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From the Ground Up: Lessons on Incorporating Behavior Change Research in Sustainability Programs

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Abstract: Individual- and household-level behaviors contribute to 40% of U.S. energy use and carbon emissions. Pro-environmental behavior change research has repeatedly found feedback, social norms, and commitments to be influential factors in motivating change. Sustainability programs and environmental policies that incorporate the underappreciated findings of this research stand to gain significant ground in meeting their goals. In this paper, I describe in detail the design, implementation, and preliminary results of a sustainability behavior change program implemented through the collaboration of a nonprofit organization and a municipality in Southern California. The program focused on simple low- or no-cost behavior changes and results indicate some significant reductions in GHG emissions. Results indicate significant potential for influencing sustainability behavior in groups through a suite of behavior change mechanisms. At the same time, questions are raised about the implementation strategy and measurement tools for the particular behaviors addressed. The lessons from the application of behavior change research in the development of effective sustainability programs are outlined in summary. Internal and external factors contributing to the successes and challenges of the sustainability behavior change program are also discussed.

Keywords: sustainability; lessons for practitioners; behavior change; social norms; behavior metrics

Introduction

Policies and programs that seek to create a more sustainable world often underutilize the potential of household behavior in the achievement of pro-environmental goals. Consider developments in recycling and composting infrastructure to achieve landfill diversion policy goals. While curbside pick-up and standardized bins for separation reduce some structural barriers to pro-environmental behavior, the success of these programs ultimately depends on individuals changing their behavior to make use of that infrastructure. Supportive infrastructure and human behavior are both important parts of the equation. The emphasis in this paper on the latter should in no way suggest the irrelevance of the former. Rather, I propose that programs focusing on individual behavior can increase the success of structural improvements, by incorporating the findings of behavior change research. To this end, the project described below provides the following: a model for applying existing research to sustainability programs, evidence of gains in motivating behavior change through the use of a suite of interventions, and lessons for future programs. The lessons provided herein should inform practitioners who develop implementation strategies for environmental policies and programs.

Approximately 40% of the energy use and carbon emissions in the U.S. are attributable to "households and non-business travel," a figure greater than the emissions from the national industrial sector (Dietz et al. 2009). Although a portion of this stems from single-passenger car use, which may be dependent on structural factors (e.g., the lack of an effective public transit system), significant gains can be made in other behavioral domains. Intervention programs that target household behavior could reduce nationwide emissions by 7.4% in the short term by targeting no- and low-investment behaviors with existing technologies (Carrico et al. 2011; Dietz, Gardner, et al. 2009; Gardner and Stern 2010; Vandenbergh, Barenbus, and Gilligan 2008). While the potential of household behavior in achieving sustainability goals has recently been acknowledged, pro-environmental behavior change has been the subject of academic research for decades (Blamey 1998; Hopper and Nielsen 1991; McKenzie-Mohr 1999; Schwartz 1977; Stern 1986). Yet opportunities to apply these findings remain underutilized in the development of environmental policies and programs.

Research-based Sustainable Behavior Change Program

In this paper, I will explore the lessons and successes in bridging the research-practitioner divide to motivate pro-environmental behavior change. First, I will discuss the findings of previous research. Then, I will review how these findings were incorporated into the design of a behavior change program offered through a 501 (c)(3) nonprofit organization called Community Sustainability USA, Inc (CSUSA). In developing this research-based behavior change program, the founder of CSUSA and I found no other sustainability organizations that based their program design on academic findings or that emphasized measuring behavior and environmental impact. Implemented with community, school and civic groups, the design of CSUSA's program incorporated findings from pro-environmental behavior change research in social psychology (Gardner and Stern 1996; Goldstein, Cialdini, and Griskevicius 2008; Schultz 1998; Schwartz 1977) and social marketing (McKenzie-Mohr 1999). Moreover, this program was designed to measure behavior, program success, and ultimately environmental impact.

Social psychological research on pro-environmental behavior change questions the efficacy of conventional strategies used by many programs and policies. Specifically, the tendency to rely on educating consumers, providing financial incentives, and instituting punitive measures to achieve sustainability goals has proven disappointing or counterproductive in some cases (Carrico et al. 2011). For example, attempts to influence pro-environmental behavior using information about environmental impact alone have yielded significantly worse results than communicating what other people do or what other people expect (Carrico and Riemer 2010; Gardner and Stern 1996; Goldstein, Cialdini, and Griskevicius 2008; Hopper and Nielsen 1991; Schultz 1998). In a quasi-experimental design testing different methods to increase the reuse of towels by hotel guests, Goldstein, Cialdini and Griskevicius found that "merely informing hotel guests that other guests generally reused their towels significantly increased towel reuse compared to focusing guests on the importance of environmental protection" (2008, 477).

An overview of behavior change research by Carrico et al. (2011) suggests that the use of financial incentives or disincentives may lead to "motivational crowding, which occurs when external rewards undermine intrinsic motivation, resulting in a reduction in the desired behavior" (Carrico et al. 2011, 63). For example, findings from a daycare imposing a late-pick-up fee revealed an increase in tardy parents that remained even after the fee was removed (Carrico et al. 2011). Carrico et al. (2011) also found that "personal commitment or social norms," account for more of the variation in pro-environmental behavior than do factors such as cost (62). Schultz (1998) defines norms as "sets of beliefs about the behavior of others" (26) and cites Cialdini et al. (1990) to distinguish between descriptive and injunctive norms: descriptive norms pertain to beliefs about the *actual behavior* of others, whereas injunctive norms reflect beliefs about the *expectations* of others (Schultz 1998). Social psychologists emphasize that attempts to use norms to influence behavior require making norms salient to individuals in a given context, also known as "activating norms" (Blamey 1998; Carrico and Riemer 2010; Schultz 1998; Schwartz 1977). Feedback is one way to activate norms; it can take the form of communicating an individual's behavior in relation to the actual behavior of others, the expectations of others, or both (Carrico and Riemer 2010, Schultz 1998).

Social marketing research suggests two ways through which employing group commitment can increase pro-environmental behavior. First, when individuals take a small action, such as committing in writing to change a particular behavior, they begin to see themselves as the kind of person who cares about that behavior (McKenzie-Mohr 1999). Second, people have a strong desire to be seen as consistent in the eyes of others and will alter their behavior to fit with their commitments. McKenzie-Mohr cites a study done to increase curbside recycling in Salt Lake City, Utah in which securing a signed commitment resulted in greater participation than "receiving a flyer, telephone call, or personal contact alone" (1999, 52).

Previous research on pro-environmental behavior change has used a variety of methods to measure behavior change. For example, previous studies have used self-report data to capture the level of adoption of pro-environmental behaviors by participants (Hopper and Nielsen 1991; McKenzie-Mohr 1999; Schultz 1998). Some studies rely on more objective data, for example, measuring the change in kilowatt-hour (KWH) use before and after the intervention (Carrico and Riemer 2010). Although this objective data gives precise information about KWH reduction, it lacks insight into what changes are actually occurring related to energy use.

The design of the CSUSA behavior change program was based on the findings described above. It employed self-reported behavior, group commitment, regular feedback, and descriptive norms. The following sections discuss the details of the program and how these strategies were incorporated.

City of Mission Viejo Case Study

With a population of over 95,000 people, Mission Viejo is nestled in the southern-most part of Orange County, California. The city differs from the state of California on a number of demographic factors that had important implications for CSUSA program design and success:

Mission Viejo residents are older, more highly educated, and higher paid than Californians as a whole.

The City of Mission Viejo partnered with CSUSA to implement the sustainability behavior change program under a grant from the State of California. The City Department of Public Works received a Beverage Container Grant to expand recycling through infrastructure development and public outreach and education (City of Mission Viejo 2010). CSUSA's program contributed to the fulfillment of the latter goal by incorporating recycling among a suite of sustainable behaviors in the program. The Environmental Program Administrator and Program Engineer worked closely with CSUSA throughout the program arranging workshops, motivating participation, and functioning as the communication liaisons between the organization and the employees.

Program Design and Implementation

In this section, I will first define the target population and sub-populations (i.e. respondents and non-respondents). Then, I will discuss details of program development and implementation for the City of Mission Viejo employees. For the purposes of this study, the employees of the City of Mission Viejo were considered the target population (N=267). Of the 267 employees, 134 completed the baseline survey and 129 completed the post-program survey one year later. "Respondents" refer to all employees who completed both the baseline and the post-program surveys (n=86). Those who did not complete the baseline, post-program, or neither, are "non-respondents". The target population and the two sub-populations had similar average ages (44, 47, 43 respectively). In each of these populations, females were over-represented compared with the general population (65%, 77%, 59% respectively). The percent of the non-respondents who are female is slightly lower than both the respondents and the target population indicating that men were slightly more likely to be non-respondents. It should be noted that the target population is also somewhat older (44 vs. 42 respectively) and has a higher percentage of females (65% vs. 51%), compared with the city's average. I address the impact of these demographic disparities in terms of limiting replicability below. Table 1 highlights basic demographic information and the stages of the program each population was exposed to.

Table 1: Sub-populations and Program Implementation

	Target Population, Employees (N=267)		
	Non-Respondents (n=181)	Respondents (n=86)	
Average Age	43	47	
Percent Female	59%	77%	
		Non-participants (n=52)	Participants (n=34)
Complete Baseline Survey	-	x	x
Attend Workshop	x	x	x
Commit to Change Behaviors			x
Track and Report Behavior Changes			x
Receive Feedback and Impact Info			x
Complete Post-Program Survey	-	x	x

Dash indicates some of the population took the survey while others did not

Participants

"Participants" were city employees who completed the baseline and the post-program surveys, and who voluntarily committed to change their behavior as part of the CSUSA program (n=34). Participants were assigned to one of three groups, each of which received the same email communications three to four times per month from the Environmental Program Assistant. These communications included tally sheets to self-monitor behavior, prompts, monthly follow-up surveys, and feedback. The three groups competed against each other for greatest participation rates and performance related to target behavior changes. Winners and group performance levels were reported to all participants each month.

Non-Participants

City employees who took the baseline and the post-program survey, but who did not volunteer to participate in the program were considered "non-participants" (n=52). These non-participants serve as the control group and are key to assessing whether changes in behavior are attributable to the program. The role of non-participants and control groups will be discussed below.

Baseline and Post-Program Survey

This program used a pre-test/ post-test design to measure changes in behavior before and after completing the program. The pre-test or "baseline survey" was administered prior to any other elements of the program. Employees received the same "post-program survey" at the end of the program. All surveys and other documents, such as data collection tools and prompts, were distributed electronically.

Target Behavior Selection

The goal of the program was to change the behavior of participants; especially those habitual behaviors that go largely undetected by the individual but that might have substantial environmental impacts. This was accomplished using a number of mechanisms derived from the literature on behavior change that focus the participants' attention on a small set of target behaviors. These mechanisms include selection of relevant and achievable behaviors, commitment based on social ties, single-behavior focus, self-tracking of behavior, and social norms activated in part by descriptive feedback on group performance (Goldstein, Cialdini, and Griskevicius 2008; McKenzie-Mohr 1999; Schultz 1998).

The baseline survey revealed which behavioral domains offered the greatest room for improvement across participants (e.g. energy use, waste). From these domains, the Environmental Program Assistant and Program Engineer worked with CSUSA to identify sustainable behaviors that needed the most improvement, that were feasible for the group, and for which environmental impact data were available. This approach to target behavior selection maximizes the environmental impact of the program (McKenzie-Mohr 1999) and the ability to measure this impact.

Four target behaviors were engaged in the following order: reducing laundry loads washed in hot water, reducing the use of disposable bags, reducing the use of single-use plastic bottles, and increasing purchases of recycled paper products. Participants focused on a single target behavior for a total of three-months each, over a total of 12 months, allowing monitoring of behavior change over time.

For the first target behavior, participants were encouraged to reduce the total loads of laundry washed in hot water, thereby reducing the amount of energy used to heat water while washing clothes. According to the U.S. Environmental Protection Agency (US EPA), 90% of the energy needed to operate a washing machine is used to heat the water (EPA 2013); however, this is unnecessary with modern detergents. In order to track this behavior, participants simply recorded the water temperature setting for each load of laundry they washed ("hot," "warm," or "cold") during the months of November, December and January.

Between February and April, participants committed to reduce their use of disposable bags. In place of paper and plastic bags at the grocery (check-out and produce), department stores, and elsewhere, participants either used a reusable bag or went without a bag. Participants recorded the number of disposable bags they used each week and how many times they used a reusable bag in place of a disposable one. Reducing the use of disposable plastic bags decreases demand for petroleum-based plastics and landfill space (where they never fully biodegrade), and reduces the pervasive litter of plastic bags.

During the months of May, June, and July, participants focused on using reusable bottles rather than single-use cups and bottles. Participants recorded each time they used a single-use container or a reusable bottle. This behavior change can decrease demand for single-use containers and alleviate the environmental impact from the systems of production, distribution, and disposal.

The final target behavior was slightly more complex in scope of adoption and in measurement. Between August and October participants tallied their purchases of 100% recycled-content paper products. This was more complex because participants were asked to focus on their purchases of multiple items: toilet paper, paper towels, and printer paper. Systematically tracking purchases is more complicated for participants than tallying the number of laundry loads washed, for example. This is discussed further below. Some participants found it challenging to adopt this target behavior. Although research on the environmental costs of virgin pulp compared to recycled content is definitive; consumers remain somewhat resistant to recycled paper products for certain uses, especially toilet paper.

Behavior Metrics

Once behavior domains with the most potential for improved sustainability were identified based on the baseline survey, the selection of target behaviors must balance contending issues of feasibility and measurement. Target behaviors must be feasible for participants to adopt, track, and report, especially when relying on self-report data (McKenzie-Mohr 1999). Selecting quantifiable behaviors is also critical to communicate how participants' behavior has changed. Moreover, identifying behaviors for which environmental impact data is available improves the ability of the analyst to measure program impact and render feedback communications more salient. For example, participants can reduce household energy consumption by remembering to turn off lights when no one is in the room or unplugging electronics guilty of vampire load. While these behaviors affect energy consumption, they are difficult to quantify and it is difficult to estimate their environmental impact. In contrast, reducing hot water laundry loads (discussed in more detail below) is an example of a behavior change that is quantifiable, easy to track for participants, and has measurable environmental impact. While target behaviors cannot always satisfy all of these standards, program design should focus on: the extent of environmental impact, the ease of tracking for participants, and the provision of substantive data for analysts.

Workshop

Employees of the City of Mission Viejo were required to attend a yearly environmental workshop to comply with Storm Water Permits. This workshop was conducted after the baseline survey had been completed by city employees. CSUSA educated attendees regarding the science of sustainability and the links between household-level consumption patterns and anthropogenic environmental degradation. The CSUSA portion of the workshop engaged the audiences with interactive learning, storytelling, and games.

Group Commitment

Attending the workshop was mandatory; however, participation in the CSUSA program was not. Attendees who chose to participate in the program committed in writing, as a group, to change their behavior. Group commitment, especially written commitment, has been shown to increase the relevant behavior based on people's desires to be seen as consistent by others and on the social ties they feel to the group (McKenzie-Mohr 1999). To maximize the likelihood of social interaction, which reinforces these desires and social ties, participants were grouped by department

Self-Tracking and Monthly Follow-ups

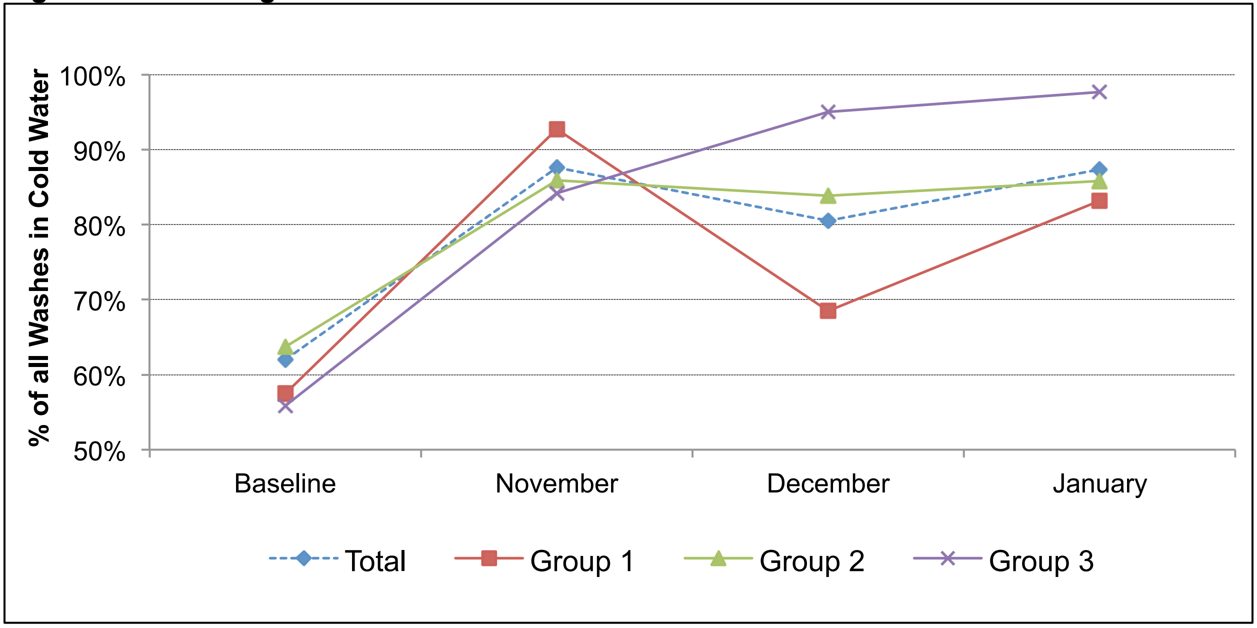
Each month, participants received a tally sheet, a follow-up survey, and a prompt for the next month; in addition, they received the performance and environmental impact results from the previous month. These tools represent the formal normative mechanisms of the program that motivate behavior change. The influence of these normative mechanisms is discussed further in this section.

The tally sheets encouraged daily documentation and self-reflection of behaviors, and included information about the environmental impact of the target behavior. At the end of each month, respondents received a brief follow-up survey (5-12 questions) regarding the frequency, perceived barriers, and personal strategies related to the target behavior for that month. Performance and environmental impact results were calculated for individuals and groups using the self-reported data. At the end of each quarter, the progress for the target behavior over time was also communicated to participants. Feedback such as this has been used in previous research as a tool to communicate group (descriptive) norms (Carrico and Riemer 2010; Hopper and Nielsen 1991; Schultz 1998).

Feedback

The communication of performance relative to the other participants is critical to making social norms salient regarding behavior change. If participants are unaware of the practices or preferences of others, the potential for social normative influence is lost (Carrico and Riemer 2010; Goldstein, Cialdini, and Griskevicius 2008; McKenzie-Mohr 1999; Schultz 1998). Because many of the target behaviors occur outside the workplace and would go unseen by other participants, this regular and publicized feedback serves as the main communication of descriptive norms (Cialdini 2007). Figure 1 is an example of part of a quarterly review of the hot water wash target behavior; it shows the change in laundry loads washed in cold water rather that hot for each group over the three-month time period. Each month, participants received feedback similar to this figure to monitor group performance.

Figure 1. Percentage of washes in cold water over time



Results

I will focus on the change in target behaviors by participants and non-participants before and after the program, rather than on the monthly follow-up data discussed above. Initial results are presented in Table 2. Each target behavior is listed with participant and non-participant mean performance by row. The first two columns show the baseline and post-program mean performance per week for each behavior. I performed a paired two-sample t-test to determine whether differences in mean behavior between the baseline and post-program were statistically significant for each population independently. For example, the table shows that, for the hot water wash target behavior, participants reduced their average hot water laundry loads from 2.4 to 1.2 per week (SD = 2.19, p = .002).

Participants demonstrated the greatest improvement in reducing their hot water laundry loads, compared to non-participants. Participants and non-participants reported similar baseline performance with an average of about 2 laundry loads washed in hot water each week; the difference was not statistically significant (M_P = 2.38, M_{NP} = 2.58, SD = 2.24, $t(86)$ = 2.07, p = .98). Comparing performance between baseline and post-program, participants reported a statistically significant change in hot water washes. (M_1 = 2.38, M_2 = 1.24, SD = 2.19, $t(34)$ = 3.05 p =.002); whereas non-participants reported no change during the same time (M_1 = 2.58, M_2 = 2.50, SD = 2.20, $t(52)$ =.25 p =.40).

It is important to note that this tells us nothing about whether these changes are significantly different from each other; it only shows that each group changed independently. I calculated difference scores in order to determine this. These scores take the difference in baseline and post-program performance for each respondent. Two-group t-tests conducted using difference scores revealed that the difference in reductions of hot water washes by participants and non-participants is statistically significant (DID = -1.07, SD = 2.24, $t(86)$ = 2.21 p = .015). This evidence suggests that the CSUSA program had an effect on the behavior of participants resulting in a reduction of hot water washes and subsequently energy consumption.

Table 2: CSUSA Sustainable Behavior Change Program Outcome

	Mean Behavior in Number per Week			
	Baseline	Post-Program	T-Test[a]	Standard Deviation
Hot Washes				
Participants	2.38	1.24	3.05**	(2.19)
Non-Participants	2.58	2.50	0.25	(2.20)
Disposable Bags				
Participants	6.32	6.29	0.03	(6.24)
Non-Participants	7.73	6.79	1.09	(6.20)
Disposable Bottles				
Participants	8.24	5.06	1.91*	(9.68)
Non-Participants	8.65	6.83	1.61	(8.22)
Recycled Content Paper Purchases		See Table 3		
(Participants = 34, Non-Participants = 52)				p<.01** p<.05*

[a] T-tests presented here were calculated using a paired two-sample mean comparison testing if the mean of participants at the baseline and the post-program survey is the same.

Perhaps most notable was the gain shown in Figure 2, which shows nearly a four-fold increase in the percentage of participants who wash "None" of their loads in hot water, from about 9% to over 40%. Figure 3 shows the distribution of the non-participant hot wash frequency for comparison. Importantly, when considering the first two response categories (respondents washing "None" and "1 or fewer" in hot) participants increased by 42%, while non-participants maintained their behavior over time (52% to 74% and 46% to 44% respectively).

Figure 2. Percent of participants who report washing clothes with hot water at baseline and post-program.

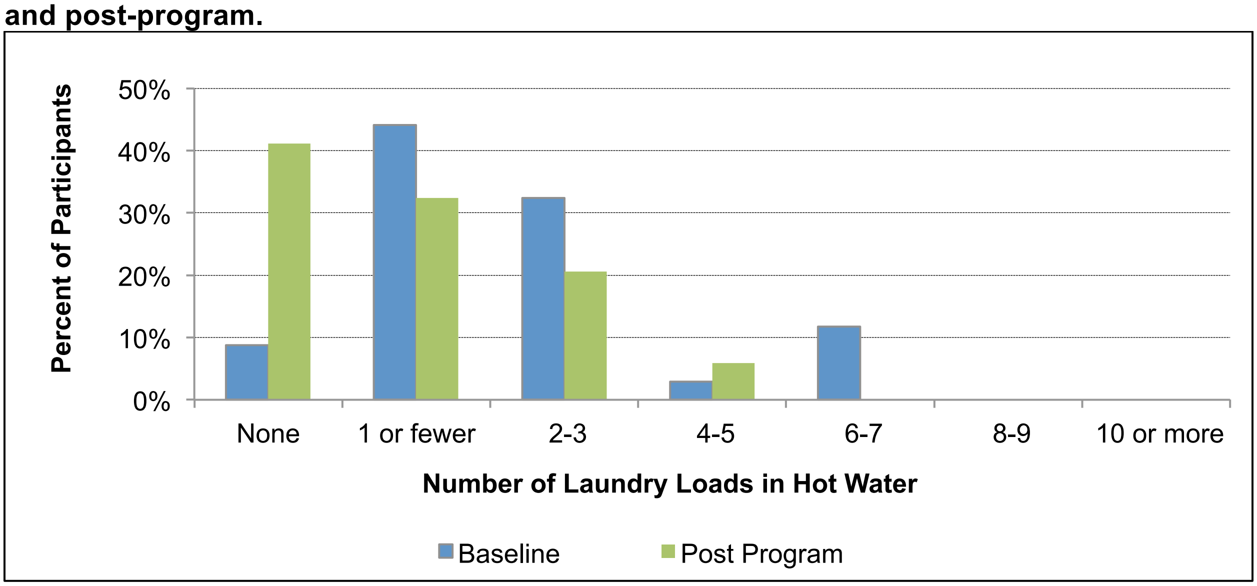
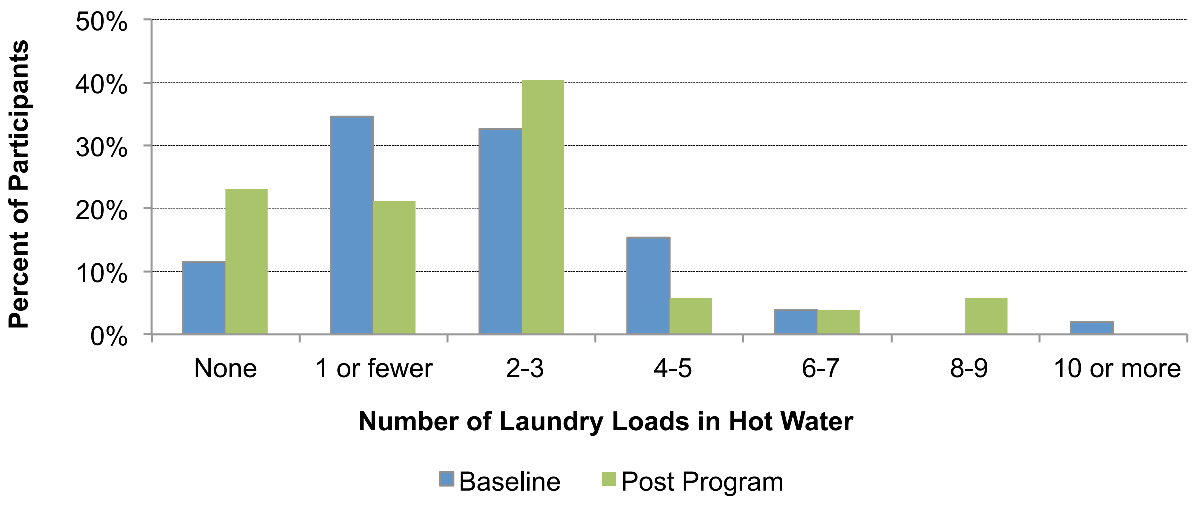


Figure 3. Percent of non-participants reporting washing clothes with hot water at baseline and post-program.



For participants, the average performance and distribution of "disposable bag use per week" remained stable between the baseline survey (*M* = 6.32) and the post-program (*M* = 6.29, *SD* = 6.24), *t*(34) = .03, *p* = .49). Non-participants demonstrated similar behavior stability between the baseline (*M* = 7.73) and post-program mean disposable bag use (*M* = 6.79, *SD* = 6.20), *t*(52) = 1.09, *p* = .14). In this case, the difference between the baseline performance of the participant and non-participant groups was also non-significant (M_P = 6.32, M_{NP} = 7.73, *SD* = 6.21, *t*(86) = .87, *p* =.81) and no difference for baseline to post-program performance between the two groups (*DID* = -.91,*SD* = 6.20, *t*(86) = .67, *p* = .75).

However, participants significantly reduced their use of single-use beverage containers. Participants reported using an average of about 8 disposable bottles per week at baseline (*M* = 8.24), and 5 per week at the end of the program (*M* = 5.06, *SD* = 9.68), *t*(34) = 1.91, *p* = .03). Non-participants also reported a reduction in mean disposable bottle use (M_1 = 8.65, M_2 = 6.83), but this was not statistically significant (*SD* = 8.22, *t*(52) = 1.61, *p* = .06). Although the reductions by participants in disposable bottle use were statistically significant, the difference between the two groups was not significant (*DID* = 1.35, *SD* = 8.79, *t*(86) = .69, *p*= .25). The implications of this finding are analyzed in the discussion section.

The percent of participants reporting the use of no disposable bottles increased almost 300%, from 12% to 44%. The increase in non-participants who reported use of no disposable bottle was 75%. The distribution of participant disposable bottle use is shown in Figure 4 and non-participants in Figure 5.

Figure 4. Percent of participants reporting use of disposable bottles at baseline and post-program.

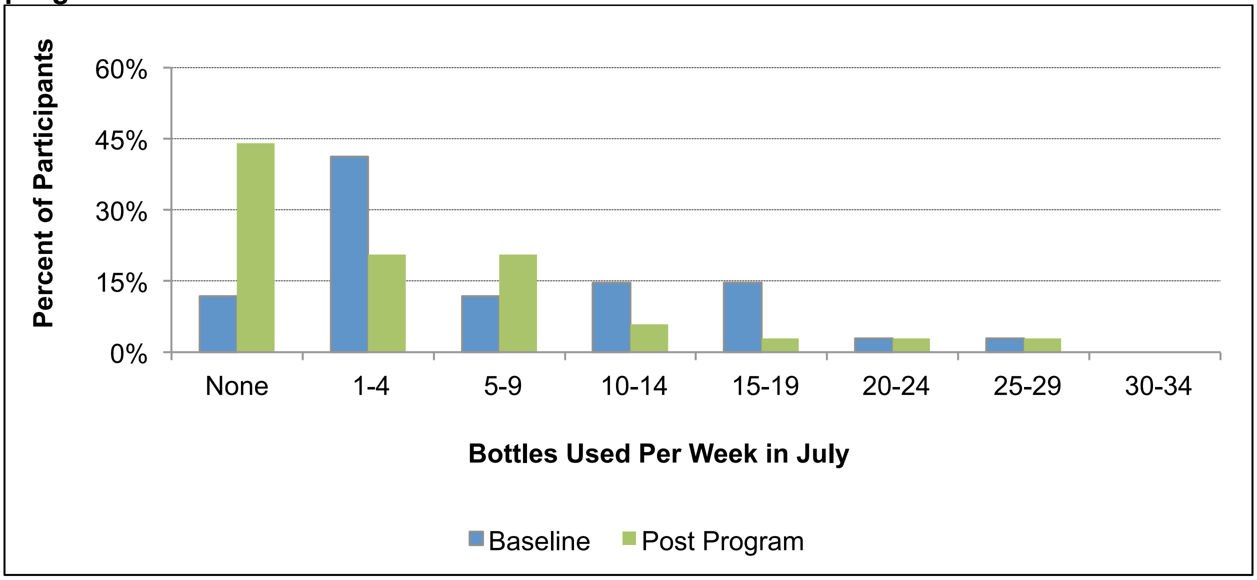
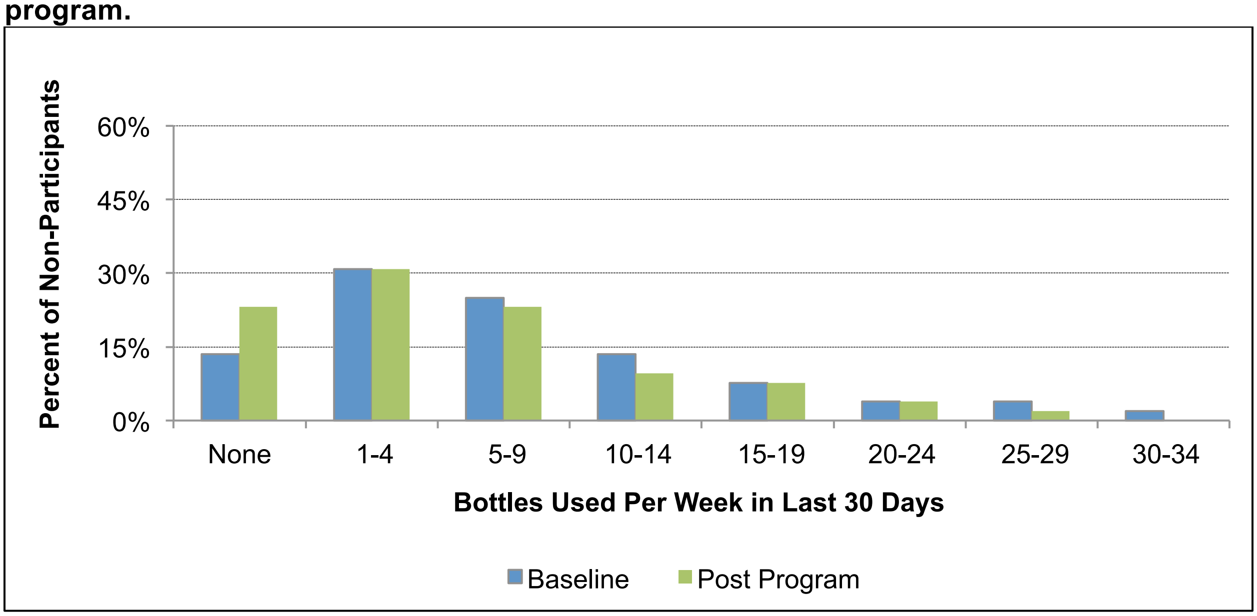


Figure 5. Percent of participants reporting use of disposable bottles at baseline and post-program.



For the final target behavior, participants were asked to report how frequently they purchased the specified paper products on a 6-point Likert scale from "Never" to "Always." Table 3 displays the percent of respondents who reported "Always" or "Never" purchasing the relevant paper product with 100% recycled content. There was no definitive trend in behavior change for participants and non-participants. Possible explanations of this are explored in the discussion and limitations section.

Table 3: Respondent Reported Purchases of Recycled Content Paper Products

	Participant (n=34)		Non-participant (n=52)	
	Baseline	Post-Program	Baseline	Post-Program
Paper Towels				
Always	0%	6%	6%	4%
Never	55%	36%	31%	33%
Toilet Paper				
Always	0%	5%	2%	4%
Never	56%	50%	42%	42%
Printer Paper				
Always	12%	24%	8%	24%
Never	27%	32%	23%	18%

Measuring Environmental Impact

The environmental impact analysis focused on the target behaviors with the most significant changes made by participants: hot water wash and disposable bottle use. The analysis calculated the impact of participants' behavior change over the twelve-month period. Next, I explored what the environmental impact of these behavior changes would be if every household in the U.S. were to reduce these behaviors by the same amount. The latter is simply an exercise that demonstrates the potential of small behavior changes to achieve immediate and significant reductions in environmental impact and resource consumption. Conclusions regarding the causal influence of the program are addressed later in this section.

Using the Greenhouse Gas Equivalencies Calculator developed by the U.S. EPA (U.S. Environmental Protection Agency 2012), I estimated the environmental impacts of the behavior change program. The EPA provides a series of equivalencies that aid the analyst to present environmental impact data in meaningful terms using KWHs, or some other measure, as input. For example, the total reduction in hot water washes by the 34 participants was 39 loads per week or about 1 hot water wash fewer per participant per week (see Appendix I). This is equivalent to about 180 KWH per week, or over 9700 KWH per year (California Energy Commission 2010). According to the EPA calculator, this reduction is equivalent to removing 1.4 cars from the road for an entire year. This is also equivalent to supplying electricity for a single-family home for an entire year.

The total reduction in disposable plastic bottles by participants from the baseline to the post-program surveys was 108 bottles per week (see Appendices III.a. and III.b.). That is a reduction of a little more than 3 bottles per participant per week. Considering the energy used in production, transportation, and recycling plastic bottles after use, this is equivalent to about 125 KWH per week or nearly 7,000 KWH per year (U.S. Environmental Protection Agency 2002). The EPA calculator indicates that this reduction is equivalent to removing one car from the road for an entire year or powering approximately one home for a year (U.S. Environmental Protection Agency 2012).

These numbers are powerful, especially considering the minimal change made per participant on average. Imagine approaching this group of 34 people at the outset of the program and telling them that in order to reduce energy consumption and emissions we need to confiscate one of their cars and cut power to one of their homes for an entire year. If they didn't seem amenable to this offer, we could simply ask each of them to reduce their consumption of plastic bottles by about 3 per week and replace one load of hot water wash with a load of cold water each week for a year.

Consider the magnitude of behavior change on a larger scale. There are over 114 million households in the U.S. today (U.S. Bureau of the Census 2011). If each household made the same small changes that households in this program have made, the environmental impact would be substantial (See Appendices II, IV.a. and IV.b.). The energy saved if every household in the U.S. replaced one load of hot water with a load of cold water each week, for a year, would be equivalent to removing over 4.8 million cars from the road for one year. This is also equivalent to powering over 3.5 million homes (U.S. Environmental Protection Agency 2012). Likewise, if each U.S. household avoided purchasing 3 plastic bottles each week for a year, the energy saved would be equivalent to removing 3.5 million cars from the roads for an entire year or powering 2.5 million homes for a year (U.S. Environmental Protection Agency 2012).

Another way to illustrate the impact is to calculate the reduction in oil demand as a result of these behavior changes. Eliminating 3 plastic bottles and one hot water load of laundry per U.S. household per week for one year reduces the consumption of oil by over 253,000 barrels per day (U.S. Environmental Protection Agency 2012). This is roughly equivalent to the oil consumption of the entire country of Switzerland: 242,700 barrels/day (U.S. Central Intelligence Agency 2010). Also, if every U.S. household made these behavior changes, it would avoid the consumption of over 92 million barrels of oil; and could eliminate 6% of annual petroleum imports from OPEC countries (U.S. Energy Information Administration 2012).

It is important to compare the impacts of the program with its costs. I only considered the hot water wash target behavior to estimate the impact of the program in terms of carbon saved per dollar and time (hours) spent in implementing the program. I omitted the impact of disposable bottle use given the non-significant findings between participants and non-participants. This is discussed further below. The reductions in hot water wash frequency reported by participants are equivalent to approximately 15,000 pounds of CO_2 (U.S. Environmental Protection Agency 2012). CSUSA program managers, including the founder and I, committed 60 hours for program implementation over the course of the year with the help of the small grant from the city. This program boasts reductions of approximately 250 pounds of carbon per hour and about 8 pounds of carbon per dollar spent. The former is equivalent to the emissions from over 13 gallons of gasoline per hour, and the latter is equivalent to about one half gallon per dollar spent (U.S. Environmental Protection Agency 2012).

Discussion and Limitations

The discussion thus far has focused on the target behaviors for which there were measured improvements among the participants. However, further consideration is needed regarding the disposable bottle use target behavior results. The three findings were as follow: (1) The participants reported a statistically significant change in their bottle use behavior between the baseline and the post-program survey; (2) Non-participants did not show changes in their bottle use behavior. (3) Yet the difference in reported behavior change between the participants and non-participants was also non-significant. This follows the logic: (1) $A > 0$, (2) $B = 0$, (3) $A = B$. These three conclusions cannot be all true. Optimistically, only participants' behavior improved and the third conclusion is a Type II Error ($A > B$). Pessimistically, there was either no treatment effect, thus the first conclusion is a Type I Error, or some exogenous influence affected the target population. In this case, either the first or second finding would be false, indicating that the program in fact had no effect (A = 0), or both groups had significant change in behavior due to some non-programmatic influence (A > 0 and B > 0). An analytical middle ground is that conclusions 2 and 3 are Type II Errors. If this is true, then there was a program effect (A > B by a large margin), but there was also some exogenous influence (B > 0).

This case highlights the importance of establishing a control group. Control groups help detect whether the reported behavior change is explained by participation in the program or by some non-programmatic factor affecting the target population. One possible exogenous factor might have been the citywide campaign to increase recycling of beverage containers initiated by the City of Mission Viejo at the outset of the CSUSA program. While the focus of the campaign was on recycling bottles, it is possible that this increased visibility of beverage containers affected both participants' *and* non-participants' disposable bottle consumption. Therefore, although participants did significantly reduce their consumption, there can be other explanations for the reduction than the mere participation in the program.

Another possible limitation to consider is the role of selection effects in voluntary programs. For example, if participants are the type of people who are predisposed to improve their pro-environmental behavior in the first place, then analysts run the risks of overstating the effects of the program. However, baseline survey analysis of attitudes and behaviors lessens some of these concerns. Respondents indicated on a six-point Likert scale the extent to which they "Strongly Disagree" or "Strongly Agree" with statements regarding their pro-environmental attitudes on business practices, political and household decision-making criteria. Participants and non-participants reported no significant differences in pro-environmental attitudes at the baseline (p = .98; p = .41; p = .11, respectively). As discussed above, differences in baseline performance of target behaviors by participants and non-participants were likewise non-significant.

In the absence of random assignment to treatment and control groups, conclusions cannot be drawn regarding non-programmatic factors that would only influence the type of people who would volunteer for a program like this. While the ultimate goal of a pro-environmental behavior change program is to influence everyone to reduce consumption, it is important to be able to identify program effect or the lack thereof.

It is also important to consider why the results of this program were not uniformly successful. One possible explanation is that some of the methods used to measure behaviors may be more amenable to the behavior change mechanisms used in the program and some may be more prone to measurement error. Simple and centralized measurement aids in the provision of performance feedback and contributes to the self-assessment and norm activation of participants during the program. The ease of measurement for hot water wash, for example, was well suited to self-monitor behavior and to reduce measurement error. Many participants reported keeping their tally sheet in the laundry room to facilitate more precise measurement. This measurement strategy is more easily routinized than disposable bottles, bags, or paper purchases, which have no centralized location for occurrence and, as in the last case, typically occur infrequently.

The feedback mechanisms may have also played an unexpected role in the disposable bag use and paper purchases target behaviors. Analysis of monthly surveys (not presented here) revealed that, unlike hot water wash and disposable bottle use, very little change in paper purchases and disposable bag use behavior occurred during the initial target behavior months. In fact, very few paper purchases were made at all in the first month in which this behavior was the target. This means that the feedback mechanisms that would otherwise communicate the new group norms of sustainable behavior instead projected norm maintenance. It is possible that rather than influencing participants to improve their behavior to meet the group's new standard, the normative force encouraged individuals to maintain the baseline behavior of the group. By incorporating injunctive norms (i.e., expected behavior) in addition to descriptive norms (i.e., actual behavior), the effects of norm maintenance may be minimized in future programs (Goldstein, Cialdini, and Griskevicius 2008). Making improvements to measurement strategies and focusing on motivating high participation rates in the initial months of the target behavior may also increase performance.

The CSUSA program relied on self-report data to measure behavior. KWHs were not included due to aggregated meters and the nature of the selected target behaviors, many of which have no direct impact on KWHs. More in-depth qualitative approaches such as interviewing would strengthen the research design by providing insights into how individuals understand their role in consumption and environmental degradation. Instead, self-report data was used in this program because of limitations in funding and time required for collecting and analyzing data. It should be noted that concerns regarding social desirability bias in self-report data were alleviated in part by the fact that this program was not uniformly successful. Social desirability is a response bias in which respondents wish to be perceived in a positive way by others and, consequently, alter their responses accordingly. Consider that participants committed to changing their behavior for all four target behaviors. If social desirability were an issue in this case, current results would have shown improvement in all four rather than only two of the targer behaviors (hot water wash and disposable bottle use).

Furthermore, it is important to address concerns regarding the long-term effectiveness of programs with high levels of contact such as this. Once the program ends, and the official reminders and feedback stop, do participants maintain the same levels of pro-environmental behavior? Unfortunately, lack of time and resources prevented me to present the analysis of the post-program behavior maintenance here. However, there is some indication in the literature for the long-term effects of group feedback used in the program. In Schultz's (1998) study on participation in neighborhood recycling programs, participants who received group feedback on recycling behavior continued to increase their recycling participation levels, whereas those who received individual feedback decreased after the program ended. Participants in the individual feedback condition returned to their baseline behavior once they realized they were no longer being monitored (Schultz 1998). However, "[i]f norms are the causal agent in the effectiveness of the feedback interventions, ... [participants in] the group feedback condition would still have a referent against which to compare their behavior" (Schultz 1998, p. 32). If this holds, then participants in this program are expected to maintain or even continue to improve their pro-environmental behavior.

Finally, questions regarding the replicability of a highly tailored program such as this are raised. The program was designed for the specific target population, one that is not representative of the city or the state. Similar results should not be expected by simply duplicating this program in other contexts. However, similar results may be achieved by likewise tailoring programs to address the particularities of the target population. Program development should assess the environmental behavior areas in greatest need of improvement and the challenges and opportunities posed by the socio-economic characteristics of the population.

Summing Up: Lessons for Future Sustainability Programs

Rather than attempting to generate new knowledge regarding pro-environmental behavior per se, this paper explored the challenges of designing and implementing a program that incorporates a suite of mechanisms whose efficacy has been demonstrated in previous academic research. Programs and policies intended to address the human impact on the environment should incorporate the findings from behavior change research to engage the greater potential of program or policy design. I have compiled key lessons concerning both internal and external factors for future programs, based on the current findings presented and my experience with CSUSA's sustainability behavior change program,

Internal Factors

Lessons on internal factors focus primarily on the program design and implementation. A pilot of the program using control groups should be established at the outset to determine which elements of the program will sustain the greatest behavior change. Target behaviors should be selected based on the potential to reduce human impact on the environment, quantifiability, ease of measurement by participants, and availability of environmental impact data. While environmental impact is of paramount concern, target behaviors that lend themselves to systematic measurement from the outset enable program success to be determined. Few would agree to repeat or expand a program that has no evidence of success, or measurement of change. The quantifiability of behaviors is also crucial for the activation of descriptive norms. Inherent in the process of feedback and the communication of the behavior of others, quantifiability allows the assessment of performance across groups and over time.

Careful consideration of the nature of the population and the interaction among participants can enable informal communication of the new norms. In some cases the target behaviors occur in places where the population does not regularly interact thus reducing opportunities for informal norm communication to influence behavior. This increases the burden on formal communication of norms in the form of feedback in order to influence sustainable behavior. Programs should capitalize on the proliferation of hand-held technology and social media to deliver more immediate feedback and communicate behavioral norms to a wider audience.

The duration of sustainability programs will likely be a function of financial concerns, program goals, and population needs. However, special consideration should be given to respondent fatigue. Programs lasting twelve months, as the present one, will face challenges in maintaining participation levels for the length of the program. Timely motivational events may serve to counter this fatigue by re-energizing, strengthening commitments, and solidifying bonds among participants.

The achievement of sustainability goals, especially in times of austerity, demands innovation and collaboration. The partnership between the City of Mission Viejo and CSUSA was mutually beneficial and contributed to the achievement of common goals. By collaborating with a non-profit, the City was able to alleviate some of the financial and personnel pressures involved in implementing a program of this nature. CSUSA, on the other hand, was able to increase effectiveness in program implementation by utilizing internal liaisons to communicate with and motivate participants. Participation may be improved by recruiting passionate and dedicated group members — not necessarily in positions of authority — to serve as "sustainability champions" motivating group members and communicating program goals. Collaboration with organizational leaders may also help legitimize the program from the perspective of participants. If the access to the population is not perceived as legitimate, program implementation and success will be difficult to achieve.

External Factors

External factors pertain to the contextual realities of the relevant populations that may provide opportunities or challenges to program and policy success. Demographic and socio-economic factors, such as age, income, and household status, may limit or expand the behavior changes that are relevant, measurable, and achievable. For example, it would be imprudent to select target behaviors with significant upfront investment or structural residential upgrades for participants from low-income households or who live in multi-family housing. There is evidence that allowing participants to deliberate on the selection of relevant target behaviors from a list of low-performing areas In the CSUSA program may engender greater commitment to and ownership over the target behaviors themselves (McKenzie-Mohr 1999). However, in the CSUSA program, this approach was not a viable option due to the population size and time constraints.

Behavior change programs that rely on digital communication and transmission of materials, and that work with low-tech communities will need to adapt to the needs of the population therein. In the current program electronic communication was feasible given the workplace context: participants had reliable access to their email and all the tools and information related to the program. In future programs, collaboration with local organizations or community centers may aid in balancing some technological deficits. Wherever possible, program design must be sensitive to these factors, especially in terms of implementation strategy, duration, and selection of pro-environmental behaviors. In this way policies and programs must be built from the ground up, i.e., from the foundations of research on behavior change and from the contextual realities of the target population.

Conclusion

Individual- and household-level behavior is a largely untapped resource for achieving sustainability goals. Structural changes regarding, for example, environmental legislation, energy sources, the food system, the design of cities, and the availability of more sustainable modes of transportation are fundamental in fostering sustainability. However, as this study demonstrated, the cumulative impact of individual- and household-level behavior change may also be substantial. The behavioral changes proposed in the CSUSA program are low- or no-cost and may be implemented immediately.

Thus, programs focusing on behavior-change should be encouraged. By applying the findings of existing pro-environmental behavior change research, policies and programs can achieve greater success. The role of feedback, social norms, and group commitment in motivating behavior change can be integrated into the implementation strategies of existing and future programs. The lessons learned through the partnership between the City of Mission Viejo and CSUSA shed light on the challenges and opportunities for the design and implementation of future sustainability programs focusing on behavior change.

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Appendix I

Environmental Impact: Group Level (n=34 households)

Hot Water Wash Reduction

Variables:

(a) 8.34 BTUs required to heat one gallon 1 degree

(b) 40 Gallons per full load in conventional washer (California Energy Commission 2010)

(c) 106°F/41°C Temperature of hot water wash setting

(d) 57°F/14°C Average groundwater temperature in U.S

(e) 39 Total group hot water wash reduction per week

Calculate:

1.BTUs avoided per week by group

$$[(a * b) * (c - d)] * e$$

$$[(8.34 * 40) * (106 - 57)] * 39$$

$$[(333.6) * (49)] * 39 = 16346.4 * 39 = \mathbf{637509.6} \textbf{ BTUs per week}$$

2. BTUs avoided per year by group

$$637509.6 * 52 = \mathbf{33150499.2} \textbf{ BTUs per year}$$

3. Convert BTUs to KWHs avoided per year by group

$$33150499.2\ BTU = \mathbf{9708.95\ KWHs\ per\ year}$$

4. Input into EPA Calculator at:

http://www.epa.gov/cleanenergy/energy-resources/calculator.html

Appendix II

Environmental Impact: U.S. Household Level (n=114,761,359 households)

Hot Water Wash Reduction

Variables

(a) 8.34 BTUs required to heat one gallon 1 degree

(b) 40 Gallons per full load in conventional washer (California Energy Commission 2010)

(c) 106°F/41°C Temperature of hot water wash setting

(d) 57°F/14°C Average groundwater temperature in U.S

(e) 39 Total group hot water wash reduction per week

(f) 1.147 Average hot wash reduction per household (e/34 participants)

(g) 114761359 Total U.S. households

(h) 16346.4 BTUs avoided per load washed in cold instead of hot water

Calculate:

1.BTUs avoided per load using cold instead of hot water

$$(a * b) * (c - d)$$

$$(8.34 * 40) * (106 - 57)$$

$$333.6 * 49 = \mathbf{16346.4}$$ **BTUs per load**

2. Estimated BTUs avoided per week by U.S. household hot water wash reduction

$$(g * f) * h$$

$$(114761359 * 1.147) * 16346.4 = \mathbf{2151697535334.9}$$ **BTUs per week**

2. BTUs avoided per year by US household hot water wash reduction

$$2151697535334.9 * 52 = \mathbf{111888271837418.3}$$ **BTUs per year**

3. Convert BTUs to KWHs avoided per year by group

$$111888271837418.3\ BTU = \mathbf{32769277613.6\ KWHs\ per\ year}$$

4. Input into EPA Calculator at:

http://www.epa.gov/cleanenergy/energy-resources/calculator.html

Appendix III. a

Environmental Impact: Group Level (n=34 households)

Disposable Plastic Bottle Reduction

Production and Distribution

Variables

(a) 3.95 Million joules per bottle (Gleick & Cooley 2010)

(b) 1.097 KWHs per bottle (convert a to KWH)

(c) 108 Total group plastic bottle reduction per week

Calculate:

KWHs avoided per week by group from bottle reduction

$$(b * c)$$

$$(1.097 * 108) = \mathbf{118.5\ KWH\ per\ week}$$

2. KWHs avoided per year by group from bottle reduction

$$118.5 * 52 = \mathbf{6161.9\ KWHs\ per\ year}$$

3. Input into EPA Calculator at:

http://www.epa.gov/cleanenergy/energy-resources/calculator.html

Appendix III .b

Environmental Impact: Group Level (n=34 households)

Disposable Plastic Bottle Reduction

Recycling

Variables

(a) 3.95 Million joules per bottle (Gleick & Cooley 2010)

(b) 1.097 KWHs per bottle (convert a to KWH)

(c) 108 Total group plastic bottle reduction per week

(d) 500 BTUs per bottle to recycle (U.S. Environmental Protection Agency 2002)

Calculate:

1.BTUs avoided per week by group from bottle reduction

$$(c * d)$$

$$(108 * 500) = \mathbf{54000\ BTUs\ per\ week}$$

2. BTUs avoided per year by group

$$54000 * 52 = \mathbf{2916000\ BTUs\ per\ year}$$

3. Convert BTUs to KWHs avoided per year by group

$$2916000\ BTU = \mathbf{822.39\ KWHs\ per\ year}$$

5. Sum Production, Distribution, and Recycling KWHs

$$6161.9 + 822.39 = \mathbf{6984.3\ KWHs\ per\ year}$$

4. Input into EPA Calculator at:

http://www.epa.gov/cleanenergy/energy-resources/calculator.html

Appendix IV. a

Environmental Impact: U.S. Household Level (n=114,761,359 households)

Disposable Plastic Bottle Reduction

Production and Distribution

Variables:

(a) 3.95 Million joules per bottle (Gleick & Cooley 2010)

(b) 1.097 KWHs per bottle (convert a to KWH)

(c) 108 Total group plastic bottle reduction per week

(d) 500 BTUs per bottle to recycle (U.S. Environmental Protection Agency 2002)

(e) 3.17 Average disposable cup reduction per household (c/34 participants)

(f) 114761359 Total U.S. households

(g) 363793508 Total U.S. household bottle reduction based on group average

Calculate:

1. 1. Estimated plastic bottles avoided per week by US household from bottle reduction

$$(e * f)$$

$$(3.17 * 114761359) = \mathbf{363793508\ bottles\ per\ week}$$

2. KWHs avoided per week by US household from bottle reduction

$$(b * g)$$

$$(1.097 * 363793508) = \mathbf{399081478.3\ KWH\ per\ week}$$

2. KWHs avoided per year by US household from bottle reduction

$$399081478.3 * 52 = \mathbf{20752236870.4\ KWHs\ per\ year}$$

3. Input into EPA Calculator at:

http://www.epa.gov/cleanenergy/energy-resources/calculator.html

Appendix IV .b

Environmental Impact: U.S. Household Level (n=114,761,359 households)

Disposable Plastic Bottle Reduction

Recycling

Variables:

(a) 3.95 Million joules per bottle (Gleick & Cooley 2010)

(b) 1.097 KWHs per bottle (convert a to KWH)

(c) 108 Total group plastic bottle reduction per week

(d) 500 BTUs per bottle to recycle (U.S. Environmental Protection Agency 2002)

(e) 3.17 Average disposable cup reduction per household (c/34 participants)

(f) 114761359 Total U.S. households

(g) 363793508 Total U.S. household bottle reduction based on group average

Calculate:

1. BTUs avoided per week by US household from bottle reduction

$$(g * d)$$

$$(363793508 * 500) = \mathbf{181896754000\ BTUs\ per\ week}$$

2. BTUs avoided per year by US household from bottle reduction

$$181896754000 * 52 = \mathbf{9458631208000\ BTUs\ per\ year}$$

3. Convert BTUs to KWHs avoided per year by group

$$9458631208000\ BTU = \mathbf{2775850505.9\ KWHs\ per\ year}$$

4. Sum Production, Distribution, and Recycling KWHs for U.S. per year

$$20752236870.4 + 2775850505.9 = \mathbf{23528087376.3\ KWHs\ per\ year}$$

5. Input into EPA Calculator at:

http://www.epa.gov/cleanenergy/energy-resources/calculator.html