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DO IMMIGRANT STUDENTS CONSUME LESS ENERGY  
THAN NATIVE-BORN AMERICAN STUDENTS?

by

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A thesis submitted in partial fulfillment of the requirements  
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## ABSTRACT

This paper uses a sociological model to compare the residential energy consumption between immigrant students and native-born American students and to explain the difference by demographic characteristics, values, and specific attitudes. Further, it tries to explore whether the relationship between immigration status and residential energy consumption is mediated by value orientation towards frugality and specific attitudes towards energy conservation. The data of an online survey among native-born and foreign-born students at the University of Central Florida are used. The results suggest that immigrants consume less energy at home than native-born Americans, but the time stayed in the US doesn't have an impact on the energy consumption of immigrants. In addition, the results do not show evidence that value orientation towards frugality and specific attitudes toward energy conservation mediate the relationship between immigration status and energy consumption at home.

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# 1. INTRODUCTION

It has been found that residential energy consumption is shaped by a complex interaction of technological, economic, social, and cultural factors (Abrahamse and Steg 2009; Heslop, Moran and Cousineau 1981; Hunter 2000; Lutzenhiser 1992; Lutzenhiser 1993; Ritchie, McDougall and Claxton 1981). Population groups with different economic, social, and cultural backgrounds show disparities in the pattern of energy consumption at home (Hackett and Lutzenhiser 1991; Hunter 2000). Past studies have been focused on demographic characteristics such as stage in life cycle, income, race and ethnicity, and urban-rural residence (Lutzenhiser 1993). However, the differences between immigrants and the native-born Americans in energy use have not attracted much attention from researchers.

Whether immigrants extend the carbon footprint of the US and destroy the environment has raised heated debates. Anti-immigration groups (such as the Federation for American Immigration Reform (FAIR)) claim that the immigrant-driven population growth was responsible for the energy consumption increase in the US. They gave the evidence that energy consumption per capita in the US has dropped by 6.4% from 1973 to 2007, but the total energy consumption of the US has increased by about 34% (Martin 2009). A newly released report by the Center for American Progress rebutted this argument. The report states that “The 10 highest carbon-emitting cities have an average immigrant population below 5 percent, according to a 2008 Brookings Institution study. The cities with the lowest carbon footprint, on the other hand, have an average immigrant population of 26 percent” (Madrid 2010:2). It also says that immigrants, especially recent immigrants, tend to adopt a greener



lifestyle than native-born Americans, and have more environmental friendly habits, such as using public transportation, conservation, and recycling.

Immigrants play an increasingly important role in energy consumption, but little is known about immigrants' energy consumption attitudes and behaviors. Therefore, it is meaningful and important to compare energy consumption of immigrants and native-born residents and explore the reason for the difference between immigrants and non-immigrants. Using data from a survey among international and American students at a state university, this study aims to (1) compare the energy consumption of immigrants and native born Americans; (2) explore how the length of time stayed in the US affects the pattern of energy consumption of immigrants; and (3) explain how values, attitudes, and social norms explain the difference between immigrants' and native-born Americans' energy consumption.

## 2. THEORETICAL AND EMPIRICAL BACKGROUND

In the current literature, there are several types of approaches to explain residential energy consumption. A lot of studies use engineering models (Hackett and Lutzenhiser 1991) which consider variables such as the site of building, insulation level, the square footage, energy efficiency of houses, and variations in climate. Models of this type do not involve human subjective choices and decisions about energy use and social factors that restrain human behaviors. The second type of approach is an economic approach which focuses on the effect of price on individual consumption choices. As a supplement and improvement to technology models, the economic approach adds income and energy price to engineering models (Douthitt 1989), which makes it more favored by policy makers (Hackett and Lutzenhiser 1991). Still, both approaches fail to capture the variances in energy consumption caused by cultural and social factors. The sociological approach focuses on the group rather than individual behavior, and emphasizes the impacts of socially constructed values, norms, and meanings on energy using behaviors. In this study, I use the sociological approach to examine the energy consumption of an immigrant population, with a focus on cultural and social-psychological explanatory variables such as values and attitudes.

### 2.1 Immigrants' Energy Consumption

This study focuses on residential energy consumption of immigrants and non-immigrants in the US. According to my knowledge, there is no study that directly examines immigrants' energy consumption in residential households. However, several studies have

provided indirect evidence that reveals the difference in residential energy consumption between immigrant and native-born populations. Since CO<sub>2</sub> emissions is closely related to energy consumption, it is used as an approximate indicator for energy consumption. Madrid (2010) found that cities with the lowest carbon footprint have a much higher percentage (26%) of immigrants than cities with large carbon footprints (5%). The same report argues that immigrants lead a greener lifestyle than native-born Americans because they are more likely to use public transportation and live in compact communities. Another report shows that “the average estimated CO<sub>2</sub> emissions of the immigrant (legal or illegal) in the U.S. are 18 percent less than those of the average native-born American” (Kolankiewicz and Camarota 2008:1). However, this finding was relatively weak because income was used as a proxy for CO<sub>2</sub> emissions due to the absence of data of CO<sub>2</sub> emission by population categories. It also neglects the influence of many other important factors.

Examining the energy consumption in residential households in the US and in immigrants’ home countries, I find that residents in immigrants’ countries of origin consume much less energy than the US residents. As shown in Table 1, the annual residential energy consumption per capita in the US was 911.0 Kgoe (kilograms of oil equivalent) in 2005, which ranked the tenth in the world. The top five home countries of immigrants to the US are Mexico, China, India, Philippines, and Vietnam (Kolankiewicz and Camarota 2008). The energy consumption per capita for Vietnam was 314 Kgoe in 2005, 34% of the US level. It was 256.3 Kgoe for China, which was 28% of the US level. The other three countries’ annual residential energy consumptions per capita were lower than 20% of the level of the US.

Table 1: The Residential Energy Consumption per Capita of the US and Immigrants' Countries of Origin

Country	Residential energy consumption per capita (kilograms of oil equivalent [kgoe] per person)			Approximate percentage of the US consumption
	1990	2000	2005	2005
The U.S.	821.2	929.3	911.0	--
Mexico	175.1	172.9	169.5	19%
China	253.7	234.0	256.3	28%
India	144.8	141.6	142.2	16%
Philippines	72.5	70.9	71.3	8%
Vietnam	283.6	302.4	314.0	34%

Source: The World Resources Institute. Retrieved October 1, 2010  
([http://earthtrends.wri.org/searchable\\_db/index.php?theme=6&variable\\_ID=634&action=select\\_countries](http://earthtrends.wri.org/searchable_db/index.php?theme=6&variable_ID=634&action=select_countries))

The huge discrepancy in energy consumption levels between residents in the US and in immigrants' home countries can be partly explained by economic development and industrialization level. But culture, social norms, lifestyle, and attitudes might also account for the difference in energy use between native-born residents and immigrants. If immigrants are used to conserving energy in their home countries due to culture and lifestyles, they would probably keep the low level of energy consumption after they move to the US. Thus, I propose that:

*Hypothesis 1:* Immigrants in the US consume less residential energy than native-born Americans.

Even if immigrants retain their own culture, lifestyle, and attitudes when they arrive, they are likely to become more "American" as they stay longer in the US due to acculturation. There are four possible paths of acculturation: (1) immigrants give up their own culture

completely and are totally assimilated into American culture; (2) immigrants keep their own culture as well as become integrated into American culture, which can be described as “bicultural”; (3) immigrants retain their own culture without trying to integrate in to the mainstream culture and end up being segregated; (4) immigrants forgo their original culture and do not attempt to involve in the new culture, and end up being “isolated” (Pérez-Escamilla and Putnik 2007). However, usually, as immigrants stay longer in the US, they will be gradually acculturated through adopting the language, lifestyle, dressing style, values, and attitudes in the new social environment. As a result, their energy consumption profile should become similar to that of the native-born Americans. Lutzenhiser (1997:74) found that “the immigrant populations studied move toward the white American pattern as a function of acculturation, reflected by the language spoken in the household”. This finding implies that adoption of American culture increases energy use in immigrant households. He also suggests that immigrants may adopt the American pattern of energy consumption in one generation or two. Therefore, I propose that:

*Hypothesis 2:* The longer immigrants stay in the US, the closer their energy consumption at home becomes to that of native-born Americans.

## 2.2 Why Immigrants and Native-Born Residents Differ in Energy Consumption?

Social economic status (SES) and culture are potential factors that could account for the difference between immigrant and non-immigrants in energy consumption. In the

following sections, I explain the possible mechanisms through which the two variables might influence residential energy consumption.

### 2.2.1 Social Economic Status

Income is often used as a measure of SES in research on environmental behaviors. Many studies demonstrate that income is positively related to household energy consumption (Heslop, Moran and Cousineau 1981; Newman and Day 1975; Ritchie, McDougall and Claxton 1981). In addition, Lutzenhiser (1997) found that low income households (<\$15,000 per year) and high income households (>\$50,000 per year) had significantly lower annual energy consumption than middle income households when controlling other factors. Other research found that income has no significant impact on energy using behaviors (Johnson-Carroll 1985).

The reason for the disparity of the findings is that income has two opposite effects on energy consumption. On one hand, less wealthy people tend to restrict their energy use because of economic pressure, so low-income residents should consume less energy than high-income residents. On the other hand, high-income residents have been found to be more willing to save energy at home because they have a better understanding of the benefits of energy conservation (Laquatra and Chi 1988) and could afford more expensive energy-efficient technologies (Eichner and Morris 1984).

Since income is one of the most obvious reasons for different residential energy consumption levels, we need to examine the income of immigrants in the US. First, most immigrants suffer a considerable earnings disadvantage compared to native-born workers

(Borjas 2006). According to an analysis of the Current Population Survey (CPS) in 2007, native-born Americans had higher average annual income per capita than immigrants in the US in general (Kolankiewicz and Camarota 2008). Secondly, incomes of immigrants vary widely by countries of origin. Individuals from advanced economies perform much better in the U.S. labor market than those from poorer countries (Borjas 2006). Kolankiewicz and Camarota (2008) found that immigrants from Mexico have lower average income than native-born Americans, while Chinese and Indian immigrants earn more than the native-born. Thirdly, incomes of immigrants increase as they stay longer in the US. For example, a study of Mexican immigrants showed that with longer time in the US, the male immigrants achieved higher earnings than before, and the female immigrants got more hours of paid work (Allensworth 1997). Income of Mexican immigrants was found to be closely related to the time they had lived in the US.

Unfortunately, in this study, I cannot examine the relationship between income and residential energy use. The target population of this study consists of international and native-born students in a state university. This controls the variance in income, because their economic statuses are relatively similar to each other. Another reason why I cannot include income into this analysis is the lack of validity of the income measure in the survey. As students, the respondents don't have earnings from work and they failed to count all other sources of income into the total amount, for example, support from parents or relatives.

## 2.2.2 Culture

### 2.2.2.1 *Lifestyles and habits*

The most evident difference between immigrants and native-born residents is culture. As it is defined by Hofstede (2001), culture is a shared set of meanings, beliefs, norms, symbols, and values within a social group. Coming from different countries, immigrants possess unique collective mental programming of their own nations (Hofstede 1980). National culture influences energy consumption because it predicts people's lifestyle and habits. Immigrants' habits and lifestyles are formed under the influence of the climates, geographic characteristics, material conditions (such as buildings, furnishings, clothing, and other objects), and social relations, rules and beliefs in their countries (Lutzenhiser 1992). As a part of lifestyle, cultural conventions for energy use behaviors will also be formed. Foreign-born energy consumers tend to behave according to the conventions and norms in their original cultures, because they receive information, approval, criticism, and legitimacy from families and friends who share the same national culture (Lutzenhiser 1992). Although immigrants also receive feedback from neighbors, friends, and communities which represent American culture, it is still likely that the major source of normative influence comes from their significant others who typically share their original cultures.

Through qualitative interviews among an international population of families living in the US, Hackett and Lutzenhiser (1991) found that immigrants and US citizens show wide cultural variations in energy use habits. Some of the habits could result in significantly less energy consumption at immigrant households. For example, Mediterranean and South Asian immigrants tended to lower their hot-water temperatures because they think that hot water should be used directly without mixing it with cold water (Hackett and Lutzenhiser 1991).



North Asian and European families had the habit of controlling heaters and air conditioners manually based on actual feelings; US citizens were more likely to rely on thermostats and kept their rooms comparatively hot in the winter and cold in the summer (Hackett and Lutzenhiser 1991). Asian and European residents are used to line drying clothes, while Americans are more likely to use dryers.

Past studies demonstrated significant discrepancies in residential energy consumption across groups of various races and nationalities, who have different cultures, after controlling for other variables. In a study conducted among international student families in the US, household energy consumption was found to be related to culture when economic factors, climate, and housing structure were controlled (Hackett and Lutzenhiser 1991). The results show that more than 75% of South Americans are high users and about 65% of North Asians are low users. Most high-income third world households fall into the high-income/high-use category, while half of high-income European families lie in the high-income/low-use group. This finding demonstrates the impact of national culture on household energy consumption. In another study, Lutzenhiser (1997) found that after controlling for climate, number of household members, dwelling size, housing characteristics, household technology, and income, African-American households consume more energy, and Spanish-speaking Hispanic households and Asian (both English-speaking or non-English speaking) households consume less energy as compared to White households. He also found that in absolute terms, the high income Hispanic, Asian, and Black households consume even less energy per capita than the low income whites.

### 2.2.2.2 Values and specific attitudes

People from different nations may have different energy consumption choices because culture shapes their values and general beliefs, which in turn affect their specific attitudes towards energy use. According to the hierarchical causal model developed by Stern, Dietz, and Guagnano (1995) an individual's position in the social structure is causally antecedent to values, and values, in turn, are antecedent to more specific attitudes, and ultimately to behavioral intentions and behaviors (See Figure 1).

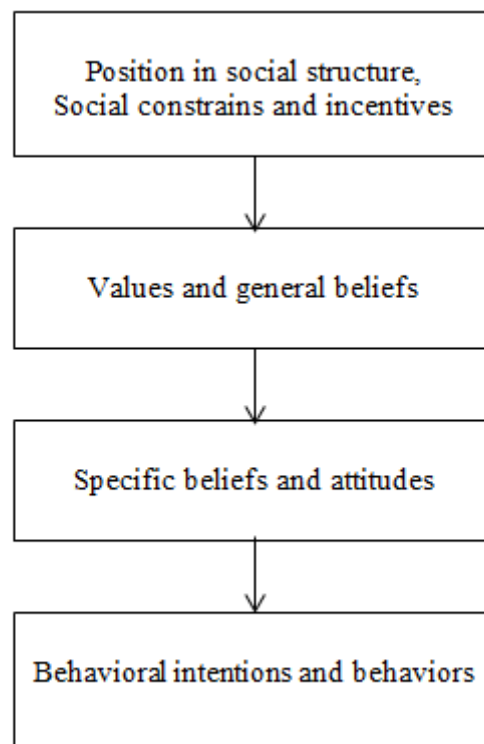


Figure 1: A schematic casual model of environmental concern modified from Stern, Dietz, and Guagnano (1995)

Stern, Dietz, and Guagnano (1995) argue that individuals are embedded in a social structure, which determines early experience and thus shapes values and general beliefs of individuals. Immigrants, especially recent immigrants, have grown up in different social structures compared to native-born Americans, so they should possess different value

orientations. Different values will cause immigrant populations to develop different attitudes toward environmental issues and energy use. Earlier studies show that short-term immigrants express significantly higher levels of concern for environmental problems and engage in more pro-environmental behaviors as compared to native-born residents (Hunter 2000). Deng, Walker, and Swinnerton (2006) found that Chinese immigrants in Canada are more supportive of social-altruistic values and the new environmental paradigm (NEP) than are Anglo-Canadians.

Since social structure determines the formation of values and attitudes, in this study, I focus on how values and specific attitudes act as intervening variables between immigration status and energy consumption. Values refer to important life goals or standards that serve as guiding principles in life (Rokeach 1973). They are likely formed in early life and are stable during the life course (Stern, Dietz and Guagnano 1995). Individuals tend to accept information and ideas that are consistent with their personal values, so that values and general beliefs shape the formation of specific attitudes toward certain objectives and guide one's behaviors. I measure value orientation toward frugality, which is directly linked to the attitudes toward energy conservation. The issue of energy conservation often raises a conflict between the comforts of life and frugality/saving. Some cultures may recognize frugality as a virtue or a social norm, but some cultures do not. Immigrants from countries which are less wealthy than the US may endorse frugality more than native-born Americans, because insufficient living resource may cultivate the value towards frugality. Individuals who consider frugality as a virtue probably consume less energy in their households. Therefore, I propose that:

*Hypothesis 3:* Value orientation towards frugality mediates the relationship between immigration status and energy consumption.

Formed in reference to basic values and more general beliefs, specific attitudes are cognitions and evaluations toward a certain behavior, which could predict behavioral intentions and actual behaviors (Stern, Dietz and Guagnano 1995). Cognition refers to people's knowledge about the attributes and consequences of a behavior. After understanding a behavior, individuals develop favorable or unfavorable feelings towards the behavior according to their cognitions. Schwartz's (1977) normative-action model (NAM) describes three dimensions of attitudes. He argues that pro-social behaviors (including pro-environmental behaviors) are determined by individuals' awareness of the problem, ascription of responsibility, beliefs about outcome efficacy, and recognition of one's ability to provide relief. This study focuses on the first two dimensions of attitudes towards energy conservation. First, individuals who express concern about the problem of global warming and energy crisis should hold more positive attitudes towards energy conservation and consequently consume less energy. Second, people who feel responsibility to reduce energy use would possibly consume less energy at home.

Past research found that immigrants express greater concern for environmental problems and stronger support for new the new environmental paradigm (NEP) than native-born Americans and Canadians (Deng, Walker and Swinnerton 2006; Hunter 2000). Meanwhile, according to the reasoning above, people who hold more positive attitudes towards pro-environmental behaviors and energy conservation tend to consume less residential energy. Therefore, I propose that:

*Hypothesis 4:* Attitudes towards energy conservation mediate the relationship between immigration status and energy consumption. (See the conceptual model of all of the hypotheses in Figure 2)

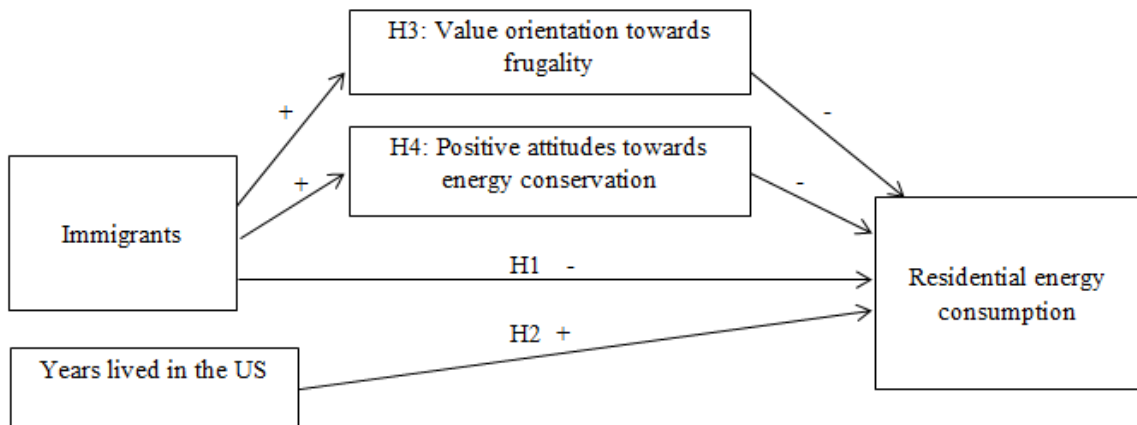


Figure 2: Conceptual model

### 3. DATA AND METHODS

#### 3.1 Data Collection

To compare the energy consumption of international students and native-born American students, I conducted an online survey at the University of Central Florida (UCF). UCF is an ideal place to study immigrants because it has 1,670 international students from 128 countries. Among the international students, 58% are graduate students and 42% are undergraduate students (data provided by International Service Center at UCF). The survey was created on the website [www.surveygizmo.com](http://www.surveygizmo.com). To recruit international students, emails with the link of the survey were sent out by the International Service Center to all the international students at UCF (both graduate and undergraduate). In addition, the Graduate Student Association sent out emails with the survey link to all of its members (predominantly native-born American graduate students). Professors from various departments (including sociology, biology, psychology, computer science, electronic engineering, and finance) also helped to send out emails to undergraduate students in their classes, most of whom are native-born Americans.

The online survey was conducted from mid-February to the end of March, and during the whole November in 2010. In February and March, 197 students filled out the survey, and another 87 students participated in the survey in November 2010. In total, I have 284 responses for the survey. Most questions are the same in the two surveys; however, some questions were cut and some were added in the second survey.

## 3.2 Measures

### 3.2.1 Dependent Variable

#### 3.2.1.1 *Energy Use*

My dependent variable is residential energy consumption, measured by self-reported average electricity bill per person per month (here I only consider energy consumed within a house or an apartment where respondents live; energy used in traveling is not included). It is calculated using the average self-reported electricity bill for a household per month in the past six months divided by the number of people living in that household. Table 2 shows that the average electricity bill per person per month ranges from 3.25 to 500 dollars, with the mean being 59 dollars. On average, an immigrant spends 50 dollars on electricity per person per month, while a native-born American spends 71 dollars. This difference is statistically significant as indicated by the t-test ( $p < .01$ ).

Table 2: Residential Energy Consumption (Electricity Bill), Value, and Specific Attitudes by Immigration Status

Variables	Range	Mean (SD)			T-test P value	N
		All	Immigrants	Native-born Americans		
Electricity bill per person per month (\$)	3.25-500	59 (55)	50 (46)	71 (63)	.005	217
<i>Value</i>						
Frugality as a virtue in original culture	1-5	3.2 (1.2)	3.7 (1.2)	2.6 (0.9)	.000	254
<i>Attitudes: Saving energy because of ...</i>						
Global warming	1-6	4.6 (1.5)	4.8 (1.3)	4.4 (1.6)	.020	270
Saving money	1-6	5.2 (1.1)	5.2 (1.1)	5.1 (1.1)	.329	270
Other people doing it	1-6	3.0 (1.4)	3.0 (1.6)	3.0 (1.4)	.935	268

Note: The t-test measures whether the means for immigrants and native-born Americans are significantly different.  
 Source: UCF Energy Use and Conservation Study (Lei 2010).



## 3.2.2 Explanatory Variables

### 3.2.2.1 *Immigration Status*

My main independent variable is immigration status, which refers to whether a respondent is an immigrant or a native-born American. In this study, an “immigrant” is defined as an individual who was not an American citizen when he/she was born and is living in the US currently. The question in the survey asks “were you born as a U.S. citizen?” The response categories are “Yes” (native-born American) and “No” (immigrant). Table 3 summarizes the descriptive statistics for independent variables. In this study, half of the respondents are immigrants and half are native-born Americans. In the regression analysis I use a dummy variable, “Native-born”, with 1 referring to native-born Americans, and 0 referring to immigrants.

Table 3: Descriptive Statistics of Independent Variables

Explanatory and control variables	Category/Range	Percentage/ Mean(SD)	Total N
Immigration status	Native-born Americans	50%	280
	Immigrants	50%	
Time stayed in the US	2 months - 29 years	4 years	136
	Short-term ( $\leq 4$ years)	71%	136
	Long-term ( $> 4$ years)	29%	
Gender	Male	43%	284
	Female	57%	
Age	18 - 60	25 (6.2)	282
Race	White	53%	284
	Minorities	47%	
Educational level	Undergraduate	48%	284
	Graduate	52%	
Type of residence	On-campus dormitory	10%	281
	Off-campus rental house/apartment	64%	
	Off-campus house/apartment owned by yourself or family members	25%	

Source: UCF Energy Use and Conservation Study (Lei 2010).

### 3.2.2.2 *Time Stayed in the US*

Independent variable for hypothesis 2 is time lived in the US. The survey asks, “If you are not born as a US citizen, how long have you lived in the US?” The respondents answered the length of time that they have stayed in the US in years and months. As shown in Table 3, the length of time ranges from 2 months to 29 years. The average is 4 years because the target immigrant population for this study is international students who came to the US to pursue academic degrees. According to time stayed in the US, immigrants are divided into

two groups: 1) short term immigrants (who have stayed in the US for less than or equal to 4 years) and 2) long term immigrants (who have stayed in the US for longer than 4 years). In this sample, 71% of the immigrants are short term and 29% are long term. A dummy variable for short term immigrants is used in the regression analysis.

### 3.2.2.3 *Value Orientations*

The first proposed mediating variable for the relationship between immigration status and residential energy consumption is the cultural value orientation towards frugality. The survey asks, “Does the culture of your original country regard saving, thrift, or austerity as a virtue? (If you are a native-born American, consider your country of origin as the US.)” The potential answers are “Not at all”, “a little”, “moderately”, “quite a lot”, and “very much”, coded from 1 to 5. Larger numbers mean higher agreement with the statement that their cultures treat frugality as a virtue. The mean for immigrants is 3.7 which is close to “quite a lot” and the mean for native-born Americans is 2.6 which is between “a little” and “moderately” (see Table 2). T-test shows that immigrants’ cultures support frugality more than non-immigrants’ (American) culture ( $p < .001$ ).

### 3.2.2.4 *Specific Attitudes*

As proposed in the hypothesis, specific attitudes are second type of mediators for the relationship between immigration status and residential energy consumption. Respondents are asked to what extent they agree with the following statements: (1) “I need to reduce my energy consumption because of global warming”; (2) “I need to reduce my energy

consumption in order to save money”; and (3) “I need to reduce my energy consumption because people around me do it”. These three specific attitudes are measured by 6-point Likert scales, ranging from strongly disagree to strongly agree (larger value means greater endorsement to the idea). According to the t-test reported in Table 2, immigrants are more likely to agree that they need to save energy because of global warming as compared to native-born Americans ( $p < .05$ ). There was no statistically significant difference between immigrants and native-born Americans in the other two attitudes.

#### 3.2.2.5 *Control Variables*

In addition to the dependent and explanatory variables, I use gender, age, race, educational stage, and type of residence as control variables (see Table 3). In this survey, 43% of the respondents are male (coded as 1), and 57% are female (coded as 0). The age of the respondents ranges from 18 to 60, with the mean being 25. Since the target population is graduate and undergraduate students, the average age is relatively young. Whites (48%) and Asians (26%) compose the majority of the respondents, followed by Hispanics (15%) and African Americans (6%). I use a dummy variable for White in the analysis, with minorities being the omitted category<sup>1</sup>. Almost half of the respondents are undergraduate students (48%), and 52% are graduate students (master’s and PhD students)<sup>2</sup>. A dummy variable for graduate students is created, with undergraduate students as the reference category. Types of residence include on-campus dormitory (10%), off-campus rental house/apartment (64%), and off-

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<sup>1</sup> I combine Asian, Hispanic, Black, and Other race into minorities, because the number of cases in each category is very small.

<sup>2</sup> There is one faculty or post doctorate student being categorized into the graduate student category.

campus house/apartment owned by self or family members (25%). Two dummy variables are created for the three residential categories (compared against off-campus rental residence).<sup>3</sup>

### 3.3 Analyzing Methods

To test hypotheses 1 and 2, I estimate a set of nested linear regression models with OLS estimators using electricity bill per person per month as my dependent variable. The first model includes only control variables: gender, age, race, stages of education, and types of residence. The second model includes immigration status. The t-test for the coefficient of immigration status and change in F-statistics between the two models could indicate whether immigration status has a significant effect on residential energy use. In the third model, I add the dummy for short-term immigrants, whose comparison category is long-term immigrants. From the coefficient for short-term immigrants and the improvement of model fit, I could tell whether short-term immigrants and long-term immigrants are significantly different in energy use.

In hypothesis 3 and 4, I expect the relationship between immigration status and residential energy use to be mediated by value orientation towards frugality and specific attitudes towards energy conservation. Four conditions need to be met in order to verify the existence of a mediating effect: (1) the independent variable (immigration status) has to have

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<sup>3</sup> Income has also been measured in the survey by asking the average monthly income from all resources in the last six months (including earnings, scholarship, loans, stipend from parents, and so on). Because some students do not consider these types of money they received as their income (even if I have clarified in the survey question), this measure of income is not valid. It doesn't show the actual economic status of the students. Thus, I will not use income as a predictor in the analysis.

a significant effect on the dependent variable (residential energy use); (2) the independent variable should significantly influence the mediating variables (value and specific attitudes); (3) the mediating variables should significantly affect the dependent variable; and (4) including the mediating variables in the model should significantly reduce the effect of the independent variable on the dependent variable (Baron and Kenny 1986). First, I use linear regressions to test the effects of immigration status on values and several specific attitudes. Then, I establish nested linear regression models to predict residential energy consumption using immigration status and general values and specific attitudes. The basic model will include controls and immigration status. For hypothesis 3, value orientation is added in the second model. To test hypothesis 4, the basic model is the same, and the three specific attitudes toward energy conservation are included in the second model.

## 4. RESULTS

The first two models in Table 4 show the effect of immigration status on residential energy use. Model 1 includes only control variables. Including the dummy for native-born Americans in model 2 improves the model fit significantly (change in F-statistics=4.06;  $df=1$ ;  $p<.05$ ). Consistent with my expectation, native-born American students consume more electricity at home than immigrant students, when controlling for gender, age, race, type of residence, and educational stage ( $p<.05$ ). Based on this regression, native-born American students are predicted to pay about 24 dollars more per person for electricity in their residence than immigrants. This supports my hypothesis 1 and satisfies the first condition of a mediating effect for hypotheses 3 and 4.

Table 4: Effects of Immigrant Status and Time Stayed in the US on Residential Energy Consumption: Unstandardized Coefficients from Linear Regressions

Independent variables	Energy bill per person per month		
	(1)	(2)	(3)
Male	8.03	12.09	10.95
Age	.63	.68	.76
White	3.52	-6.16	-7.06
Graduate Student	-19.26	-13.76	-15.18
<i>Type of residence<sup>a</sup></i>			
On-campus dormitory	-12.05	-21.45	-21.55
Off-campus house/apartment owned by self or family members	27.03**	23.57*	24.04**
<i>Immigration Status</i>			
Native-born Americans		21.05*	26.26*
Short term immigrants (<=4years)			8.09
Constant	42.66*	32.29	26.64
R <sup>2</sup>	.08	.09	.10
F-statistics	2.91**	3.11**	2.78**
Degrees of freedom	6	7	8
Change in F-statistics		4.11*	.53
Degrees of freedom		1	1

Note: <sup>a</sup> The reference category is off-campus rental house/apartment.

Source: UCF Energy Use and Conservation Study (Lei 2010); N=215.

\* p<0.05, \*\* p<0.01 (two-tailed tests)

In model 3, I include a dummy variable for short-term immigrants. Now the reference category is long-term immigrants, allowing me to do a comparison between short-term and long-term immigrants. However, including this dummy does not improve the model fit significantly (change in F-statistics=.53;  $df=1$ ;  $p>.05$ ). The coefficients show that native-born American students consume more energy at home than long-term immigrant students do ( $p<.05$ ), but short-term immigrant students do not significantly differ from long-term immigrant students in residential energy consumption. Therefore, my hypothesis 2 is not supported.



Table 5: Effects of Immigration Status on Value and Specific Attitudes: Unstandardized Coefficients from Linear Regression

Independent variables	Frugality as a virtue in original culture	Saving energy because of ...		
		Global warming	Saving money	Other people doing it
	(1)	(2)	(3)	(4)
Male	.05	-.33	-.00	-.38
Age	-.02	.00	.02	-.01
Graduate Student	.03	.08	-.15	.07
Native-born Americans	-1.16***	-.46*	-.11	-.13
Constant	3.16***	4.37***	4.59***	3.36***
R <sup>2</sup>	.23	.03	.02	.02
F-statistic	18.78***	2.06 <sup>†</sup>	1.00	1.10
Degrees of Freedom	4	4	4	4
N	253	267	269	267

Source: UCF Energy Use and Conservation Study (Lei 2010).

<sup>†</sup> p<.10; \* p<.05, \*\* p<.01, \*\*\* p<.001 (two-tailed tests)

In order to build the mediation models, I estimate linear regression models<sup>4</sup> showing the effects of immigration status on the hypothesized mediating variables, namely value orientation and specific attitudes, when controlling for gender, age, and educational stage (in other models, not shown, I also control for race, but the effect of immigrant status on attitudes is not changed. For simplicity, I report the table without controlling for race). In Table 5, Model 1 shows that native-born American students have significantly lower level of belief that their culture regards frugality as a virtue as compared with immigrant students (p<.001). Consistent with what is indicated in the literature, this reflects that cultural value orientation toward frugality is different for native-born Americans and immigrants. Model 2 shows the impact of immigration status on the attitude of saving energy because of global warming. The F-statistic for Model 2 is only marginally significant (F-statistic=2.06, df=4,

<sup>4</sup> I have also estimated these models using ordered logistic regressions, which show similar results. I report the models using linear regression for the simplicity of explanations.

$p < .10$ ). The regression coefficient shows that native-born American students believe less than immigrant students that they should reduce energy use because of global warming ( $p < .05$ ). However, because the model fit only approaches significance, I am cautious in claiming that native-born American students and immigrant students are significantly different in this attitude towards energy conservation. According to model 3 and 4, immigrant students and native-born American students are not significantly different in terms of the attitudes towards saving energy in order to save money and saving energy because other people do it. Thus, only value orientation towards frugality meets the second condition of a mediating effect. Attitudes towards energy conservation because of “global warming”, “saving money”, and “other people doing it” do not pass the test of mediation.

Table 6: Effects of *Value* on Residential Energy Consumption: Unstandardized Coefficients of Linear Regressions

Independent variables	Energy bill per person per month	
	(1)	(2)
Male	12.59	12.56
Age	.65	.69
White	-7.94	-7.60
Graduate student	-11.42	-11.60
<i>Type of residence</i> <sup>a</sup>		
On-campus dormitory	-22.06	-22.88
Off-campus house/apartment owned by Self or family members	25.42*	25.47*
Native-born Americans	24.49*	26.19*
<i>Value</i>		
Frugality as a virtue in original culture		1.57
Constant	54.98**	50.04*
R <sup>2</sup>	.10	.10
F-statistics	3.01**	2.65**
Degrees of freedom	7	8
Change in F-statistics		.18
Degrees of freedom		1

Note: <sup>a</sup> The reference category is off-campus rental house/apartment.

Source: UCF Energy Use and Conservation Study (Lei 2010); N=197.

\* p<.05, \*\* p<.01 (two-tailed test)

As next step, I estimate a set of nested linear regression models to test the relationship between mediating variables and residential energy use. Regarding to hypothesis 3, I first build a model that includes only immigration status and control variables (model 1 in Table 6), and then include value orientation towards frugality in model 2. Including this variable does not improve the model fit significantly (change in F-statistic=.18;  $df=1$ ;  $p>.05$ ) and the regression coefficient of value orientation is not significant. This shows that value orientation does not have a significant effect on residential energy use and it fails to meet the third condition of a mediating effect. Therefore, I can't establish the mediation effect through value orientation and do not find support for my hypothesis 3.

Table 7: Effects of *Specific Attitudes* on Residential Energy Consumption: Unstandardized Coefficients of Linear Regressions

Independent variables	Energy bill per person per month	
	(1)	(2)
Male	13.23	11.84
Age	.69	.68
White	-8.90	-10.31
Graduate student	-12.66	-12.03
<i>Type of residence</i> <sup>a</sup>		
On-campus dormitory	-22.87	-27.83
Off-campus house/apartment owned by self or family members	24.28*	23.76*
Native-born Americans	24.06*	23.51*
<i>Saving energy because of ...</i>		
Global warming		-6.12 <sup>†</sup>
Saving money		3.73
Other people doing it		.72
Constant	55.31**	63.20*
<hr/>		
R <sup>2</sup>	.10	.11
F-statistic	2.94**	2.44**
Degrees of freedom	7	10
Change in F-statistic		1.25
Degrees of freedom		3

Note: a: The reference category is off-campus rental house/apartment.

Source: UCF Energy Use and Conservation Study (Lei 2010); N=203.

<sup>†</sup> p<.10 \* p<.05, \*\* p<.01 (two-tailed tests)

Nested models in Table 7 aim to test the hypothesis 4. Model 1 includes only control variables and immigration status. Including the three measures of specific attitudes in model 2 does not improve the model fit significantly (change in F-statistic=1.25; *df*=3; *p*>.05). The regression coefficient for “saving energy because of global warming” is marginally significant (*p*<.10, two-tailed tests), which weakly indicates that this attitude has a negative impact on residential energy use. This is consistent with my expectation. The other two attitudes, “saving energy in order to save money” and “saving energy because other people do it” do not have significant impact on residential energy use. Thus, these three specific

attitudes do not meet the third condition of mediation. Therefore, my hypothesis 4 is not supported and I cannot claim the existence of a mediating effect.

## 5. LIMITATIONS

As most of the studies, this one has its limitations. First, the sample is drawn from a highly educated student population, who might have better knowledge about energy conservation and environmental issues than the general population. The energy consumption attitudes and behaviors of highly educated people have been found to differ from people with lower level of education. Thus, I am not able to generalize the results to the general population.

Another problem is that many of the immigrants in this sample came to the US recently to study and therefore have been here for very short time. More than 70% of the immigrant respondents have stayed in the US less than or equal to 4 years. So the results of this study cannot be generalized to the whole population of immigrants in the US.

In addition, income is not controlled in this study because the high rate of missing cases and the validity problem of the question for a student population. As students, respondents may not have earnings from work. I specified income in the questionnaire as including stipend from parents, scholarships, assistantships, wages, loans, and money from other sources. But some respondents still do not count every source of income when they answer the question. Concerned about the validity of the measure and the missing values, I have decided not to use income in the analysis.

Finally, because the sample size is relatively small, I am forced to limit the number of variables included in the regression models. Due to this I have decided to leave out some

control variables that do not have an effect on the dependent variable or do not affect the relationship between my main independent variables and the dependent variable. One of these omitted control variables is, for example, marital status.

## 6. DISCUSSION AND CONCLUSION

Using a sociological model, I predict energy consumption in households by demographic characteristics, values and specific attitudes. I compare the difference between residential energy consumption of immigrant students and native-born American students and try to explain the difference by cultural values and specific attitudes towards energy conservation.

I found that immigrant students use less residential energy than native-born American students. This is consistent with the literature which claims that immigrants have a greener lifestyle and consume less energy in daily life. Regarding the effect of time stayed in the US, I did not find a significant difference between short-term immigrants and long-term immigrants in residential energy consumption. Thus, using the data from this sample, I cannot claim that immigrant students increase their energy use as they stay longer in the US.

The effect of immigration status on residential energy use could be explained by a lot of factors, such as economic situation, habits, and values and attitudes. I test whether the relationship between immigration status and residential energy consumption is mediated by a cultural value orientation towards frugality and specific attitudes towards energy conservation. However, I cannot establish the mediating effect because of the third condition of a mediating effect was not met. The results show that immigrants are more likely to believe that their cultures regard frugality as a virtue than native-born Americans are. But this cultural value orientation towards frugality does not have a significant impact on residential energy



consumption. The potential reasons could be that even if individuals hold different values towards consumption, their energy using behaviors are more determined by life situations and facilities, such as the places they live, the existing appliances at home, and the requirements from school and work.

I also test whether specific attitudes mediate the relationship between immigration status and residential energy use. However, none of the three attitudes passed the test of a mediating effect. The results weakly indicate that immigrants are more likely to agree that they need to reduce energy use because of global warming and that people who believe they need to reduce energy use because of global warming tend to use less energy at home. But both effects are only marginally significant, so that I am not able to claim that the relationship between immigration status and residential energy use is mediated by an attitude towards saving energy because of global warming.

In conclusion, the results of this study show that variance in residential energy consumption could be explained by cultural and social factors. Especially it shows the difference in household energy consumption between population groups who have different values, attitudes, norms and social economic status. A merit of this study is that it tries to link different levels in the causal model of Stern, Dietz, and Guagnano (1995). Most social psychological studies of pro-environmental behaviors typically focus on a lower level in the diagram (Figure 1), that is, on specific attitudes-behavior relationship. Through including value and immigration status, I made worthy efforts to test the causal chain from position in social structures to values and specific attitudes, and then to behaviors.

The findings of this study are valuable for policy makers who design and implement interventions to reduce energy consumption in households. In order to make the intervention programs effective, they need to consider that immigrant population have special lifestyles and habits, and hold different value orientations and attitudes than native-born Americans. Educational interventions emphasizing the value of frugality and energy consumption's impact on global warming should be more important for native-born American than for immigrants, because immigrants have stronger value orientation towards frugality and more positive attitudes towards saving energy because of global warming.

Sociological investigation in residential energy consumption is an importation area of research. A lot of things are unknown in this area. This study does not successfully explain why immigrants consume less energy at home than native-born Americans do. Future study could include more explanatory variables such as income, lifestyle, habits, other dimensions of values and attitudes and so on. To further explore this problem, I would increase the sample size and include respondents with different educational levels, occupations, and social economic backgrounds. To gain a better understanding of the relationship between time stayed in the US and residential energy consumption, I also need to include immigrants who have lived longer in the US and those who have completed their education.

**APPENDIX: IRB APPROVAL LETTER**



University of Central Florida Institutional Review Board  
Office of Research & Commercialization  
12201 Research Parkway, Suite 501  
Orlando, Florida 32826-3246  
Telephone: 407-823-2901 or 407-882-2276  
[www.research.ucf.edu/compliance/irb.html](http://www.research.ucf.edu/compliance/irb.html)

### Approval of Exempt Human Research

From: **UCF Institutional Review Board #1  
FWA00000351, IRB00001138**

To: **Lei Lei and Co-PIs: Penelope Canan**

Date: **February 02, 2010**

Dear Researcher:

On 2/2/2010, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review: Exempt Determination  
Project Title: Energy consumption of immigrants and native-born Americans  
Investigator: Lei Lei  
IRB Number: SBE-10-06682  
Funding Agency:  
Grant Title:  
Research ID: N/A

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the [Investigator Manual](#).

On behalf of Joseph Bielitzki, DVM, UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 02/02/2010 08:50:19 AM EST

A handwritten signature in black ink that reads "Joanne Muratori".

IRB Coordinator

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