Energy Efficiency (2021) 14: 46
https://doi.org/10.1007/s12053-021-09959-8

ORIGINAL ARTICLE

Explaining green technology purchases by US and Canadian households: the role of pro-environmental lifestyles, values, and environmental concern

Holly Berman Caggiano · Pranay Kumar · Rachael Shwom · Cara Cuite · Jonn Axsen

Received: 14 October 2020 / Accepted: 28 April 2021 / Published online: 26 May 2021

Abstract Household energy consumption is a significant driver of greenhouse gas emissions associated with global climate change. Thus, identifying social and psychological determinants of household-level consumption warrants further study. Using nationally representative samples from Canada ($N=1220$) and the USA ($N=1001$), we examine the impact of three categories of behavioral antecedents on decision to purchase energy-efficient technology: values, environmental concern, and lifestyle orientation. Green lifestyle orientation refers to the importance of environmental action to one's overall lifestyle, a theory that has been primarily explained through qualitative methods. We report three key findings comparing US and Canadian green technology purchasing intentions. The results of three structural equation models suggest the presence of a relationship between biospheric and altruistic values, environmental concern, and green lifestyle orientation that predict green technology purchasing intention in both samples. Additionally, income has a strong effect on purchase intentions in both US and Canadian consumers. Other sociodemographic factors also influence potential purchases and identifying as female was positively related to electric vehicle purchase intention in the US sample, but this relationship did not hold in the Canadian sample. We suggest that future research continue to explore pro-environmental behaviors not in isolation, but as integrated within broader green lifestyle perceptions and contexts.

Keywords Consumption · Sustainability · Lifestyles · Values

H. Berman Caggiano (✉) · P. Kumar
Edward J. Bloustein School of Planning and Public Policy, Rutgers University, New Brunswick, NJ, USA
e-mail: holly.berman@rutgers.edu

R. Shwom · C. Cuite
Department of Human Ecology School of Environmental and Biological Sciences, Rutgers University, New Brunswick, NJ, USA

J. Axsen
School of Resource and Environmental Management, Simon Fraser University, Burnaby, BC, Canada

Introduction and background

Globally, 72% of GHG emissions can be attributed to household consumption when accounting for both direct and embedded emissions (Hertwich & Peters, 2009). Thus, one strand of the climate change mitigation literature explores policy and interventions focusing on the household (Dubois et al., 2019). This paper specifically explores antecedents of green purchasing behaviors, which offer large potential for household energy savings and emissions reductions. First, we review scholarship on household behavior change, green purchasing behaviors, and pro-environmental lifestyles. We then analyze the effect of pro-environmental lifestyles, environmental concerns, values, and sociodemographic variables on three key purchasing behaviors: buying high-efficiency lightbulbs, buying energy-efficient appliances, and buying an energy-efficient vehicle. We conclude with implications of our findings and directions for future research.

The potential for household behavior change

About two-thirds of the world's anthropogenic greenhouse gas emissions are accounted for by energy production and consumption activities (IEA 2015). Energy efficiency (EE) interventions are generally considered the lowest direct cost option for saving energy and addressing climate change (EPA, 2009; U.S. House Select Committee on Climate Crisis 2020). In the USA, 118.2 million total households account for 55% of all energy used in buildings (US Energy Information Administration, 2018). These households produce more than 5 gigatons of carbon equivalent emissions each year (Song et al., 2019). Similarly, residential consumption accounts for 54.5% of buildings' energy use in Canada (US Energy Information Administration, 2015). Traditionally, EE policies and program interventions have mainly relied on technological upgrades and market instruments, largely overlooking the potential and importance of "non-price"-based human factors (Allcott, 2011). However, much research focuses on the role of non-price factors as potential behavioral drivers.

To reduce household energy consumption, researchers focus on two types of voluntary actions: (a) no-cost or low-cost behavior changes done repeatedly (like turning off lights or washing clothes with cold water) and (b) behaviors that require an initial financial investment. The second category typically requires adopting energy-efficient technology (Dieu-Hang et al., 2017). Karlin and colleagues (Karlin et al., 2014) classify energy conservation behaviors into two distinct categories, "curtailment" and "efficiency" behaviors. They identify energy conservation activities, such as purchasing energy-efficient products or structural changes of buildings that generally require an upfront investment without any loss of amenities as efficient behaviors. On the other hand, activities such as turning off lights and unplugging or reducing appliance use that generally do not require investment but cut back on amenities or comforts are curtailment behaviors.

The GHG emissions reduction potential of household energy curtailment and efficiency behaviors in the USA, known as the "behavioral wedge," has been estimated at 7% reduction of total US emissions (Dietz et al. 2009). Dietz and colleagues' analysis breaks household energy-saving actions into categories based on behavior: home weatherization and upgrades of heating and cooling equipment; more efficient vehicles and non-heating/cooling home equipment; equipment maintenance; equipment adjustments; and daily use behaviors. While the first two categories focus on adopting equipment, the last three targets changing the ways consumers use the equipment. Here, the study calculates potential for GHG emissions reduction by the amount of emissions reduced per action times the estimated number of households likely to change behavior with effective interventions. Our analysis focuses specifically on actions which involve purchasing household technology that is energy-efficient. Dietz et al. add that these actions have a high level of behavioral plasticity, suggesting that patterns of purchasing behavior can change with targeted interventions. By understanding the motivations and characteristics of green technology consumers, we can begin to better estimate this behavioral wedge, by understanding factors such as the number of consumers likely to increase pro-environmental behavior in response to interventions.

The majority of past studies on energy conservation behavior have focused on the causes and efficacies of curtailment behaviors despite the fact that the energy-saving potential of efficiency behaviors is considered greater than that of curtailment behaviors (Abrahamse et al. 2005). However, there appears to be no uniformity, consistency, and finality regarding efficacy of such behaviors and their underlying motivations forming a critical gap in literature requiring further research (Karlin et al. 2014; McCoy & Lyons, 2017). A study conducted to find the determinants of green purchase behavior among EU customers found significant differences based on knowledge, subjective norms, and cultural dimensions (Liobikienė et al., 2016). Further to this, a comparative study on citizens from the USA and Canada found significant similarities in each sample's levels of environmental concern (Xiao & Dunlap, 2007). We are not aware, however, of any peer-reviewed study that explores green purchase behaviors in the USA and Canada for energy-efficient appliances and vehicles.

In this paper, we explore three purchasing decisions that range in cost and potential energy savings: buying high-efficiency lightbulbs, buying energy-efficient appliances, and buying an efficient vehicle based on representative samples of residents from the USA and Canada. While focusing on habitual behaviors that show savings over time, like turning off the lights or adjusting a thermostat, is necessary for reducing overall household energy consumption, purchasing behaviors require a one-time action that often realizes high levels of savings over time.

Green consumption

Green purchasing behavior entails consumer willingness to purchase environment-friendly products or appliances (Joshi & Rahman, 2015). Pro-environmental or "green" purchasing behaviors occur when consumers choose environmentally friendly products or services instead of default or mainstream options. While many eco-friendly products require a larger upfront investment than comparable traditional products, they often realize financial savings over time through energy, water, or other operational savings. Pro-environmental behaviors are based on a complex combination of our emotions, morals, habits, and social and normative factors, and many theoretical models have been developed to explain and influence such behaviors (Martiskainen, 2007). While structural and contextual factors, such as economic incentives (Endres & Rundshagen, 2010), federal and state policy (Hall & Helmers, 2013), availability, and ease of use of green technology (Stragier et al., 2010) are also important predictors of pro-environmental behaviors, we focus on individual-level behavioral predictors and return to potential policy considerations in our discussion.

The Theory of Reasoned Action (Fishbein & Ajzen, 1975) and the subsequent Theory of Planned Behavior (TPB) (Ajzen, 1991) are common starting points for empirical green purchasing behavior studies (Hua & Wang, 2019; Moser, 2015; Vazifehdoust et al. 2013). TBP explains that one's attitude, subjective norms, and perceived behavioral control determine intention to act, and intention leads to behavior. Attitudes and other TPB constructs predict some pro-environmental behaviors including household recycling, waste composting, and water use (Steg & Vlek, 2009). Specific to green purchasing, Vazifehdoust et al. (2013) found that consumer attitudes towards green product choices resulted from environmental concern, product quality, and a combination of green advertising and labeling. Because pro-environmental behaviors vary widely in characteristics like time, effort, and cost, and consumers have a range of priorities, it is unlikely that a single decision-making theory will ever apply universally. Many studies cite the persistent gap between environmental attitude and environmental behavior, leading scholars to look towards other theoretical motivators (Kollmuss & Agyeman, 2002; Peattie, 2010; Pickett-Baker & Ozaki, 2008; Schuitema & Groot, 2015).

Values, or the overarching guiding principles in one's life, present an additional key theoretical predictor of pro-environmental behavior (Dietz et al., 2005). Values are understood to remain stable over time and impact pro-environmental behavior primarily indirectly, through beliefs, attitudes, or norms (Steg & De Groot, 2012; Stern et al., 1999). Stern et al.'s (1999) value-belief-norm theory (VBN) links value theory to norm activation theory. In the case of supporting environmental movements, VBN theory states, "individuals who accept a movement's basic values believe that valued objects are threatened and believe that their actions can help restore those values experience an obligation (personal norm) for pro-movement action that creates a predisposition to provide support" (p. 81). *Biospheric values* prioritize the intrinsic value of the Earth and environment for its own sake, rather than for that of humans. Linked to historical understandings of environmental ethics, biospheric values have been found to influence a wide variety of PEBs, particularly green purchases despite perceived barriers (Ateş, 2020; Schuitema & Groot, 2015; van der Werff & Steg, 2016; van der Werff et al., 2013). Biospheric values are typically positively correlated with *altruistic values*, or those that prioritize the welfare of other people. Steg and De Groot (2012) note the importance of distinguishing these values despite their similar characterization as self-transcendent, prosocial values, as they are empirically distinct and activate different behavioral intentions. Biospheric and altruistic values have been found to directly or indirectly affect a variety of pro-environmental behaviors (Dietz et al., 2005; Klöckner, 2013; van der Werff & Steg, 2016).

Stern (2000), while advocating for the explanatory power of VBN theory, points to "contextual forces" as a causal variable for environmentally significant behavior. He provides an extensive list of these forces, including institutional factors like restrictions on occupants of rental housing, monetary incentives and costs, and capabilities and constraints of technology and the build environment. Income is generally associated with increased energy efficiency investments (Dieu-Hang et al., 2017), although they are not always related (Barr et al., 2005; Ruderman et al., 1984). Dieu-Hang and colleagues (Dieu-Hang et al., 2017) also propose the idea that utility bills make up a smaller percentage of overall budget for higher income households, which could potentially be associated with lower energy efficiency investments. Other sociodemographic factors, including age and gender, influence green consumption patterns. The ways that age impacts energy efficiency decisions is less clear, with many studies finding evidence that younger consumers may use newer, more efficient technology than older consumers (Carlsson-Kanyama et al. 2005; Nair et al. 2010), and others arguing that older consumers have more time to devote to reducing energy consumption (Barr et al. 2005; Dieu-Hang et al. 2017).

Green lifestyle orientation

Sustainable or green lifestyles go beyond isolated pro-environmental behaviors and take shape when an individual engages in practices oriented around sustainable living, often in an attempt to address environmental problems (Axon, 2017; Axsen et al. 2012; Lorenzen, 2012). Lifestyle encompasses ones' beliefs, values, identities, behavioral patterns, and "practical and cultural commitments to certain practices of consumption" (Elf et al. 2019). Wrapped up in lifestyle is self-identity, or the way that one identifies their intentions and creates meaning out of the practices that make up their lifestyle. Explained by Lorenzen (2012):

> To change a lifestyle, people not only have to change their practices, but also the story they tell about their practices… Thus, a *green lifestyle* is a pattern of living that involves deliberation over the uncertain environmental impacts of everyday practices and a guiding narrative that makes that process personally meaningful (p. 95).

Here, we refer to a self-identified green lifestyle as "lifestyle orientation," where respondents identify how important environmental action is as a part of their overall lifestyle. This research attempts to quantitatively measure lifestyle orientation—a novel approach as many studies exploring green lifestyles employ qualitative methods to get at the rich complexity inherent in the subject (Axsen et al. 2012). While quantitative research will fail to capture the same nuance, we might begin to make more generalizable conclusions about the role of lifestyle orientation in pro-environmental behavior engagement. Theoretically, as part of an overarching identity, green lifestyle orientation should predict a wide range of pro-environmental behaviors that one enacts through practices in their daily life (Shove et al. 2012). We understand green lifestyle orientation as bound up with environmental identity, or the way that one sees themselves as an environmentally friendly person (Whitmarsh & O'Neill, 2010). Environmental identity is associated with a wide range of pro-environmental behaviors, including carbon offsetting behaviors (Whitmarsh & O'Neill, 2010) and interest and participation in smart energy systems (van der Werff & Steg, 2016).

Comparing samples in the USA and Canada

This paper focuses specifically on the USA and Canada, as they are among the highest emitting countries in the world per capita (World Bank, 2020). As outlined in the "The potential for household behavior change" section, significant potential exists for emissions reduction at the household level, and the widespread adoption of energy-efficient technology in developed countries will help achieve climate mitigation goals.

To our knowledge, few existing studies compare individual-level environmental social-psychological variables in the USA and Canada. Thus, more research is needed to uncover similarities and differences in individual-level environmental behavior in the neighboring countries. While we might assume North American industrialized nations would have very similar behavioral models, policy contexts related to climate change mitigation differ in each country, as Canada has set more ambitious goals at the federal level, including ratifying the Kyoto protocol in 2002 (Harrison, 2007).

Limited evidence suggests consumer attitudes and behavior might interact differently in these samples and more research is needed to uncover these relationships. While Xiao and Dunlap (2007) found consistency in environmental concern between US and Canadian samples, Hanson (2013) found key differences. In the Canadian sample, environmental concern was significantly related to green consumer attitudes, as hypothesized, while this relationship was weak in the US sample. In a study of high school-aged students, Lin and Shi (2014) found Canadian students scored higher for environmental knowledge, awareness, and pro-environmental behaviors, suggesting higher overall levels of environmental literacy in part driven by instructional methods.

Research objectives

The objective of this research is to better understand drivers of these green technology purchasing behaviors. To do this, we test five hypotheses in three structural equation models across two samples:

- H1: Green lifestyle orientation is positively related to green technology purchasing frequency.
- H2: Environmental concern is positively related to green lifestyle orientation, indirectly affecting green technology purchasing frequency.
- H3a: Biospheric values are positively related to environmental concern and green lifestyle orientation, indirectly affecting green technology purchasing frequency.
- H3b: Altruistic values are positively related to environmental concern and green lifestyle orientation, indirectly affecting green technology purchasing frequency.
- H4: Income is positively related to green technology purchasing frequency.

Theoretically, these hypotheses test similar relationships put forth by VBN theory, proposing a causal relationship between values, environmental concern, green lifestyle orientation, and green technology purchasing intention. This conceptual framework is illustrated in Fig. 1. We explore each of these hypotheses in both samples (US and Canada) to facilitate comparison between samples and suggest more generalized conclusions. We expect similar results for both samples, following previous research on environmental attitudes and behavior in the USA and Canada (Steger et al., 1989; Xiao & Dunlap, 2007).

Methods

Participants and procedure

The cross-sectional survey, administered by Decision Analyst market research in February 2013, was designed to investigate engagement in pro-environmental behavior. Respondents received $5 (US or CAD) for participation in the survey. US and Canadian samples were recruited in an effort to represent each country's population by age and gender. For the Canadian survey, more than 54,000 individuals received an invitation to participate in the study. Of the first 2046 respondents, 534 were excluded based on demographic criteria and 292 did not finish the survey, resulting in a total sample size of 1220. The US survey invitation was sent to 14,000 individuals. 1395 individuals initially responded and 240 did not meet demographic quotas, resulting in a total sample size of 1000 (Schmitt et al., 2018). (See Schmitt et al., 2018 for more details on Canadian sampling procedures.)

Table 1 provides sample distributions by gender, age, education, and household income in comparison to US and Canadian census data. Although both samples have small sampling biases (e.g., overrepresentation of males, underrepresented of 19–24 age group), threats to generalizability are limited as the following

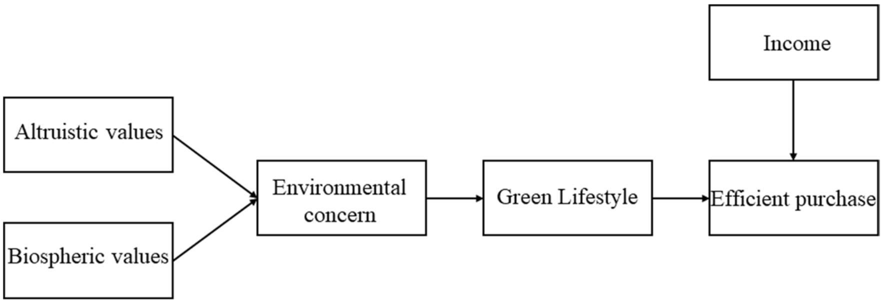

Fig. 1 Conceptual framework linking values, environmental concern, green lifestyle orientation, and income to green technology purchasing intentions

Table 1 Sample demographic characteristics compared to census data (adapted from Schmitt et al., 2018)

	USA		Canada	
	Survey[a]	Census[b]	Survey[a]	Census[b]
Sex (%)				
Female	39.9	50.8	43.4	51.0
Age (%)				
19–34 years old (20–25 for census)	19.5	29.3	17.9	25.4
35–54 years old	46.7	41.2	39.3	38.3
55 year and older	33.9	29.5	42.8	36.4
Education level (%)				
Bachelor's degree	38.3	20.0	41.6	16.5
Graduate degree	21.2	11.6	7.3	9.4
Household income (%)				
< $70 k/year	57.2	62.4	63.5	53.1
$70–99 k/year	19.6	15.1	19.3	21.4
$100 k/year or more	23.2	22.5	16.4	25.5

[a]All survey respondents are 19 or older.

[b]US age, sex, and residence data are from 2010 census data, and income and education are from 2013 census data (www.census.gov).

[c]Canada income data are from 2006 census data, and age, sex, and education data are from 2011 census data (www.statcan.gc.ca).

[d]Age distributions for Canada and US census are for the segment of the population that is aged 20 or older.

[e]Education figures for Canada and US census are for the population aged 25 or older.

[f]Excluding respondents that did select "prefer not to answer," which was 4.7% of the US sample and 10.0% of the Canada sample.

regression analyses control for demographic characteristics (Babbie, 2013; Schmitt et al., 2018).

Demographic controls

Income Income was measured as pre-tax income category, also measured in classes (from 1 = less than $10,000 and 13 = greater than $150,000), where we used the natural log of the midpoint of each class.

Sex Participants indicated sex by selecting male (coded as 0) or female (1). Information on gender identity was not collected in this survey.

Age Age was measured in eight classes (19–24, 25–34, 35–44, 45–49, 50–54, 55–64, 65–74, 75, or older), and in the analysis coded as midpoints of each class (except for the last class, coded as 75). Eligible respondents were over the age of 19.

We also included dummy variables to indicate if the respondent rents or owns a home (0 = rent, 1 = own) or owns a vehicle (1 = own, 0 = does not own) to control for these factors when asking about appliances and vehicle. Renters may not have the opportunity to make appliance purchasing decisions, just as vehicle ownership is not relevant to non-drivers.

Measures

Dependent variable—self-reported green technology purchasing frequency We measure the dependent variable with a scale that asks participants "How often do you engage in each of the following activities?" for the following three activities: buy high-efficiency lightbulbs, buy energy-efficient appliances, and buy an efficient vehicle. The scale includes never (1), rarely (2), occasionally (3), usually (4), and always (5). Participants had the option to indicate that they had no opportunity to engage in the behavior. Such responses were assigned never (1), and additional controls for vehicle and home ownership were added to regression models. In the following analysis, we use both the combined, averaged scale and the individual items as dependent variables. The scale was internally reliable ($\alpha = 0.73$) (Tavakol & Dennick, 2011). When accounting for the full set of pro-environmental behavior questions in the survey, the scale had a higher reliability rating ($\alpha = 0.94$).

Values Biospheric and altruistic values were measured in this survey using scales from Stern et al. (1998). Respondents indicated the importance of each value as a guiding principle in their life from not important at all (1) to very important (4). Each value was measured with three items. Biospheric values include respecting the earth, harmony with other species; protecting the environment, preserving nature; and unity with nature, fitting into nature (internally reliable scale, $\alpha = 0.90$). Altruistic values include equality, equal opportunity for all; social justice, correcting injustice, care for the weak; and a world at peace, free of war and conflict (internally

Table 2 Principal component analysis of value scales

Value statements	Coefficient
Biospheric (TVE = 42.02%)	
Respecting the earth, harmony with other species	0.900
Protecting the environment, preserving nature	0.891
Unity with nature, fitting into nature	0.800
Altruistic (TVE = 36.1%)	
Equality, equal opportunity for all	0.880
Social justice, correcting injustice, care for the weak	0.860
A world at peace, free of war and conflict	0.628
Measures of fit	
Kaiser–Meyer–Olkin sampling adequacy = 0.833	
Bartlett's test of sphericity = $p < 0.001$	

reliable scale, $\alpha = 0.80$). Principal component analysis (PCA) with Varimax rotation was used to reduce the items and differentiate the two sets of values. Table 2 reports the results of the PCA including factor coefficients and total variance explained (TVE) of each construct. Each factor loaded onto a single construct, excluding loadings less than 0.4. Results from the PCA were used to calculate Bartlett's scores used to measure the two values in subsequent analyses. Bartlett's scores provide unbiased estimates of the true factor score and do not correlate with other factors (DiStefano et al., 2009).

Environmental concern We measure environmental concern by asking respondents to rate their level of concern on two environmental issues and averaging these scores: climate change and air pollution. Response options included the following: it is not a problem and does not require any action (1); more research is needed before action is taken (2); it could be a serious problem, and we should take some action now (3); and it is a serious problem, and immediate action is necessary (5). Respondents could indicate that they did not know about the issue, and these responses were coded as missing values. These two items formed an internally reliable scale ($\alpha = 0.71$).

Green lifestyle orientation To measure green lifestyle orientation, we asked how participants see their overall lifestyle. Response choices included the following: not green, environmental activities are not a priority (1); light green, environmental activities are sometimes a priority (2); medium green, environmental activities are generally a priority (3) and; dark green, environmental activities are the main lifestyle priority (4) (Table 3).

Results

To test the research hypotheses, we used structural equation modeling (SEM) with AMOS software version 26. We ran three multi-group SEMs to compare US and Canadian samples for each purchasing frequency variable. Figure 2 displays the SEM diagram used in all three models, with each purchase frequency variable. Estimation of the lightbulb purchasing model yielded the following statistics: chi-square = 172.569, df = 16 ($p < 0.0001$); IFI = 0.910; CFI = 0.907; TLI = 0.583; RMSEA = 0.066. Estimation of the appliance purchasing model yielded the following: chi-square = 193.310, df = 26 ($p < 0.0001$); IFI = 0.926; CFI = 0.924; TLI = 0.736; RMSEA = 0.054. Estimation of the vehicle purchasing model yielded the following: chi-square = 190.915, df = 28 ($p < 0.0001$); IFI = 0.918; CFI = 0.916; TLI = 0.730; RMSEA = 0.051. Following Hooper et al. (2008), these statistics indicate acceptable model fit, with the exception of chi-square which is sensitive to sample size. To determine significance of indirect effects, we used the test of joint significance (TJS) following Leth-Steensen and Gallitto (2016). Table 4 outlines the results of the three SEMs, including direct effects. Although the

Table 3 Descriptive statistics for key measures

	Min, max	USA		Canada	
		Mean	SD	Mean	SD
Values					
Biospheric	3, 12	9.67	2.25	10.17	1.99
Altruistic	3, 12	10.43	1.93	10.75	1.65
Environmental concern	1, 4	3.07	0.77	3.30	0.71
Green lifestyle orientation	1, 4	2.27	0.73	2.46	0.72
Purchase intentions					
Lightbulbs	1, 5	3.43	1.25	3.56	1.15
Appliances	1, 5	3.30	1.35	3.60	1.07
Vehicles	1, 5	2.51	1.39	3.00	1.13

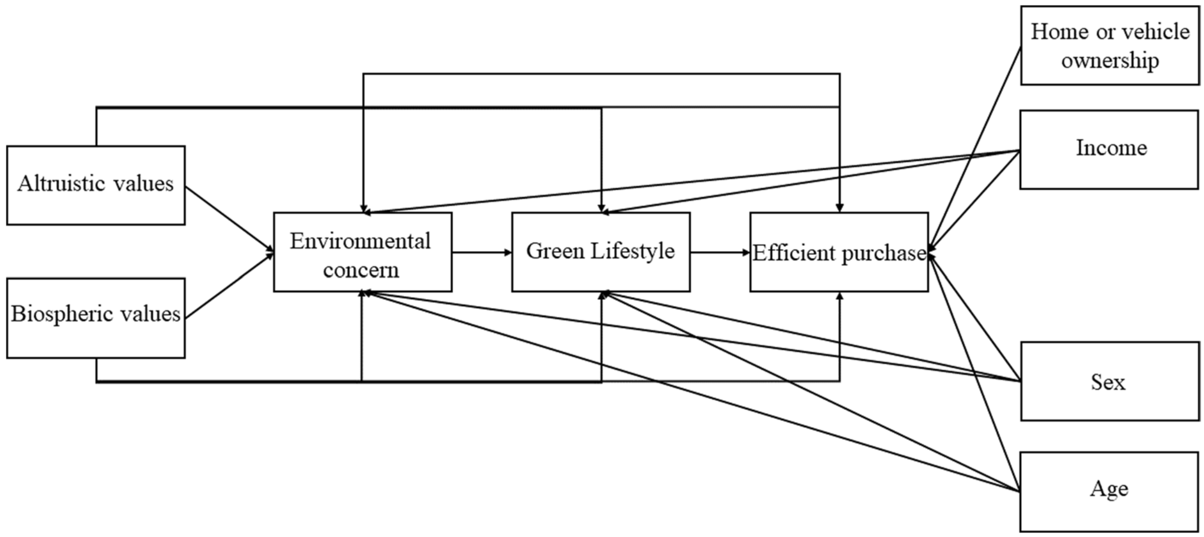

Fig. 2 Structural equation model diagram

conceptual framework does not call for investigation of direct effects on purchasing intention from values and environmental concern, we test these relationships to understand the salience of these variables in explaining purchase behavior on their own, as research finds some evidence of their direct causal effects on pro-environmental behavior (de Groot and Thøgersen 2018). Table 5 outlines indirect effects of key variables.

H1 predicted that green lifestyle orientation is positively related to green purchasing frequency. The results support this hypothesis, as the coefficient is positive and significant across models in both US and Canadian samples. Green lifestyle orientation is positively related to lightbulb purchasing frequency in the US model 1a ($b=0.238$, $p<0.01$) and Canada model 1b ($b=0.154$, $p<0.001$), appliance purchasing frequency in the US model 2a ($b=0.172$, $p<0.001$) and Canada model 2b ($b=0.140$, $p<0.001$), and vehicle purchasing in the US model 3a ($b=0.182$, $p<0.001$) and Canada model 3b ($b=0.032$, $p<0.001$).

H2 predicted that environmental concern is positively related to green lifestyle orientation, indirectly affecting green technology purchasing frequency. Green lifestyle orientation is positively related to green technology purchasing frequency across models: 1a ($b=0.279$, $p<0.001$), 1b ($b=0.194$, $p<0.001$), 2a ($b=0.279$, $p<0.001$), 2b ($b=0.193$, $p<0.001$), 3a ($b=0.279$, $p<0.001$), and 3b ($b=0.193$, $p<0.001$). Environmental concern also indirectly affects green technology purchase frequency across models, determined by TJS, as both direct paths are positively related and statistically significant across models. In models 1a, 1b, and 2b, the effect is partially mediated, as concern has a statistically significant positive direct effect on purchase in addition to lifestyle (1a: $b=0.085$, $p<0.05$); (1b: 0.146, $p<0.001$); (2b: 0.078, $p<0.01$). In models 2a, 3a, and 3b, the effect is fully mediated, as concern does not have a statistically significant effect on purchase, but lifestyle does.

H3a predicted that biospheric values are positively related to environmental concern and green lifestyle orientation. The results support this hypothesis across models. Biospheric values are positively related to environmental concern in model 1a ($b=0.421$, $p<0.001$), model 1b ($b=0.364$, $p<0.001$), model 2a ($b=0.421$, $p<0.001$), model 2b ($b=0.364$, $p<0.001$), model 3a ($b=0.421$, $p<0.001$), and model 3b ($b=0.364$, $p<0.001$). Additionally, biospheric values are positively related to green lifestyle orientation in model 1a ($b=0.331$, $p<0.001$), model 1b ($b=0.340$, $p<0.001$), model 2a ($b=0.331$, $p<0.001$), model 2b ($b=0.341$, $p<0.001$), model 3a ($b=0.331$, $p<0.001$), and model 3b ($b=0.341$, $p<0.001$). Further to this, the model provides evidence that biospheric values indirectly affect green technology purchasing frequency, as the TJS indicates

Table 4 Structural equation model results, direct effects

Path	USA (group A)						Canada (group B)					
	Lightbulb (1a)		Appliance (2a)		Vehicle (3a)		Lightbulb (1b)		Appliance (2b)		Vehicle (3b)	
	Std. coeff	*t*-value	Std. coeff	*t*-value	Std. coeff	*t*-value	Std. coeff	*t*-value	Std. coeff	*t*-value	Std. coeff	*t*-value
Bio ➔ concern	.421	16.27***	.421	16.28***	.421	16.28***	.364	14.08***	.364	14.09***	.364	14.09***
Bio ➔ lifestyle	.331	10.94***	.331	10.94***	.331	10.94***	.340	12.32***	.341	12.33***	.341	12.33***
Bio ➔ purchase	.049	1.42	.064	1.86	.082	2.40*	.063	2.03*	.073	2.42*	.069	2.19*
Alt ➔ concern	.358	13.83***	.358	13.84***	.358	13.84***	.222	8.58***	.222	8.58***	.222	8.58***
Alt ➔ lifestyle	.025	.861	.025	.865	.025	.87	.054	2.03*	.054	2.03*	.054	2.04*
Alt ➔ purchase	.116	3.65***	.063	2.01*	.064	2.03*	.047	1.68	.021	.77	.022	.76
Concern ➔ lifestyle	.279	8.42***	.279	8.41***	.279	8.41***	.194	6.77***	.193	6.76***	.193	6.75***
Concern ➔ purchase	.085	2.29*	.024	.64	− .027	− .720	.146	4.69***	.078	2.59**	.137	1.01
Lifestyle ➔ purchase	.238	6.98**	.172	5.09***	.182	5.34***	.154	5.05***	.140	4.73***	.032	4.42***
Age ➔ concern	− .092	− 3.52**	− .092	− 3.53***	− .092	− 3.54***	− .153	− 5.89***	− .153	− 5.89***	− .153	− 5.90***
Age ➔ lifestyle	.008	.291	.008	.291	.008	.29	.061	2.34*	.061	2.34*	.061	2.34*
Age ➔ purchase	.077	2.62**	.113	3.86***	.115	3.94***	.017	.60	.090	3.29**	.082	2.91**
Sex ➔ concern	− .031	− 1.19	− .030	− 1.17	− .030	− 1.17	− .016	− .62	− .016	− .63	− .016	− .62
Sex ➔ lifestyle	− .012	− .45	− .012	− .45	− .012	− .46	− .031	− 1.21	− .031	− 1.21	− .031	− 1.21
Sex ➔ purchase	.067	2.31*	− .017	− .59	.113	3.94***	− .024	− .90	− .060	− 2.28*	− .010	− .36
Income ➔ concern	.063	2.41*	.062	2.40*	.062	2.40*	.000	.002	.000	− .01	.000	− .01
Income ➔ lifestyle	.068	2.51*	.068	2.51*	.068	2.51*	.044	1.73	.044	1.73	.044	1.73
Income ➔ purchase	.154	5.24***	.175	5.63***	.216	7.04***	.125	4.57***	.126	4.28***	.122	4.09***
Own home ➔ purchase	–	–	.216	7.05***	–	–	–	–	.218	7.37***	–	–
Own vehicle ➔ purchase	–	–	–	–	− .156	− 5.17***	–	–	–	–	− .076	− 2.55*

$^{***}p<.001$, $^{**}p<.01$, $^{*}p<.05$

Table 5 Standardized indirect effects of DVs on purchase frequency

	US (group A)			Canada (group B)		
	Lightbulb (1a)	Appliance (2a)	Vehicle (3a)	Lightbulb (1b)	Appliance (2b)	Vehicle (3b)
Biospheric values	0.143*	0.087*	0.070*	0.116*	0.086*	0.068*
Altruistic values	0.060*	0.030*	0.013*	0.047*	0.031*	0.020*
Environmental concern	0.067*	0.048*	0.051*	0.030*	0.027*	0.027*

*Determined statistically significant through TJS (Leth-Steensen & Gallitto, 2016).

that each piece of the causal pathway is positive and significant across models (biospheric values are positively related to environmental concern, environmental concern is positively related to green lifestyle orientation, and green lifestyle orientation is positively related to green technology purchase frequency).

H3b predicted that altruistic values are positively related to environmental concern and green lifestyle orientation. This hypothesis is partially supported by the SEM. The results indicate that altruistic values are consistently positively related to environmental concern across models: 1a ($b = 0.358$, $p < 0.001$), 1b ($b = 0.222$, $p < 0.001$), 2a ($b = 0.358$, $p < 0.001$), 2b ($b = 0.222$, $p < 0.001$), 3a ($b = 0.358$, $p < 0.001$), and 3b ($b = 0.222$, $p < 0.001$). Altruistic values, however, are only positively related to green lifestyle orientation in the Canadian sample ($b = 0.054$, $p < 0.05$). This relationship does not hold in the US sample. Indirect effects, however, track altruistic values along the causal path from values to concern to lifestyle to purchase frequency, and thus have statistically significant positive indirect effects on purchase frequency across all three models in both samples.

H4 predicted that income is positively related to green technology purchasing frequency, and this hypothesis is supported by our results across models. Income is positively and statistically significantly related to green technology purchase frequency in model 1a ($b = 0.154$, $p < 0.001$), model 1b ($b = 0.125$, $p < 0.001$), model 2a ($b = 0.175$, $p < 0.001$), model 2b ($b = 0.126$, $p < 0.001$), model 3a ($b = 0.216$, $p < 0.001$), and model 3b ($b = 0.122$, $p < 0.001$).

Discussion

Across samples, our hypotheses hold when tested in a series of SEMs, linking biospheric and altruistic values to environmental concern, concern to green lifestyle orientation, and lifestyle to green technology purchasing frequency. Additionally, income and contextual factors (home ownership and vehicle ownership) impact green technology purchasing frequency. Our findings align with other studies that find value-based theories successful in predicting a range of pro-environmental behaviors, but our conceptual framework is unique in its focus on green lifestyle orientation, rather than personal norms, as a behavioral determinant of green purchasing intention.

Our findings suggest the relevance of green lifestyle as a behavioral determinant, particularly in the case of efficient purchasing behaviors. Green lifestyle orientation is positively related to green technology purchasing intention across models, including lightbulb, appliance, and vehicle purchasing intention across US and Canadian samples. This finding reinforces the idea that individual pro-environmental behaviors are embedded in one's overall lifestyle and cannot be viewed as isolated actions. Whitmarsh and O'Neill (2010) note that shopping for material objects is a type of "conspicuous" or visible form of consumption and thus often an expression of identity, which we understand as a component of lifestyle orientation. The way we see our overall lifestyle in the context of environmentalism drives the way we make decisions, and purchases are particularly wrapped up in perceptions of lifestyle and identity.

Comparing across purchase types, the direct effect of lifestyle orientation on purchase intention appears to decrease (based on standardized beta coefficient size) as the cost of purchases increases. In the US sample, the relationship between lifestyle and lightbulb purchase intention has a larger standardized coefficient ($b = 0.238$) than appliance ($b = 0.172$) or vehicle ($b = 0.182$) purchase. In the Canadian sample, this relationship also holds, as lifestyle appears to have a greater impact on lightbulb purchase intention ($b = 0.154$) than appliance purchase intention ($b = 0.140$) or vehicle purchase intention ($b = 0.032$).

One explanation for this finding is the fact that efficiency behaviors explored here have an associated upfront cost that may dampen the impact of psychological variables, following the "low-cost hypothesis" that predicts the strength of effects of attitudinal variables decrease with increasing behavioral costs (Diekmann & Preisendörfer, 2003). Stern (2000) also finds that attitudinal variables explain less variance than contextual factors and personal capabilities in behaviors that are expensive or difficult to accomplish. Additionally, policy context differs in the US and Canada—for example, Canada phased out incandescent bulbs in 2007, while they are still available to purchase in the USA (Ivanco et al., 2007).

Following this point, we observe the clear strong effect of income and contextual factors on purchasing intentions. In accordance with the "low-cost hypothesis," the opposite holds true for income where effects strengthen as cost rises in contrast to attitudinal variables. Household income was statistically significant and positively related to all purchasing behaviors in both samples. In the US sample, the standardized beta coefficient for income grew larger as the purchase measured became more expensive, from lightbulbs to cars. This pattern did not hold in the Canadian sample, but coefficients remained close in size across models. Dummy variables for home ownership and vehicle ownership were positively related and statistically significant in all models in which they were included, illustrating the reality that consumers cannot make the choice to purchase efficient appliances if they do not own their own home or efficient vehicles if they do not own a car. Carpooling, biking, taking public transit, and other alternative modes of transportation reduce more emissions than driving even the most fuel-efficient vehicle.

Other sociodemographic variables also played a role in predicting purchasing intention, but a smaller one than income. Respondent gender was significant in all behaviors except appliance purchases in the US sample, and no behaviors in the Canadian sample, with a positive relationship indicating that identifying as female is tied to green purchasing behaviors. The US results follow consistent findings that women are more likely to be environmentally concerned and purchase green products (Fisher et al., 2012; Laroche et al., 2001; Subiza-Pérez et al., 2020). Finally, age was associated with all green purchasing behaviors in the US sample and only appliance purchases in the Canadian sample. Older respondents are likely to have had more opportunities to make big purchases such as appliances or vehicles. While Fisher et al. (2012) note mixed results on age and environmentally friendly behavior in multiple studies, our results align with a meta-analysis by Wiernik et al. (2013) that found small but significant relationships between older age and various environmental attitudes and behaviors.

Limitations

It is important to note is that the data were collected in 2013 and thus may not represent the precise current state of public opinion and behavior on sustainability in 2020. Additionally, the survey sample was collected recruited to be representative but is not perfectly representative of US and Canadian populations. These data are still useful for investigating relationships between variables, testing hypotheses, and building theory. Controlling for sociodemographic factors through linear regression allows us to isolate these variables. This dataset is particularly useful as it collects data on a large number and a wide variety of pro-environmental behaviors.

Additionally, it is unclear how these green technology purchases interact with savings or use behaviors. Specific to appliances, the way an individual uses the appliance often determines actual energy or water savings, and these savings can vary significantly (Sekar et al., 2019). Many scholars have pointed to the potential for a "rebound effect" as an unintended consequence of increased energy efficiency—the idea that consumers will buy an energy-efficient product but in turn use it more frequently (Herring, 2006; Orea et al., 2015; Saunders, 2013). While studies have found empirical evidence for the rebound effect, researchers generally conclude that the effects are too minor to outweigh energy savings from efficiency measures (Gillingham et al., 2013).

Finally, there are other possible ways to measure the dependent variable of self-reported purchasing behaviors that may result in less potential for measurement error. The measures we use ask how often the respondent purchases efficient lightbulbs, appliances, and vehicles, which may be an inefficient way of measuring infrequent purchases. The survey asked about a larger list of 45 pro-environmental behaviors, using a Likert-type scale to measure frequency.

Heterogeneity in the responses, however, suggests that many participants understood the intent of the survey questions.

Implications

Our research suggests the importance of green lifestyle orientation, environmental concern, values, and sociodemographic variables, to green technology purchasing behavior in US and Canadian consumers. Theoretically, this research contributes to a growing body of work that understands consumption as embedded in daily life, and green lifestyles as the long-term process of prioritizing environmentally conscious consumption (Lubowiecki-Vikuk et al., 2021). Purchasing green technology is just one piece of a broader pro-environmental lifestyle, shaped by material, social, and economic constraints. To echo Whitmarsh and O'Neill (2010), our findings reinforce the idea that how we think about ourselves can impact our pro-environmental intentions and behaviors.

The practical implications of our findings are twofold. Lifestyle orientation as a predictor of green technology purchases suggests opportunity for better communication practices to this segment of the population to encourage efficient technology adoption. The strong impact of household income, home ownership, and vehicle ownership in our models, on the other hand, point to areas of structural lock-in that demand institutional change. While we recognize broad structural and institutional level changes are necessary for rapid decarbonization, we believe there is value in the "dichotomizing of strategies (cultures versus structures and individual versus institutions)" to push forward (Boucher, 2016).

If the way one sees their overall lifestyle impacts what kind of purchases they make, how can researchers, industry, and policymakers better communicate with green consumers? Longo et al. (2019) describe how overwhelming amounts of information can lead to paralysis and even dread in green consumers, as factors outside of their control inhibit true sustainable consumption. The study recommends a wide variety of approaches to combat this barrier, including top-down regulations on manufacturing and bottom-up community-stakeholder partnerships to disseminate trustworthy information. In contrast to this sense of dread, Bukchin and Kerret (2020) find that higher levels of hope and motivation are significant predictors of early green technology adoption. Future research should consider these facets of identity and lifestyle orientation to craft messaging that speaks to the way consumers see themselves and understand their motivations. Further to this, future research might integrate lifestyle orientation with the norm activation aspect of VBN theory, considering if green lifestyle orientation is consistent with the activation of pro-environmental norms when making green purchasing decisions (Blamey, 1998; Van Liere & Dunlap, 1978).

Dietz et al. (2009) suggest a variety of interventions to encourage energy-efficient technology adoption including financial incentives for both households to purchase green technology and industry to produce and sell it. Our finding that income is linked to frequency of energy-efficient purchasing speaks to the need for increased financial incentives, particularly for purchases with higher upfront costs. Additionally, implementations of energy efficiency policies targeting the household sector have been linked to an increased number of patented energy efficiency inventions, a measure of innovation (Girod et al., 2017). A large body of research evaluates emissions reductions and energy savings as a result of energy efficiency policies and programs, and these results are largely mixed—one recent comprehensive review found that introducing product standards and financial incentives have higher energy savings potential than behavioral and informational programs, although often subject to misevaluation that overestimates savings (Gillingham et al. 2018).

Critiques of household consumption research have long acknowledged that individual action can only move us so far towards rapid emissions reductions. Increased income is linked with greater individual emissions, despite levels of environmental concern (Boucher, 2016; Csutora, 2012; Gatersleben et al., 2002; Wilson et al., 2013). Wilson et al. (2013) found additionally that even respondents who reported energy-efficient behaviors did not have significant differences in GHG emissions. Our findings, linking higher income to greater frequency of green technology purchases, complicates this relationship, suggesting that even if high-income consumers are consuming more efficiently, they are still likely consuming at higher rates than low-income households. Boucher (2016) suggests, "rather than thinking of income as a medium for buying and disposing of products, energy, and emissions, it could be thought of as a proxy for a set of normative, socially positioned behaviors—an *income lifestyle, a class culture*" (p. 69, emphasis in original). High-income consumers presumably have the most disposable income to spend on upgrading to efficient technology and higher levels of household emissions to reduce, positioning them as ideal targets for both behavioral and structural policy programs.

Conclusion

The purpose of this research is to investigate social-psychological factors associated with frequency of green technology purchasing in US and Canadian consumers. The results of three structural equation models across two samples suggest the presence of a relationship between biospheric and altruistic values, environmental concern, and green lifestyle orientation that predict green technology purchasing intention. Additionally, income has a strong effect on purchase intentions across samples. Other sociodemographic factors also influence potential purchases. Identifying as female was positively related to electric vehicle purchase intention in the US sample, but this relationship did not hold in the Canadian sample. As cultural and political shifts persist, future research should continue to monitor the ways in which consumers perform environmental identity and lifestyle through purchases. Beyond individual attitudes, behavior, and choices, existing institutions including government and industry must provide affordable, reliable, and equitable green technology to consumers.

Declarations

Conflict of interest The authors declare no competing interests.

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. https://doi.org/10.1016/j.jenvp.2005.08.002

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*, 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Allcott, H. (2011). Social norms and energy conservation. *Journal of Public Economics, 95*, 1082–1095. https://doi.org/10.1016/j.jpubeco.2011.03.003

Ateş, H. (2020). Merging Theory of Planned Behavior and Value Identity Personal norm model to explain pro-environmental behaviors. *Sustainable Production and Consumption, 24*, 169–180. https://doi.org/10.1016/j.spc.2020.07.006

Axon, S. (2017). "Keeping the ball rolling": Addressing the enablers of, and barriers to, sustainable lifestyles. *Journal of Environmental Psychology, 52*, 11–25. https://doi.org/10.1016/j.jenvp.2017.05.002

Axsen, J., TyreeHageman, J., & Lentz, A. (2012). Lifestyle practices and pro-environmental technology. *Ecological Economics, 82*, 64–74. https://doi.org/10.1016/j.ecolecon.2012.07.013

Babbie, E. (2013). *The basics of social research*. Cengage learning.

Barr, S., Gilg, A. W., & Ford, N. (2005). The household energy gap: Examining the divide between habitual-and purchase-related conservation behaviours. *Energy Policy, 33*, 1425–1444

Blamey, R. (1998). The activation of environmental norms: Extending Schwartz's model. *Environment and Behavior, 30*, 676–708. https://doi.org/10.1177/001391659803000505

Boucher JL (2016) Culture, carbon, and climate change: A class analysis of climate change belief, lifestyle lock-in, and personal carbon footprint. *SocEkol* 25:53–80. https://doi.org/10.17234/SocEkol.25.1.3

Bukchin, S., & Kerret, D. (2020). Once you choose hope: Early adoption of green technology. *Environmental Science and Pollution Research, 27*, 3271–3280. https://doi.org/10.1007/s11356-019-07251-y

Carlsson-Kanyama, A., Lindén, A.-L., & Eriksson, B. (2005). Residential energy behaviour: Does generation matter? *International Journal of Consumer Studies, 29*, 239–253

Csutora, M. (2012). One more awareness gap? The behaviour–impact gap problem. *Journal of Consumer Policy, 35*, 145–163. https://doi.org/10.1007/s10603-012-9187-8

de Groot JIM de, Thøgersen J (2018) Values and pro-environmental behaviour. In: Environmental Psychology. John Wiley & Sons, Ltd, pp 167–178

Diekmann, A., & Preisendörfer, P. (2003). Green and greenback: The behavioral effects of environmental attitudes in low-cost and high-cost situations. *Rationality and Society, 15*, 441–472. https://doi.org/10.1177/1043463103154002

Dietz, T., Fitzgerald, A., & Shwom, R. (2005). *Environmental values. Annu Rev Environ Resour, 30*, 335–372. https://doi.org/10.1146/annurev.energy.30.050504.144444

Dietz, T., Gardner, G. T., Gilligan, J., et al. (2009). Household actions can provide a behavioral wedge to rapidly reduce US carbon emissions. *Proceedings of the National Academy of Sciences, 106*, 18452–18456. https://doi.org/10.1073/pnas.0908738106

Dieu-Hang, T., Grafton, R. Q., Martínez-Espiñeira, R., & Garcia-Valiñas, M. (2017). Household adoption of energy and water-efficient appliances: An analysis of attitudes, labelling and complementary green behaviours in selected OECD countries. *Journal of Environmental Management,* *197*, 140–150. https://doi.org/10.1016/j.jenvman.2017.03.070

DiStefano C, Zhu M, Mîndrilã D (2009) Understanding and using factor scores: Considerations for the applied researcher. *Practical assessment, research, and evaluation 14*: https://doi.org/10.7275/DA8T-4G52

Dubois, G., Sovacool, B., Aall, C., et al. (2019). It starts at home? Climate policies targeting household consumption and behavioral decisions are key to low-carbon futures. *Energy Research & Social Science, 52*, 144–158

Elf P, Gatersleben B, Christie I (2019) Facilitating positive spillover effects: New insights from a mixed-methods approach exploring factors enabling people to live more sustainable lifestyles. *Front Psychol 9*: https://doi.org/10.3389/fpsyg.2018.02699

Endres, A., & Rundshagen, B. (2010). Standard oriented environmental policy: Cost-effectiveness and incentives for 'green technology.' *German Economic Review, 11*, 86–107. https://doi.org/10.1111/j.1468-0475.2009.00477.x

EPA. (2009). *A resource of the national action plan for energy efficiency: Energy efficiency as a low-cost resource for achieving carbon emissions reductions*. Environmental Protection Agency.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Addison-Wesley.

Fisher, C., Bashyal, S., & Bachman, B. (2012). Demographic impacts on environmentally friendly purchase behaviors. *Journal of Targeting, Measurement and Analysis for Marketing, 20*, 172–184. https://doi.org/10.1057/jt.2012.13

Gatersleben, B., Steg, L., & Vlek, C. (2002). Measurement and determinants of environmentally significant consumer behavior. *Environment and Behavior, 34*, 335–362. https://doi.org/10.1177/0013916502034003004

Gillingham, K., Keyes, A., & Palmer, K. (2018). Advances in evaluating energy efficiency policies and programs. *Annual Review of Resource Economics, 10*, 511–532. https://doi.org/10.1146/annurev-resource-100517-023028

Gillingham, K., Kotchen, M. J., Rapson, D. S., & Wagner, G. (2013). Energy policy: The rebound effect is overplayed. *Nature, 493*, 475–476. https://doi.org/10.1038/493475a

Girod, B., Stucki, T., & Woerter, M. (2017). How do policies for efficient energy use in the household sector induce energy-efficiency innovation? An evaluation of European countries. *Energy Policy, 103*, 223–237. https://doi.org/10.1016/j.enpol.2016.12.054

Hall, B. H., & Helmers, C. (2013). Innovation and diffusion of clean/green technology: Can patent commons help? *Journal of Environmental Economics and Management, 66*, 33–51. https://doi.org/10.1016/j.jeem.2012.12.008

Hanson, C. B. (2013). Environmental concern, attitude toward green corporate practices, and green consumer behavior in the United States and Canada. *ASBBS E-Journal, 9*, 62

Harrison, K. (2007). The road not taken: Climate change policy in Canada and the United States. *Global Environmental Politics, 7*, 92–117. https://doi.org/10.1162/glep.2007.7.4.92

Herring, H. (2006). Energy efficiency—A critical view. *Energy, 31*, 10–20. https://doi.org/10.1016/j.energy.2004.04.055

Hertwich, E. G., & Peters, G. P. (2009). Carbon footprint of nations: A global, trade-linked analysis. *Environmental Science and Technology, 43*, 6414–6420. https://doi.org/10.1021/es803496a

Hooper D, Coughlan J, Mullen M (2008) Evaluating model fit: A synthesis of the structural equation modelling literature. In: 7th European Conference on research methodology for business and management studies. pp 195–200

Hua, L., & Wang, S. (2019). Antecedents of consumers' intention to purchase energy-efficient appliances: An empirical study based on the technology acceptance model and theory of planned behavior. *Sustainability, 11*, 2994. https://doi.org/10.3390/su11102994

IEA (2015) World Energy Outlook Special Report. INTERNATIONAL ENERGY AGENCY

Ivanco M, Karney BW, Waher KJ (2007) To switch, or not to switch: A critical analysis of Canada's ban on incandescent light bulbs. In: 2007 IEEE Canada Electrical Power Conference. pp 550–555

Joshi, Y., & Rahman, Z. (2015). Factors affecting green purchase behaviour and future research directions. *International Strategic Management Review, 3*, 128–143. https://doi.org/10.1016/j.ism.2015.04.001

Karlin, B., Davis, N., Sanguinetti, A., et al. (2014). Dimensions of conservation: Exploring differences among energy behaviors. *Environment and Behavior, 46*, 423–452

Klöckner, C. A. (2013). A comprehensive model of the psychology of environmental behaviour—A meta-analysis. *Global Environmental Change, 23*, 1028–1038. https://doi.org/10.1016/j.gloenvcha.2013.05.014

Kollmuss, A., & Agyeman, J. (2002). Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research, 8*, 239–260. https://doi.org/10.1080/13504620220145401

Laroche, M., Bergeron, J., & Barbaro-Forleo, G. (2001). Targeting consumers who are willing to pay more for environmentally friendly products. *Journal of Consumer Marketing, 18*, 503–520. https://doi.org/10.1108/EUM0000000006155

Leth-Steensen, C., & Gallitto, E. (2016). Testing mediation in structural equation modeling. *Educational and Psychological Measurement, 76*, 339–351. https://doi.org/10.1177/0013164415593777

Lin, E., & Shi, Q. (2014). Exploring individual and school-related factors and environmental literacy: Comparing U.S. and Canada using PISA 2006. *Int J of Sci and Math Educ, 12*, 73–97. https://doi.org/10.1007/s10763-012-9396-2

Liobikienė, G., Mandravickaitė, J., & Bernatonienė, J. (2016). Theory of planned behavior approach to understand the green purchasing behavior in the EU: A cross-cultural study. *Ecological Economics, 125*, 38–46

Longo, C., Shankar, A., & Nuttall, P. (2019). "It's not easy living a sustainable lifestyle": How greater knowledge leads to dilemmas, Tensions and Paralysis. *Journal of Business Ethics, 154*, 759–779. https://doi.org/10.1007/s10551-016-3422-1

Lorenzen, J. A. (2012). Going green: The process of lifestyle change. *Sociological Forum, 27*, 94–116. https://doi.org/10.1111/j.1573-7861.2011.01303.x

Lubowiecki-Vikuk, A., Dąbrowska, A., & Machnik, A. (2021). Responsible consumer and lifestyle: Sustainability insights. *Sustainable Production and Consumption, 25*, 91–101. https://doi.org/10.1016/j.spc.2020.08.007
Martiskainen M (2007) Affecting consumer behaviour on energy demand: Final report to EdF Energy March 2007. Sussex Energy Group SPRU - Science and Technology Policy Research University of Sussex
McCoy, D., & Lyons, S. (2017). Unintended outcomes of electricity smart-metering: Trading-off consumption and investment behaviour. *Energy Efficiency, 10*, 299–318. https://doi.org/10.1007/s12053-016-9452-9
Moser AK (2015) Thinking green, buying green? Drivers of pro-environmental purchasing behavior. *Journal of Consumer Marketing*. https://doi.org/10.1108/JCM-10-2014-1179
Nair, G., Gustavsson, L., & Mahapatra, K. (2010). Factors influencing energy efficiency investments in existing Swedish residential buildings. *Energy Policy, 38*, 2956–2963
Orea, L., Llorca, M., & Filippini, M. (2015). A new approach to measuring the rebound effect associated to energy efficiency improvements: An application to the US residential energy demand. *Energy Economics, 49*, 599–609. https://doi.org/10.1016/j.eneco.2015.03.016
Peattie, K. (2010). Green consumption: Behavior and norms. *Annual Review of Environment and Resources, 35*, 195–228. https://doi.org/10.1146/annurev-environ-032609-094328
Pickett-Baker, J., & Ozaki, R. (2008). Pro-environmental products: Marketing influence on consumer purchase decision. *Journal of Consumer Marketing*. https://doi.org/10.1108/07363760810890516
Ruderman, H., Levine, M. D., & McMahon, J. E. (1984). *Energy efficiency choice in the purchase of residential appliances*. Lawrence Berkeley Lab.
Saunders, H. D. (2013). Historical evidence for energy efficiency rebound in 30 US sectors and a toolkit for rebound analysts. *Technological Forecasting and Social Change, 80*, 1317–1330. https://doi.org/10.1016/j.techfore.2012.12.007
Schmitt, M. T., Aknin, L. B., Axsen, J., & Shwom, R. L. (2018). Unpacking the relationships between pro-environmental behavior, life satisfaction, and perceived ecological threat. *Ecological Economics, 143*, 130–140. https://doi.org/10.1016/j.ecolecon.2017.07.007
Schuitema, G., & de Groot, J. I. M. (2015). Green consumerism: The influence of product attributes and values on purchasing intentions. *Journal of Consumer Behaviour, 14*, 57–69. https://doi.org/10.1002/cb.1501
Sekar, A., Williams, E., Hittinger, E., & Chen, R. (2019). How behavioral and geographic heterogeneity affects economic and environmental benefits of efficient appliances. *Energy Policy, 125*, 537–547. https://doi.org/10.1016/j.enpol.2018.10.035
Shove E, Pantzar M, Watson M (2012) The dynamics of social practice: Everyday life and how it changes. SAGE.
Song, K., Qu, S., Taiebat, M., et al. (2019). Scale, distribution and variations of global greenhouse gas emissions driven by U.S. households. *Environment International, 133*, 105137. https://doi.org/10.1016/j.envint.2019.105137
Steg L, De Groot JI (2012) Environmental values. In: The Oxford handbook of environmental and conservation psychology
Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology, 29*, 309–317. https://doi.org/10.1016/j.jenvp.2008.10.004
Steger, M. A. E., Pierce, J. C., Steel, B. S., & Lovrich, N. P. (1989). Political culture, postmaterial values, and the new environmental paradigm: A comparative analysis of Canada and the United States. *Political Behavior, 11*, 233–254. https://doi.org/10.1007/BF00992298
Stern, P. C. (2000). New Environmental theories: Toward a coherent theory of environmentally significant behavior. *J Social Isssues, 56*, 407–424. https://doi.org/10.1111/0022-4537.00175
Stern, P. C., Dietz, T., Abel, T., et al. (1999). A value-belief-norm theory of support for social movements: The case of environmentalism. *Human Ecology Review, 6*, 17
Stern, P. C., Guagnano, G. A., & Dietz, T. (1998). A brief inventory of values. *Educational and Psychological Measurement, 58*, 984–1001
Stragier J, Hauttekeete L, De Marez L (2010) Introducing smart grids in residential contexts: Consumers' perception of smart household appliances. In: 2010 IEEE Conference on Innovative Technologies for an Efficient and Reliable Electricity Supply. pp 135–142
Subiza-Pérez, M., Santa Marina, L., Irizar, A., et al. (2020). Who feels a greater environmental risk? Women, younger adults and pro-environmentally friendly people express higher concerns about a set of environmental exposures. *Environmental Research, 181*, 108918. https://doi.org/10.1016/j.envres.2019.108918
Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education, 2*, 53–55. https://doi.org/10.5116/ijme.4dfb.8dfd
US Energy Information Administration. (2018). *What's new in how we use energy at home: Results from EIA's 2015 Residential Energy Consumption Survey (RECS)*. U.S. Department of Energy.
US Energy Information Administration. (2015). *Issues in international energy consumption analysis: Canadian Energy Demand*. U.S.Department of Energy.
U.S. House Select Committee on Climate Crisis (2020) Solving the climate crisis: The congressional action plan for a clean energy economy and a healthy, resilient, and just America
van der Werff, E., & Steg, L. (2016). The psychology of participation and interest in smart energy systems: Comparing the value-belief-norm theory and the value-identity-personal norm model. *Energy Research & Social Science, 22*, 107–114. https://doi.org/10.1016/j.erss.2016.08.022
van der Werff, E., Steg, L., & Keizer, K. (2013). The value of environmental self-identity: The relationship between biospheric values, environmental self-identity and environmental preferences, intentions and behaviour. *Journal of Environmental Psychology, 34*, 55–63. https://doi.org/10.1016/j.jenvp.2012.12.006
Van Liere, K. D., & Dunlap, R. E. (1978). Moral norms and environmental behavior: An application of Schwartz's norm-activation model to yard burning. *Journal of*

Applied Social Psychology, 8, 174–188. https://doi.org/10.1111/j.1559-1816.1978.tb00775.x
Vazifehdoust, H., Taleghani, M., Esmaeilpour, F., & Nazari, K. (2013). Purchasing green to become greener: Factors influence consumers' green purchasing behavior. *Management Science Letters, 3*, 2489–2500
Whitmarsh, L., & O'Neill, S. (2010). Green identity, green living? The role of pro-environmental self-identity in determining consistency across diverse pro-environmental behaviours. *Journal of Environmental Psychology, 30*, 305–314. https://doi.org/10.1016/j.jenvp.2010.01.003
Wiernik, B. M., Ones, D. S., & Dilchert, S. (2013). Age and environmental sustainability: A meta-analysis. *Journal of Managerial Psychology, 28*, 826–856. https://doi.org/10.1108/JMP-07-2013-0221
Wilson, J., Tyedmers, P., & Spinney, J. E. L. (2013). An exploration of the relationship between socioeconomic and well-being variables and household greenhouse gas emissions. *Journal of Industrial Ecology, 17*, 880–891. https://doi.org/10.1111/jiec.12057
World Bank (2020) World development indicators: CO2 emissions (metric tons per capita) - Canada, United States
Xiao, C., & Dunlap, R. E. (2007). Validating a comprehensive model of environmental concern cross-nationally: A U.S.-Canadian comparison*. *Social Science Quarterly, 88*, 471–493. https://doi.org/10.1111/j.1540-6237.2007.00467.x