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HEE JUNG HONG

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M.A.

degree in

INTERIOR DESIGN &
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**ACCEPTABILITY OF ENERGY-EFFICIENT LIGHTING AND ENVIRONMENTAL
BEHAVIORS BY HOMEOWNERS**

By

Hee Jung Hong

A THESIS

**Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of**

MASTER OF ARTS

Interior Design & Facilities Management

2009

ABSTRACT

ACCEPTABILITY OF ENERGY-EFFICIENT LIGHTING AND ENVIRONMENTAL BEHAVIORS BY HOME OWNERS

By

Hee Jung Hong

Consumers' acceptance of the energy-efficient technology has been slow to grow despite efforts of promoting the use of energy-efficient lighting in homes in the past 20 years. With the perspective of encouraging energy efficient lighting choices, this research was initiated to ascertain home owners' underlying perceptions for energy-efficient lighting with particular emphasis on environmental lighting behaviors for their homes.

The mail survey was administered to homeowners in the Meridian Township area in Michigan using systematic random sampling method. Utilizing t-test, analysis of variance (ANOVA), and regression analysis, home owners' lighting perceptions and four types of environmental lighting behaviors: energy-efficient lighting usage behavior, habitual behavior, citizenship behavior and replacement behavior, and relationships between lighting perceptions and lighting behaviors were examined.

The results indicate that there was a significant relationship between homeowners' environmental lighting behaviors and lighting perceptions. The subjects who had more positive perceptions towards energy-efficient lighting were more likely to demonstrate the environmental lighting behaviors. The study further revealed clear gender differences in terms of lighting perceptions. In sum, the findings of the present study suggests that policy makers and lighting researchers should implement new methods of promoting energy-efficient lighting more effectively and prevent generating further lighting misconceptions.

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**This dissertation is dedicated to
my family for their unconditional love and support
and to God for Making All this possible.**

ACKNOWLEDGMENTS

I would like to give my highest thanks to God for blessing me with this opportunity to pursue my academic dream and allowing me to be influenced by group of individuals in past four years at Michigan State University.

I would like to thank members of my dissertation committee for their constant encouragement and support. I am extremely grateful for Dr. Nam Kyu Park and Dr. Eunsil Lee for their valuable advice, intellectual guidance and emotional support in completion of my master's thesis through out the years. Their passion and enthusiasm towards research and depth of knowledge enabled me to think creatively and directed me to a right path. I am also grateful for Dr. April Allen and Dr. Patricia Huddleston for sharing their knowledge and providing valuable insights to my thesis.

I would like to extend my gratitude to my professor in my program who had been a great teacher and advisor to me. I express my thanks to Bobby Kilty for offering the opportunity to teach and sharing her teaching philosophy. Her dedication to the interior design program and passion for art and design allowed me to appreciate what teaching is about.

At last, I would like to express my deepest gratitude to my husband, Robert M. Song, for his constant love and support, and to my precious and loving daughter, Haven Dahee Song, for being a source of inspiration all these years. I am also greatly thankful to my parents and parents-in-law for their unconditional love and support with endless prayers. My special thanks also go to my brother and sister-in-law who also encouraged and supported me.

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CHAPTER I

INTRODUCTION

Sustainable design is defined as “design that focuses on products and processes that protect the environment while conserving energy for future generations” (Winchip, 2005). With population increase and depletion of natural resources, the concept of sustainable design is rising as a new set of opportunities for the design industry (Adler, 2006). With this sustainability movement, integrating daylight and energy-efficient artificial lighting into buildings has been utilized as one of the most important strategies to increase energy-efficiency in the design industry.

According to the U.S. Department of Energy (2009), artificial lighting consumes 30-35% of the energy used in commercial buildings, and an average household dedicates almost 15% of its total energy to lighting consumption. Although use of new lighting technologies can reduce energy used for lighting homes by 50-75%, lighting consumption for homes increased from 9% of total consumption in 2001 to 15% in 2009 (U.S. Department of Energy, 2009). Household energy use is a major cause of air pollution and global warming. According to the U.S. Department of Energy (2009), 16 % of U.S. greenhouse gas emissions are generated from energy used in houses.

In the aspects of sustainable lighting movements, researchers and public advocates have encouraged the use of fluorescent lighting. Fluorescent lighting requires less electricity to operate than conventional lighting, therefore requiring less fossil fuel to be burned by power plants in order to produce that electricity. Since fossil fuels are nonrenewable and burning them emits harmful atmospheric pollutants, the use of fluorescent lighting has been cited not only as a means of saving energy, but also of

preserving the environment. The U.S. Department of Energy (2009) states that if every U.S. household replaced just one light bulb or fixture with an ENERGY STAR qualified bulb, it would save more than \$600 million each year in energy costs and prevent greenhouse gas emissions equivalent to those of more than 800,000 cars.

Many governmental agencies and utility companies have promoted the use of energy-efficient lighting for homes in the past 20 years. However, despite their efforts, consumers' acceptance of energy-efficient technology has been slow to grow in the residential lighting market. In the United States, the dominant light source in residential households is still the incandescent lamp. Eighty-seven percent or 453 million lamps out of a total of 523 million used one or more hours per day are incandescent (International Energy Agency, 2006). Therefore, encouraging energy-efficient lighting usage for residential applications is a critical component of today's utility management.

The Purpose of study

Given the current trend of sustainability and increasing concern of conserving energy, it is important to understand why home dwellers are not willing to accept newly developed energy-efficient lighting technology which reduces costs and practices the environmental values that seem to prevail in today's society. However, few empirical studies have been conducted regarding homeowners' perceptions about energy-efficient lighting products or environmental lighting behaviors (Banwell & Figueiro, 2005; Banwell, Brons, Freyssinier-Nova, Pizzo & Figueiro, 2004; Brons, 2004; Conway & Leslie, 1992; Conway, & Mehra, 1998; Veitch & Gifford, 1996; Veitch, Hine, & Gifford, 1993). Therefore, the purpose of the study is to identify homeowners' perceptions of energy-efficient lighting and how the lighting perceptions are related to their

environmental lighting behaviors in their homes. Understanding underlying beliefs about lighting in general and energy-efficient lighting in particular, the behavioral intentions of homeowners, and examining the relationship of these factors is important in improving the means we choose to encourage energy conservation through lighting choices at homes.

The specific research questions to accomplish the purpose of the study are:

1. What perceptions do homeowners have about lighting in general?
2. What perceptions do homeowners have about energy-efficient lighting?
3. What are homeowners' environmental lighting behaviors?
4. How do homeowners' lighting perceptions influence their environmental lighting behaviors for home?

Significance of the study

In order to understand the reasons that home lighting decision makers resist using energy-efficient lighting, this study proposes to assess the basis for such resistance.

The lighting industry can benefit and adopt its behavior accordingly by investigating homeowners' lighting perceptions and behaviors. Besides, if there are differences in the unspoken beliefs and attitudes among homeowners and professionals (i.e. architects, home builders or residential interior designers), then it is imperative that the professionals understand the opinions of homeowners' lighting perceptions in order to successfully communicate with their clients or customers.

To encourage energy-efficient lighting choices, the study also attempts to provide design professionals, policy makers, and lighting researchers with the most current information about homeowners' lighting practices. The findings will be invaluable for design professionals in developing strategies for assisting clients effectively, for policy

makers in developing new energy-policy to encourage the use of energy-efficient lighting and for lighting researchers in focusing on a quality lighting environment. This study is also expected to promote end users' awareness of energy-efficient lighting and sustainable design for home environments.

CHAPTER II

LITERATURE REVIEW

This chapter consists of four sections. The first section reviews end-users' perceptions towards energy-efficient lighting. In the second section, residential lighting environments are discussed particularly focused on two areas: 1) light source and 2) energy consideration for home environments and the use of energy-efficient lighting at home. Next, environmental behaviors are reviewed in the third section. Lastly, theoretical background was reviewed in the fourth section.

End-users' perceptions towards energy-efficient lighting

Fluorescent lighting technology: old vs. new

With surging energy consumption and increasing concern of the rise of carbon dioxide emissions, it is imperative that consumers use lighting systems that conserve energy. The Illuminating Engineering Society of North America (IESNA) considers discharge lamps such as fluorescent, metal halide and high-pressure sodium to be the most efficient white light sources (Rea, 2000).

Fluorescent lighting technology has improved over the last decade. Many unfavorable impressions (i.e. slow start-up time, flicker, hum, poor color rendering, and etc.) about fluorescent lighting are based on old technologies. New technologies are available that make fluorescent lighting not only energy-efficient, but attractive as well (Brons, 2004). As for the latest fluorescent lighting technology, compact fluorescent lamps (CFLs) are a good substitute for incandescent lamps because they consume up to 70 percent less electricity and last six times longer. A variety of shapes and color temperatures of the fluorescent lamps are also available to serve different lighting needs.

Therefore, many professionals and lighting researchers suggest that homeowners can enhance the appearance of homes by utilizing current energy-efficient lighting systems (Banwell et al., 2004; Brons, 2004 & Karlen & Benya, 2004).

General energy-efficient lighting perceptions

In the United States, the general population considers energy-efficient lighting as ugly (Banwell et al., 2004). According to Banwell et al. (2004), some of the complaints that American homeowners associated the fluorescent lighting are based on characteristics of the older systems: “flicker, hum, poor color rendering, high correlated color temperatures (CCTs), and large, awkward sizes.” As mentioned earlier, these complaints are no longer issues. The new technology compact fluorescent lamps (CFLs) last up to 12 times longer than incandescent lamps and color rendition qualities indicating “how colors appear when illuminated by a light source” (IESNA) are closer to those of incandescent lamps (Gordon, 2003; Winchip, 2008).

Consumers’ acceptance of energy-efficient technology has been slow to grow in the residential lighting market. In the United States, the dominant light source in residential households is still the incandescent lamp, which remains “inexpensive, easy to use, versatile, and reliable” (Smithsonian Institution, 2008).

Energy-efficient lighting perceptions vs. lighting preferences

Within this context, Beckstead and Boyce (1992) conducted research to determine the influence of subjects’ beliefs and attitudes about fluorescent lighting on their behaviors related to the use of the energy-efficient compact fluorescent lamps (CFLs). Results indicated that the use of compact fluorescent lighting was dependent on beliefs about the effects of fluorescent lighting on people, not on beliefs about the cost, energy

efficiency, or operation of the products. Two additional studies identified knowledge of lighting beliefs and preferences (Veitch, Hine, & Gifford, 1993; Veitch & Gifford, 1996) and confirmed that a significant proportion of the population believe that fluorescent lighting is detrimental to one's health. The studies also concluded that people who endorse beliefs about health effects of lighting also endorse beliefs about natural light and lighting that simulates daylight over other types as being superior.

Lighting preferences vs. lighting behaviors

Lighting preferences influence an individual's decisions on lighting and consequently affect individual's lighting behaviors. The work of Biner and Butler (1987) indicated that people exhibit consistent preferences for luminance levels in a given setting and when participants believed lighting conditions to be important to a situation, they wanted to control the lighting. This suggests that homeowners may desire to have particular types of lighting in certain areas or rooms in their homes based on their lighting preferences.

One additional study examined homeowners' lighting preferences in regard to aspects of the color of light (Banwell & Figueiro, 2005) and described that American homeowners are more accustomed to the warm colors of incandescent and halogen lamps. The findings of the study also imply that the lighting and light color preferences might be related to people's historical and cultural home lighting traditions. Within this context, Wilhite, Nakagami, Marsuda, Yamaga and Haneda (1996) conducted a cross-cultural analysis of household energy use behavior in Japan and Norway and identified that some specific energy use behaviors are related to homeowners' social and cultural

contexts. For example, it is considered “socially appropriate” for Norwegians to allocate ample use of space and light to create a cozy home regardless of environmental concerns.

Residential Lighting Environment

Environmental concern in residential lighting environments

Conserving energy has emerged as a major concern for many of today’s residential lighting environments around the world. The International Association of Energy-efficient Lighting (IAEEL) conducted a study of thirty eight countries. The IAEEL report states that “globally, electric lighting accounts for more than 2000 TWh electricity and 2900 million metric tons of carbon dioxide (CO₂) emissions per year” (2000). Households in each country partly contribute to these emissions through day-to-day gas and electricity use.

Energy is used for a wide variety of activities in households. Specifically home energy is related to activities such as home heating, lighting, and the use of household appliances (Poortinga, Steg & Vlek, 2004). As indicated earlier, 16 % of U.S. greenhouse gas emissions are generated from energy used in houses (U.S. Department of Energy, 2009). For this reason, homeowners are considered an important target group for energy conservation (Abrahamse, Steg, Vlek & Rothengatter, 2007).

Light sources and fixtures for home environments

The most common electric light sources used for home environments are incandescent, tungsten-halogen, linear fluorescent and compact fluorescent lamps. In the mid 1980s, compact fluorescent lamps (CFLs) were introduced for home applications, combining the energy efficiency of fluorescent lamps with the convenience and popularity of incandescent lamps. Some of the fluorescent lamps that

are used in residential lighting include T-2, T-5, T-8 and T-12 lamps. T-8 and T-12 are particularly identified with energy-efficiency, good color rendering properties, and a variety of lengths and color temperatures (Rea, 2000).

Household Energy behaviors

Household energy saving behavior, such as turning off lights in unoccupied rooms is considered an example of habitual action. The 'habitual' action is defined as "focused around everyday reductions in energy use that require either no or minimal structural adjustment" (Barr, Gilg & Ford, 2005). Barr et al. (2005) further emphasized that these conserving behaviors are related to decisions that humans make everyday, based on their previous experience. Similarly an on-going study by the Smithsonian Institution indicates one's upbringing and personal experiences of energy shortages, such as the Energy Crisis of the 1970s and 2001 shortages, are believed to be some of the factors that influence lighting conserving behaviors (2008). Below are excerpts posted from the Smithsonian online survey:

"I was just a kid then, but the oil embargo helped to shape my outlook to be a generally energy-conscious consumer. It is just habit to conserve when and where I can." (Dann, a homeowner).

"Absolutely none whatsoever. Of course I was around ten then and Mom was always shouting to turn off the lights whether there was a crisis or not." (Tammie, a homeowner)

Energy-efficient lighting barriers in the residential lighting environments

During the past 20 years, governmental agencies and utility companies have promoted the use of energy-efficient lighting in homes. Despite these attempts, consumers are largely unaware of energy-efficient lighting's benefits (Conway & Mehra,

1998). According to Electric Power Research Institute, the utility rebate and discounted programs contributed to “an universal belief that the compact fluorescent products are overpriced (1992). Back in 1992, Electric Power Research Institute prepared a special report on perceptions of compact fluorescent lamps (CFL) in the residential market by interviewing residential customers. The main purpose of this report was to understand residential customer’s attitudes toward current compact fluorescent lighting products and address their concerns in the residential lighting environments. According to the report, price was a major barrier of the compact fluorescent lighting products. Some other perceived drawbacks resulted from the report are: 1) they do not fit in many standard fittings; 2) they cannot be used with dimmer switches; 3) they do not produce enough light for major applications (especially reading); and 4) they cannot be used outdoors.

Several other studies also have investigated key barriers to the use of energy-efficient lighting system (Conway & Leslie, 1992; Conway & Mehra, 1998; Banwell & Figueiro 2005; Jennings, Moezzi, Brown, Mills, Sardinsky, & Heckendron et al., 1997; Winchip, 2008). Some common barriers pointed out by researchers are as follows: 1) limited knowledge regarding benefits of energy-efficient lighting by builders and homeowners, 2) lack of awareness for the aesthetic and technological advances that have been made in recent years, 3) limited selection of good quality luminaries, 4) limited availability of replacement parts.

Promoting energy-efficiency for homeowners

To encourage more widespread use of energy-efficient lighting, a variety of media and educational tools are currently used as a means to encourage consumers to implement energy-efficient lighting. Banwell et al. (2004) from the Lighting Research Center (LRC)

and U.S. Environmental Protection Agency (EPA) surveyed visitors by using a designer showcase home. The visitors were asked to rate the energy efficient fluorescent lighting in the model home and in a nearby comparable home having only traditional incandescent lighting. The results showed that both random visitors and paid subjects rated the energy-efficient lighting as “equivalent to or better” than the incandescent lighting in regards to “color appearance, brightness, light distribution, appearance of people, flicker, visual comfort, visibility, and overall appearance of the home”. Nearly 90% of the respondents said that they would like to have the energy-efficient fluorescent lighting in their homes. As the study suggests, the general public perceived the energy-efficient lighting more positively when they were able to visualize the effects of the energy-efficient lighting.

As consumers have indicated on on-going Smithsonian Institution study about the energy-efficient lighting (2008), a variety of media (TV programs, Web, advertisements), and educational tools (research articles, consumer reviews, product information, brochures, and a college course) were some of many ways people learn about energy-efficient lighting. Also “distribution of real energy-efficient light bulbs for try-outs, personal recommendations, promotions on energy efficiency by government and utility companies” were mentioned additionally as possible means to reach out to consumers.

Importance in promoting lighting knowledge

Several studies have implied a need for acquiring end-users’ information about lighting (Veitch, Hines & Gifford, 1993; Beckstead & Boyce, 1992). Veitch et al. (1993) have indicated that an understanding of end-users is necessary in order to create a quality environment. Furthermore, they emphasized a need for more organized information about

newly developed energy-efficient lighting technology since the lighting system and technology is rather complex for the general public to fully understand and misconception about the lighting can be created if consumers are not exposed to “unbiased and detailed information about lighting” (Veitch, Hine & Gifford, 1993).

Consumers’ responses in the Smithsonian Research about energy-efficient lighting (2008) also coincide with the above findings. Many consumers indicated that they are still not aware of new lighting technologies or energy-efficient lighting in general. And some have mentioned that more education is necessary for homeowners or consumers to adopt efficient lighting systems and change their notions about lighting in their daily lives.

Environmental behaviors

Several studies have investigated household environmental behaviors in relation to demographic characteristics. Barr, Gilg & Ford, (2005) researched household energy-saving behavior and examined the characteristics of the ‘energy saver’. Among the identified groupings: environmentalists vs. non-environmentalists, the most committed to sustainable energy user groups were characterized as “older, tended to own their home, lived in a terrace property, voted Green/Liberal Democrat and were members of community groups.”

The most committed environmentalists owned smaller household sizes and most were most likely to own their homes. In regard to homeownership, it was identified as one of the significant factors which motivate individuals to feel a sense of belonging. Black, Stern, & Elworth (1985) and Painter, Semenik, & Belk (1983) described that people who own a property may feel more responsibility or feel obligated to care for

their property. Furthermore, ownership may motivate homeowners to think more consciously about saving energy.

The most committed environmentalists were significantly more likely to be a member of a community organization. According to the study of Barr et al. (2005), non-environmentalists were significantly more likely to be “younger, male, on low incomes, who had received less formal education, and were less involved in the community.” The purchase of energy saving devices and energy saving light bulbs were low on both non-environmentalists and the most committed environmentalists. Barr et al. (2005) indicated that this was somewhat concerning from a policy perspective given the need to encourage sustainable consumption.

Theoretical background

A body of research has been developed to explain why individuals engage in environmentally significant behaviors (Dunlap, Van Liere, Mertig, & Jones, 2000; Stern, Dietz, Abel, Guagnano, & Kalof, 1999 & Stern, 2000). Recent works of Stern and colleagues (Stern, 2000; Stern, Dietz, & Guagnano, 1995 & Stern et al., 1999) developed and tested the value-belief-norm (VBN) theory which is known as the most comprehensive theory to date in the field of environmentalism.

Value-belief-norm theory (VBN)

The VBN theory links three theoretical concepts: value theory, norm-activation model (NAM) theory, and the New Environmental Paradigm (NEP) through a causal chain of variables leading to proenvironmental behavior (Stern, 2000). The theory suggests that personal values and beliefs are the basis for proenvironmental behaviors.

According to Stern, the general personal beliefs directly affect the personal norms which in turn directly influence proenvironmental behaviors.

In terms of proenvironmental behaviors, Stern (2000) organized and classified several distinct types of environmentally significant behavior: environmental activism, non-activist behaviors in the public sphere, private-sphere behaviors, and behaviors in organizations.

First of all, homeowners' energy-efficient lighting behaviors can be categorized as private-sphere behaviors. This behavior is measured by buying behaviors (i.e. purchasing energy-efficient light bulbs) and habitual behaviors (i.e. turning off lights when leaving a room). Private-sphere behaviors are identified as having direct environmental consequences (Stern, 2000). However, as Ozanne and Vlosky (1997) concluded in their study, respondents' actual behavior can be different as opposed to their willingness to pursue environmental values.

Secondly, the non-activist behavior in the public sphere is presented as a citizenship behavior and can be evaluated by asking if homeowners are willing to pay higher prices to buy energy efficient lighting to conserve energy and support public policy in terms of promoting and supporting energy-efficient lighting. Stern (2000) emphasizes that such non-activist behaviors affect environmental behaviors indirectly but may have stronger impact on changing people's behaviors at once.

CHAPTER III

RESEARCH METHODOLOGY

This chapter presents research methodology in detail. First, descriptions of the research design (i.e. rationale for research method, population and sample, and data collection procedures) employed for this study are presented. Next, instrument and measurement utilized in the survey are described. At last, methods of data analysis for the survey are explained.

Research design

Rationale for research method

The main goal of this study was to identify homeowners' perceptions about energy-efficient lighting and how their perceptions were related to their environmental behaviors regarding use of lighting for the home. In order to accomplish the main goal for the study, four research questions were developed.

In answering these research questions, survey research method was chosen to be appropriate over other types of research methods such as qualitative research. While a qualitative method offers more in-depth detailed information focusing on a smaller number of subjects, this study attempted to obtain broader and more generalized findings of U.S. homeowners' underlying perceptions and behaviors in relation to energy-efficient lighting for their homes (Judd, Smith, & Kidder, 1991). Therefore, the survey research design was chosen for this study.

Sampling

Since the main purpose of the study was to investigate homeowners' perceptions and behaviors in relation to energy-efficient lighting, the population of the survey was

U.S. homeowners and the survey respondents were essentially defined as homeowners who reside in the Meridian Charter Township, Ingham County, Michigan.

Homeownership is considered as one of the factors that may motivate homeowners with more energy-saving practices since owning a home may exert more responsibility (Black et al., 1985; Painter et al., 1983). For this reason, renters were excluded in this survey.

Lists of homeowners' addresses were obtained from the Meridian Charter Township office in Michigan and the Township's official Internet site. Using systematic random sampling, every other address was selected from the list of total address records. Approximately 2,000 homeowners' names and addresses were drawn for collecting data for the present study.

Data collection procedure

Survey questionnaires were developed from a thorough literature review. Before the survey was administered, a pilot test of the survey instrument was conducted to clarify the format, arrangement of questions, and any confusing statements. Approximately 35 participants were recruited through convenience sampling. An open-ended question asked participants to address any suggestions or difficulties in understanding the survey questions. Based on the participants' suggestions, survey questionnaires were modified. The resulting questionnaires were reviewed by two lighting researchers. The data collected for the pilot test was not included for the main analysis of the study. The reliability for each measurement construct was also examined. Upon the receipt of approval of Michigan State University Institutional Review Board (IRB), data for this research were collected by utilizing mail surveys sent to homeowners during the summer of 2008. The survey questionnaires were distributed to all selected

households by mail with a reply-paid, self addressed return envelope. A cover letter (Appendix A) explaining the purpose of the study, confidentiality of the participants, and merits of the study was included as well as demographic survey (i.e. gender, age, educational level, income level, house size and etc). The participants' confidentiality was guaranteed as consent was established when the questionnaire was completed and returned to the researcher. For selected households who had not returned the survey within two weeks, a reminder post card was sent out to encourage their participation in the study. The survey questionnaire is presented in Appendix B.

Of the 2,000 questionnaires mailed, a total of 326 cases were returned. The overall response rate was about 16.3% which was above typical response rate (5 or 10 percent) (Alreck & Settle, 2003). Out of 326 cases, 11 cases were not used due to incomplete responses. As a result, 315 cases were retained for analysis.

Survey instrument and Measurement

Instrument Design

The survey instrument was developed on the basis of previous studies about lighting perceptions and behaviors (Beckstead & Boyce, 1992; Veitch & Gifford, 1996) and review of the Lighting Handbook published by the Illuminating Engineering Society of North American (Rea, 2000), and modified for the purpose of the present study. This research instrument was pretested to check for any biased, misleading, or confusing questions and to verify the quality and comprehensiveness of information received.

The first page of the survey instrument explained the research purposes and provided information about the informed consent procedure. The survey questionnaire used for the present study consisted of four sections and background information. The

first section of the survey asked participants to answer the questions concerning general lighting perceptions. The second section consisted of questions asking about lighting behaviors. The third section asked participants' opinions about compact fluorescent lamp (CFL). The fourth section of the survey consisted of questions about beliefs on lighting and the environment. In the last section, demographic questions and background questions were included.

Measurement and scale

Lighting perception. Respondents were asked to rate their perceptions on lighting using 7-point Likert-type scale (1 = strongly disagree; 7 = strongly agree). It consisted of 20 statements featuring the following measures: importance of lighting (5 items), preference for incandescent lighting (3 items), and beliefs regarding fluorescent lighting's impact on health (3 items). Most of questions about lighting preference and importance were adopted from the studies of Beckstead and Boyce (1992) and Veitch and Gifford (1996) respectively. Additional questions were developed from the Lighting Handbook published by the Illuminating Engineering Society of North American (Rea, 2000).

For importance of lighting, respondents were asked to evaluate overall lighting perception related to their well-being, types of lighting, mood, and work performance. In terms of preference for incandescent lighting, the respondents were asked to evaluate their beliefs about incandescent lighting (i.e. 'incandescent lights are attractive', 'I like incandescent lights', 'incandescent lights produce a warmer and more flattering color to people's appearances). Questions regarding beliefs about fluorescent lighting on health asked to rate respondents' opinions about negative effects of fluorescent lighting on health (i.e. eye strain and headache).

Lighting behavior. The questions about respondents' lighting behavior consisted of three items: energy-efficient lighting usage behaviors, habitual behaviors, and citizenship behaviors. The lighting behavior questions were selected and modified from the study of Beckstead and Boyce (1992). Participants were asked to indicate the extent to which they agree or disagree with each of the statements on a seven-point Likert-type scale (1 = strongly disagree; 7 = strongly agree).

Energy-efficient lighting usage behaviors inquired about subjects' effort and commitment to buy energy-efficient lighting over other types and how much energy-efficient lighting is utilized in their homes. The habitual behavior was defined as "activities focused around everyday reductions in energy use that require either no or minimal structural adjustment" (Barr, Gilg, & Ford, 2005). Participants were asked to rate the extent to which they agree with the statements such as "As I leave the room, I make sure that I turn off the light switch." Citizenship behavior was evaluated by homeowners' willingness to pay higher prices to buy energy efficient lighting to conserve energy and their support of public policy in terms of promoting and supporting the energy-efficient lighting (Stern, 2000)

Perceptions of energy-efficient lighting. The participants' general perceptions of energy-efficient lighting were measured by their beliefs and attitudes about energy-saving practices at home and environmental awareness of lighting issues. Participants were asked to evaluate the extent to which they agree with the statements such as "Using energy-efficient lighting at home is an important way to conserve energy" and "Government and utility companies should raise our awareness of the environmental issue on lighting."

Homeowners' perceptions about compact fluorescent lamp (CFL) were addressed with five variables: visual comfort, aesthetics, impression, cost, and technological attributes. First, homeowners' perceptions about visual comfort of CFLs were measured with 4 items: glaring/not glaring, tense/relaxing, irritating/soothing, uncomfortable/ comfortable. Second, aesthetics of CFLs were measured with 3 items: unpleasant/ pleasant, unattractive/ attractive, ugly/ beautiful. A seven-point bi-polar scale was used to evaluate the perceptions of visual comfort and aesthetics of CFLs: "1" for the most negative to "7" for the most positive.

The last three measurements of impression, cost, and technological attributes of CFLs used a seven-point Likert-type scale: "1" for strongly disagree to "7" for strongly agree. In order to measure the general perception of CFLs, impression of CFLs was measured with two items: "Compact fluorescent bulbs make the home look bad" and "Compact fluorescent bulbs make people look awful". Homeowners' perceptions about the cost of CFLs was measured with one item using the statement "Compact fluorescent bulbs are costly to buy." The perceptions about technological attributes of CFL were measured with four items asking about slow start-up time, flicker and incompatibility with common light fixtures.

Demographic background. The demographic information in the last section of the questionnaire inquired about information of the participants. The demographic survey portion contained questions about general characteristics of the respondents (i.e. respondent's age, respondent's gender, house size, if they consider themselves as a member of an environmental group and question about viewpoint 'how liberal or how conservative'), as well as socio-economic status (i.e. education and household income).

Respondents were asked to report their house size from six categories with less than 1,000 sq.ft. being the smallest to more than 3,000 sq. ft. being the largest. Education was based on five categories: 1) less than high school; 2) high school/ GED; 3) some college; 4) Bachelor's degree; 5) graduate or professional degree. Household income was categorized, with the lowest being less than \$25,000 to the highest being \$100,000 or more. In addition to documenting characteristics of the respondents, two qualitative questions were added to probe further analysis of homeowners' perceptions about energy-efficient lighting and opinions about environmental movement.

Data Analysis

All data collected from the surveys were tabulated, coded, and statistically analyzed in a manner designed to identify a list of evaluative criteria. For socio-demographic data, frequencies, percentages, and measures of central tendency were calculated for the characteristics of the participants. This information enabled the researcher to make general observations concerning the sample selected for the study.

Survey data were analyzed in three steps. First, preliminary statistics such as descriptive statistics and reliability test were obtained using the Statistical Package of the Social Sciences (SPSS 17.0). Descriptive statistics were obtained to determine the distributional characteristics of each variable, including the mean and standard deviation. Reliability test was employed to examine internal consistency of scales. Next correlations among variables were examined. Afterwards, t-test, ANOVA and regression analysis were conducted to examine relationship between variables.

CHAPTER IV

FINDINGS

The remainder of this chapter discusses the results and findings based on the research questions outlined in Chapter One. First, the results of descriptive statistics and reliability tests are provided. Then findings of t-test, analysis of variance (ANOVA), and regression are employed to examine homeowners' perceptions and behaviors in relation to energy-efficient lighting.

Descriptive Statistics

As a first step of preliminary analyses, descriptive statistics were examined for demographic variables employed in the study. Table 1 presents the frequency and percentage distributions for demographic characteristics of the sample: gender, age, educational level, household income, house size, member of environmental group and viewpoints (i.e. if subjects consider themselves as conservative vs. liberal).

Females slightly outnumbered (56.5%) male respondents (41%). About one third of respondents (32.7%) were in the 55- to 64-year-old age class. An additional one third (29.2 %) were 45- to 54-year-old range while slightly over 20% of respondents were in their 25- to 44-year-old range.

In terms of the educational level, over half (53%) of respondents had a graduate or professional degree (53%). Additionally college graduates were 30% of the sample (N=315) and another 12.7% of respondents had high school and some college education.

With regard to household income, the majority of respondents were in two income categories: about half of the respondents (52.1%) in '\$100,000 or more' category and about one third (35.1%) of respondents in '\$50,000 to \$99,999' category.

Table 1. Percentage Distribution of Demographic Characteristics

Demographic Characteristics		Frequency	%
Gender	Male	129	42.0
	Female	178	57.9
	<i>Total</i>	307	100
Age	25 – 44 years	66	21.0
	55 – 64 years	92	29.2
	65 years and over	103	32.7
		54	17.1
	<i>Total</i>	315	100
Educational	High school/GED/ some college	40	12.8
	Bachelor's degree	106	33.9
	Graduate or professional degree	167	53.3
	<i>Total</i>	313	100
Household income	\$49,999 or less	37	12.8
	\$50,000- \$99,999	101	35.1
	\$100,000 or more	150	52.1
	<i>Total</i>	288	100
House size	2,000 sq.ft. or less	122	39.3
	2,001 – 3,000 sq.ft.	128	41.3
	3,000 sq.ft. or more	60	19.4
	<i>Total</i>	310	98.4
Environmental Group	Yes	56	18.1
	No	254	81.9
	<i>Total</i>	310	100
Viewpoint	Liberal	145	47.1
	Conservative	163	52.9
	<i>Total</i>	308	100

Majority of respondents lived in a house which is 3000 sq. ft or less: slightly over 40% of respondents in 2001 - 3000 sq. ft. and slightly less than 40% of respondents in 2000 sq. ft. or less. About 20% of respondents lived in a house that is 3000 sq. ft. or more. The vast majority of respondents (81.9 %) were not a member of an environmental group while only about 18% of respondents were the members of environmental group. Lastly,

more than half (52.9 %) of respondents reported themselves as conservative while 47.1 % of respondents reported themselves as liberal.

Reliability of Measures

Prior to further analyses, a factor analysis and reliability analysis using Cronbach's alpha was performed on the variables to test the internal consistency of scale measuring variables. Results of the reliability measures are listed in Table 2. For detailed reliability information along with number of items are presented in Appendix D.

Table 2. Results of Reliability Analysis

Research Questions	Variables	N of items	Cronbach's Alpha
<i>RQ1. Homeowners' general lighting perception</i>			
	Importance of lighting	5	0.84
	Preference for incandescent lighting	3	0.77
	Fluorescent lighting beliefs on health	3	0.80
<i>RQ2. Homeowners' energy-efficient lighting perceptions</i>			
	General perception of energy-efficient lighting	4	0.70
	Visual Comfort of CFLs	4	0.71
	Aesthetics of CFLs	3	0.77
	Impression of CFLs	2	0.70
	Technological attributes of CFLs	4	0.65
<i>RQ3. Homeowners' environmental lighting behaviors</i>			
	Energy-efficient lighting usage behavior	2	0.83
	Habitual behavior	2	0.87
	Citizenship behavior	2	0.71

The reliability of these variables ranged from 0.65 to 0.87 according to Cronbach's alpha. Since each of these alpha levels is above the acceptable threshold (0.60) for reliability (Nunnally, 1970), these variables are used for further analysis.

RQ1. What perceptions do homeowners have about lighting in general?

Homeowners' general lighting perceptions were measured by following three items: importance of lighting, preferences for incandescent lighting, and fluorescent lighting beliefs on health. The results of one way ANOVA (analysis of variance) and t-test for these variables are presented below.

Importance of lighting

To investigate the importance of lighting, to the subjects, were asked to rate importance of lighting on their well-being, mood, and work performance, and importance of lighting types (i.e. fluorescent vs. incandescent) used in a room. The ANOVA and t-test results in Table 3 indicate that lighting importance was significantly different according to three variables: gender ($p < .01$), age ($p < .05$), and association with an environmental group ($p < .01$) while there was no statistically significant difference in education level, income level and viewpoint.

Table 3. ANOVA and t-test summaries for importance of lighting

ANOVA Results				
Variables	<i>df</i>	SS	MS	<i>F</i>
Age	3	10.302	3.434	3.259*
Educational level	2	1.253	0.627	0.579
Income level	2	1.492	0.746	0.697
House size	2	2.480	1.240	1.152
T-test Results				
Variables		Mean	df	t
Gender	Male	5.17	305	-5.381**
	Female	5.79		
Environmental Group	Member	5.72	304	3.506**
	Non-member	5.30		
Viewpoint	Conservative	5.44	306	-1.713
	Liberal	5.64		

* $p < .05$; ** $p < .01$

Female subjects rated significantly higher on lighting importance than male subjects. In regard to age and association with an environmental group, older subjects and subjects who were current members of an environmental group were more likely to perceive lighting and types of lighting used in a space to be essential to their well-being, mood, and work performance.

Preference for incandescent lighting

As for the lighting preference, the subjects were asked to rate their feelings about incandescent lighting in terms of aesthetic and color rendition qualities. Results of ANOVA and the t-test (Table 4) indicate that the subjects' preferences for incandescent lighting were significantly different for gender ($p < .01$) and income level ($p < .05$) while there was no statistically significant difference on other variables of age, educational level, house size, association with an environmental group and viewpoint.

Table 4. ANOVA and t-test summaries for preference for incandescent lighting

ANOVA Results				
Variables	<i>df</i>	SS	MS	<i>F</i>
Age	3	8.115	2.705	2.466
Educational level	2	2.513	1.257	1.125
Income level	2	9.425	4.713	4.351*
House size	2	2.156	1.078	0.957
T-test Results				
Variables	Mean		<i>df</i>	<i>t</i>
Gender	Male	4.34	305	-4.108**
	Female	4.83		
Environmental Group	Member	4.69	304	1.014
	Non-member	4.57		
Viewpoint	Conservative	4.72	306	1.706
	Liberal	4.52		

* $p < .05$; ** $p < .01$

Female subjects showed more positive assessment on the appearance and the color rendition of the incandescent lighting than male subjects. In regard to the income level, the findings showed that the subjects whose income was in the lowest categories (\$49,999 or less) and highest (\$100,000 or more) categories perceived the incandescent lighting to be more positive than those in the middle income category (\$50,000-99,999).

Fluorescent lighting beliefs about health

Questions regarding health items inquired about subjects' beliefs of the negative effects of fluorescent lighting on health, eyestrain, and headache. Results of ANOVA and the t-test (Table 5) indicate that the subjects' beliefs on the negative effects of fluorescent lighting on health were significantly different for two variables: gender ($p < .01$) and association with an environmental group ($p < .05$).

Table 5. ANOVA and t-test summaries of fluorescent lighting beliefs on health

ANOVA Results				
Variables	<i>df</i>	SS	MS	<i>F</i>
Age	3	13.639	4.546	2.137
Educational level	2	7.974	3.987	1.855
Income level	2	1.937	0.969	0.451
House size	2	6.819	3.409	1.598
T-test Results				
Variables	Mean		<i>df</i>	<i>t</i>
Gender	Male	5.17	034	4.443**
	Female	5.79		
Environmental Group	Member	4.52	303	-2.356*
	Non-member	4.91		
Viewpoint	Conservative	4.54	305	-2.272
	Liberal	4.92		

* $p < .05$; ** $p < .01$

Female subjects rated significantly higher on the negative effects of fluorescent lighting on health than male subjects did, indicating their beliefs that fluorescent lighting may be detrimental to one's health. Non-members of an environmental group also scored significantly higher on the negative effects of fluorescent lighting on health than members did, indicating that they believed fluorescent lights are bad for health and working under fluorescent lighting causes headache and eyestrain.

RQ2. What perceptions do homeowners have about energy-efficient lighting?

Homeowners' perceptions about energy-efficient lighting were evaluated in regard to two aspects: (1) general perception of energy-efficient lighting and (2) perceptions about specific attributes of compact fluorescent lighting including visual comfort, aesthetics, impression, cost, and technology.

General perceptions of energy-efficient lighting

First, general perceptions of energy-efficient lighting were measured based on their beliefs and attitude about energy-saving practices at home and environmental awareness of the lighting issues. The results of ANOVA and the t-test (Table 6) indicate that the general perceptions of energy-efficient lighting were significantly different on three variables: house size ($p < .05$), association with an environmental group ($p < .01$), and viewpoint ($p < .01$) while there was no statistically significant difference on other variables of age, gender, educational level, and income level.

In terms of environmental association, the subjects who were currently members of an environmental group showed more positive attitudes about using energy-efficient lighting to conserve energy and protect the environment than non-members did. Subjects who considered themselves liberal and owned a larger house (more than 3,000 sq.ft.)

rated significantly higher on implementing energy-efficient lighting into their homes and supporting the roles of government and utility companies to raise awareness of the environmental issues on lighting.

Table 6. ANOVA and t-test summaries of general perception of energy-efficient lighting

ANOVA Results				
Variables	<i>df</i>	SS	MS	<i>F</i>
Age	3	2.224	0.741	0.642
Educational level	2	6.725	3.363	2.973
Income level	2	1.463	0.732	0.660
House size	2	8.858	4.429	3.872*
T-test Results				
Variables	Mean		<i>df</i>	<i>t</i>
Gender	Male	4.97	302	-1.076
	Female	5.10		
Environmental Group	Member	5.30	301	4.370**
	Non-member	4.77		
Viewpoint	Conservative	4.74	304	-5.630**
	Liberal	5.40		

* $p < .05$; ** $p < .01$

Perceptions of Compact Florescent Lighting (CFL)

Homeowners' perceptions about compact fluorescent lighting (CFL) were measured based on the following items: (1) visual comfort, (2) aesthetics, (3) impression, (4) cost, and (5) technology.

Visual comfort of CFL Homeowners' perceptions about visual comfort (i.e. glaring/not glaring, tense/relaxing, irritating/soothing, uncomfortable/ comfortable) of CFLs were measured. The ANOVA and t-test results in Table 7 indicate that the homeowner's perception about visual comfort of CFLs was significantly different according to gender ($p < .01$) and age ($p < .05$).

The results indicated that male rated more positively on the visual comfort of CFLs than females did. Older subjects showed more positive perception about the visual comfort of CFLs than younger subjects did.

Table 7. ANOVA and t-test summaries of Visual comfort of CFL

ANOVA Results				
Variables	<i>df</i>	SS	MS	<i>F</i>
Age	3	7.461	2.487	2.990*
Educational level	2	2.126	1.063	1.251
Income level	2	0.046	0.023	0.027
House size	2	0.273	0.137	0.159
T-test Results				
Variables	Mean		<i>df</i>	<i>t</i>
Gender	Male	4.21	301	3.289**
	Female	3.86		
Environmental Group	Member	3.94	300	-1.516
	Non-member	4.10		
Viewpoint	Conservative	3.92	302	-1.832
	Liberal	4.11		

* $p < .05$; ** $p < .01$

Aesthetics of CFL Homeowners' perceptions about aesthetics (i.e. unpleasant/ pleasant, unattractive/ attractive, ugly/ beautiful) in relation to CFLs were measured using a bipolar scale. As for the aesthetical aspects of CFLs (Table 8), gender ($p < .01$) was the only variable that showed a statistically significant difference. The results indicated that male subjects rated significantly higher on the aesthetics of CFLs than female subjects did.

Table 8. ANOVA and t-test summaries for Aesthetics of CFL

ANOVA Results				
Variables	df	SS	MS	F
Age	3	4.361	1.454	1.140
Educational level	2	3.420	1.710	1.335
Income level	2	2.206	1.103	0.842
House size	2	3.306	1.653	1.278
T-test Results				
Variables	Mean	df	t	
Gender	Male	3.96	301	2.888**
	Female	3.59		
Environmental Group	Member	3.74	300	-0.304
	Non-member	3.78		
Viewpoint	Conservative	3.68	302	-1.224
	Liberal	3.83		

*p<.05; **p<.01

Impression of CFL Subjects' current impressions of the CFLs were measured by asking if compact fluorescent bulbs make the home and people look bad. Table 9 shows that the impression of CFLs had a significant difference on two variables: gender ($p < .01$) and viewpoint ($p < .01$). Males and liberal subjects showed more positive general impressions of CFLs than females and conservatives did.

Table 9. ANOVA and t-test summaries for Impression of CFL

ANOVA Results				
Variables	df	SS	MS	F
Age	3	13.222	4.441	2.265
Educational level	2	6.982	3.491	1.782
Income level	2	6.916	3.458	1.713
House size	2	4.974	2.487	1.251

Table 9. Continued

T-test Results				
Variables		Mean	df	t
Gender	Male	4.80	303	3.574**
	Female	4.22		
Environmental Group	Member	4.52	301	1.076
	Non-member	4.35		
Viewpoint	Conservative	4.24	304	-2.727**
	Liberal	4.68		

*p<.05; **p<.01

Cost of CFL When the subjects were asked to evaluate their perception about the cost of CFLs, gender ($p < .05$) was the only variable that showed a statistically significant difference (Table 10). The results indicated that more female subjects than males perceived compact fluorescent bulbs as more costly to buy.

Table 10. ANOVA and t-test summaries for Cost of CFL

ANOVA Results				
Variables	df	SS	MS	F
Age	3	11.484	3.828	1.857
Educational level	2	3.689	1.844	0.888
Income level	2	1.914	0.957	0.454
House size	2	4.896	2.448	1.168

T-test Results				
Variables		Mean	df	t
Gender	Male	2.74	303	-2.190*
	Female	3.10		
Environmental Group	Member	2.96	301	0.115
	Non-member	2.94		
Viewpoint	Conservative	2.95	304	-0.092
	Liberal	2.97		

*p<.05; **p<.01

Technological attributes of CFL The technological attributes of CFLs included slow start-up time, flicker, and incompatibility with common light fixtures. Table 11 shows homeowners' perceptions regarding the technological attributes of the compact fluorescent bulbs were significantly different on two variables: gender ($p < .01$) and viewpoint ($p < .01$). The results indicated that males and liberal subjects more positively perceived the technological attributes of CFLs than female and conservative subjects did.

Table 11. ANOVA and t-test summaries for Technological attributes of CFL

ANOVA Results				
Variables	df	SS	MS	F
Age	3	0.629	0.210	0.159
Educational level	2	5.165	2.582	2.008
Income level	2	2.072	1.036	0.788
House size	2	3.037	1.519	1.150
T-test Results				
Variables	Mean		df	t
Gender	Male	4.34	303	2.922**
	Female	3.96		
Environmental Group	Member	4.17	301	1.004
	Non-member	4.04		
Viewpoint	Conservative	3.93	304	-3.147**
	Liberal	4.33		

* $p < .05$; ** $p < .01$

RQ3. What are homeowners' environmental lighting behaviors?

To identify subjects' environmental lighting behaviors for their homes, four variables were investigated: 1) energy-efficient lighting usage behavior, 2) habitual behavior, 3) citizenship behavior, 4) replacement behavior and willingness to replace.

Energy-efficient lighting usage behavior The homeowners' lighting behaviors about energy-efficient lighting were measured based on their effort and commitment to purchase energy-efficient lighting such as CFLs and how much the energy-efficient lighting was utilized in their homes.

Table 12 indicates results of ANOVA and t-test for the behavior about energy-efficient lighting for the subjects' homes. The energy efficient lighting usage behavior was significantly different on three variables: income ($p < .05$), association with environmental group ($p < .01$), and viewpoint ($p < .01$).

Table 12. ANOVA and t-test summaries for Energy efficient lighting usage behavior

ANOVA Results				
Variables	<i>df</i>	SS	MS	<i>F</i>
Age	3	14.318	4.773	2.297
Educational level	2	2.786	1.393	0.660
Income level	2	13.781	6.890	3.348*
House size	2	4.346	2.173	1.027
T-test Results				
Variables		Mean	<i>df</i>	<i>t</i>
Gender	Male	4.81	304	-1.108
	Female	4.99		
Environmental Group	Member	5.17	303	3.361**
	Non-member	4.62		
Viewpoint	Conservative	4.52	305	-5.262**
	Liberal	5.36		

* $p < .05$; ** $p < .01$

For the income level, those in the lowest income categories (\$49,999 or less) rated significantly higher on buying and using energy-efficient lighting for their homes than those in the higher income categories. In terms of environmental groups and viewpoint, the members of an environmental group and liberal subjects also rated significantly

higher on purchasing and implementing energy-efficient lighting for their homes than non-members and conservatives did.

Habitual behavior The habitual behavior assessed subjects' habitual energy-saving behaviors in their homes. The energy-saving behaviors included for this measure were "household activities (i.e. turning off lights when leaving a room) that focused around everyday reductions in energy use that require no or minimal structural adjustment" (Barr et al., 2005). Table 13 presents the habitual behavior was significantly different on three variables: gender ($p < .05$), income level ($p < .05$), and viewpoint ($p < .05$).

Table 13. ANOVA and t-test summaries for Habitual behavior

ANOVA Results				
Variables	df	SS	MS	F
Age	3	0.831	0.277	0.148
Educational level	2	1.678	0.839	0.449
Income level	2	12.357	6.178	3.389*
House size	2	11.027	2.981	2.981
T-test Results				
Variables	Mean		df	t
Gender	Male	5.42	302	-2.509*
	Female	5.82		
Environmental Group	Member	5.80	301	2.100*
	Non-member	5.47		
Viewpoint	Conservative	5.54	303	-1.431
	Liberal	5.77		

* $p < .05$; ** $p < .01$

Subjects whose income fell in the mid range (\$50,000 to \$99,999) rated significantly higher on their habitual energy-saving behaviors than other subjects whose income were under \$49,999 and more than \$100,000. In terms of gender and viewpoint,

female and liberal subjects presented significantly higher energy saving behaviors in their homes than male and conservative subjects did.

Citizenship behavior Citizenship behavior assessment was based upon two behavior criteria: 1) subjects' willingness to pay higher prices for buying environmentally friendly products to protect the environment and 2) subjects' attitude toward government policies banning incandescent light bulbs.

Results of the ANOVA and t-test in Table 14 indicate that citizenship behavior was significantly different on four variables: educational level ($p < .01$), house size ($p < .05$), association with an environmental group ($p < .01$) and viewpoint ($p < .01$).

Table 14. ANOVA and t-test summaries for Citizenship behavior

ANOVA Results				
Variables	<i>df</i>	SS	MS	<i>F</i>
Age	3	12.274	4.091	1.457
Educational level	2	42.212	21.106	7.760**
Income level	2	5.101	2.551	0.909
House size	2	20.700	3.695	3.695*
T-test Results				
Variables		Mean	<i>df</i>	<i>t</i>
Gender	Male	4.31	303	-0.894
	Female	4.48		
Environmental Group	Member	5.00	302	7.166**
	Non-member	3.72		
Viewpoint	Conservative	3.75	304	-7.921**
	Liberal	5.14		

* $p < .05$; ** $p < .01$

In terms of the educational level and house size, the subjects who had more education (i.e. graduate and professional degree) and smaller sized houses (less than 2,000 Sq. ft) rated their citizenship behaviors significantly higher than the subjects who

had lesser education and larger sized houses. As for the association with an environmental group and political viewpoint, members of an environmental group and liberal subjects rated significantly higher on their implementation of energy-efficient lighting and support for government policies than non-members of an environmental groups and conservative subjects did.

Replacement behavior and willingness to replace. In order to measure home owner's behavior of implementing energy-efficient lighting for their homes, it was asked (1) if subjects have replaced entire lighting to more efficient lighting and if not, (2) if they are willing to replace existing fixtures with more efficient lighting for their home. The logistic regression analysis in Table 15 shows the results of the first question asking if they have replaced the entire lighting for more efficient lighting. It was found that none of the variables were significantly associated with subjects' replacement behavior of the energy efficient lighting.

Table 15. Results of the logistic regression analysis on replacement behavior

Variable	Have replaced entire lighting fixtures to use more efficient bulbs				
	Beta	S.E	Wald	df	p-value
Age	- 0.024	0.134	0.033	1	0.856
Gender	- 0.047	0.275	0.030	1	0.864
Income	- 0.059	0.196	0.092	1	0.762
Educate	0.177	0.198	0.794	1	0.373
House size	- 0.220	0.186	1.411	1	0.235
Environmental group	- 0.185	0.272	0.464	1	0.496
Viewpoint	0.429	0.271	2.503	1	0.114

For those who have not replaced their entire lighting with more energy efficient lighting, their willingness to replace was measured by asking if they are willing to replace existing

fixtures with more efficient lighting for their home. Results of the logistic regression analysis in Table 16 indicate that two variables: association with environmental group ($\beta = -0.725, p < .01$) and viewpoint ($\beta = 0.595, p < .05$) were significantly related to the homeowners' willingness to replace their existing lighting. The subjects who were current members of an environmental group with more liberal viewpoints expressed their willingness to replace their entire lighting with more efficient bulbs more strongly than non-members of an environmental groups and conservative subjects.

Table 16. Results of the logistic regression analysis on subjects' willing to replace

Variable	Will replace existing fixtures with more efficient bulbs				
	Beta	<i>S.E</i>	<i>Wald</i>	<i>df</i>	<i>p-value</i>
Age	- 0.085	0.135	0.396	1	0.529
Gender	0.154	0.276	0.313	1	0.576
Income	- 0.085	0.202	0.178	1	0.673
Educate	0.027	0.188	0.021	1	0.886
House size	- 0.123	0.183	0.453	1	0.501
Environmental group	- 0.725**	0.278	6.797	1	0.009
Viewpoint	0.595*	0.423	4.531	1	0.033

* $p < .05$; ** $p < .01$

RQ4. How do homeowners' lighting perceptions influence their environmental lighting behaviors?

In order to examine how homeowner's perceptions about lighting are associated with their environmental lighting behaviors for their homes, a series of regression analyses were conducted based on four variables of environmental behaviors and six variables of lighting perceptions. Four environmental behaviors as dependent variables included 1) energy-efficient lighting usage behavior, 2) habitual behavior, 3) citizenship behavior, and 4) willingness to replace existing lighting with more efficient lighting.

Independent variables included seven variables: three variables of general lighting perceptions: (1) importance of lighting, (2) preference for incandescent, and (3) fluorescent lighting beliefs on health, and four variables of energy-efficient lighting perceptions: (1) general perception of energy-efficient lighting, (2) impression of CFLs, (3) cost of CFLs, and (4) technological attributes of CFLs.

Energy-efficient lighting usage behaviors

The energy-efficient lighting usage behaviors indicated subjects' effort and commitment to buy and utilize energy-efficient lighting for their homes. The results of the regression analysis in Table 17 show that energy-efficient lighting usage behaviors were significantly related to six variables: importance of lighting, preferences to incandescent, general perception of energy-efficient lighting, impression of CFLs, cost of CFLs, and technological attributes of CFLs.

Subjects' energy-efficient lighting usage behaviors showed a positive relationship ($\beta = 0.136, p < .05$) with the importance of lighting. The more the subjects believed that their lighted environment and types of lighting were important for their well-being, mood, and work performance, the more likely the subjects were to follow energy-saving behaviors by purchasing environmentally friendly products and using more efficient light bulbs for their homes.

As for the preference for incandescent lighting, the results showed a negative relationship between subject's preference for incandescent lighting and energy-efficient lighting usage behavior ($\beta = -0.136, p < .05$). The more the subjects preferred the attributes of incandescent lighting (e.g., attractive appearances and flattering color to their

appearance), the less the subjects purchased and utilized the energy-efficient lighting for their homes.

All four perceptions of energy-efficient lighting were significantly associated with energy-efficient usage behavior: (1) general perception of energy-efficient lighting ($\beta = 0.477, p < .01$) and (2) impression of CFLs ($\beta = 0.383, p < .01$), (3) cost of CFLs ($\beta = 0.149, p < .01$), (4) technological attributes of CFLs ($\beta = 0.281, p < .01$). All four variables showed the positive relationship with the energy-efficient lighting usage behaviors.

Results suggest that the more positive perceptions the subjects showed about energy-efficient lighting in general (i.e., impression of CFLs, cost and technological attributes of CFLs), the more the subjects tended to purchase and utilize energy-efficient lighting for their homes.

Table 17. Results of the regression analysis for energy-efficient lighting usage behaviors

Variable	<u>Energy-efficient lighting usage behaviors</u>	
	Beta	<i>p</i>
General lighting perception		
Fluorescent lighting beliefs on health	0.004	0.942
Importance of lighting	0.136*	0.016
Preference for incandescent lighting	-0.136*	0.016
Energy-efficient lighting perceptions		
General perception of energy-efficient lighting	0.477**	0.000
Impression of CFLs	0.383**	0.000
Cost of CFLs	0.149**	0.008
Technological attributes of CFLs	0.281**	0.000

* $p < .05$; ** $p < .01$

Habitual behaviors

The habitual behaviors indicated subjects' energy-saving activities in everyday life at home. Results of the regression analysis in Table 18 show that homeowners'

general perception of energy-efficient lighting ($\beta = 0.234, p < .01$), impression of CFLs ($\beta = 0.161, p < .01$) and technological attributes of CFLs ($\beta = 0.216, p < .01$) except for the cost of CFLs were significantly related to their habitual energy-saving activities for their lighting use at home. The results suggest that the more positive perception homeowners had towards the energy-efficient lighting, the more likely the subjects were to pursue and practice energy-saving activities for their homes.

Table 18. Results of the regression analysis for habitual behaviors

Variable	Habitual behavior	
	Beta	<i>p</i>
General lighting perception		
Fluorescent lighting belief on health	0.026	0.652
Importance of lighting	0.091	0.110
Preference for incandescent lighting	-0.084	0.138
Energy-efficient lighting perceptions		
General perception of energy-efficient lighting	0.234**	0.000
Impression of CFLs	0.161**	0.004
Cost of CFLs	0.064	0.252
Technological attributes of CFLs	0.216**	0.000

* $p < .05$; ** $p < .01$

Citizenship behaviors

The citizenship behaviors indicated subjects' willingness to protect the environment by conserving energy and support of government policies banning incandescent light bulbs. Results of the regression analysis in Table 19 showed citizenship behaviors were significantly associated with five variables: preference for incandescent, general perception of energy-efficient lighting, impression of CFLs, cost of CFLs, and technological attributes of CFLs.

Among the three variables of lighting perceptions in general, preference for incandescent ($\beta = -0.188, p < .01$) was the only variable that was significantly and

negatively related to the citizenship behaviors. The results revealed that the subjects who perceived incandescent lighting more positively were less likely to practice energy-saving and support the government policy of banning incandescent light bulbs.

All variables of the energy-efficient lighting perceptions were significantly and positively related to the subjects' citizenship behaviors: general perception of energy-efficient lighting ($\beta = 0.609, p < .01$), impression of CFLs ($\beta = 0.332, p < .01$), cost of CFLs ($\beta = 0.148, p < .01$), and technological attributes of CFLs ($\beta = 0.281, p < .01$). The results suggest that the subjects who more positively perceived about energy-efficient lighting in general, impression of CFLs, cost and technological attributes of CFLs, would be more likely to protect environment by conserving energy and supporting government policies banning incandescent light bulbs.

Table 19. Results of the regression analysis for citizenship behaviors

Variable	Citizenship behaviors	
	Beta	<i>p</i>
General lighting perceptions		
Fluorescent lighting belief on health	0.085	0.136
Importance of lighting	0.101	0.075
Preference for incandescent	-0.188**	0.001
Energy-efficient lighting perceptions		
General perceptions of energy-efficient lighting	0.609**	0.000
Impression of CFLs	0.332**	0.000
Cost of CFLs	0.148**	0.009
Technological attributes of CFLs	0.281**	0.000

* $p < .05$; ** $p < .01$

Willingness to replace

Table 20 shows results of the logistic regression analysis for subjects' willingness to replace existing fixtures with more efficient bulbs for their homes. The results showed that the subjects' willingness to replace their current fixtures with more energy-efficient

lighting were significantly associated with the energy-efficient lighting perceptions. All the variables of the energy-efficient perceptions: energy-efficient lighting in general ($\beta = 0.651, p < .01$), impression of CFLs ($\beta = 0.501, p < .01$), cost of CFLs ($\beta = 0.223, p < .05$), and technological attributes of CFLs ($\beta = 0.473, p < .01$) showed significant positive relationships. As findings suggest, the subjects who perceived more positively about the energy-efficient lighting in general, impression of CFLs, cost of CFLs and technological attributes of CFLs, tended to demonstrate more willingness to replace their existing fixtures with more efficient bulbs.

Table 20. Results of the regression analysis on subjects' willingness to replace

Variable	Will replace existing fixtures with more efficient bulb				
	Beta	S.E	Wald	df	p-value
General lighting perceptions					
Florescent lighting belief on health	0.080	0.094	0.728	1	0.393
Importance of lighting	- 0.035	0.129	0.075	1	0.785
Preference for incandescent lighting	- 0.196	0.129	2.314	1	0.128
Energy-efficient lighting perceptions					
Energy-efficient lighting in general	0.651**	0.150	18.763	1	0.000
Impression of CFLs	0.501**	0.112	19.877	1	0.000
Cost of CFLs	0.223*	0.109	4.178	1	0.041
Technological attributes of CFLs	0.473**	0.138	11.760	1	0.001

* $p < .05$; ** $p < .01$

CHAPTER V

CONCLUSION

Chapter Five has two sections. In the first section, an overview of main findings from the survey is discussed along with research questions outlined in Chapter 2. In the second section, implications and limitations of the present study are discussed.

Overview of main findings

Encouraging energy-efficient residential lighting usage is a critical component of today's utility management. In general, it is anticipated that energy-efficient lighting can play a major role in conserving energy as well as saving natural resources. With the perspective of encouraging energy efficient lighting choices, this research was initiated to ascertain homeowners' underlying perceptions of energy-efficient lighting with particular emphasis on environmental lighting behaviors for their homes. The reasons that home lighting decision makers resist using energy-efficient lighting are not well understood. This study was proposed to assess the basis for such resistance.

The homeowners' perceptions about lighting were measured in two components: lighting in general and energy-efficient lighting. The lighting perceptions were further analyzed with four different behavior types to identify their behavioral intentions. The four types of behaviors included were energy efficient lighting usage behavior, habitual behavior, citizenship behavior, and willingness to replace existing fixtures with more efficient bulbs.

Based on t-test, ANOVA and regression analyses, major findings about the homeowners' lighting perceptions as well as their environmental lighting behaviors are

summarized, along with the research questions below:

RQ1. What perceptions do people have about lighting in general?

Homeowners' perceptions about lighting in general were measured by examining three items: importance of lighting, preference for incandescent lighting, and beliefs about the effects of fluorescent lighting on health.

As for the importance of lighting, female, older subjects and members of the environmental group perceived strongly that lighting was important for their well-being, mood, and performance more than male, younger subjects, and nonmembers of an environmental group respectively. In terms of the preference for incandescent lighting, again female subjects more strongly preferred the appearance and warm color of incandescent lighting than male subjects. The subjects whose income was the lowest categories (\$49,999 or less) and highest categories (\$100,000 or more) more strongly favored the incandescent lighting than those whose income was in the middle range. In dealing with fluorescent lighting beliefs on health, female subjects and nonmembers of an environmental group more strongly believed fluorescent lighting provide harmful effects one's health than male subjects and members of an environmental group.

The findings revealed that females strongly believed incandescent lighting to be superior over fluorescent lighting in terms of physical characteristics as well as their effects on mood, well-being, and performance. Females also showed their underlying beliefs that fluorescent lighting had negative effects on people's health.

As previous study indicated (Barr et al., 2005), people who were actively involved in community movements would be more likely to pursue environmental

values. It was not surprising that non-members of an environmental group showed higher significance on negative beliefs about effects of fluorescent lighting on health.

In terms of the income level and lighting preference for incandescent lighting, the subjects whose income was the highest also perceived the incandescent lighting to be more aesthetically and visually pleasing.

RQ2. What perceptions do homeowners have about energy-efficient lighting?

Homeowners' energy-efficient lighting perceptions were evaluated in two ways. First, homeowners' general perceptions of energy-efficient lighting were questioned with their energy-saving practice and environmental awareness on lighting issues. Secondly general perceptions about compact fluorescent lamp (CFL): visual comfort, aesthetics, impression, cost and technological attributes were asked to evaluate the homeowners' energy-efficient lighting perceptions.

Results of the homeowners' general perception of energy-efficient lighting showed significant differences in environmental group membership, house size and viewpoint. As expected from previous study, members of an environmental group had a higher preference for using energy-efficient lighting for conserving energy to protect the environment than the subjects who were non-members (Barr et al., 2005).

More subjects who considered themselves liberal and owned larger houses (more than 3,000 sq.ft.) rated significantly higher on implementing energy-efficient lighting for their homes and supported the roles of government and utility companies to raise awareness of the environmental issues on lighting. In order to cut energy use and increase energy efficiency, undoubtedly subjects who owned larger house were more willing and likely to implement energy-efficient lighting for their homes.

In terms of people's viewpoint and its relationship to environmental behaviors, more liberal people were generally considered to be the most committed to sustainable energy use (Barr et al., 2005). And it was the same case for the present study where more liberal subjects showed more interest in saving energy by implementing the energy-efficient lighting for their homes.

In regards to visual comfort of CFLs, older subjects (55-64 years and 65 years and over) perceived attributes of visual comfort of CFLs more positively than younger subjects due to their age and deteriorated vision.

Male subjects perceived attributes of the CFLs more positively than female subjects not only for visual comfort but also for aesthetics. This finding was unexpected since the males were identified as non-environmentalists in the previous study by Barr et al. (2005). The current findings imply that males might be more aware of current energy-efficient lighting technological updates such as better color rendition qualities and availability of more shapes and colors. On the other hand, female subjects were more cost-conscious, perceiving the cost of the compact fluorescent bulbs to be higher than the male subjects.

RQ3. What are homeowners' environmental lighting behaviors?

The environmental lighting behaviors for the home were identified by five different variables: energy-efficient lighting usage behavior, habitual behavior, citizenship behavior, replacement behavior, and willingness to replace.

First, the homeowners' energy-efficient lighting usage behavior inquired about the subjects' effort and commitment to purchase energy-efficient lighting such as CFLs and how much the energy-efficient lighting was utilized in their homes. The results

indicated that the lowest income categories (\$49,999 or less) rated significantly higher on energy-efficient lighting usage behavior for their homes than other higher income categories. This finding was different from previous studies which have indicated end-users with more income would be more willing to practice energy-efficient lighting behavior since energy-efficient lighting behaviors often require long-term commitment on finance as well as duration of time (Dilman et al. 1983). This finding implies that only the subjects who have positive perceptions toward the energy-efficient lighting and who pursue environmental values would be willing to practice energy-efficient lighting behaviors regardless of the income level.

In terms of the habitual behavior, subjects whose income fell in the mid range (\$50,000 to \$99,999) and female and liberal subjects rated significantly higher on their habitual energy-saving behaviors than subjects whose income were under \$49,999 and more than \$100,000, and male and conservative subjects.

Other significant results included were findings of the citizenship behavior. The citizenship behavior was based upon two behavior criteria: 1) subjects' willingness to pay higher prices for buying environmentally friendly products to protect the environment and, 2) subjects' attitude towards government policies banning incandescent light bulbs. The results indicated that the subjects who had more education (i.e. graduate and professional degrees) and smaller sized houses (less than 2,000 sq. ft) demonstrated more citizenship behaviors than subjects who had lesser education and larger sized houses. The results confirmed the previous finding that subjects with higher education and smaller homes tended to be energy-savers (Barr et al. 2005).

As for the association with an environmental group and viewpoint, it also confirmed the previous finding where the subjects who were associated with an environmental group and liberal subjects showed higher significance on implementation of the energy-efficient lighting and support for government policies than non-members of an environmental group and conservative subjects (Barr et al., 2005).

Lastly, in terms of the subjects' willingness to replace existing lighting, those who were current members of an environmental group with liberal viewpoint showed stronger intentions to replace their entire lighting fixtures with energy-efficient bulbs than the non-members and more conservative subjects. Subjects who were current members of an environmental group and more liberal were also more likely to pursue environmental values.

RQ4. How do homeowners' lighting perceptions influence their environmental lighting behaviors for home?

The results showed that energy-efficient lighting usage behaviors such as purchasing environmentally friendly products and utilizing more efficient light bulbs for their homes were significantly related to the importance of lighting, preference for incandescent lighting, and perceptions of energy-efficient lighting including CFLs.

The more conscious the subjects were of their lighted environment and the types of lighting they used in a room, the more likely the subjects were to follow energy-saving behaviors by purchasing and utilizing more efficient light bulbs for their homes. However, the more the subjects preferred the attributes of incandescent lighting, the less the subjects purchased and utilized energy-efficient lighting for their homes. As

anticipated, energy-efficient lighting usage behaviors were found to be positively related to energy-efficient lighting perceptions: general perception of energy-efficient lighting, cost of CFLs, impression of CFLs, and technological attributes of CFLs.

In terms of habitual behavior, the results demonstrated that the more positive perceptions homeowners had towards the energy-efficient lighting, the more likely the subjects were to pursue and practice habitual energy-saving activities for their homes.

The citizenship behaviors were found to be negatively related to their preference for incandescent lighting. The subjects who perceived the incandescent lighting more positively were less likely to practice energy-saving and support the government policy of banning incandescent light bulbs. Conversely, the subjects who perceived the energy-efficient lighting more positively, would be more likely to demonstrate energy-saving activities, approve government policies in order to protect the environment and conserve more energy, and would be more willing to demonstrate environmental behaviors by replacing their existing fixtures with more efficient bulbs.

As VBN theory suggested (Stern, 2000), having positive perceptions toward the use of energy-efficient lighting (i.e. positive values and beliefs) would initiate and lead subjects' into more energy-saving behaviors and supporting government policy (i.e. proenvironmental behaviors).

The present study demonstrated that homeowners' environmental lighting behaviors were significantly associated with their underlying lighting perceptions toward incandescent lighting as well as energy-efficient lighting. The findings clearly showed that subjects, who perceived the energy-efficient lighting to be more positive and less preferred incandescent lighting, would 1) be more likely to buy and utilize energy-

efficient lighting for their homes, 2) demonstrate habitual energy-saving behaviors in their daily life, 3) approve government environmental policies, and 4) replace their existing fixtures with more efficient bulbs.

The study also revealed some significant differences in homeowners' lighting perceptions and behaviors in relation to demographic characteristics. First, gender difference was evidently shown. Females considered lighting to be an important factor on their mood, well-being, and work performance more significantly than males. They also felt the incandescent lighting to be more aesthetically attractive, while they believed that the fluorescent lighting produced harmful effects on their health. On the other hand, it was interesting to note that females practiced more habitual energy-saving activities at home than male subjects although they perceived energy-efficient lighting more negatively than males. The findings showed males tended to be more positive about attributes of the energy-efficient lighting (i.e. visual comfort, aesthetics, and impression). They didn't perceive the technological problems of CFLs (i.e. slow start-up time, flicker, and incompatibility with common fixtures) to be as serious as the female subjects.

Secondly, as Barr et al. (2005) indicated that members of an environmental group and liberal subjects participated more actively in following environmental values and implementing energy-efficient lighting for their homes. The findings demonstrated the membership of an environmental group and viewpoint were significantly associated with homeowners' lighting perceptions and behaviors. Being a member of any environmental groups and having a liberal viewpoint was significantly related to higher willingness to protect the environment by conserving energy and to support government policies banning incandescent light bulbs. Those who had a liberal viewpoint also displayed more

habitual energy-conserving activities in their home such as switching off lights in unoccupied rooms.

Thirdly, the homeowners' age showed significant differences in their importance of lighting. It was not surprising that older subjects considered the lighting at home to be more significant on their well-being and an essential element to their visual comfort than the younger subjects due to their deteriorated vision and physical condition. They may also spend more time at home than younger age groups.

Fourth, the household income showed significant differences in their preference for incandescent lighting, energy-efficient usage behaviors, and habitual behaviors. The mid range income group showed significantly higher habitual energy-saving activities in their homes while the highest and the lowest income groups showed a higher preference for the attributes of incandescent lighting than the mid range income group. On the other hand, the lowest income group purchased and utilized more energy-efficient lighting fixtures for their homes.

Fifth, in terms of house size, not surprisingly, subjects who owned larger houses showed more positive perceptions for the utilization of more energy-efficient lighting for their homes in order to cut energy and increase energy-efficiency.

Sixth, regarding education level, the findings showed education level was significantly related to citizenship behavior. The higher the homeowners' education level, the more they were willing to pay for energy-efficient lighting products and support government policies banning incandescent lighting in homes.

Implications and limitations

Several implications are presented for both lighting researchers and

professionals. As demonstrated in the present study, professionals (i.e. architects and interior designers) may consider gender differences when working with their clients. Marketing strategies of promoting the use of energy-efficient lighting can be designed to highlight areas that each gender might be interested in learning about since gender differences affect subjects' energy-efficient lighting perception and their behaviors accordingly. For example, the findings demonstrated that males showed more positive perceptions toward attributes of the CFLs than females. The professionals may reinforce positive aspects of the energy-efficient lighting to their clients (i.e. female clients) and offer updated technological insights.

Furthermore it is important for government and lighting researchers to implement new methods (i.e. using a model house to showcase newly developed energy-efficient lighting fixtures) to publicize new lighting technologies and prevent generating further misconceptions about lighting since lighting misconceptions ultimately affect lighting behaviors (Veitch et al., 1993). Additionally, to ensure that professionals create a quality lighting environment that is both functional and energy-efficient for their clients, education for the trade professionals is essential.

Although this study utilized a systematic random sampling method, the sample of this study consisted of homeowners in the Meridian township area in Michigan where the subjects' income was known as the highest among the surrounding areas and the educational level was highly skewed. Therefore, the findings of the study should be cautiously apply to homeowners living in different locations. It is recommended to replicate the study with samples from other areas that represent normal distributions of demographic factors, particularly educational and income level for more reliable

findings.

For future study, it is strongly recommended to further investigate on differences in lighting perceptions among homeowners and professionals (i.e. architects, home builders or residential interior designers). As Ozanne and Vlosky (1997) concluded in their study, people who were current members of environmental groups might but just do so in respect to their motivation or willingness to practice environmental values may not actually demonstrate environmental behaviors when faced with making certain lighting decisions (i.e. purchasing energy-efficient lighting for their homes to conserve energy). For this reason, it is necessary to investigate further if current members of the community movements or environmental groups follow environmental values both theoretically and practically in relation to their lighting perceptions.

As demonstrated in the current study, homeowners' preference for incandescent lighting was not just on the cost issue since the subjects whose income was the highest also placed higher significance and perceived the incandescent lighting to be more aesthetically and visually pleasing. Further investigation on associations in lighting preferences and lighting perceptions and developing clearer profiles of consumers' lighting needs, attitudes, and behaviors is also necessary.

APPENDICES

APPENDIX A: Cover Letter

What are your thoughts on lighting at home?

Dear Respondent,

I am a Master student in the School of Planning, Design, & Construction at Michigan State University. As part of my thesis, I am conducting a survey to understand your beliefs, attitudes, and behaviors on lighting. Along with this letter, I have attached a survey which I am hoping you will fill out and return it to me. The survey should take you about 20 minutes to complete.

There are no risks to you or to your privacy if you decide to join this study by filling out the survey. Your identity will be kept confidential to the extent provided by law and your participation is voluntary. *[You should not put your name on the questionnaire.]* Regardless of whether you choose to participate, I would be very happy to share my results with you if you are interested. To receive the results, please email (hongheej@msu.edu) me.

If you have any questions about the survey, or about being in this study, you may contact me at 517-432-3249. The Institutional Review Board (IRB) at Michigan State University has approved this study. If you have any concerns about your rights as a participant in this study, you may contact Dr. Nam-Kyu Park, faculty supervisor via email (parkn@msu.edu) or by phone (517-353-3054).

I would truly appreciate if you could complete the questionnaire and send it back to me with the self-addressed prepaid envelope that I provided. Thank you very much for your participation.

Hee Jung (Kelly) Hong
Master Candidate
School of Planning, Design, and Construction
Michigan State University

MICHIGAN STATE
U N I V E R S I T Y

APPENDIX B: Questionnaire

Instruction: You will see that there are all sorts of questions regarding use of lighting for the home. You may think many items are similar. Actually, no two items are exactly alike so be sure to circle only one number for each statement. The higher the number, the more you tend to agree with the statement. Please remember, there are no right or wrong answers. I just want your honest opinion.

Section 1: This section of questions asks about your beliefs on lighting.

Please circle only one number for each item based on “1 = strongly disagree” through “7 = strongly agree”

	<i>strongly disagree</i>		<i>neutral</i>		<i>strongly agree</i>		
	1	2	3	4	5	6	7
1. The quality of light wherever I am is important to my well-being.	1	2	3	4	5	6	7
2. It makes no difference to me what kind of lighting is in a room.	1	2	3	4	5	6	7
3. Lighting is important to my mood.	1	2	3	4	5	6	7
4. Fluorescent lights are bad for your health.	1	2	3	4	5	6	7
5. Incandescent lights are attractive.	1	2	3	4	5	6	7
6. I get eyestrain from working under fluorescent lights.	1	2	3	4	5	6	7
7. Lighting is important to my work performance.	1	2	3	4	5	6	7
8. If I want to create an intimate setting, I dim the lights.	1	2	3	4	5	6	7
9. I like incandescent lights.	1	2	3	4	5	6	7
10. Soft, diffuse light is soothing.	1	2	3	4	5	6	7
11. Reading under dim light doesn't damage your vision	1	2	3	4	5	6	7
12. As long as I can see to work, I don't care about the lighting in a room.	1	2	3	4	5	6	7
13. Sunny days make me happy.	1	2	3	4	5	6	7
14. Bright lights rarely make me feel excited and full of anticipation.	1	2	3	4	5	6	7
15. Incandescent lights produce a warmer, more flattering color to people's appearances.	1	2	3	4	5	6	7
16. Fluorescent light gives me a headache.	1	2	3	4	5	6	7
17. Bright lights are stimulating; they make me feel energetic.	1	2	3	4	5	6	7
18. I don't like fluorescent lights.	1	2	3	4	5	6	7
19. Lack of sunlight in winter does not bother me.	1	2	3	4	5	6	7
20. Given that human beings have evolved to live under the sun, we should use artificial sources of light as little as possible.	1	2	3	4	5	6	7

Section 2: This section of questions asks about your lighting behaviors.

Please circle only one number for each item based on “1 = strongly disagree” through “7 = strongly agree”

	<i>strongly disagree</i>			<i>neutral</i>			<i>strongly agree</i>		
1. I make every effort to save electricity in my home.	1	2	3	4	5	6	7		
2. I make a strong effort to recycle everything I possibly can.	1	2	3	4	5	6	7		
3. When I buy lighting products, I look for the energy efficient ones.	1	2	3	4	5	6	7		
4. Most of the areas in my house use energy-efficient lighting.	1	2	3	4	5	6	7		
5. I only turn on lights in the rooms where I am in.	1	2	3	4	5	6	7		
6. As I leave the room, I make sure that I turn off the light switch.	1	2	3	4	5	6	7		
7. I use dimmers and/or sensors for light controls to save energy in my house.	1	2	3	4	5	6	7		
8. I always separate and dispose of fluorescent bulbs at the Eco-spot container.	1	2	3	4	5	6	7		
9. I would be willing to pay higher prices for environmental friendly lighting products to protect the environment.	1	2	3	4	5	6	7		
10. I would support government policies banning energy-wasting incandescent light bulbs for homes.	1	2	3	4	5	6	7		

Section 3: This section asks for your opinion about compact fluorescent lighting.

A. Please circle only one number for each set of opposite adjectives.

Compact fluorescent lighting is:

	<i>very</i>		<i>neutral</i>			<i>very</i>		
bad for health	1	2	3	4	5	6	7	good for health
relaxing	1	2	3	4	5	6	7	tense
dull	1	2	3	4	5	6	7	bright
warm-colored	1	2	3	4	5	6	7	cool-colored
unpleasant	1	2	3	4	5	6	7	pleasant
noisy	1	2	3	4	5	6	7	quiet
easy to dim	1	2	3	4	5	6	7	difficult to dim
irritating	1	2	3	4	5	6	7	soothing
attractive	1	2	3	4	5	6	7	unattractive
uncomfortable	1	2	3	4	5	6	7	comfortable
beautiful	1	2	3	4	5	6	7	ugly
glaring	1	2	3	4	5	6	7	not glaring
ecologically friendly	1	2	3	4	5	6	7	not ecologically friendly
acceptable	1	2	3	4	5	6	7	unacceptable
low quality	1	2	3	4	5	6	7	high quality

B. Please choose one only number for each item that best represents your opinion.

	<i>strongly disagree</i>			<i>neutral</i>			<i>strongly agree</i>		
1. Compact fluorescent bulbs make the home look bad.	1	2	3	4	5	6	7		
2. Compact fluorescent bulbs are costly to buy.	1	2	3	4	5	6	7		
3. Compact fluorescent bulbs require few minutes to reach full light output.	1	2	3	4	5	6	7		
4. Compact fluorescent bulbs flicker noticeably.	1	2	3	4	5	6	7		
5. Compact fluorescent bulbs make people look awful.	1	2	3	4	5	6	7		
6. Compact fluorescent bulbs don't turn on quickly enough.	1	2	3	4	5	6	7		
7. Compact fluorescent bulbs are incompatible with common light fixtures.	1	2	3	4	5	6	7		

Section 4: This section asks about your beliefs on lighting and the environment.

Please circle only one number for each item based on "1 = **strongly disagree**" through "7 = **strongly agree**"

	<i>strongly disagree</i>			<i>Neutral</i>			<i>strongly agree</i>		
1. My light bulb choices can have an impact on the environment.	1	2	3	4	5	6	7		
2. Using energy-efficient lighting at home is an important way to conserve energy.	1	2	3	4	5	6	7		
3. Government and utility company should raise our awareness of the environmental issue on lighting.	1	2	3	4	5	6	7		
4. Most people I know use energy-efficient light bulbs wherever it is possible.	1	2	3	4	5	6	7		
5. I feel that I should use energy-efficient light bulbs for the sake of the environment.	1	2	3	4	5	6	7		
6. I am jointly responsible for high energy consumption levels caused by using the incandescent bulbs instead of energy-efficient bulbs at home.	1	2	3	4	5	6	7		
7. I feel morally obliged to use energy-efficient light bulbs, regardless of what others do.	1	2	3	4	5	6	7		
8. I am, along with the government and industry, responsible for using energy-efficient bulbs.	1	2	3	4	5	6	7		
9. Energy-efficient bulbs are only good where the quality of light is not an issue.	1	2	3	4	5	6	7		
10. I can help solve my town/city's electricity shortage by using energy-efficient bulbs at home.	1	2	3	4	5	6	7		
11. Most people I know don't care whether I use energy-efficient bulbs.	1	2	3	4	5	6	7		
12. My family and friends expect me to use energy-efficient bulbs wherever it is possible.	1	2	3	4	5	6	7		
13. I don't feel any personal responsibility for using energy-efficient bulbs.	1	2	3	4	5	6	7		
14. I feel guilty when I don't use energy-efficient light bulbs at home.	1	2	3	4	5	6	7		
15. Electric energy consumed by lighting is just little.	1	2	3	4	5	6	7		

16. Avoiding the use of incandescent bulbs at home will help reduce global warming.	1	2	3	4	5	6	7
17. Using energy-efficient bulbs don't make a dramatic difference in my utility bills.	1	2	3	4	5	6	7
18. It is just too difficult for me to use energy-efficient lights in my home.	1	2	3	4	5	6	7
19. I worry about conserving energy when it helps to lower my utility bills.	1	2	3	4	5	6	7
20. Using energy-efficient lights at home is not up to me.	1	2	3	4	5	6	7
21. Humans are severely abusing the environment.	1	2	3	4	5	6	7
22. Global warming is a serious problem for society.	1	2	3	4	5	6	7
23. The balance of nature is strong enough to cope with the impacts of modern industrial nations.	1	2	3	4	5	6	7
24. The earth is like a spaceship with very limited room and resources.	1	2	3	4	5	6	7
25. Toxic substance in air, water and the soil is a serious problem.	1	2	3	4	5	6	7
26. The so-called "ecological crisis" facing humankind has been greatly exaggerated.	1	2	3	4	5	6	7
27. The exhaustion of energy sources is a serious problem.	1	2	3	4	5	6	7
28. If things continue on their present course, we will soon experience a major ecological catastrophe.	1	2	3	4	5	6	7

Background Information

These data will be kept in the strictest confidence and used for statistical purposes only.

- | | |
|---|--|
| <p>1. Your gender: a) Male b) Female</p> <p>2. Your age:</p> <p> a) 18-24 years b) 25-34 years</p> <p> c) 35-44 years d) 45-54 years</p> <p> e) 55-64 years f) 65-74 years</p> <p> g) 75 years and over</p> <p>3. Your racial/ethnic identity:</p> <p> a) Caucasian b) African American</p> <p> c) Hispanic d) Asian/Pacific Islander</p> <p> e) Other (please specify): _____</p> <p>4. Your highest education level completed:</p> <p> a) Less than high school</p> <p> b) High school/GED</p> <p> c) Some college d) Bachelor's degree</p> <p> e) Graduate or professional degree</p> <p>5. Your religious preference: _____</p> <p>6. Into which of the following categories does your annual household income fall?</p> <p> a) under \$25,000 b) \$25,000-\$34,999</p> <p> c) \$35,000-\$49,999 d) \$50,000-\$74,999</p> <p> e) \$75,000-\$99,999 f) \$100,000 or more</p> | <p>7. What best describes your living situation?</p> <p> a) Own home b) Rent home</p> <p>8. What is the size of your house?</p> <p> a) less than 1,000 Sq.ft</p> <p> b) 1,001 - 1,500 Sq.ft</p> <p> c) 1,501 - 2,000 Sq.ft</p> <p> d) 2,001 - 2,500 Sq.ft</p> <p> e) 2,501 - 3,000 Sq.ft</p> <p> f) more than 3,000 Sq.ft</p> <p>9. Are you a member of an environmental group?</p> <p> a) Yes b) No</p> <p>10. Donated money to an environmental group within last 5 years?</p> <p> a) Yes b) No</p> |
|---|--|

11. Wrote a letter supporting an environmental issue?

a) Yes b) No

12. Signed a petition in support of protecting the environment?

a) Yes b) No

13. Generally speaking, would you consider yourself to be?

Conservative 1 2 3 4 5 6 7 Liberal

14. Have you received any information about energy-efficient lighting through? (Check all that apply)

___ TV programs ___ Radio ___ Internet

___ Newspapers ___ Brochures by utility company

___ Consumer reviews

___ Research reports

___ Manufacturer product information

15. Have you replaced entire lighting fixtures in order to use more efficient bulbs? a) Yes b) No

If not, would you consider doing so?

a) Yes b) No

16. From options, select the name that is associated with the images. Record your choice on the line next to each image.

Options: 1) Compact Fluorescent 2) Incandescent
3) Fluorescent



Q1. Is there any information that you would like to share regarding using energy-efficient lighting at home?

Q2. In your experience, has the environmental movement helped create demand for efficient lighting? Can you cite any specific examples?

Thank you for your participation!

Please return the completed survey in the self-addressed prepaid envelope provided no later than August 2, 2008.

APPENDIX C: REMINDER POST CARD

MICHIGAN STATE
UNIVERSITY

School of Planning, Design, and Construction

Michigan State University

Hee Jung (Kelly) Hong

Interior Design Programs

203B Human Ecology

East Lansing MI 48824-9902

are your thoughts on
what
lighting?

APPENDIX D: Results of Reliability Analysis with more details

Table 2. Results of Reliability Analysis

Research Questions	Variables	N of items	Cronbach's Alpha
<i>RQ1. Homeowners' general lighting perception</i>			
	Importance of lighting	5	0.84
	1. The quality of light wherever I am is important to my well-being. 2. It makes no difference to me what kind of lighting is in a room. 3. Lighting is important to my mood. 4. Lighting is important to my work performance. 5. As long as I can see to work, I don't care about the lighting in a room.		
	Preference for incandescent lighting	3	0.77
	1. Incandescent lights are attractive. 2. I like incandescent lights. 3. Incandescent lights produce a warmer, more flattering color to people's appearances.		
	Fluorescent lighting beliefs on health	3	0.80
	1. Fluorescent lights are bad for your health. 2. I get eyestrain from working under fluorescent lights. 3. Fluorescent light gives me a headache.		
<i>RQ2. Homeowners' energy-efficient lighting perceptions</i>			
	General perception of energy-efficient lighting	4	0.70
	1. Using energy-efficient lighting at home is an important way to conserve energy. 2. Government and utility company should raise our awareness of the environmental issue on lighting. 3. Electric energy consumed by lighting is just little. 4. Using energy-efficient bulbs don't make a dramatic difference in my utility bills.		
	Visual Comfort of CFLs	4	0.71
	1. Glaring/ not glaring 2. Tense/ relaxing 3. Irritating/ soothing 4. Uncomfortable/ comfortable		

	Aesthetics of CFLs	3	0.77
	1. Unpleasant/ pleasant 2. Unattractive/ attractive 3. Ugly/ beautiful		
	Impression of CFLs	2	0.70
	1. Compact fluorescent bulbs make the home look bad. 2. Compact fluorescent bulbs make people look awful.		
	Technological attributes of CFLs	4	0.65
	1. Compact fluorescent bulbs require few minutes to reach full light output. 2. Compact fluorescent bulbs flicker noticeably. 3. Compact fluorescent bulbs don't turn on quickly enough. 4. Compact fluorescent bulbs are incompatible with common light fixtures.		
<i>RQ3. Homeowners' environmental lighting behaviors</i>			
	Energy-efficient lighting usage behavior	2	0.83
	1. When I buy lighting products, I look for the energy efficient ones. 2. Most of the areas in my house use energy-efficient lighting.		
	Habitual behavior	2	0.87
	1. I only turn on lights in the rooms where I am in. 2. As I leave the room, I make sure that I turn off the light switch.		
	Citizenship behavior	2	0.71
	1. I would be willing to pay higher prices for environmental friendly lighting products to protect the environment. 2. I would support government policies banning energy-wasting incandescent light bulbs for homes.		

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