, S., & Levy, S. Using social norms to change behavior and increase sustainability in the real world: A systematic review of the literature. *Sustainability, 11*, 5847. https://doi.org/10.3390/su11205847

Yuriev, A., Dahmen, M., Paillé, P., Boiral, O., & Guillaumie, L. (2020). Pro-environmental behaviors through the lens of the theory of planned behavior: A scoping review. *Resources, Conservation & Recycling, 155*, 104660. https://doi.org/10.1016/j.resconrec.2019.104660

Zelezny, L. C., Chua, P.-P., Aldrich, C. (2000). Elaborating on gender differences in environmentalism. *Journal of Social Issues, 56*(3), 443-457.

Ziegler, A. (2017). Political orientation, environmental values, and climate change beliefs and attitudes: An empirical cross country analysis. *Energy Economics, 63*, 144-153. http://dx.doi.org/10.1016/j.eneco.2017.01.022

APPENDIX A

Table A.1. **Initial List of Behaviors**

Abandoned farmland restoration [a]	Green and cool roofs [a]	Peatland protection and rewetting [a]
Alternative cement [a]	Grid flexibility [a]	Perennial biomass production [a]
Alternative refrigerants [a]	**Hanging laundry to dry [b]**	Perennial staple crops [a]
Avoid medium flight [b]	Having one fewer child [b]	Plant a tree [b]
Bamboo production [a]	Health and education [a]	**Plant-based diet [a, b]**
Bicycle infrastructure [a]	High-efficiency heat pumps [a]	**Purchasing green energy credits [b]**
Biochar production [a]	High-performance glass [a]	Purchase carbon offsets [b]
Biogas for cooking [a]	High-speed rail [a]	**Recycling at home [b]**
Biomass power [a]	Hybrid cars [a]	Reduce lawn mowing [b]
Bioplastics [a]	Improved clean cookstoves [a]	Refrigerant management [a]
Building automation systems [a]	Improved rice production [a]	Rooftop solar [a]
Building retrofitting [a]	Indigenous Peoples' forest tenure [a]	Run full dishwasher [b]
Buy Ecolabel products [b]	**Installing CFL/LED bulbs [b]**	Silvopasture [a]
Buy energy efficient appliances [b]	Insulation [a, b]	Small hydropower [a]
Calculate home's footprint [b]	Keep backyard chickens	Smart thermostats [a]
Coastal wetland protection [a]	Landfill methane capture [a]	Solar hot water [a]
Coastal wetland restoration [a]	**Laundry in cold water [b]**	Sustainable intensification for smallholders [a]
Composting [b]	Low-flow fixtures [a]	System of rice intensification [a]
Concentrated solar power [a]	**Living motor vehicle free [b]**	Telepresence [a]
Conservation agriculture [a]	**Living personal vehicle free [b]**	Temperate forest restoration [a]
Distributed energy storage [a]	Managed grazing [a]	Tree intercropping [a]
Distributed solar photovoltaics [a]	**Meatless day (one/week) [b]**	Tree plantations on degraded land [a]
District heating [a]	Methane digesters [a]	Tropical forest restoration [a]
Dynamic glass [a]	Micro wind turbines [a]	Turning off electronics [d]
Efficient aviation [a]	Microgrids [a]	Turning off lights [d]
Efficient ocean shipping [a]	Multistrata agroforestry [a]	Use reusable shopping bags [b]
Efficient trucks [a]	Net-zero buildings [a]	Utility-scale energy storage [a]
Electric bicycles [a]	**Non-ruminant diet [c]**	Utility-scale solar photovoltaics [a]
Electric cars [a, b]	Nuclear power [a]	**Vegan diet [b]**
Electric trains [a]	Nutrient management [a]	**Vegetarian diet [b]**
Farm irrigation efficiency [a]	Ocean power [a]	Walkable cities [a]
Forest protection [a]	Offshore wind turbines [a]	Waste-to-energy [a]
Geothermal power [a]	Onshore wind turbines [a]	Water distribution efficiency [a]
Grassland protection [a]	Pay bills online [b]	

Note. Behaviors in bold are those deemed relevant to the current study's target audience.
[a] Project Drawdown (2020)
[b] Wynes and Nicholas (2017)
[c] Aleksandrowicz et al. (2016)

APPENDIX B

Table B.1. **CBSM Questions from the Phase 2 Survey**
Note. Wording that changed based on whether participants lived on- or off-campus is marked with brackets.

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?

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

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 1
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7

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

APPENDIX C

Table C.1. **Demographic Questions**

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

APPENDIX D

Table D.1. **The Commitment to the Environment (CTE) Scale (Davis et al., 2009)**

Section 3: For the next section, you'll be asked to consider how much you **personally relate** to a series of statements. Please read each statement carefully. Then use the following scale to record your answers: 0 (do not agree at all) to 8 (agree completely).

To what extent do you agree with these statements?

	Do not agree at all				Agree somewhat				Agree completely
I am interested in strengthening my connection to the environment in the future.	○	○	○	○	○	○	○	○	○
I feel strongly linked to the environment.	○	○	○	○	○	○	○	○	○
When I make plans for myself, I take into account how my decisions may affect the environment.	○	○	○	○	○	○	○	○	○
It seems to me that humans and the environment are interdependent.	○	○	○	○	○	○	○	○	○
It makes me feel good when something happens that benefits the environment.	○	○	○	○	○	○	○	○	○
Feeling a connection with the environment is important to me.	○	○	○	○	○	○	○	○	○
I expect that I will always feel a strong connection with the environment.	○	○	○	○	○	○	○	○	○
I believe that the well-being of the natural environment can affect my own well-being.	○	○	○	○	○	○	○	○	○
It is unlikely that I'll feel a connection to the environment in the future.	○	○	○	○	○	○	○	○	○
I feel very attached to the natural environment.	○	○	○	○	○	○	○	○	○
I feel committed to keeping the best interests of the environment in mind.	○	○	○	○	○	○	○	○	○

APPENDIX E

Table E.1. **The Personal Attributes Questionnaire (PAQ)**

Section 4: Instructions

The items below ask about what kind of person you think you are. Each item consists of a pair of characteristics, with the letters A-E in between. For example:

Not at all artistic A - B - C - D - E Very artistic

Each pair describes contradictory characteristics - that is, you cannot be both at the same time, such as very artistic and not at all artistic.

The letters form a scale between the two extremes. **Please choose the letter that best describes where you fall along the scale.** For example, if you think that you have no artistic ability, you would choose A. If you think that you are pretty good, you might choose D. If you are only medium, you might choose C, and so forth.

Please read each pair of items carefully. Then select the response that best represents who you are.

	A	B	C	D	E	
Not at all aggressive	○	○	○	○	○	Very aggressive
Not at all independent	○	○	○	○	○	Very independent
Not at all emotional	○	○	○	○	○	Very emotional
Very submissive	○	○	○	○	○	Very dominant
Not at all excitable in a major crisis	○	○	○	○	○	Very excitable in a major crisis
Very passive	○	○	○	○	○	Very active
Not at all able to devote self completely to others	○	○	○	○	○	Able to devote self completely to others
Very rough	○	○	○	○	○	Very gentle
Not at all helpful to others	○	○	○	○	○	Very helpful to others
Not at all competitive	○	○	○	○	○	Very competitive
Very home-oriented	○	○	○	○	○	Very worldly
Not at all kind	○	○	○	○	○	Very kind
Indifferent to others' approval	○	○	○	○	○	Highly needful of others' approval
Feelings not easily hurt	○	○	○	○	○	Feelings easily hurt

	A	B	C	D	E	
Not at all aware of feelings of others	○	○	○	○	○	Very aware of feelings of others
Can make decisions easily	○	○	○	○	○	Has difficulty making decisions
Gives up very easily	○	○	○	○	○	Never gives up easily
Never cries	○	○	○	○	○	Cries very easily
Not at all self-confident	○	○	○	○	○	Very self-confident
Feels very inferior	○	○	○	○	○	Feel very superior
Not at all understanding of others	○	○	○	○	○	Very understanding of others
Very cold in relations with others	○	○	○	○	○	Very warm in relations with others
Very little need for security	○	○	○	○	○	Very strong need for security
Goes to pieces under pressure	○	○	○	○	○	Stands up well under pressure

APPENDIX F

Table F.1. **Climate Change Beliefs and Trust in Authorities Questions**

In this last section, you'll be asked to think about a few more personal characteristics and opinions.

Please read each item carefully. Then select the answer that best represents you.

Do you think global climate change is happening?
- o Yes
- o No
- o I don't know

[If yes or no] How sure are you about that position?
- o Not at all sure
- o Somewhat sure
- o Very sure
- o Extremely sure

Do you think global climate change is caused by human activities?
- o Yes
- o No
- o I don't know

[If yes or no] How sure are you about that position?
- o Not at all sure
- o Somewhat sure
- o Very sure
- o Extremely sure

How much, if at all, do you trust each of the following groups to give full and accurate information about the causes of global climate change?

	Not at all	Not too much	Some	A lot
Elected officials (for example, U.S. mayors, governors, or presidents)	○	○	○	○
Appointed officials (for example, the U.S. Secretary of State or the Administrator of the EPA)	○	○	○	○
Climate scientists	○	○	○	○
Energy industry leaders	○	○	○	○
News media	○	○	○	○

APPENDIX G

Table G.1. **CBSM Questions from the Phase 3 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.

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 1 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.

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. _____

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: _____

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. _____

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. _____

[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.

	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	○	○	○	○

Please indicate how **healthy** you think it is to engage in each behavior.
Please indicate how **masculine** you think it is to engage in each behavior.
Please indicate how **feminine** you think it is to engage in each behavior.

	Not at all [characteristic]	Slightly [characteristic]	Moderately [characteristic]	Very [characteristic]	Not applicable
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 H

Table H.1. **Benefit Codebook**

Code	Description	Examples	Counter-examples
Easy	•The participant thinks that engaging in this behavior is easy. They don't see it as challenging, and they think it's 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 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.	•"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." •“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 doesn't 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."
Climate change	•The participant specifically mentions climate change or reduced emissions. This could include global warming, greenhouse gas emissions, carbon emissions, CO2 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're 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 doesn't 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's better. •They might mention their health, but they don't explain whether it's 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!"
Vague global benefit	•The participant doesn't 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 don't explain how it's 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 aren't 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."
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're looking for is not represented in the codebook. After 'Other', include a description of the new idea or code.	-	-

Table H.2. Barrier Codebook

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 •Isn't affordable for someone like me •Less expensive option(s) available	Plant	"Meat alternatives cost more."	NOT "Many Americans would find themselves without jobs." [Burden for Others]
		Bulb GEC	"I can't afford that in my budget."	-
		Plane	"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	"I don't know any plant-based recipes."	-
		Bulb	"Where do I find these bulbs?"	
		GEC	"I had no information about GECs from my utility company."	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]
		Motor	"Inability to ride a bike."	-
		Plane	"I need to learn how to use GPS."	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]
Inconvenient	•Too difficult or time-consuming •Limited availability	Plant	"I use meat as a central source of protein."	-

	•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)	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."	
Lack of control	•Someone else controls the behavior •Environment blocks performing the behavior •Can be real or perceived •Markers include can’t, have to, •Not 'too difficult' [inconvenient], 'unable for health reasons' [health concern], or 'not enough information' [lack of knowledge]	Plant	"My family cooks dinner for me."	-
		Bulb	"I don't install my own bulbs."	
		GEC	"I don't pay for my own electricity."	
		Motor	"There are no walking paths, roads with a shoulder, or bike paths."	NOT "Inability to ride a bike." [Lack of Knowledge]
		Plane	"I don't own a car."	-

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	"Toxic masculinity."	-
		Bulb	"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]

Table H.3. **Ways to Overcome Codebook**

Code	Description	Behavior	Examples	Counter-examples
Increased affordability	•Decreased cost OR increased income	Plant Bulb GEC Motor Plane	"To be easier would be the pricing and how much it would cost." "It would also be easier if I was making a larger income."	-
Adjust mindset	•Cognitive restructuring is needed •Includes focusing on the benefits •Includes needing to remember to do the behavior •Also includes compromising (engaging anyway, despite the challenges; enduring)	Plant	"I adjusted my mindset and my taste buds changed."	-
		Bulb	"This is something I don't think about often, so it's something I just have to remember to do."	
		GEC	"I could consider the long-term benefit from it."	
		Motor	"I usually just suck it up and bike anyway."	
Social influence	•I influence others to engage in the behavior •Others influence me to engage in the behavior •Not providing assistance [social assistance]	Bulb	"I try to influence others who may be installing lightbulbs to use CFL instead of regular."	-
Social assistance	•I provide assistance to others •Others provide assistance to me •Not encouraging others to engage [social influence]	Plant	"If my family followed a plant-based diet, it'd be easier for me to."	-
		Plane	"Having two drivers helps us stay more attentive to the road and prevent accidents."	
Increased accessibility	•Behavior should be more accessible or visible •Includes better labeling, advertising, promotion, … •Includes improvement to the alternative's support structure that makes behavior or alternative more accessible •Not a change to the behavior itself [alternative improvement]	Plant	"If more restaurants served plant-based meat."	NOT "If plant-based meat tasted better" [Alternative Improvement]
		Bulb	"They need to be easier to find at the store."	NOT "The light needs to look better." [Alternative Improvement]
		GEC	"It'd be easier if this was advertised." "If I could opt-in during lease signing." "More information from the utility company."	NOT "They need to tell me how to sign up." [Increased Knowledge]
		Motor	"Walking trails or roads with a shoulder." "If there were systems in place to make biking safer and easier." "If what I needed was within walking or biking distance, I would not use motorized transportation."	NOT "If I had a bike." [Alternative Improvement]
Alternative improvement	•Change to the alternative itself (e.g., better tasting meat replacements)	Plant	"If the non-dairy milk options had more protein."	NOT "If the non-dairy milk options were sold more places." [Increased Accessibility]

	•Includes obtaining an alternative (e.g., buying a bike) or constructing an alternative (e.g., Amtrack system) •Not a change in the environment [increased accessibility] •Not a lower price [increased affordability]	Bulb	"The light should be prettier."	NOT "They need to be easier to find at the store [Increased Accessibility]
		GEC	*Don't use [Increased Accessibility]*	-
		Motor	"If I had a bike."	NOT "Walking trails or roads with a shoulder." [Increased Accessibility]
		Plane	"I wish we had an Amtrack system." "I have a newer car that doesn't break down as much."	-
Increased knowledge	•Skill-building •Needs more information to engage in the behavior •Includes needing information about the benefits	Plant	"I've learned to cook and make my own food."	-
		Bulb	"I need to know where to buy these."	
		GEC	"They need to tell me how to sign up."	NOT "I need more information about it." [Increased Accessibility]
		Motor	"I need to learn to ride a bike."	-
Planning	•Taking steps to make the behavior happen, or acting differently in order to engage in the behavior •I accept that I can't do something as I normally would, so I do it differently •Not acting differently during behavior [changing planned activities] •Not living somewhere else [relocate]	Plant	"When I go to events with limited options, I offer to bring something plant-based."	-
		Motor	"I bundle up!"	NOT "I plan to move closer to town, so I will bike or walk more often." [Relocate]
		Plane	"I can stay at my destination longer to make the long drive more worth it."	-
Relocate	•I need to live in a different location to engage	Motor	"I plan to move closer to town, so I will bike or walk more often."	"If what I needed was within walking or biking distance, I would not use motorized transportation." [Increased Accessibility]
Sometimes don’t engage	•Occasionally failing to engage in the behavior ultimately helps me engage in the behavior more frequently	Plant	"I figure if I am getting the meat and dairy for free, then it is okay to eat it."	-
		Motor	"Taking the bus if it's over a two hour walk." "If I really need to use a vehicle, I will ask a friend for a ride."	
Act of nature	•Solution is out of human control (e.g., weather) •Magical thinking (i.e., not possible through technological advancement, urban development, etc)	Motor	"If the weather was warm all the time."	-
		Plane	"If my destination was closer."	

APPENDIX I

Table I.1. **Benefit Characteristic Comparisons using the Scheffé Post-Hoc Test**

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**

Note. 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
***$p < .001$; **$p < .01$; *$p < .05$; $^{+}p < .10$

Table I.2. **Barrier 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***

Note. 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
***$p < .001$; **$p < .01$; *$p < .05$; $^{+}p < .10$

Table I.3. **Neutral Characteristic Comparisons using the Scheffé Post-Hoc Test**

Behavior comparisons	Masculine	Feminine
	Differences between the values	
Bulb to GEC	0.32	-0.23
Bulb to plane	0.20	0.17
Bulb to plant	0.74***	-0.73***
Bulb to vehicle	0.29	-0.05
GEC to plane	-0.12	0.40
GEC to plant	0.42^{+}	-0.50*
GEC to vehicle	-0.03	0.18
Plane to plant	0.54***	-0.90***
Plane to vehicle	0.09	-0.22
Plant to vehicle	-0.45**	0.68***

Note. 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

***$p < .001$; **$p < .01$; *$p < .05$; $^{+}p < .10$

APPENDIX J

Table J.1. **Trust in Authorities Comparisons using Scheffé Post-Hoc Test**

Authority comparisons	Difference between the values
Appointed officials to climate scientists	-1.50***
Appointed officials to elected officials	0.23***
Appointed officials to energy industry leaders	-0.34***
Appointed officials to news media	0.41***
Climate scientists to elected officials	1.72***
Climate scientists to energy industry leaders	1.16***
Climate scientists to news media	1.90***
Elected officials to energy industry leaders	-0.57***
Elected officials to news media	0.18*
Energy industry leaders to news media	0.75***

***$p < .001$; **$p < .01$; *$p < .05$; $^{+}p < .10$