THE IMPACT OF ENERGY INFORMATION UPON SMALL BUSINESS OWNERS
By

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ABSTRACT

This research evaluated the impact of energy information upon business owners' energy perceptions and behaviors within their architectural and social context. Specifically, it investigated if business owners were using an online electricity monitor, and how their perceptions related to engagement with energy information. The research sample consisted of ten small business owners who had participated in a free energy assessment program run by the local government. As part of the program, participants agreed to make one change the assessment suggested and attend two informational meetings. One meeting covering general energy efficiency topics and another instructing participants in use of an online electricity monitor. Data was gathered in the form of participant interviews, copies of the energy assessments, and screen shots of the electricity monitor. Interviews in context with the business owners covered topics such as how energy information impacted motivations, behaviors, and perceived limitations. Findings indicated that although each participant expressed an interest in conserving energy, none were regularly engaging with their electricity consumption information through the online monitor. Business owners did not find the monitor useful because it did not provide them information that was relevant to their business or architectural context. This indicates that future monitor designs should make a greater effort to incorporate information about users and their contexts into the representations of energy information. Doing this could make energy information more relevant and engaging so that users can relate to it and integrate it into their behavioral routines.

ACKNOWLEDGEMENTS

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CHAPTER 1.0 INTRODUCTION

Energy efficiency in buildings could minimize energy production pollution and generate significant monetary savings for businesses, but we have a behavior problem. While physical improvements can make existing buildings more efficient, user behaviors impact energy consumption quantities (Ehrhardt-Martinez, Donnelly, & Laitner, 2010) Additionally, without behavioral changes, consumption growth often counters material and technological efficiency gains (Midden et al., 2007). Energy consumption pollution levels may be dictated by material or technological efficiency, but energy demand and use are generated by human behavior. Therefore, building energy efficiency cannot be achieved through material and technological intervention alone.

Energy efficient behaviors need to be adopted by building users in order to help prevent greater ecological damages and resulting costs. Recently, The American Association for the Advancement of Science issued a report warning that we need to acknowledge and act on human behavior as a contributor to climate change in order to prevent extreme, costly, and irreversible environmental damages (Molina et al., 2014). The Rocky Mountain Institute (RMI) estimates that a $0.5 trillion investment in energy efficiency in 2010 could save $1.9 trillion dollars by 2050; however, business owners may inhibit these substantial savings by avoiding efficiency changes that are perceived as having limited individual value (Lovins & Rocky Mountain Institute, 2011, p. 77). Architects need to be able to communicate the value of adopting energy efficient technologies and behaviors in a way that engages users despite such perceived limitations.

One of the most promising energy efficiency behavioral technologies is energy monitoring, a technology that offers the ability to communicate the value of behavioral changes to users via a variety of energy consumption information framing options. Research into the efficiency of energy monitoring has shown a wide variety of effectiveness though, with consumption reduction ranges from 5 to 55 percent (Jain, Taylor, & Peschiera, 2012). Many studies have used statistical measurements of consumption to test monitor design efficacy, but few have incorporated information about how monitor information directly influenced a change in user behaviors. The potential of a monitor to increase human behavior efficiencies could be influenced by several factors, such as monitor design, context, and user characteristics. Studies testing the efficiency of different monitor designs have often drawn on behavioral and social theories to guide design options, but lack detailed information about the behavioral or social context in which consumption took place. Without such information it is difficult to determine why monitor designs are or are not effective at changing user behaviors, and how findings of effectiveness might translate to other users' architectural and social contexts.

In the literature review I explored the need for a better energy information communication methods, how energy information could affect users' behaviors, and why energy monitoring offers the best technological opportunity to impact behavioral changes. In order to address these topics I drew on literature from architectural theory, behavioral theory, energy, the environment, environmental psychology, engineering, computer-human interaction design, information visualization design, and social theory. I looked specifically for recently published peer-reviewed research journal articles where energy monitors had been designed or tested. In most cases, these monitor designs or tests were based on literature from fields other than architecture, such as psychology, and I addressed such fields and theories as appropriate. Of particular interest were the methods used in academic studies, and how findings had been interpreted as either successful or unsuccessful in relationship to the context of the research. This review made it apparent that studies which measured consumption changes did not deeply investigate why behavioral changes were made in relationship to contextual factors of the spaces, users, or monitor designs.

1.1 Scope & Objectives

In this research I investigated how business owners interpreted their energy consumption information in relation their architectural, social, and business contexts. Considering context, I was able to examine how owners perceived value of energy efficiency related to their perceived value of daily activities within their businesses. The objective of this research was to understand how behavioral limitations are tied to users' perceptions within their context. Given a clearer understanding of how contextual factors limit behaviors in relationship to energy information we may be able to address the factors that prohibit individuals from valuing investment in technologies that enable collective savings. This research focused on assessing user perspectives, and for this reason the sample was limited to those users who were exposed to energy information, and the time frame was limited to a period of a few weeks past program participation so that participant exposure to information was relatively recent.

1.2 Expectations

While grounded theory requires a researcher to enter a space without a fixed theory, I did have some assumptions based on the literature review. I expected that the context of the spaces would affect the energy behaviors of participants. Additionally, I assumed that the characteristics of users would affect their behaviors. For instance, I assumed that the participants of this study were interested in their energy consumption based on their enrollment in the program and where interested in what behaviors contributed to it. Based on these assumptions I hypothesized that users would be aware of their behaviors and engaging with their energy information in an effort to adopt more energy efficient behaviors.

CHAPTER 2.0 LITERATURE REVIEW

2.1 Introduction

Carbon dioxide (CO2) pollution is known to damage the ecosystems by ruining environmental resources and creating expensive human health problems. By increasing energy efficiency of buildings, one of the largest producers of energy-related CO2 emissions, architects could prevent a substantial amount of pollution from entering the atmosphere. In 2010 the United States produced 18% of the world's CO2 emissions, of which 37.8% were from energy related causes in the commercial and residential building sectors (see figure 2.1) (D & R International, 2012). In 2005 the health and environmental damages from energy production pollution were an estimated $120 billion dollars in the United States (U.S.) (Brown & Sovacool, 2011). Compared to coal or nuclear power production, investment in building efficiency could save $8.46 billion dollars in building operation costs, prevent 65.5 million metric tons of carbon dioxide from entering the atmosphere, prevent construction of over 15 coal power plants, and create 216,000 jobs (Mazria & Kershner, 2008).

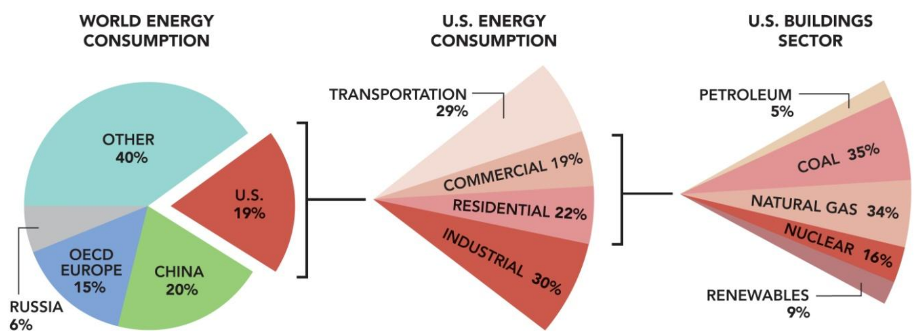

Figure 2.1 Energy Consumption by End Use and Fuel (D&R International, Ltd. 2012)

Emissions from power generation contribute to health and environmental damages in developed, as well as developing nations with rapidly increasing energy demands. Researchers estimate that in India coal power plant pollution caused 80,000 to 115,000 premature deaths in 2011, and cost the government and public 3.3 to 4.3 billion U.S. dollars in damages (Goenka & Guttikunda, 2013). Architects should ensure that buildings contribute as little as possible to energy demands to limit the damages caused by energy consumption. Users could modify energy behaviors to increase efficiency in existing buildings where material renovations are unfeasible. Architects can facilitate this process by revealing energy consumption users through energy monitoring.

For building occupants to use energy monitoring to its full advantage will require designers to create environments that foster behavioral changes. Architects could design spaces so that reduction behaviors, such as utilizing natural ventilation, can be easily adopted in combination with monitoring technologies. Changing the energy behaviors and attitudes of building users could directly reduce energy consumption and CO_2 emissions (Chen et al., 2012). Energy monitors can decrease consumption by 5% to 55% (Jain et al., 2012). Researchers can determine why one user saves 5% while another user saves 55% by investigating what factors of monitors and user context affected consumption changes. Architects could change contextual factors that limit saving behaviors to make positive behavior change easier for users.

2.2 Why Should Architects Research Energy Monitoring

Equipping buildings with energy monitors would allow their occupants to have access to comprehensive, dynamic, and action-relevant information. Additionally, monitors could offer the possibility for users to connect their behaviors, perceptions, and feelings with consumption data, possibly integrating user and building feedback information.

2.2.1 Architectural Design Alone is Not a Solution

A complete architectural solution can create an efficient building as well as an environment that supports efficient user behaviors. Architects traditionally focused on the physicality of buildings as a solution to CO2 emissions. Architectural guides suggest reducing emissions through design, integrating technologies, and using renewable energy sources (Architecture 2030, 2011). Even with technological improvements, behavioral barriers have prevented greater reductions in the residential and commercial sectors (Armel, Gupta, Shrimali, & Albert, 2013). Energy efficient behaviors require environments that integrate technology with behavioral goals rather than treating them as two separate problems. If architects can incorporate energy monitoring with architectural form, it could create a clearer connection between energy behaviors in the physical space and quantity representations of energy usage.

2.2.2 Need for a Social Science Investigation

Knowledge of how social and cultural factors affect users' behavioral decisions can identify barriers that are not apparent through measurement alone. User insights can reveal the role of monitors in social interactions regarding energy consumption. Methods such as focus groups and interviews allow users to explain what their personal barriers are in changing energy behaviors (Virgen & Mazur-Stommen, 2012). In a recent study, user interviews revealed that monitors facilitated discussions of energy use with other household members, taught normal levels of consumption, and identified when consumption was above average, but users also generally stopped regularly interacting with them after a while (Hargreaves, Nye, & Burgess, 2013). Given this knowledge, designers can focus on enhancing features that allow household communication and monitoring and explore ways to regularly engage users. Architects could use social interaction data to incorporate monitoring into buildings in ways that engage users by supporting their social needs.

2.2.3 Users Lack Building Information

Building users often do not have access to the real-time consumption information needed to connect energy behaviors with consumption quantities. Energy monitors can supply this information and connect energy consumption with its effects. Without understandable and accessible information, users disassociate energy behaviors with their removed effects (Burgess & Nye, 2008). Double-invisibility refers to this circumstance where quantities of energy consumption are invisible when used and causes of quantities are invisible when billed (Burgess & Nye, 2008). Given real-time data provision of consequences with actions, users' disassociation between behaviors and environmental effects could change (see figure 2.2). Finding what portrayal of consequences creates the most informational and motivational representation to user types will guide design and information choices.

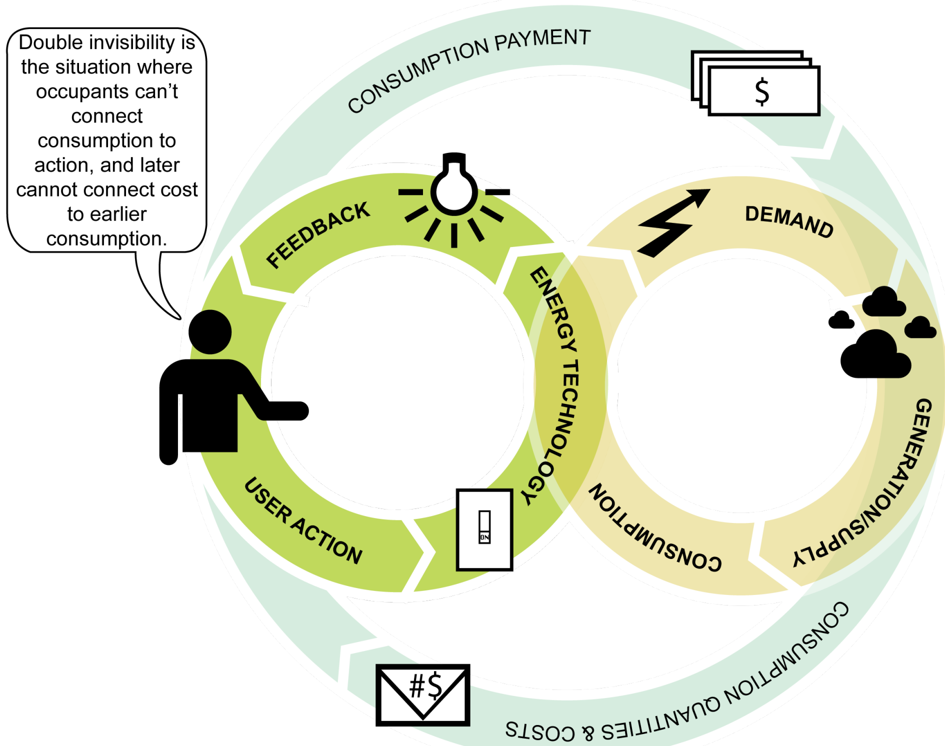

Figure 2.2 Energy Feedback: Relationship Between Users and Sources.

In addition to lacking information that can be connected to behaviors, users may not understand the format of energy consumption data they are given. A recent survey of American consumers reported that although approximately 80% of respondents felt that "energy is a topic that "people like me" can understand," but that less than half of participants were able to meaningfully interpret energy consumption information communicated in a typical bill (Southwell, Murphy, DeWaters, & LeBaron, 2012). It was concluded that in future research, "abstract notions such as energy literacy are likely best conceptualized as multifaceted ideas that can be operationalized in multiple ways" (Southwell et al., 2012). Another conclusion might be that abstract ideas such as energy may need to be communicated in ways that can adapt to a user's ways and abilities of defining energy by relating it to more graspable ideas.

2.2.4 Difficulty Connecting Information with Real-World Outcomes

Communicating the complexity of energy consumption in a two-dimensional bill or interface that captures consumption's real-world effects is the designer's challenge. A few letters, such as kWh, may hold real effects in the world, but generally mean nothing to end-users. Edward (Tufte, 2001, p. 9) notes the difficulties of capturing and communicating information saying, "the world is complex, dynamic, multidimensional; the paper is static, flat. How are we to represent the rich visual world of experience and measurement on flatland?" At a congressional hearing regarding social science investigation into energy, Vernon Ehlers asked his audience to envision energy as a purple cloud which would enable you to see where and when it was wasted, and thus know what behaviors created waste (*The Contribution of the Social Sciences to the Energy Challenge: Hearing Before the Subcommittee on Research and Scienc Education and the Committee on Science and Technology of the House of Representatives*, 2007). Instead of users seeing their energy waste happen as it occurs, they see billing quantities disconnected from the experiences that used energy. Translating static data into dynamic depictions of consumption could test how energy can be understood through a user's visual experiences instead of standardized static units.

2.3 Elements of Energy Monitoring

Users can pick intelligent energy choices easier given understandable real-time energy information; energy monitors are a digital medium that supplies this. Designers create unique visualizations that engage different data forms, units, graphics, and timeframes with underlying behavioral theories driving what chosen information will foster reduced energy consumption (see figure 2.3). For an outline of tested behavioral theories and models see (Franklin & Chang, 2013). Researchers measured a range of reductions from 5% to 55% of consumption in previous energy monitor design studies (Jain et al., 2012). Measurements showed that energy monitors succeed in lowering users' consumption to an extent, but falls short in explaining why unique visualization could succeed more in changing behavior for one user versus another. Designers developing a visualization based on individual behavior goals can employ behavioral theory and visualizations that individual users find most effective.

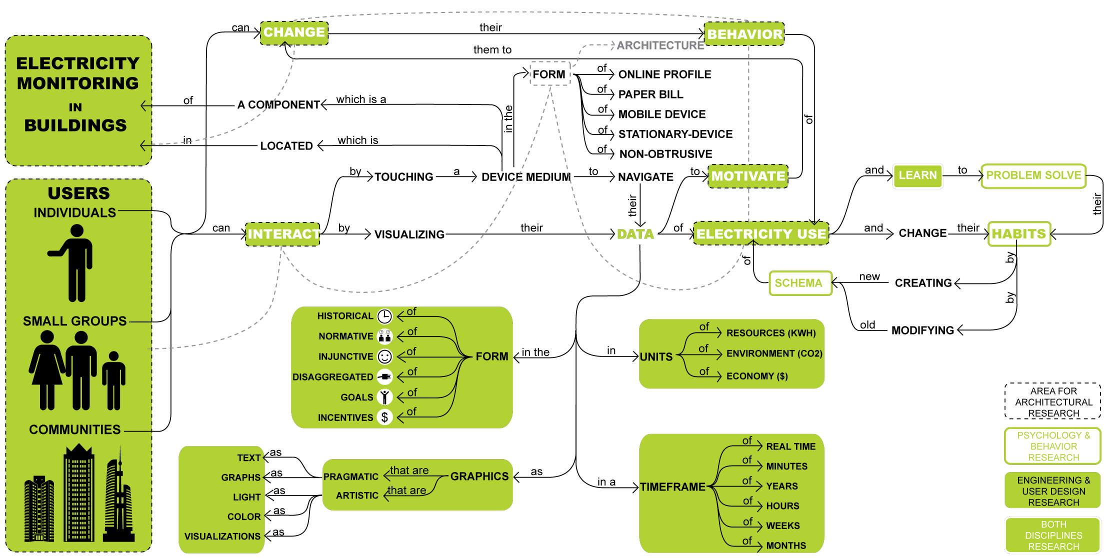

Figure 2.3 Energy Monitoring Concept Map

There is a lack of information about how different user types interact with information to create measurable changes within social, cultural, and architectural contexts. Measurements of consumption do not explain how or if users interpret information as behavioral changes. Peer network information in monitors resulted in more savings than impersonal information, but there is no data about how social group information was used (Jain et al., 2012; Peschiera & Taylor, 2012). More empirical data is needed about how users interact with energy monitors, how interactions change behaviors, and if behaviors last over time (Hargreaves et al., 2013). Research is needed to explain why behavioral theories affect different types of users within different contexts. A model for energy monitor effectiveness based on users and context would work better as a design guide than knowing measurements of a behavioral theory separate from the user profile.

2.4 Methods of Motivating Behavioral Change:

Information about existing user barriers to behavior could be incorporated into energy monitor design to help users achieve goals. This has been done through testing how environmental, social, and computational behavioral theories influence the effectiveness of monitor design in creating and sustaining behavioral changes (see table 1 and table 2).

2.4.1 Behavioral Theories

Information about environmental and economic savings alone is not powerful enough to motivate behavioral changes. Many past campaigns promoting sustainable behavior changes at home focused on using educational information; however, education and encouragement alone failed to change behaviors (McKenzie-Mohr, 2000). Situational constraints created by social, cultural, economic, and political factors prevent behavioral changes (Blake, 1999; Owens & Driffill, 2008). The ability to address specific local and personal constraints can make behavioral energy efficiency programs more effective (Virgen & Mazur-Stommen, 2012). For instance, users in cold climates may not be able to turn down their heat in winter, so a monitor that encouraged this behavior would likely not be effective. Monitors that allow users to work within and around barriers will be more effective than monitors inconsiderate of barriers.

Table 1 Environmental, Behavioral, and Computational Theories

Theory/Model	Explanation
Information-Deficit Model	Researchers identify this as the idea that providing more information about energy consumption will create understanding and that users will automatically make behavioral changes given this knowledge, and thus reduce their consumption (Hargreaves, Nye, and Burgess 2010).
Social-Norms Theory	Proponents postulate that users will not want to stray from what is considered the descriptive norm, or the definition of what is usually done (Schultz et al. 2007).
Focus Theory of Normative Conduct	This theory differentiates between descriptive or injunctive nature of norms, injunctive being what is usually approved or disapproved (Kallgren, Reno, and Cialdini 2000).
Social Network Theory	In threshold models the possibility that someone will assume a behavior can be related to the number of contacts within a social network who have the same behavior (Peschiera and Taylor 2012).
Feedback Intervention Theory	"FIT has five basic arguments: (a) Behavior is regulated by comparison of feedback to goals or standards, (b) goals or standards are organized hierarchically, (c) attention is limited and therefore only feedback-standard gaps that receive attention actively participate in behavioral regulation, (d) attention is normally directed to a moderate level of the hierarchy, and (e) FIs change the locus of attention and therefore affect behavior" (Kluger and DeNisi 1996, 259).
Gamification	Using non-game elements in game framework to potentially increase engagement, education, and motivation (Domínguez et al. 2013).
Computers As Persuasive Technology (CAPTology)	"CAPT-ology aims to alter the mindsets, attitudes, and behaviors of users via machine–user interaction, program design, and research and analysis in conjunction with other means, excluding coercion" (Chen et al. 2012, 107).

Multidisciplinary data collection and analysis methods may better explain design and behavioral theory impacts than quantitative experimental measurement alone. A personalized social connection was more effective in reducing energy consumption (Peschiera & Taylor, 2012). Measurement and surveys showed that social normative data caused users to feel social pressure to reduce consumption, but did not prompt user discussion with others (Peschiera, Taylor, & Siegel, 2010). The addition of survey data helped explain how energy monitors factored into users social behaviors beyond consumption pattern data. Mixed methods of data collection and analysis explain how individual user behaviors changed rather than just proving that they do change.

Table 2 Translation of Theories into Information Options

Information Option	*Explanation*	*Theories/Models Drawn On*
Historical	Information about past energy consumption.	• Information Deficit Model
Disaggregated	Energy consumption is broken down by appliance load.	• Information Deficit Model
Normative: Descriptive	Information about other users consumption, what the *social norm* or *descriptive norm* is.	• Social-Norms Theory
Normative: Injunctive	Information about what levels of consumption are approved or disapproved, what the *injunctive norm* is.	• Social Norms Theory • Focus Theory of Normative Conduct
Goals	The ability to set a goal.	• Feedback Intervention Theory
Rewards/Penalties	Rewards or penalties are offered based on consumption patterns.	• Feedback Intervention Theory • Social Norms Theory

Monitors can use social behavioral pressure by portraying a group behavior as the accepted norm. Users have different information needs and behavioral influences whether they are an individual, part of a small group like a family, or part of a large group like an office building or local community. Incorporation of social networks and competitions tested the effects of social pressure amongst individuals and groups (Armel et al., 2013). Incorporation of a social network in a shared resource situation showed potential savings of over 40%, compared to 25% without a social network (Hawasly, Corne, & Roaf, 2010). In this case group information created social pressure to conform to a normative use, which caused decreased energy consumption for individual users. Effective energy monitor designs will need to accommodate users at different group levels and provide appropriate information.

2.4.2 Persuasive Design

If energy monitors intend to change behaviors, each energy monitor design should follow guidelines for a persuasive technology. Monitor designs often seem passive and lack elements required of a successful persuasive technology, which could be part of the reason why they sometimes fail to create lasting behavioral changes. The Fogg Behavioral Model relates user elements of motivation, ability, and triggers required to change behavior (see figure 2.4). Researchers found upon receiving an email with energy profile information, participants would reduce their consumption, but returned to previous levels within three days (Peschiera et al., 2010). Qualitative home interviews revealed that users stopped interacting with monitors when they were no longer interested (Hargreaves et al., 2013). Another monitor design tested a disaggregated plug load element previous research indicated users wanted, but found it unsuccessful possibly due to its tedious time intensive design (Jain et al., 2012). Without a trigger in these cases the emails or a physical presence, the monitors failed to foster sustained behavior change. What users view as the elements required for motivation, abilities, and triggers will dictate energy monitor design options necessary for behavioral change.

2.4.3 Information Framing

Information framing presents data in a way intended to motivate a specific behavioral response. Data can be related to personal user interests and motivations and cast user actions in a positive or negative light to induce changes. Information framing was used to manipulate presentation of information based on user values by creating an eco-visualization design presenting energy consumption as aquarium life diversity (see figure 2.5) (Chen et al., 2012). The eco-visualization resulted in reduced energy consumption for a short time period (Chen et al., 2012). Framed information can make energy consumption effects relatable to users, in this case presenting kWh as diversity of life. To successfully frame information, designers need research connecting behavioral changes with information presentation, user characteristics, and context of use.

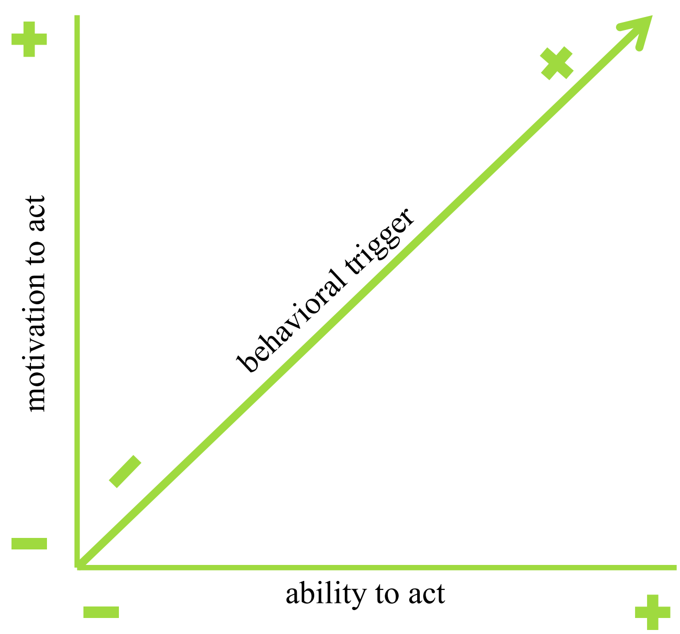

Figure 2.4 Behavioral Model for Persuasive Design (adapted from Fogg, 2009)

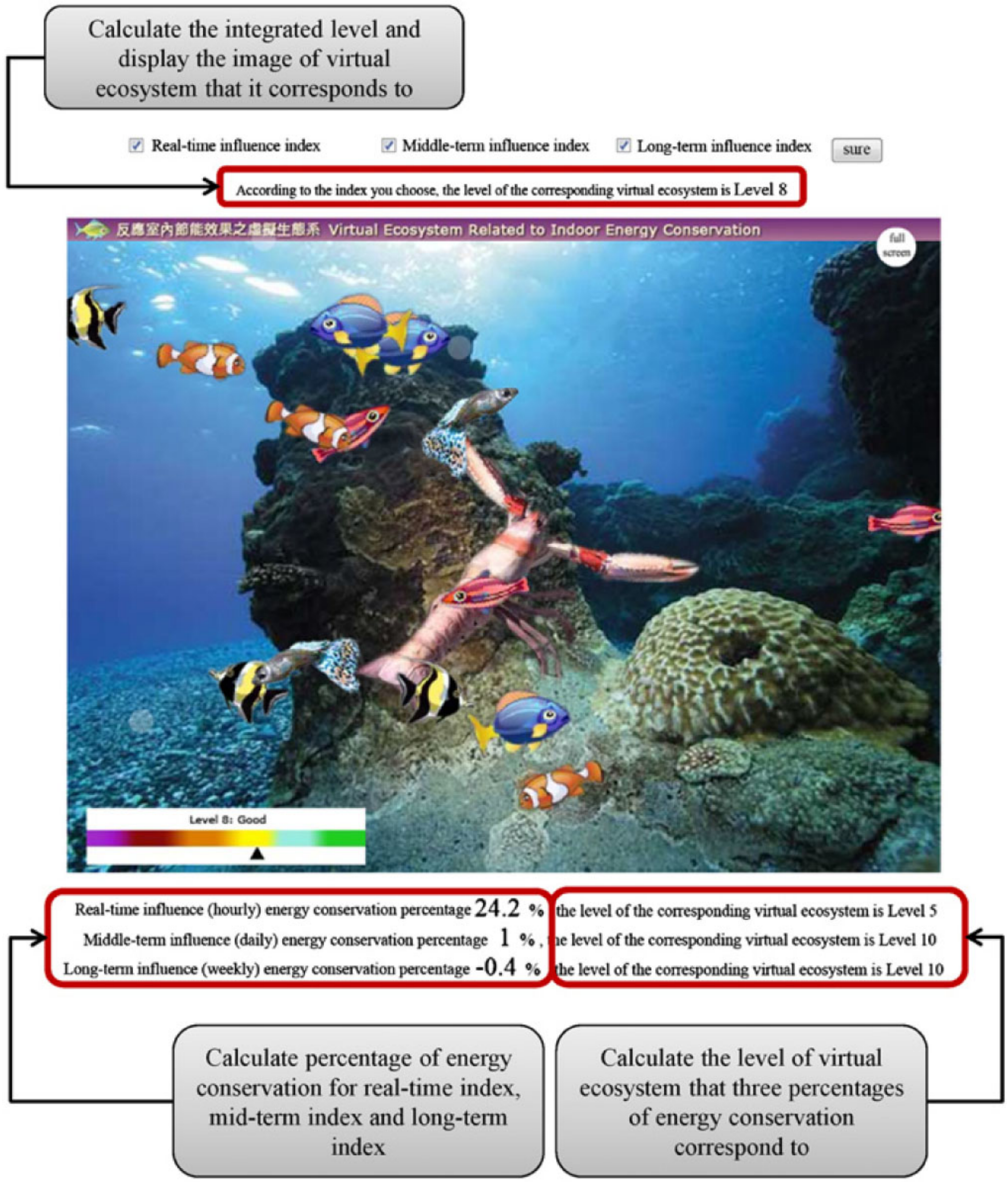

Figure 2.5 Aquarium Design of Eco-Feedback Visualization[1] (Chen et al., 2012, p. 112)

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[1] Note: Reprinted from *Energy and Buildings*, 45, Chen, H.-M., Lin, C.-W., Hsieh, S.-H., Chao, H.-F., Chen, C.-S., Shiu, R.-S., . . . Deng, Y.-C., Persuasive feedback model for inducing energy conservation behaviors of building users based on interactions with a virtual object, p.112, Copyright 2011, with permission from Elsevier.

User’s desired involvement and intensity level of information will vary. With gamification users can blur the lines between physical and mental worlds incorporating elements from one into another. “Communication should provide relevant and impactful messages in a vivid and personal way” (Virgen & Mazur-Stommen, 2012, p. 6). Gamification of energy monitoring can use real-world smart meter data to create “…self-representation, timely feedback, community connections, ranks and levels, teams, virtual economies, and compelling narratives” in the form of games that potentially influence behavior (see figure 2.6) (Reeves, Cummings, & Anderson, 2011, p. 2). Physical world actions result in virtual world bonuses or penalties creating more tangible consequences for users allowing them to connect and compete with others (Reeves et al., 2011). Gamification could tap into an existing videogame market, presenting tasks required to reach the next level of behavioral goals. Gamification offers a path to reach users who may not be otherwise engaged by energy information.

Figure 2.6 Screen Shot of Power House Energy Game (Reeves et al., 2011, p. 4)

2.4.4 Connecting Behaviors with Environment

Energy efficiency requires both building system efficiency and user behavioral efficiency otherwise one of these factors can override the other. Even efficient technologies can run inefficient through overuse. Building users cannot fully utilize efficient building systems with inappropriate use (Hawasly et al., 2010). User adjustments could be responsible for efficient buildings failing to meet their designed consumption levels (Virgen & Mazur-Stommen, 2012). A system that creates efficiency on both sides of the user-building relationship requires researchers and designers to remove barriers from both sides. Energy monitors could help prevent user behaviors that negate the effects of an efficient building system.

2.5 Understanding the User

Motivations, interests, abilities, and responsibilities change from person to person. Subsequently, user behavioral choices are affected and change in reaction to these factors. Researchers found some users were motivated by financial reasons and some by environmental reasons (Karjalainen, 2011). In identifying market segments, users attitudes were categorized as either individualist, hierarchist, or egalitarian with a range of perceptions impacting both motivation and ability to act (see figure 2.7) (West, Bailey, & Winter, 2010). Solutions should cater to the perceptions of users providing information appropriate to their abilities and motivations. For instance, a user who is unmotivated but has ability may only need motivational information.

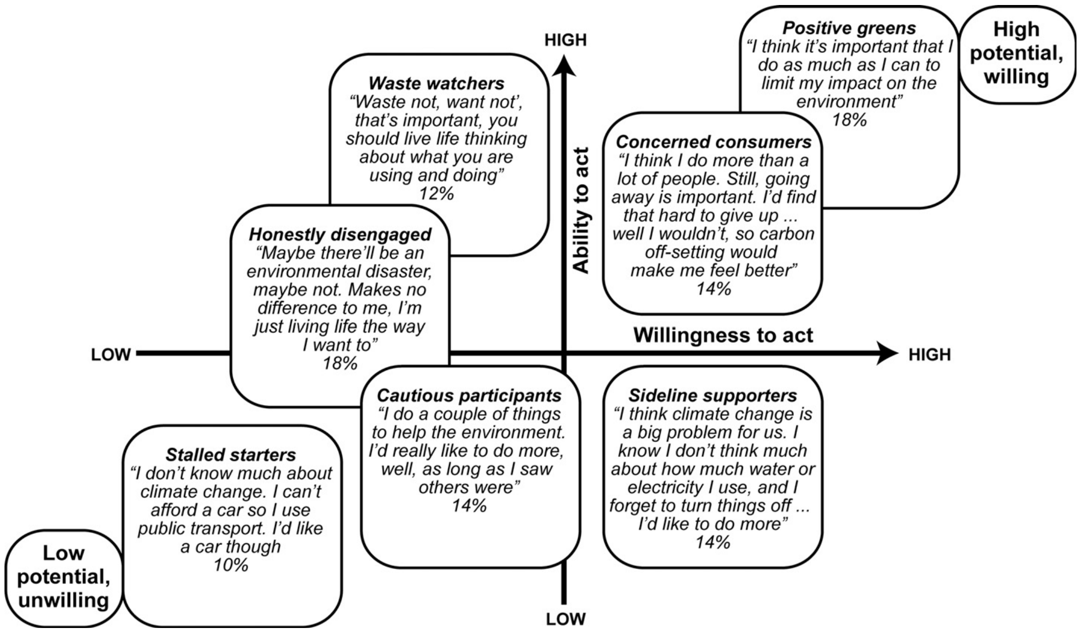

Figure 2.7 Environmental Attitudes and Behavior[2] (West et al., 2010, p. 5746)

The effectiveness of the energy monitors as a persuasive technology depends upon the behavioral reaction of users. Individual user characteristics can be an input that determines the visualization output of monitors. Successful persuasive technologies give users motivations, abilities, and triggers that create experiences to initiate behavioral change (Fogg, 2009). The characteristics of users affects their perceptions of costs and rewards, motivations, experiences, and values and in turn how they will use the environment around them (see figure 2.8) (Lang, 1987). The design that can adapt to

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[2] Note: Reprinted from *Energy Policy*, 38, West, J., Bailey, I., & Winter, M., Renewable energy policy and public perceptions of renewable energy: A cultural theory approach, 5746, Copyright 2010, with permission from Elsevier.

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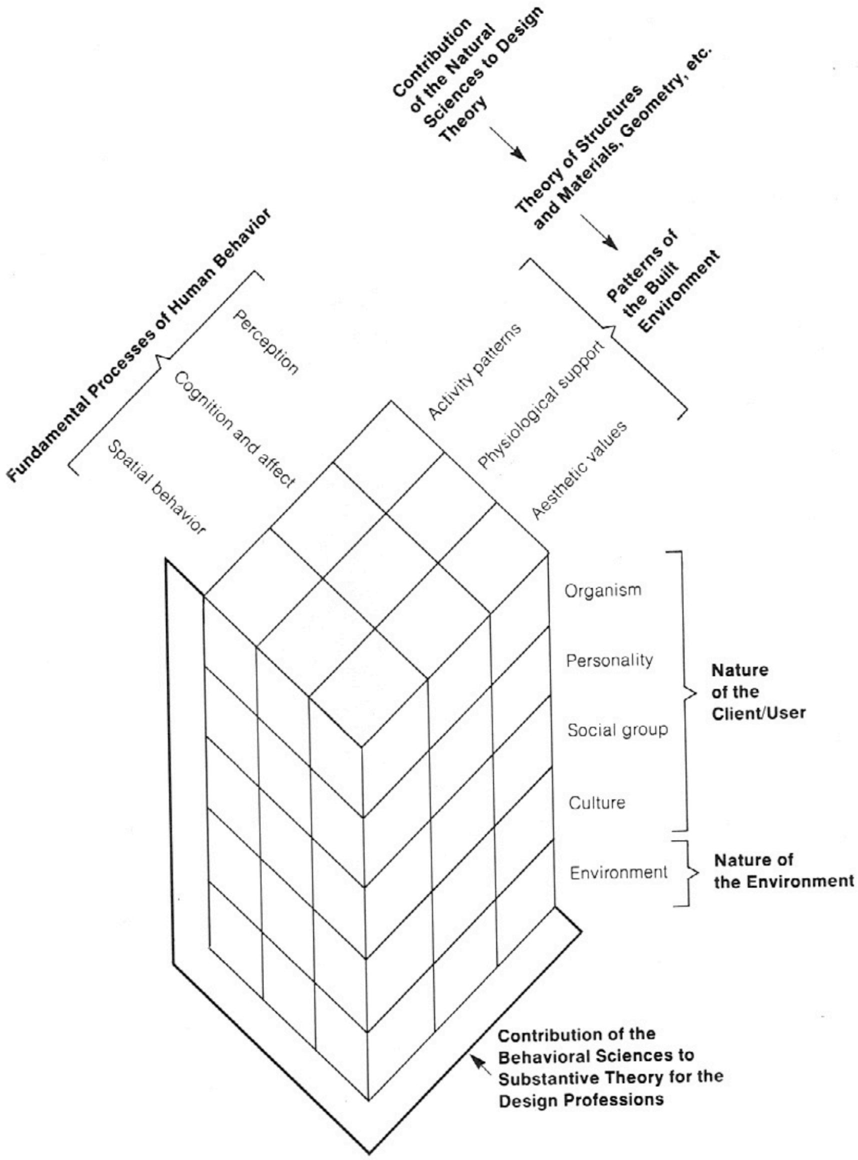

Figure 2.8 Diagram of Architectural and Behavioral Influences (Lang, 1987)

every user's characteristics will produce greater efficiencies than the one design that fits most users. Designers can create adaptable systems by classifying the roots of users' characteristics and allowing for outputs based on these rather than a general motivation method.

2.5.1 Behavioral Factors

User based design is essential for energy monitors because the goal of energy monitoring is to achieve a specific user behavior. Behaviors are determined not just by environmental intent, as an information deficit theory might assume, but by several other factors. Environmental behavioral influences can be influenced by a users' routine, income, infrastructure or they may play no major role in behavioral decisions at all (Stern, 2000). Guagnano et al (1995) postulates that attitudinal variables and contextual factors result in behaviors (as cited by Stern, 2000). Given such information to achieve a desired user behavior means that designers must consider what contexts users inhabit, and how such attitudinal variables might affect their behaviors.

2.5.2 Context

Physical and social environments can positively or negatively impact users' abilities to change consumption patterns by fostering or preventing behaviors. Linking users behavioral patterns to information about their building, location, weather, and social situations could identify when behavior is a choice versus when it is the result of an uncontrollable contextual situation. Human behavior depends in part upon our physical and social contexts (Lang, 1987). Researchers hypothesized contextual factors such as temperature changes and users' schedules as a cause of increased consumption (Chen et al., 2012; Peschiera et al., 2010). Incorporation of context unique to users could prevent monitors from sending users behavioral triggers or motivations inappropriate for their physical or social situations. For example, users might be given an option to deactivate triggers to turn off lights if they work late at night. What behaviors users view as wasteful and necessary can be incorporated to set limits within energy monitor behavioral guidance.

2.5.3 Motivations

Unique motivations of users drive behavioral decisions. Assuming a common motivation option in monitor design will exclude some users' preferences. Data frameworks could be created which display motivational information based on user preference input for motivation technique. Perception and understanding are not ensured by giving users the opportunity to behave one way (Lang, 1987). Tapping into hope or fear, pleasure or pain, and social acceptance or rejection can create motivation for behavioral change (Fogg, 2009). Assessing what users feel the impact of motivational methods are on them could create a connection between user characteristics and effective motivational methods. Designers could use this information to create motivational options specific to goal behaviors and dependent upon users inputs.

2.5.4 Control

The control that a user might exert over this process causes us to question the creation of social norms that classify choices as acceptable or unacceptable. Defining these social norms can indicate where designers should draw the line in a user's ability to control triggers. Designers noted that designing for socially courteous behaviors, they needed a baseline of acceptable behaviors (Lilley, 2009). Persuasive technology necessitates some lack of user control because the users behavior prompts feedback (see figure 2.9) (Lilley, 2009). Perhaps user control of what an acceptable behavioral baseline is would be best in order to prevent aversion to persuasive designs. Understanding how users want to control the methods of persuasion might identify limits at which users no longer want to interact with the technology. It might also identify what users think which social norms rule, and how monitor information might persuade a shift in those norms through group level data.

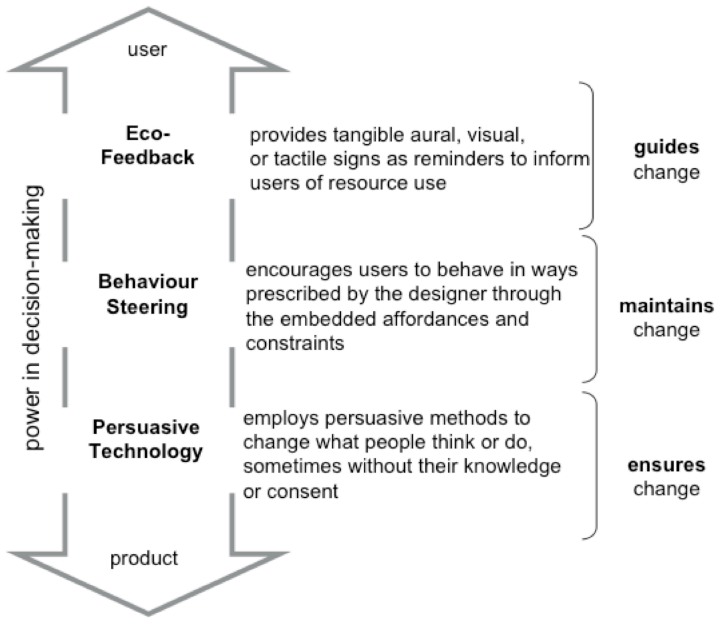

Figure 2.9 Strategies for Persuasive Design Related to Decision Making[3] (Lilley, 2009, p. 705)

2.5.5 Findings in Business Settings

Identifying what information types are valuable to certain user types in certain context will allow the creation of a set of modifiable factors that result in an optimal display for the individual user. Users in the same settings can have a range of reactions to monitors and desire a range of different feedback options. Surveys of typical office

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[3] Note: Reprinted from *Design Studies*, 30, Lilley, D., Design for sustainable behavior: Strategies and perceptions, p.705, Copyright 2009, with permission from Elsevier.

occupants who accessed energy monitors identified that a majority (57%) viewed them once a month or less and a majority also said that they increased building awareness (Lehrer & Vasudev, 2011, p. 25). Users also identified motivations for saving energy, such as environmental and monetary reasons, and metrics they wanted to see information in, such as cost or pollution (see figure 2.10) (Lehrer & Vasudev, 2011). Seeing the range of user preferences demonstrates that by providing only one option for visualization format a monitor would disregard the desires of many other users making it potentially less effective.

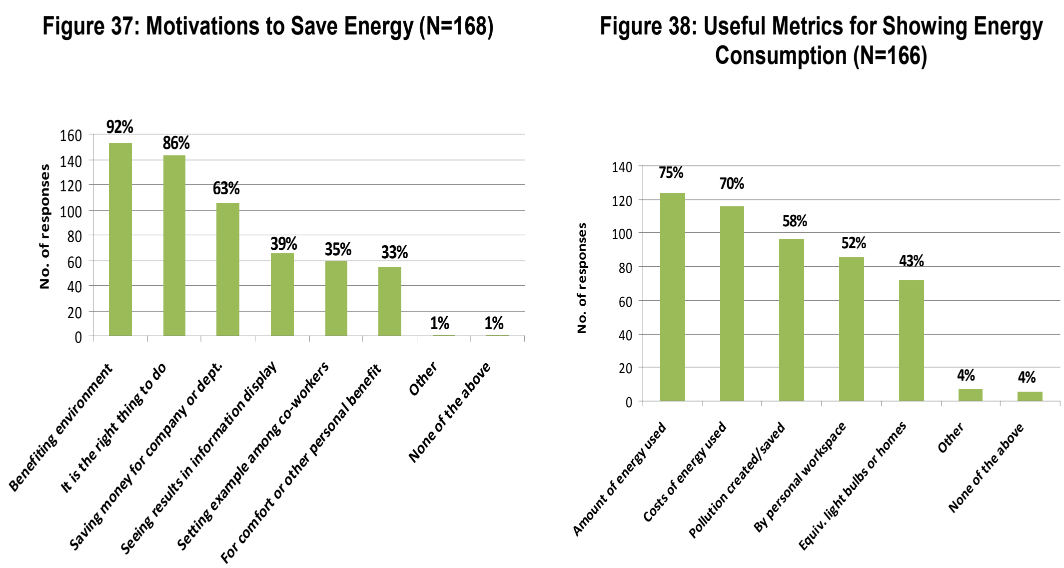

Figure 2.10 Responses to Office Survey (Lehrer & Vasudev, 2011, p. 17)

Unique user types need unique information options and levels. The environmental needs of a secretary, a facility manager, a teacher, a student, and an energy monitor designer will differ. Interviews with expert users (architects, facility managers, etc.) familiar with energy management or building management and display systems indicated a need for normalized data comparable across buildings, support features which would allow occupants to interact, and compatibility between management systems (Lehrer & Vasudev, 2011). Users also indicated the need for overview information with closer analysis techniques and connected visualizations (Lehrer & Vasudev, 2011). An energy monitor with several layers of data could support the needs of several types of users. Functions of monitors might allow for user level inputs with experts indicating that that they need analytical information, and office occupants indicating that they want more general information.

2.6 Conclusions

While energy monitoring holds great potential to increase energy efficiency in buildings, there is not yet enough research about how users will engage with monitors to achieve the desired results. Additionally, without data about how energy monitor information is being utilized within architectural and social context, design of monitors has drawn largely on research from exterior fields and studies with varying success. Without the guidance of user research, monitor designs have failed to sustain user engagement or account for user contexts. Design of more effective energy monitors will hinge on monitors delivering information suited to individual users, user groups, and communities, giving them the tools to create behavioral changes within their context. That context will include their built environment, social groups, and created meaning. Large-scale changes in energy efficiency are possible with the use of energy monitors, but ultimately depend on users. I focused this review on recent academic studies that used theory to inform energy monitor design, but the wide range of methods, contexts, users, and conclusions drawn make it impossible to interpret findings into any one widely applicable theory. The variety of technology used, targeted behaviors and related energy use make it difficult to discern the validity of efficiency outcomes (Midden et al., 2007). My cross comparison of findings yields conflicts as design and information options differ widely between studies, none are entirely comprehensive, and many lack user information or a connection of this with consumption behaviors (see figure 2.11) (Chen et al., 2012; Jain et al., 2012; Karjalainen, 2011; Peschiera & Taylor, 2012; Peschiera et al., 2010). Studies that focused on users' opinions or gave detailed information about their lives didn't connect specific behavioral data with specific consumption quantities (Bonino, Corno, & De Russis, 2012; Hargreaves et al., 2013; Karjalainen, 2011). Midden et al. (2007) draws similar conclusions pointing out that it is difficult to identify what particular features of monitors or studies created specific reactions in studies of finished prototypes. The inference gained from this is that energy-monitoring research would benefit from a study that identifies what factors might be translated across multiple contexts and accounted for more systematically in future research.

A comprehensive study, although outside the scope of this investigation, would provide greater validity by testing user indicated design options against behavioral outcomes and user characteristics. An alternative to this would be to begin identifying why specific users did or did not use specific information options and what user characteristics may have attributed to these decisions. Generalized user data does not explain this type of information, and consumption information does not explain how user characteristics or motivations affect behavioral decisions. Researchers need to know what characteristics of users cause specific behavioral reactions given energy monitor information. With this knowledge, a system could be designed which creates a data output based how a user's characteristics that will cause them to react to specific data. An initial step to this type of extended research program would be an assessment of how energy monitors in real world context has impacted user behaviors and perceptions. This would allow an identification of how, and if, energy monitoring information was incorporated into behavioral decisions, and what factors prevented or enabled adoption of monitoring technologies.

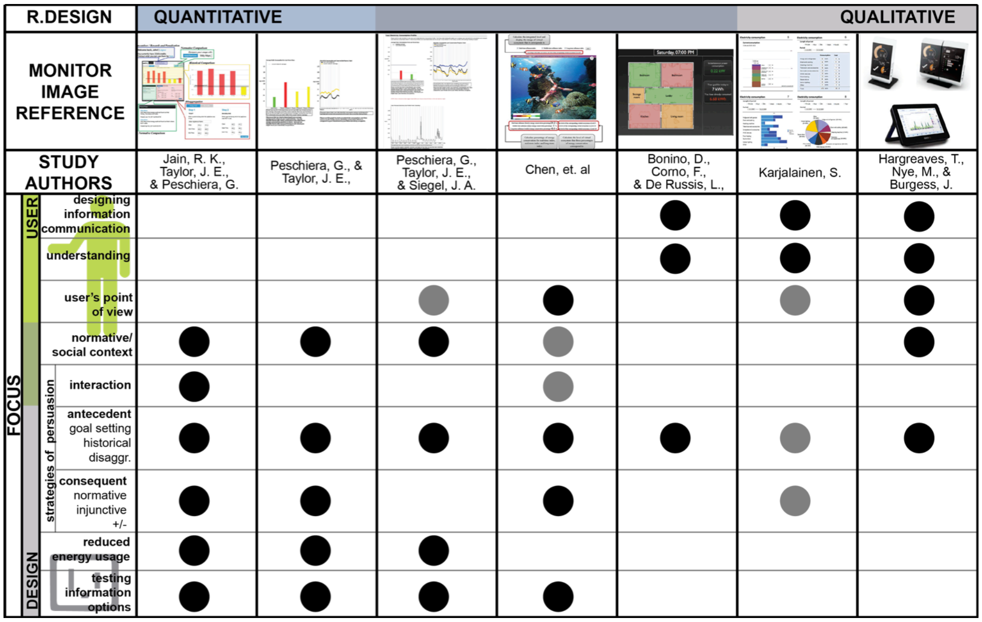

Figure 2.11 Research Study Comparison (Bonino et al., 2012; Chen et al., 2012; Hargreaves et al., 2013; Jain et al., 2012; Karjalainen, 2011; Peschiera & Taylor, 2012; Peschiera et al., 2010) [4,5,6,7,8,9]

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[4] Note: Reprinted from *Energy and Buildings*, 47, Bonino, D., Corno, F., & De Russis, L., Home energy consumption feedback: A user survey, p.386, Copyright 2011, with permission from Elsevier.

[5] Note: Reprinted from *Energy Policy*, 52, Hargreaves, T., Nye, M., & Burgess, J., Keeping energy visible? Exploring how householders interact with feedback from smart energy monitors in the longer term, 128, Copyright 2012, with permission from Elsevier.

[6] Note: Reprinted from *Energy and Buildings*, 48, Jain, R. K., Taylor, J. E., & Peschiera, G., Assessing eco-feedback interface usage and design to drive energy efficiency in buildings, 11, Copyright 2012, with permission from Elsevier.

[7] Note: Reprinted from *Energy and Buildings*, 43, Karjalainen, S., Consumer preferences for feedback on household electricity consumption, 463, Copyright 2010, with permission from Elsevier.

[8] Note: Reprinted from *Energy and Buildings*, 49, Peschiera, G., & Taylor, J. E., The impact of peer network position on electricity consumption in building occupant networks utilizing energy feedback systems, 587, Copyright 2012, with permission from Elsevier.

[9] Note: Reprinted from *Energy and Buildings*, 42, Peschiera, G., Taylor, J. E., & Siegel, J. A., Response-relapse patterns of building occupant electricity consumption following exposure to personal, contextualized and occupant network utilization data, 1332, Copyright 2010, with permission from Elsevier.

CHAPTER 3.0 RESEARCH DESIGN

Qualitative research methods were chosen for this research project because the goal was to explore the connections between information, user behaviors, user perceptions, and context. Additionally, rather than testing the effectiveness of energy monitors, I wanted to uncover what aspects of monitors influenced their success from the users' perspectives. In exploring context and user perspectives I needed to ask how and why factors such as behaviors, motivations, and design were connected. Newman (2004, p. 106) states that, "The intrinsic value of qualitative research is in its capacity to dig deeper than any survey can go, to excavate the human terrain that lurks behind the numbers. Used properly, qualitative research can pry open the black box and tell us what lies inside." In this research area the black box is a user's behavioral decision-making process after seeing energy information. Being able to offer some explanation of how users interpret information to make decisions would begin to explain why information had a specific effect, and would contribute to a deeper level of understanding of the findings presented in quantitative measurement studies.

3.1 Methodological Choice

Constructionism was the epistemological approach I used in this research because of the focus on how users formed understanding and meanings in relationship to their experiences with energy monitors. In order to discover this, I needed to know more about who the users were, and how the monitors had altered users' understanding of their behaviors. Creswell (2003, p. 8) summarizes social constructivism as seeking to identify how individuals seek understanding and create subjective meaning through social interactions, with a focus on "the specific contexts in which people live and work in order to understand historical and cultural settings of participants.” Crotty (1998) states that constructionism based researchers should:

- Allow participants to explain their point of view with open-ended questions to identify how they construct meaning from their interactions with the world.
- Seek understanding of the participants’ context by conducting research in that context, and understand that their interpretation is also constructed based on their own interactions and social context

Based on these assumptions, I decided to use qualitative research and interviews to investigate energy monitoring within users’ social contexts so that I could learn how monitors had affected users constructed understanding of energy information (see figure 3.1).

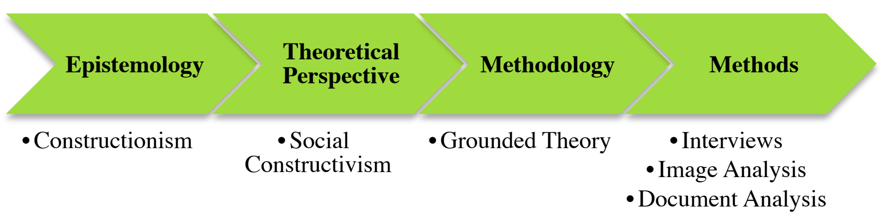


Figure 3.1 Research Design

The strategy of inquiry used was informally based in grounded theory because I wanted existing user perceptions to explain behavioral patterns, rather than imposing pre-existing behavioral or social theories into user contexts. Grounded theory researchers should enter a setting without fixed opinions and let theories emerge from an iterative process of data collection, coding, and memoing (Groat & Wang, 2002). The exercise of reassessing knowledge between these three activities implies that the data alone is not a predictor of theory, but that the researchers construct theory through the evolution of their interpretations as new knowledge is discovered (see figure 3.2). Strauss (1968) asserted that this process was not purely inductive, but that grounded theory required deduction, verification, and induction to elaborate, check out, and conceptualize theories (as cited by Groat & Wang, 2002). In my own research process, the movement back and forth between data collection, coding, and memoing allowed me to discover insights that were not readily apparent upon initial data collection.

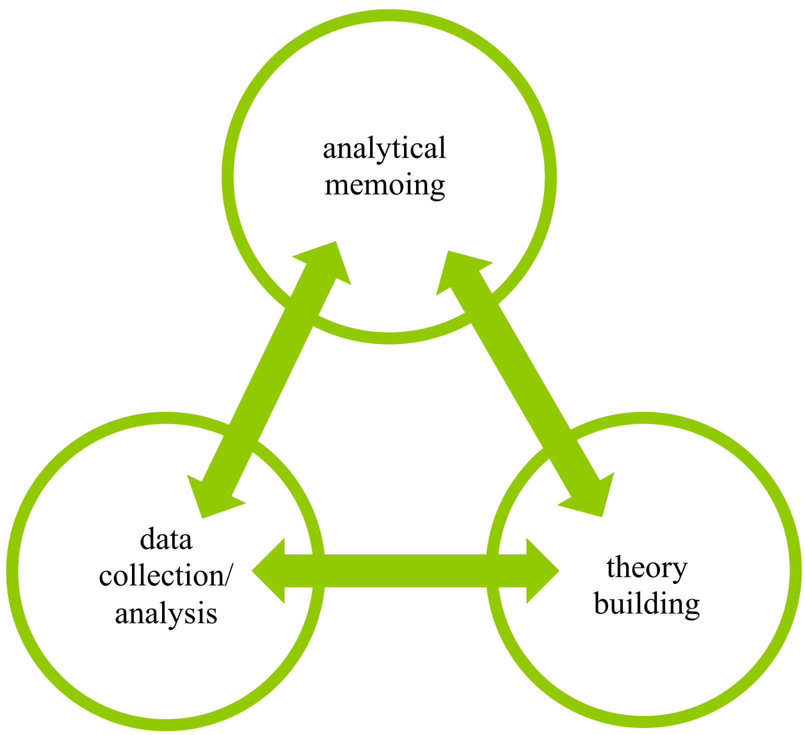


Figure 3.2 Grounded Theory Process

Data collection methods were selected that could inform my understanding of participants' point of view and would complement the research in previous studies by adding deeper descriptions of how users perceived monitoring information to be relevant to them. Open-interview questions were created focused around the sources of energy information that users were exposed to, users perceptions, and behavioral outcomes.

Creswell (2007) describes grounded theory research questions as seeking to understand from the interviewee what the processes is, what the core phenomenon is, what causal conditions it has, what strategies are related to the process, and what were the consequences of the phenomenon. In my research the central phenomenon are user understanding and energy behaviors. What I wanted to discover was the causal factors of behaviors or understanding, specifically, what role energy information played in the process of understanding, and what the impact of that information was upon behavior.

3.2 Sample Selection

A purposeful sample was utilized in this study because I needed to interview users who had been exposed to the central phenomenon. The sample consisted of ten small businesses self-elected during the spring and summer of 2013 to participate in a "green businesses" local government program that provided them with energy information about their buildings. A free energy assessment was conducted with each business, which consisted of a walk-thru of the business space and an energy assessment report outlining building type, individual and national energy consumption information, energy conservation measures, projected savings, and an energy action plan. In return for this free report, participants attended two informational meetings and verbally committed to making at least one change as suggested in their energy assessment. As part of the informational meetings, participants were instructed in the use of a free online electricity consumption monitor available to all local electricity customers.

The typology of business participants included 3 office spaces, and 3 retail spaces, and 4 restaurants. Although these properties vary in terms of size, use, and occupants, they are all situated within the same physical and social context. With one exception, the buildings are part of the main street within a small Midwest college town. Compared to industry standards, all the businesses in this sample were more energy efficient in operation than the national average, with most spending less on energy costs than the national average. It is important to note that while these businesses are comparatively "greener" than others, the national standard they are compared to is still responsible for existing CO_2 emissions, and the assessments identified ways that each business could improve their existing consumption and efficiency ratings.

3.3 Research Methods

Qualitative methodology was selected for in this research project because I wanted to focus on discovering how users interpreted energy information into behaviors, specifically information provided by energy monitors. Coming from a social constructivism epistemology, it was extremely important that I was able to gather data using methods that would take into account the context of users and would allow users to express their perspectives. For this reason I choose to use open-ended interviews focused on users' perceived motivations, behaviors, and limitations relative to the energy information that they were exposed to. Additionally, images were collected of users' energy information sources, and these were analyzed for data information options and potential behavioral triggers. Lastly, I gathered copies of the energy assessments that users were issued to analyze what information categories and behavioral suggestions were presented to them.

3.3.1 Open-Ended Interviews

Each participant was contacted either in person or through email in June of 2013 to request an interview. Before asking businesses to be part of this study, participants were read a verbal statement outlining any potential risk and their ability to stop communication at any time (see Appendix A). Participants were given an approved Institutional Review Board (IRB) form (see Appendix B) explaining the purpose of the study, any associated risks, and how data would be handled. Ten participants choose to participate, one declined, and one never responded. All participants agreed to share their information voluntarily with no incentive. Interviews were conducted over the course of 6 weeks at a time of the participants choosing within the participants' business contexts.

In order to understand how energy information created behavior change, the interview questions focused on perceptions, motivations, and behavioral outcomes. Many previous energy monitoring studies predominantly tested the efficacy of monitors through consumption measurements and statistical testing, and as Darby (2006, p. 7) notes, "our understanding of how feedback does or does not work remains unexplored or untested" (as cited by Hargreaves, Nye, & Burgess, 2010). Many studies revealed little about how users actually interpreted or reacted to this information within their architectural and social context. Without a sound understanding of context, the validity of data interpretation can become questionable (Kritzer, 1996). King, Koehane, and Verba (1994, p. 37) assert, "only with a deep cultural immersion and understanding of a subject can a researcher ask the right questions and formulate useful hypotheses." In prior studies, limited information was provided about users' contexts; however, in cases where monitors had not achieved the desired results or there was a negative change in behavior trends the context was often cited as a cause. For example, final exams were hypothesized as having an influence on energy consumption in classrooms, but without verification that the two events were related (Jain et al., 2012). In order to understand context, I interviewed users within their context and asked them what energy information meant to them based on their contextually situated behaviors.

A set of 37 open-ended interview questions was developed centered around the topics of participation within the program, the energy assessment, and the energy monitor (see appendix C). Zeisel (2006) classifies people's environmental responses by what they see, feel, do in, do to, and know within environments. Keeping this in mind, questions were developed that would reveal how users feelings and perceptions were related to their knowledge and actions regarding these three topics. For example, I asked, "How did you perceive the difficulty in making changes that might lower your energy consumption before the program?" This question allowed me to assess how, and if, energy information had influenced a change in user perceptions. To explore opinions and values, I asked questions such as, "Did you feel like you had control over your energy consumption?" and "Did you have any motivation to make changes?" These allowed me to assess what users felt about their role in energy consumption. I investigated what users did in their buildings by asking questions such as, "Do you plan to make changes, if so what?" Asking, "Did you understand the way that energy use was communicated to you previously?" allowed me to assess how much users knew about their energy consumption in relation to the provided energy information.

3.3.2 Data Collection & Storage

Interviews focused on participants' perspectives of the program, energy assessment, and energy-monitoring tool. Several interview questions were approved by IRB (see appendix C), but due to variation in response time, involvement in the program, or monitoring use, not every question applied to every interviewee. In cases where a question did not apply, I focused on other questions or relevant personal insights that the participant had to offer. Interviews lasted approximately 20 minutes and were conducted in the business owners' place of business. In four interviews, the interviewee was not the business owner, but a representative from the company who worked intimately with the owner and had been the main point of contact during the program by attended the meetings, participating in the assessment, or helping to direct energy changes.

Many of the interview questions pertained to the design of the energy-monitoring dashboard; however, most interview participants had not used the dashboard, or had only used it in their personal residence. In these cases, I used screenshots of the dashboard to allow participants to give their feedback about visual data presentation. While this allowed participants to discuss their impressions of the dashboard, it should not be considered a substitution for actual use. Furthermore, two participants were familiar with the dashboard within their residential context, and elaborated on it in relation to this, but had not used it in the context of their business.

I personally recorded and transcribed the audio from interviews using an iPad app, Audio Memos – The Voice Recorder (http://imesart.com/products.php?pid=1). After digitally recording audio of the interviews, I stored the data in a password-protected database, and deleted the files once they had undergone transcription. A total of 240 minutes were recorded over 10 interviews, or an average of 24 minutes per interview, although interview times ranged from approximately 13 to 45 minutes depending on the interviewees interest, engagement, and availability. Transcribed interview text totaled 30,898 words.

Figure 3.3 Energy Assessment Data

Besides interviews, participants were also asked to share a copy of their energy assessment report. The report was created by an architectural and engineering firm who walked through the space with the business owner, talked to owners about their energy concerns, and collected their energy consumption history information. This information was used to create a customized energy analysis for each business. The analysis consisted of a facility description, energy usage analysis, energy conservation measures, and recommendations. The energy assessment states that its objectives are to "provide a benchmark of current energy usage and to offer practical solutions for areas of further investigation into energy conservation measures that will reduce energy consumption and corresponding energy costs with quick paybacks without negatively impacting the comfort of the occupants and the function of the building" (Anonymous, 2013).

The assessments were used as a reference for comparing interview responses with energy information users had access to. A few questions were targeted towards this, asking, "Did you understand the way that energy use was communicated to you throughout the program?" Having a copy of the assessments allowed me to see the format of energy information. Additionally, a billing example was collected which was used to analyze what regular consumption information users had access to outside of the energy monitor.

3.3.3 Text Analysis

Once the interviews were transcribed, I was able to code them to discover what themes were common to multiple participants. Atlas.ti, a qualitative data analysis software, was used to import the text from multiple interviews, assign codes across all documents, create code families, and statistically analyze text. Altlas.ti enables the user to quickly compare a large quantity of codes, directly compare the text selection that codes refer to, and to engage in the activity of memoing by creating notes tied to specific codes or interview sections. Atlas.ti allows its users to import text and graphic documents (see figure 3.4), code text (see figure 3.5), link quotes with codes, and the ability to link these with analytical memos (see figure 3.6).

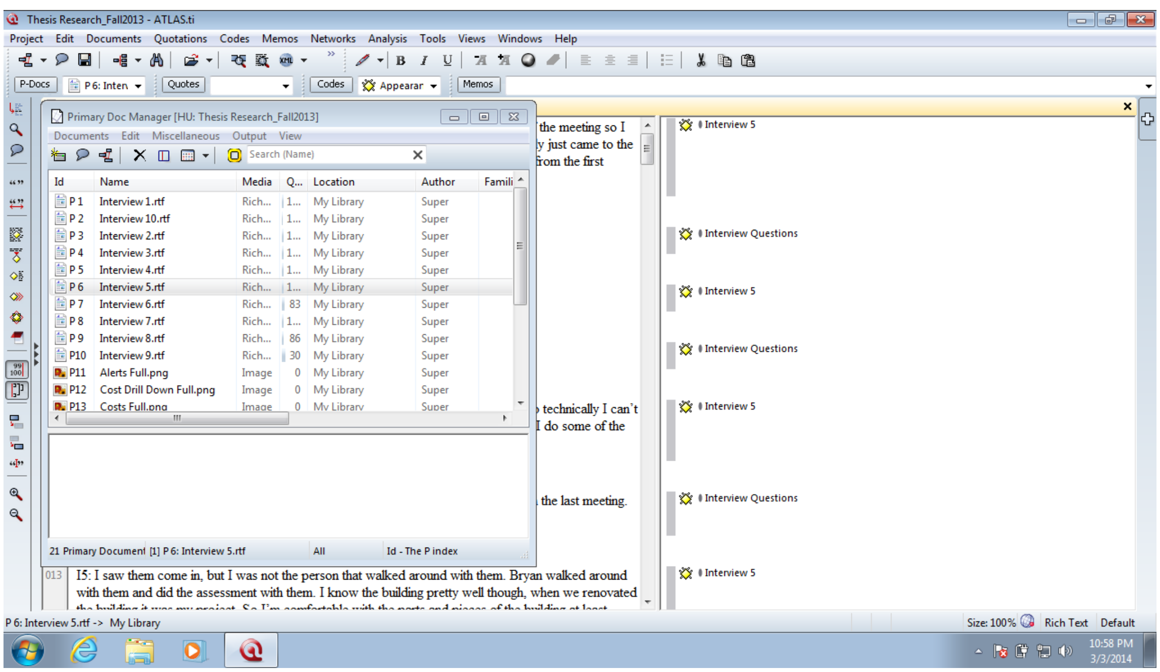


Figure 3.4 Primary Document Manager

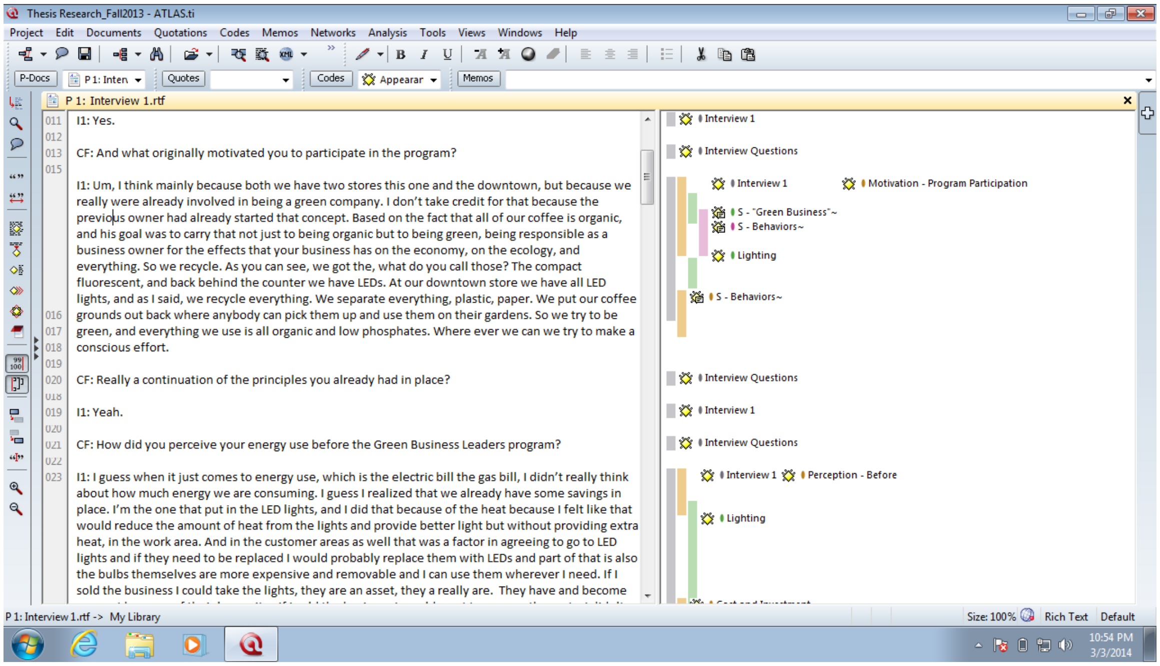


Figure 3.5 Interview Text Coding

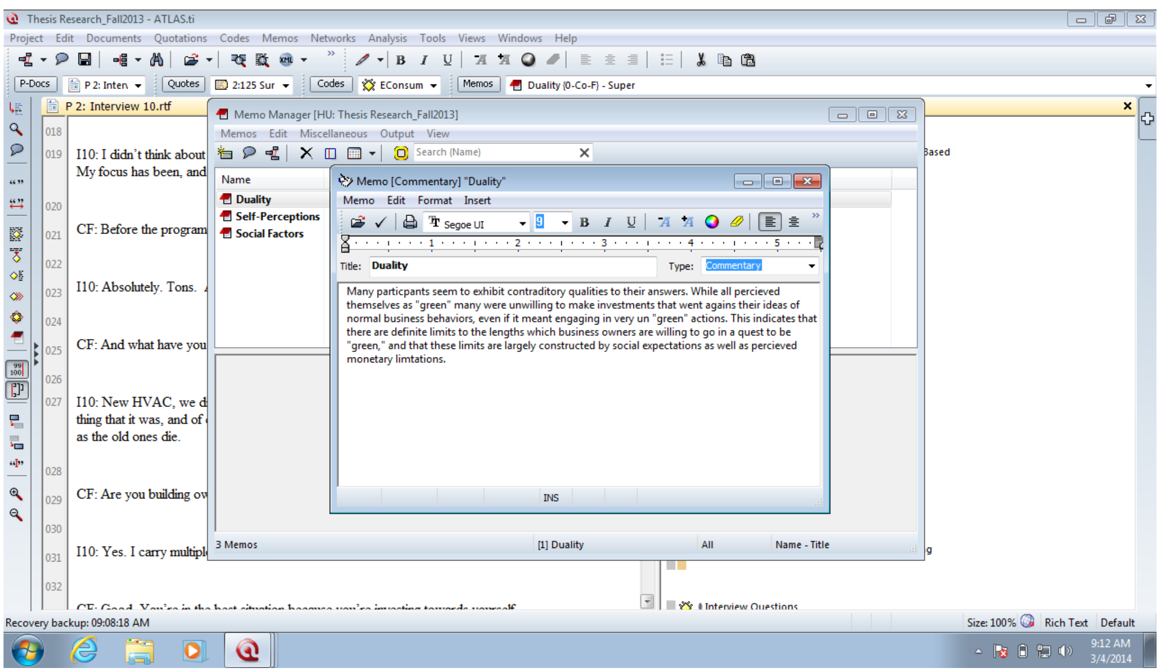


Figure 3.6 Analytical Memo Writing

Unlike quantitative analysis, qualitative text analysis requires multiple cycles of analysis to refine meaning. Saldaña (2009) blatantly states, “Rarely will anyone get coding right the first time” (see figure 3.7). As part of this iterative process, I went through two main cycles of coding. My initial cycle of coding included descriptive, in-vivo, and simultaneous coding. Descriptive coding is used to capture the main topic of discussion, in-vivo coding is when a code is generated directly from the text, and simultaneous coding occurs when a researcher assigns multiple codes to one section of text (Saldaña, 2009). In the first round of coding I focused on these types of codes to begin connecting simple ideas amongst multiple participants. In the second cycle of coding my focus was on finding out what patterns connected these ideas. To do this I used pattern coding to analyze not just what participants were discussing, but how their perspectives represented complex ideas or behavioral conditions. Through this exercise and accompanying analytical memoing, I was able to develop concepts explaining the occurrence of certain behavioral patterns. not readily apparent upon initial data collection.

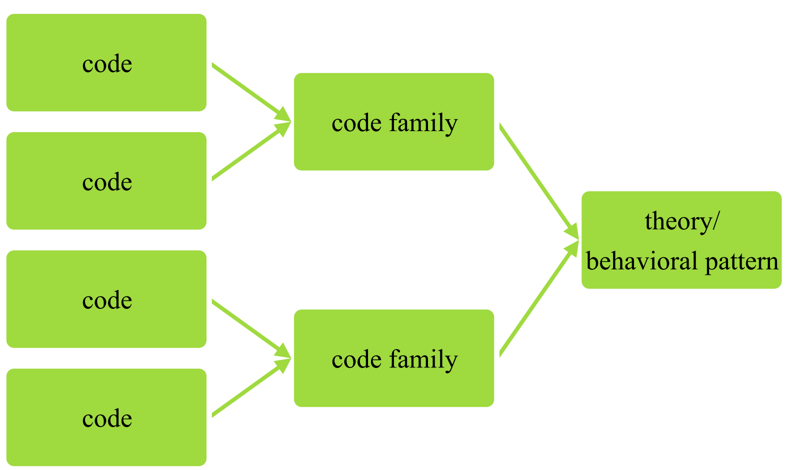


Figure 3.7 Codes to Theory Model for Qualitative Inquiry (adapted from Saldaña, 2009)

3.3.4 Image Analysis

With several screenshots of the energy monitor which participants had access to, I was able to code various data features and relate these back to the concepts utilized by previous monitors, such as the information deficit model. The primary purpose of doing this was to analyze information types that users had access to so they could be compared to their interview responses. Using Atlas.ti, I was able to upload screen shot images and code visual areas that employed ideas, such as the idea of a trigger in persuasive design. This allowed me to consider what aspects of the monitor may have engaged users, or prevented them from interacting with the monitor.

The unanalyzed version of the screenshots also served the purpose of acting as an image reference in interviews where participants were unfamiliar with the monitor. In lieu of asking questions about regular monitor use, I was able to present a screenshot (see figure 3.8) and ask questions of the interviewee such as, "Which one of these ways of presenting data do you think appeals to you the most?" The benefit of this was that I was able to gather additional data about the presented energy information. However, there was a drawback to this method due to users being unfamiliar with the monitor. Their responses must be considered as an initial reaction. Using screenshots to gain feedback allowed me to relate users' perspectives about energy information to their explanations of why they did or did not engage with the monitor.

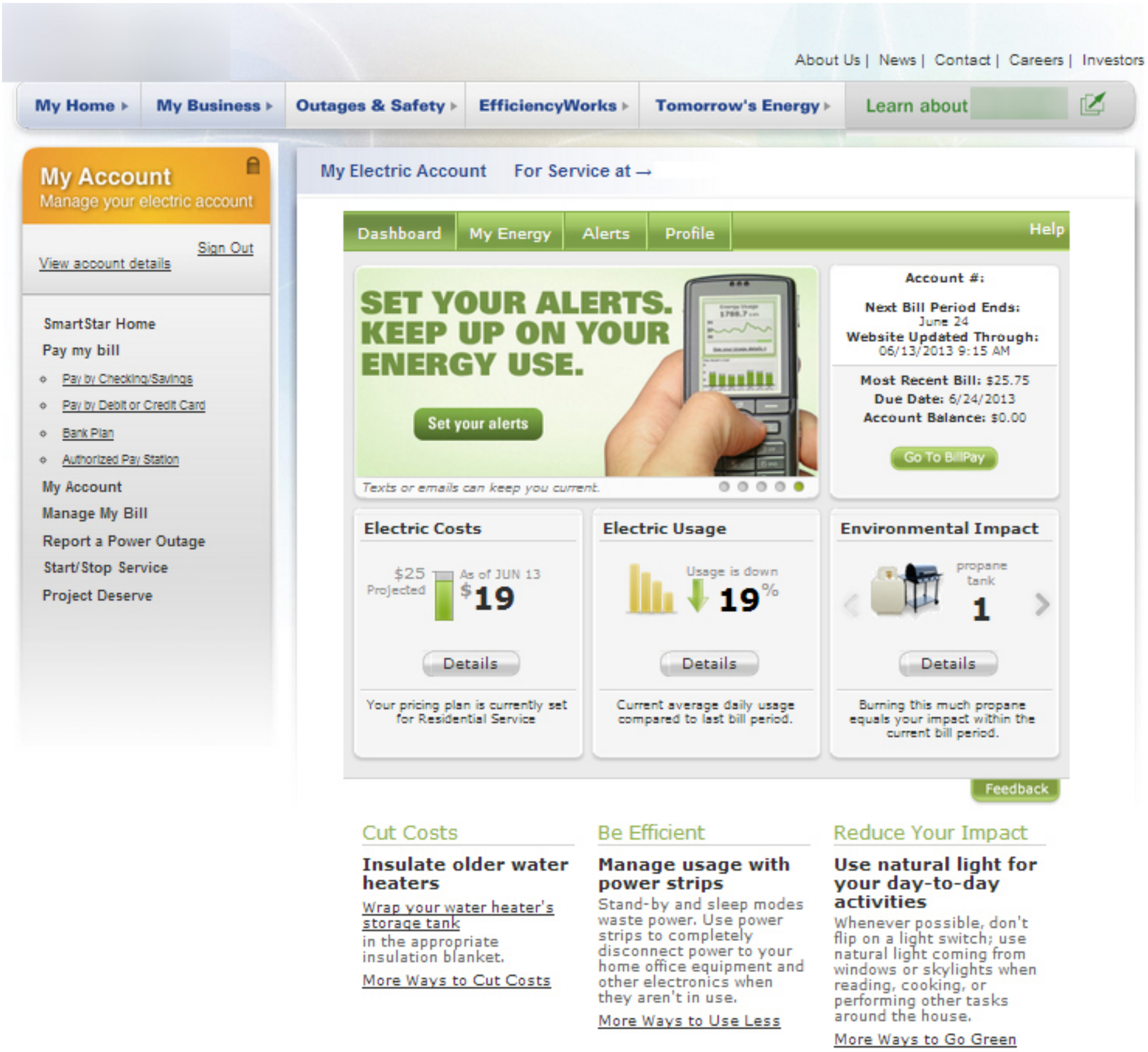


Figure 3.8 Image Reference for Interview Participants

CHAPTER 4.0 FINDINGS AND DISCUSSIONS

4.1 Introduction

The electricity provider for this study's participants serves almost 700,000 residential, commercial, and industrial customers (Anonymous, 2014a). Wind, coal, nuclear, natural gas and landfill gas generation are used by the electricity provider to fuel the creation of more than 27,000,000 mega-watt hours of electricity each year (Anonymous, 2014a). Approximately 250,000 homes are served by the provider and the location of participations is home to the third largest coal powered plant in the state, which uses approximately 5 million gallons of water per day and burns 2 million tons of coal per year (Anonymous, 2014b).

Energy monitors offer a way for customers to reduce their own consumption through informed use and a way for utility providers to address environmental concerns. As part of their 2010 strategic plan, the electricity provider indicated that risk factors, such as public concern of CO2 emissions, changes in market price, and rising costs of construction, made it prudent for them to pursue alternative strategies rather than constructing new plants to meet growing customer demand (Anonymous, 2014c). At the time those alternative strategies included energy conservation and efficiency programs as well as the deployment of smart metering to support efficiency programs, service reliability, customer control, and customer satisfaction (Anonymous, 2010). One of the benefits provided to customers by the utility is an elective program offering installation of a new programmable thermostat which is connected to the smart metering system, allowing the utility to cycle customers air conditions systems on and off during summer peak demand periods (Anonymous, 2010). In addition to the smart metering and thermostat programs, the utility company has also provided business customers with informational videos regarding energy efficiency, and allows them to enroll in building operation certification coursework. Smart metering technology has allowed utilities to have some control over consumption quantities at peak hours, to promote customer based energy efficiency, and to provide the opportunity for customers to become more engaged with their energy consumption information.

4.2 Image Analysis of The Online Energy Monitoring Dashboard

An energy-monitoring dashboard is available to all customers of the electricity provider, offering the ability to view real-time electricity consumption information in a variety of formats. Customers can access the energy-monitoring dashboard online by logging in with their account information. The site navigation is organized into the *dashboard*, *my energy*, *alerts*, and *profile* (see figure4.1). The *dashboard* is the first screen customers encounter upon logging into the tool, and divides the information customers see into three categories: a trigger prompt, an energy consumption data summary, and behavioral suggestions paired to the consumption data. Initial energy consumption data is shown simultaneously as monetary units, a usage percentage, and a changeable environmental impact unit (see table 3). The environmental impact unit represents the quantity of energy used in relationship to either an environmental unit, such as trees, or a unit that would impact the environment, such as a propane tank. Paired with this, behavioral suggestions are given in the same units (see table 3). The use of monetary, comparative (or consumptive), and environmental units is consistent throughout the other pages on the site as well.

The display of the energy monitoring display gives a user the ability to change information visualizations based on time frames and unit categories. While this is a useful feature allowing users to tailor the information to their interests, previous studies have noted that users do not understand units such as kilowatt-hours. There is a *glossary & faq* (see figure 4.2) section that states, "Every wonder what "kWh" stands for?" While this does not mean that a user would not understand a change in kWh units, the addition of this section indicates that kWh is a unit requiring explanation for some users to understand. Monetary and consumption percentage units are more understandable because users are more familiar with them outside the context of energy consumption. While environmental consumption units are provided, these again may not be comprehensible to some customers if they cannot relate them to their contexts.

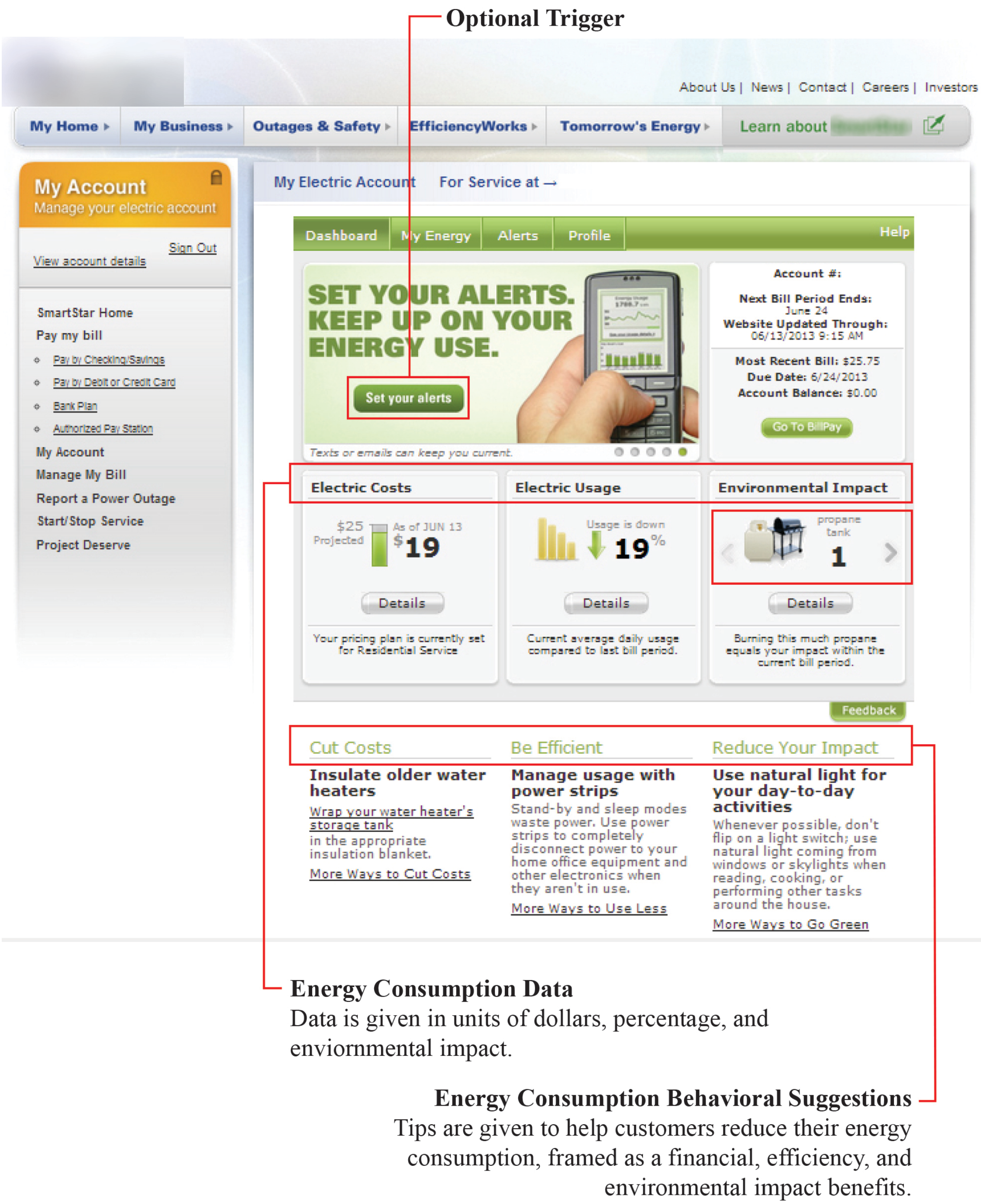


Figure 4.1 Electricity Monitor Dashboard Features

Table 3 Analysis of Energy Monitor Information Options

Monitor Navigation	*Data Given*	*Time Frame*	*Unit Category*	*Units Used*
Dashboard	Consumption	Monthly	Monetary Comparative Environmental	Dollars Change in Percentage Propane Tanks Trees
	Behavioral	N/A	Monetary Comparative Environmental	Costs Efficiency Impact
My Energy	Consumption	1 Year – Daily 1 Bill - Daily 1 Day - Hourly	Monetary Consumption Environmental	Dollars Kilowatt Hours Percentage Pounds of CO2 Propane Tank Trees
Alerts	Trigger	7 Days Billing Cycle User Budget	 Monetary	 Dollars
Profile	Goals	N/A	Monetary Consumption Environmental	Cut Cost Tips Use Less Tips Go Green Tips

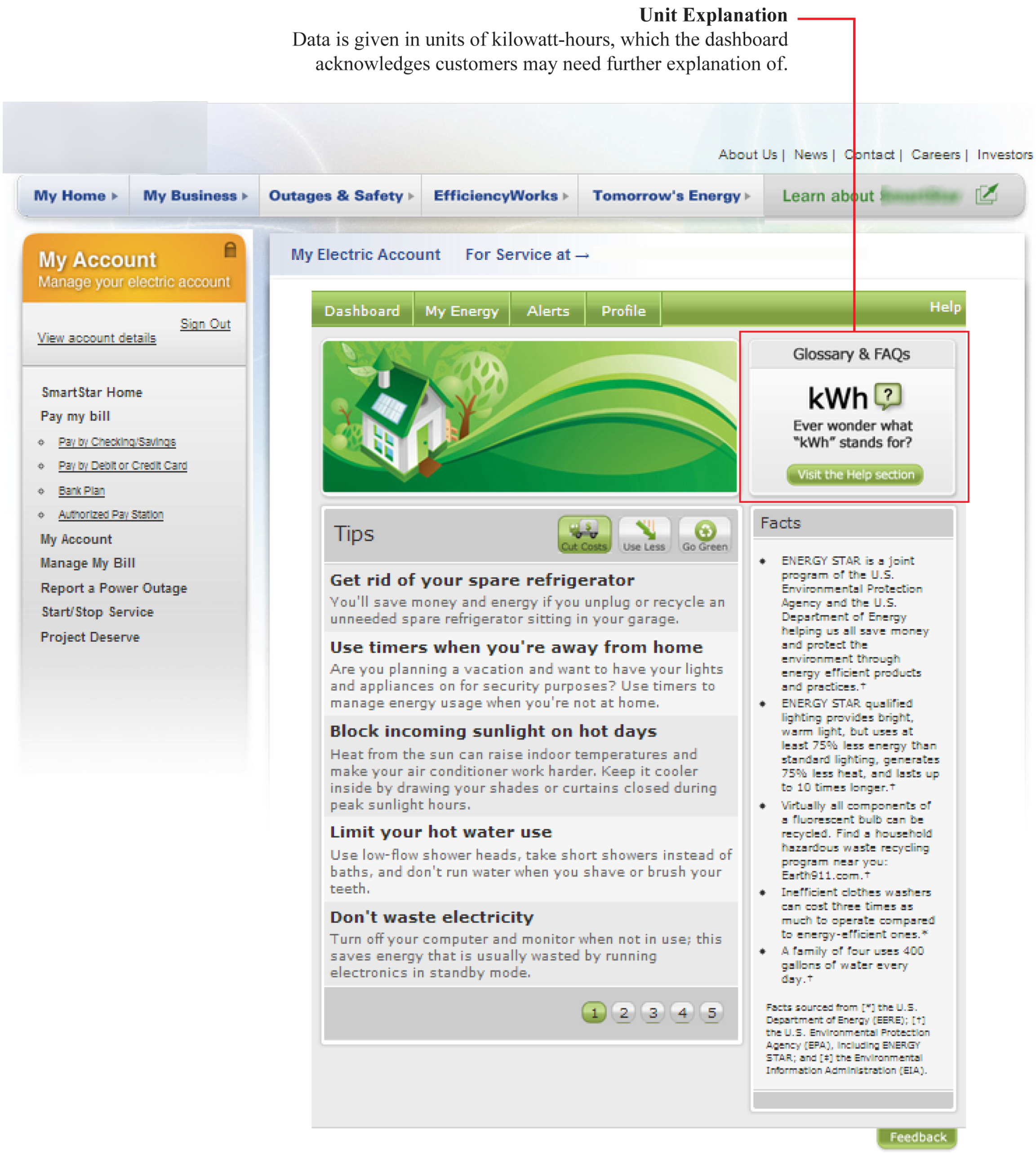


Figure 4.2 Glossary & FAQ

One of the environmental units shown is a propane tank (see figure 4.3), which is not part of the natural environment. One of the reasons that it may be difficult for users to connect their actions with environmental impacts units like this is that they have to relate behaviors to abstract representations. In this example, users would have to relate their actions to the unit of propane tanks, and then relate this to their perspective of what that means to the environment. Such representations makes energy consumption abstract, and connecting a propane tank back to an environmental unit requires almost the same mental leap as connecting a kWh back to the environment. If anything, this unit communicates more about waste versus consumption rather than environmental impact.

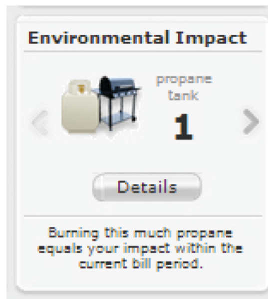


Figure 4.3 Environmental Impact Graphic

One of the main weaknesses of this monitor in comparison to the literature review studies is that there is no social feature offered for users to compare their consumption to others, and thus no opportunity to utilize any social behavioral theories that have been effective features in energy monitoring so far. Without this feature the monitor is mainly relying on the information deficit model, feedback intervention theory, and CAPTology for the monitor to serve as an effective tool for motivating behavioral changes.

A feature that could be a great strength in this monitor is its ability to relate energy consumption back to the users physical context. In the *My Energy* section of the monitor, users have the ability to incorporate weather into their consumption views. Just viewing consumption alone does not explain much more than a bill. It simply tells the user what was used rather than how or why it was used. However, comparing weather patterns with consumption patterns might allow users can make an informed guess about how weather affected their consumption behaviors (see figure 4.4). Additionally the *tips* section also begins to relate consumption back to context by discussing what behaviors might contribute to excessive energy consumption, although it does not relate it to a personalized context but offers general tips.

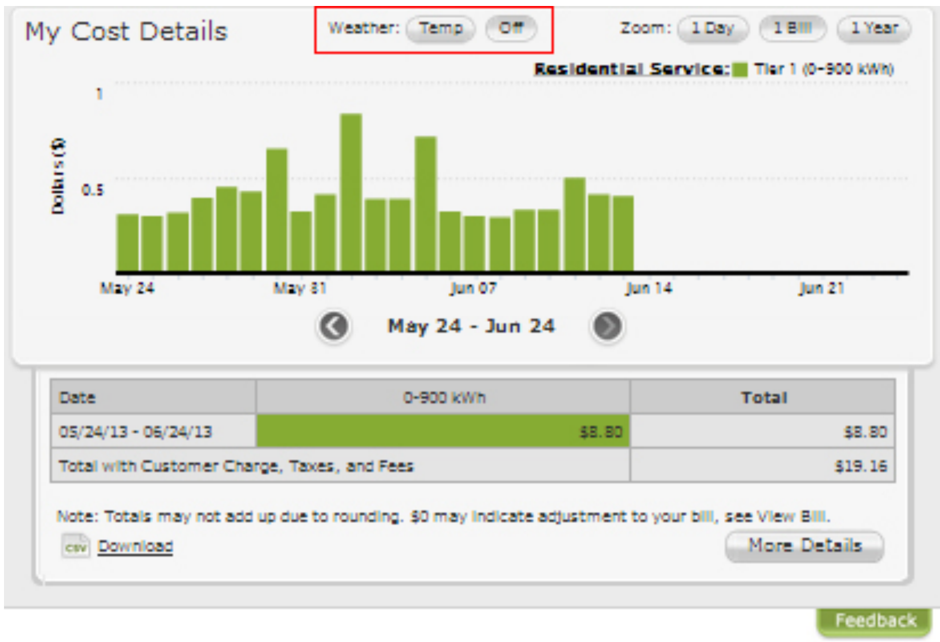
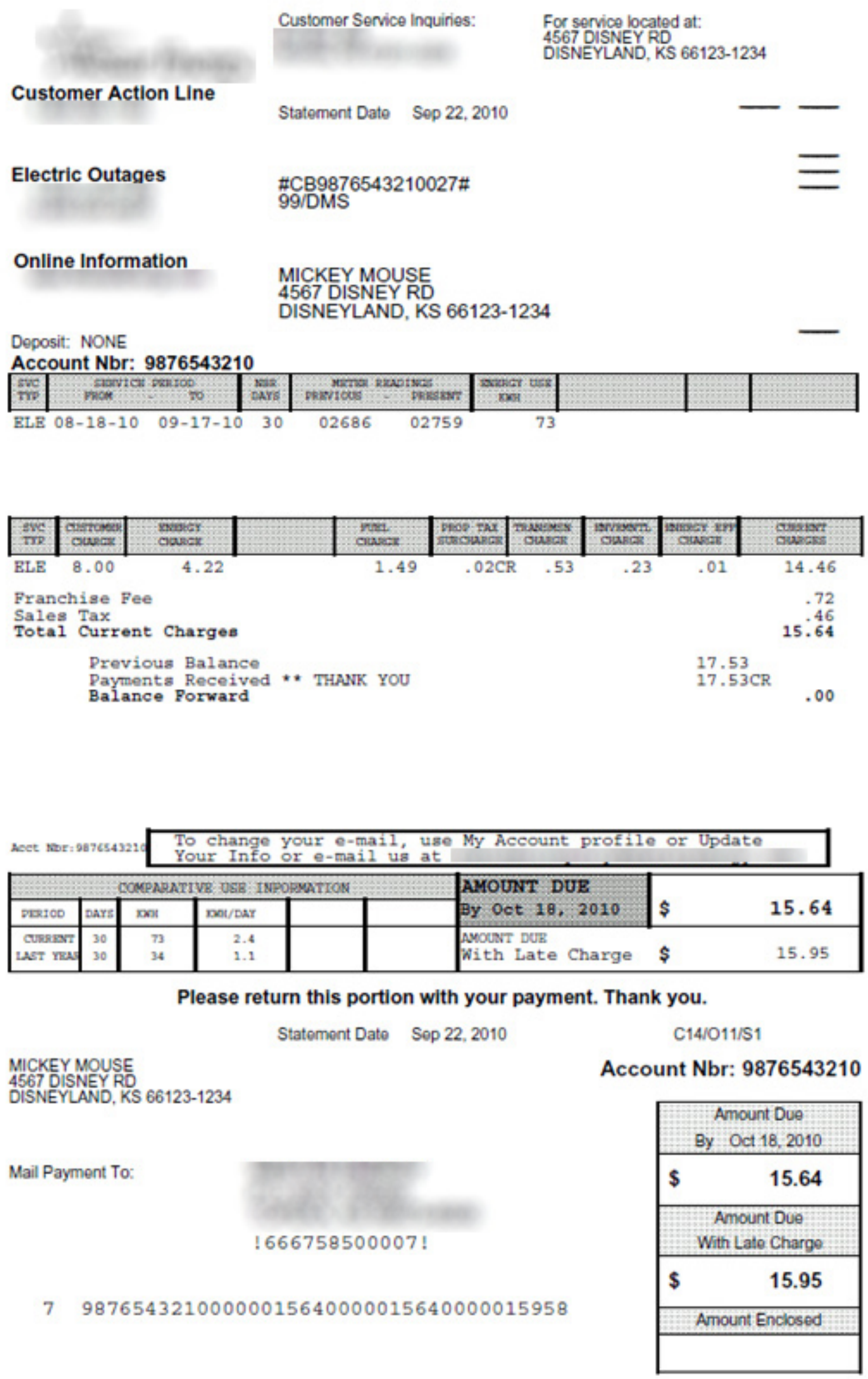


Figure 4.4 Weather Option

In cases where interview participants were the business owner and had access to the monitor, they also had access to the monthly billing statements issued by the electricity provider. In comparison to the monitor, the bill offers much less user-friendly information. The bill lists the utility type, service period, meter readings, kWh, and relevant charges (see figure 4.5). There is no visual breakdown of consumption quantities or relationship between usage quantities and usage time. The most clearly emphasized information on the bill is the monetary payment due.



Customer Action Line

Customer Service Inquiries:

For service located at:
4567 DISNEY RD
DISNEYLAND, KS 66123-1234

Statement Date Sep 22, 2010

Electric Outages

#CB9876543210027#
99/DMS

Online Information

MICKEY MOUSE
4567 DISNEY RD
DISNEYLAND, KS 66123-1234

Deposit: NONE

Account Nbr: 9876543210

SVC TYP	SERVICE PERIOD FROM	TO	NBR DAYS	METER READINGS PREVIOUS	PRESENT	ENERGY USE KWH			
ELE	08-18-10	09-17-10	30	02686	02759	73			

SVC TYP	CUSTOMER CHARGE	ENERGY CHARGE		FUEL CHARGE	PROP TAX SURCHARGE	TRANSMSN CHARGE	ENVRMNTL CHARGE	ENERGY EFF CHARGE	CURRENT CHARGES
ELE	8.00	4.22		1.49	.02CR	.53	.23	.01	14.46

Franchise Fee	.72
Sales Tax	.46
Total Current Charges	**15.64**

Previous Balance	17.53	
Payments Received ** THANK YOU	17.53CR	
Balance Forward		.00

Acct Nbr:9876543210 — To change your e-mail, use My Account profile or Update Your Info or e-mail us at

COMPARATIVE USE INFORMATION						
PERIOD	DAYS	KWH	KWH/DAY			
CURRENT	30	73	2.4			
LAST YEAR	30	34	1.1			

AMOUNT DUE By Oct 18, 2010	**$ 15.64**
AMOUNT DUE With Late Charge	$ 15.95

Please return this portion with your payment. Thank you.

Statement Date Sep 22, 2010 C14/O11/S1

Account Nbr: 9876543210

MICKEY MOUSE
4567 DISNEY RD
DISNEYLAND, KS 66123-1234

Amount Due By Oct 18, 2010
$ 15.64
Amount Due With Late Charge
$ 15.95
Amount Enclosed

Mail Payment To:

!666758500007!

7 98765432100000015640000015640000015958

Figure 4.5 Energy Bill Example

4.3 Interview Text Analysis

Originally, I sought to find if building occupants understood data they were given via energy monitors, if they were motivated by it, and how it impacted their behavior. However, interviews revealed that most occupants were not using the energy monitors to access their data and thus the analysis focus changed to an exploration of how interviewee perspectives related to this lack of use. I have bolded the codes used in the following text so that you may relate my analysis back to preliminary coding.

4.3.1 Coding

Preliminary coding followed two types of categories; behavioral and physical aspects of occupant interactions with energy and energy data. Behavioral aspects included categories such as ***behaviors***, ***motivation***, ***feelings of control***, and ***understanding***. Physical aspects included categories such as ***em-energy monitors***, ***ei-energy information***, and ***lighting*** (see table 4). This preliminary level coding started to reveal more complex relationships present in interview data. Two of the most interesting patterns that I found were based in self-perception and social perception. Several interviewees exhibited self-perceptions or proclaimed interests with a dual-nature, sometimes aspects of self-descriptions conflicted with each other and sometimes interest descriptions were not supported by actions. Although social influence originally encouraged participants to participate in the program, social perceptions within their businesses were also found to override the value of energy knowledge that building occupants had access to, causing them to engage in behaviors they knew were wasteful and ignore the information about this waste.

Table 4 Interview Text Codes and Code Families

Code Family	*Code*	*Code Family*	*Codes*
Awareness Behaviors	Need for Change	*Open*	Appearance vs. Cost
	Changes Made		Assessment Accuracy
	Assessment		Assessment Recommendations
	Class Discussion		Building Typology
	Conservation		Return on Investment
	Current		Taxes
	Goals		Water Conservation
	Sustainable	*Perceptions*	The Future
Feelings of Control	Have It		Self
	Environmental Impact		Saving Money
	Don't Have It		Green Businesses
Energy Communication	With Employees		Future Plans
	With Family		From Program
	With Investors		From Audit
Energy Consumption	Sources		Disinterest
	Equipment		Difficulties
	Business Based		Changes - None
	Building Based		Before
Energy - General	Sources		Alternative Energy
	Consumption		Advanced Awareness
Energy Information	Assessment	*Physical*	Building Material
	Billing		Lighting
	Disaggregation	*Limits*	Building
	Understanding		Business Requirements
Energy Monitor	Confused About Name		Financial
	Doesn’t Know if Using		Ownership - Doesn't Own the Building
	Doesn’t Need To Use It		Ownership - Owns the Building
	Doesn’t Use		Technology
	Home Use	*Responsibility*	Not Mine
	Information Format		Someone Else’s
	Prior Knowledge	*Motivations*	Environmental
	Purpose Speculation		Financial
	Reasons Doesn’t Use		Program Participation
	Usefulness		
	Uses It		

4.3.2 Conflicting Answers

One reason that interview subjects may have given conflicting answers with more data based questions was that they did not want to appear as though they did not know the answers. Interview subjects were questioned about their level of ***understanding*** of assessment and billing energy information. One subject answered, *"I think so, it was pretty clear. I guess I have some of the baseline information so some of it made sense. I mean no, did all these things make sense, no. It was pretty well laid out."* Additionally, they were asked if they knew what the ***fuel sources*** of their energy might be (coal, gas, etc.). Some subjects gave clear answers that they didn't or guessed, but some subjects also gave unclear answers to this such as, *"It's coal. I think I really knew that, but I don't think about that,"* and, *"The business did, I didn't. I think we do a good job of, we use a lot of natural gas and then I don't know, we use a few different things."* This was the simplest form of duality exhibited in answers, which I believe subjects used to talk around the questions and give both answers in a belief that it would make them appear more knowledgeable.

Conflicting answers may have been given due to confusion and participants' desire to appear to know something they did not fully understand. Research into how much Americans actually understand about their energy consumption found that only 38% of participants knew that coal was the number one source of electricity generation in the United States (Southwell et al., 2012). However, despite such a low level of knowledge, a majority (79%) of participants agreed that they could understand energy information(Southwell et al., 2012). My findings seem to support this, showing that participants perceived themselves or someone around them as understanding energy information, but were not necessarily able to give confident answers.

A more complex form of duality arose when subjects expressed their ideas about ***responsibility*** for the effects of energy consumption. Subjects were asked what their biggest limits were to making changes were. Many answers cited ***limits-financial*** as was expected, but an unforeseen limit was ***ownership-doesn't own the building*** and feelings regarding ***responsibility***. Responsibility became a particularly interesting topic because it defined to what degree each subject was willing to contribute personally before they expected another entity to take over the task of sustainability. In other words, their sustainable behaviors had a fixed end point, yet they still adamantly advertised themselves as sustainable. This was most easily noticed by comparing ***responsibility*** to the descriptions of self that participants gave when asked about their ***motivations*** to join the program.

One example of this is the ***motivation*** of "*…being green, being responsible as a business owner for the effects that your business has on the economy, on the ecology, and everything.…*" contrasted with the same subject's idea of ***responsibility*** that "*I think of the energy company itself as being the one who has the impact on the environment…Even in my home I don't think of the electricity that we use or the heat we use is as having an impact on the environment."* So while this participant defined their business as being ecologically responsible they simultaneously held the perception that it was the energy provider rather than him/herself who was responsible for the ecological damages of energy consumption.

Another example compares ***motivation*** as *"I guess I've always been green conscious. Growing up my parents were kind of capitalist hippies, but always very green conscious."* and views of ***responsibility*** as, *"For the most part, what is there is what they get and they need more that is kind of their responsibility. There could be discussions that we would offset part of it if we thought another restaurant could use it in the future, something not all the tenants in the future would benefit from, but for the most part it's like here is the box [referring to an unfinished tenant build out], have fun."* In this case the interview subject was the landlord of this property. So while they considered themselves to be aware of being green, any major changes to a space to increase energy efficiency were seen as the responsibility of a tenant. Changes were something they might consider, but weren't in any rush to invest in themselves despite the fact that this would make their business greener.

While subjects communicated a desire to be aware of their energy usage, they also they also reported that they did not use the information the energy monitors provided to them. The root of what made monitoring information inapplicable to business owners can be found by comparing ***motivations***, ***em-doesn't-doesn't need to,*** and ***limits-business requirements***. Interview subjects were asked if they did or didn't use the free electricity monitors available to them and why, as well as what their biggest limitations were to making changes. Previously, motivations listed by interview subjects to engage in the program centered around ideas of being green, saving money, and learning more about their energy use. ***Motivations*** were described such as *"…it is just wanting to be green, not using more energy than you have to"*, *"to keep those bills as low as I can",* and, *"the opportunity to get a free assessment of what our energy situation was."* Based on these statements; it was assumed that each participant would naturally be interested in viewing their energy consumption breakdowns in the online monitor, but instead the vast majority of interview subjects were unsure of what the monitor was even called and not interested in using it. The one subject who had engaged with it did so only to set up the service.

When asked why they did not engage with the monitor (***em-doesn't-doesn't need to***) answers scratched the surface of what prevented engagement by describing that they did not need to check the monitor or were disinterested in it. Interview subjects explained this as *"Yeah, because I just don't, you know I'm not going to spend time doing that. I just don't."* and as, *"This just doesn't apply to me."* What was fascinating about this was that each interview subject had expressed interest in their energy information, but in the form of the monitor they were not clearly interested in it. This finding supports the idea that users' motivations were not successfully captured by the monitor.

4.3.3 Social Behavioral Influence

I believe that the duality exhibited between motivations and actual actions can be attributed to the social perceptions of energy consuming activities within each business. When asked to describe their limitations to change, many businesses cited that they could not change what their customers expected of them, even though they knew that they were wasteful energy behaviors. One particularly poignant example of a ***limit-business*** follows:

> *"Of course the worst thing that we did, and continue to do, is to keep the door open during the day even when it is in the 90s because it helps to draw traffic in. We still do that, even though at the energy meeting we've been told we shouldn't*

do that. It's hard to stop; we know it's what brings people in. They are more likely to come in an open door than a closed door."

In this example the business owner knows they are wasting energy, they know that they shouldn't be doing this activity, and at another point they even describe their motivations as contributing to building energy loss. However, they have the idea that they need to invite customers inside by opening their doors even when the outdoor conditions are unfavorable. Under this behavior, knowledge of wasteful energy consumption is s useless because such information would not alter their behaviors that were based in established perspectives of social business interaction norms.

Other listed ***limitations-business*** support this same idea through different examples. For instance one subject said, *"The lights are on all the time because it is a restaurant. You don't turn the lights out just because there is no customers in, they will think you are closed."* Others said *"Well, you we can't say to a customer wait a second while I plug this in."* and, *"If I turn my computer off I can't access my computer from home. So I don't turn my computer off."* The need to support a specific business function for a customer became embodied by an energy-consuming activity, which was then viewed as required. It was something that business owners felt absolutely unable to change, and energy monitors were in no way equipped to address this limitation.

CHAPTER 5.0 CONCLUSION

While I was originally frustrated that no businesses were using the monitor, this research has given me hope that there is a way to correct the divide between user perceptions and energy information. I believe understanding the underlying motivations of users could greatly change the way that energy information is presented. While each business desired to be green, what ultimately motivated their actions was a required social norm of customer interaction. To them, customer interactions and business perceptions were most valuable, not the energy consumed. If in the future we could find a way to communicate energy consumption as a valued social good, I believe that would represent the value of behavior change to small businesses.

Energy was not really important to these subjects, but the actions it enabled and the perceptions associated with responsible use were. By taking this into consideration, future research should seek to identify how users define value in relation to their social and architectural contexts. The answers will most likely not be surface level. In this case, it was the dual nature of answers that helped reveal what business owners valued most. By exploring what prevents users from making behavioral change, we can reveal what is most valuable to them. This information could be used to communicate the value of energy efficient behaviors in a way that they can understand, relate to themselves, and relate to their businesses. Given this knowledge we can assess that the typical method of communicating energy consumption through traditional units is not affective because those units do not reflect the activities that generate energy consumption, or communicate how saving energy could socially benefit a business.

Findings from this study support arguments that social sciences have approached pro-environmental behaviors in an unsuccessful way. Flyvbjerg argues that "social science has attempted to emulate natural science in producing universal, invariable and context-independent models and theories of social life" (as cited by Hargreaves, 2012, p. 316). Without considering context, theories seeking to explain social life "fundamentally fail to capture its situated and contextual nature" (Hargreaves, 2012, p. 316). Hargreaves (2012, p. 319) asserts that because of this, research should focus on understanding the how different behavioral factors interact within context, but that this may reveal green behaviors to be impossible within certain contexts. The social context of most business owners in this study made it possible to adopt only certain green behaviors. Some behaviors could never be chosen in the participants' opinion because they worked against their social context.

As we remove ourselves from nature, environment becomes a more abstract concept that pales in importance to the immediacy of human interaction. There is no one idea of "environment," but rather each person's understanding of environment is contextually dependent. This understanding is created, "through its repeated articulation in routine, everyday practices and performances" (Hargreaves, 2012, p. 320). This study reinforced this idea, demonstrating that while each user had an idea of what being "green" meant to them, it varied according to a user's business practices, social contexts, architectural context, financial context, and personal beliefs. In some cases being green meant saving energy, but in others it meant sustaining business growth. While energy monitors assume one fixed meaning they may fail to address what users envision their role in "being green" to mean.

While this research does not offer an immediate solution, it does provide us with the knowledge that traditional approach of providing context independent energy monitoring may continue to have limited success or even work against contextual factors. Given such facts, it seems to indicate that studies focusing on a singular product design may not be representative of the universal effectiveness of such a design, and that those disregarding the influence of users attitudes and context on behavior may not provide widely applicable or accurate information.

5.1 Limitations

A major limitation to this study from a grounded theory perspective is that it should have had a larger sample of participants. Creswell (2007) recommends a grounded theory sample size of 20-30 individuals. This study only consisted of ten individuals and it is therefore unlikely that any theory put forth is broadly applicable to a larger population. The sample selection in this study was also a selective sample, which again would limit the applicability of any theory put forth from the findings.

Another clear limitation to this study was that practically none of the participants were familiar with the electricity monitor. While this offered an opportunity to investigate why users did regularly use the monitor, it also prevented me from collecting feedback about monitor features that I had assumed would constitute a large part of the interviews. Although I used screenshots to gather aesthetic and comprehension opinions from users, these are not really a substitute for feedback from actual use and familiarity with the monitor functions. The fact that users were not engaging with the monitor could be viewed as a limitation, but it is also an important finding because it indicates that any monitor design might not be successful in certain contexts with overriding social constraints.

Part of the verbal agreement which interviewees entered into as program participants was agreement to make one change suggested by the energy audit. In some cases participants had already made changes during the course of this study, but others had yet to make any changes suggested by the assessment. The energy audit report utilized by the electric utility company program is classified as a preliminary energy use analysis by the American Society of Heating and Air Conditioning Engineers (ASHRAE), which is the most basic type of energy audit. Because the assessment was more basic, and geared towards suggestions that would pay back quickly, many suggestions were focused on what can be achieved through behavioral changes, or minimum investment changes. For example, a behavioral change might be turning off the lights. A minimum investment change might be installing more energy efficient lamps.

5.2 Next Steps

Based on the findings from this study, several conclusions should be considered for future studies. While many studies have focused on the success of certain design features, it may be interesting to study how likely users are to engage with a monitor in the first place based on their context. Several contextual factors could affect a user's willingness and interest in engaging with a monitor, and if these factors were better understood then it is possible that there could be steps taken to work around these with the monitor design. For instance, users in this study saw social interactions within their business context as being more valuable than saving money or the environment. If this was known, then it is possible that monitors could communicate the value of environmental benefits as a social benefit since this was seen as more valuable to users.

In the future rather than trying to establish an "efficiency" rating of monitors, it would be beneficial to investigate how a user's context and personality affected their interpretation of value of environmental behaviors. One way to do this would be to focus not on why a user did not value environmental behavior, but to focus on what it was that they did value. If specific demographic, contextual, and attitudinal factors could be correlated with value systems, then it is possible that monitor design could follow a flexible framework that based information communication off of these. This would allow one type of system to tap into the maximum efficiency for each user rather than trying to impose a singular design upon users and expecting similar results.

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APPENDICES

Appendix A: Oral Consent Script

KU RESEARCH & GRADUATE STUDIES
The University of Kansas

Oral Consent Script

As a student in the University of Kansas's Department of Architecture, I am conducting a research project about how energy information from buildings impacts occupant perception. I would like to observe this meeting today and explain my research to obtain your views on the Green Business Leaders program. Your participation is expected to take about 10 minutes. You have no obligation to participate and you may discontinue your involvement at any time.

Your participation should cause no more discomfort than you would experience in your everyday life. Although participation may not benefit you directly, the information obtained from the study will help us gain a better understanding of how to create more effective ways of communicating energy information. Your identifiable information will not be shared unless (a) it is required by law or university policy, or (b) you give written permission.

**It is possible, however, with internet communications, that through intent or accident someone other than the intended recipient may hear your response.*

Participation in the observation indicates your willingness to take part in this study and that you are at least 18 years old. Should you have any questions about this project or your participation in it you may ask me or my faculty supervisor, Jae Chang at the Department Architecture. If you have any questions about your rights as a research participant, you may call the Human Subjects Protection Office at (785) 864-7429 or email irb@ku.edu.

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Appendix B: IRB Approval Form

KU RESEARCH & GRADUATE STUDIES
The University of Kansas

Approved by the Human Subjects Committee University of Kansas, Lawrence Campus (HSCL). Approval expires one year from *May 15, 2013* HSCL # *20869*

Impact of Energy Data Upon Building Occupant Perception and Behaviors

INTRODUCTION

The Department of Architecture at the University of Kansas supports the practice of protection for human subjects participating in research. The following information is provided for you to decide whether you wish to participate in the present study. You may refuse to sign this form and not participate in this study. You should be aware that even if you agree to participate, you are free to withdraw at any time. If you do withdraw from this study, it will not affect your relationship with this unit, the services it may provide to you, or the University of Kansas.

PURPOSE OF THE STUDY

The purpose of this study is to gain information regarding building occupant understanding of the role of energy in buildings and energy feedback information, as well as perceptions and motivations for involvement with the Green Business Leaders program. Being able to compare building occupant perception along with energy usage information will allow a greater understanding of how perception and energy consumption are related, and of what the impact of this information might be.

PROCEDURES

You will be interviewed regarding the information mentioned above for a period of approximately 15-20 minutes. The audio from interview will be digitally recorded and stored in a password-protected database, which only the researcher will have access to. The researcher will personally transcribe the audio recordings and destroy them immediately afterwards. You have the option to not have the interview audio recorded, or to stop recording at any point in time. All data will be made anonymous. You will be asked to share your energy consumption information for a period of six months before and after involvement in the Green Business Leaders program. You will also be asked to share relevant information from your energy assessment issued as part of the program.

You may opt out of one of these options if you are uncomfortable sharing that information, options are listed below. If you choose to do so in the future, you may inform the researcher verbally or in writing.

☐ I agree to be interviewed regarding my experiences with the Green Business Leaders program.
☐ I do NOT agree to be interviewed regarding my experiences with the Green Business Leaders program.

☐ I agree to an audio recording of this interview.
☐ I do NOT agree to an audio recording of this interview.

☐ I agree to share my energy consumption information for a period of one year, starting 6 months prior to the beginning of the Green Business Leaders program.
☐ I do NOT agree to share my energy consumption information for a period of one year, starting 6 months prior to the beginning of the Green Business Leaders program.

☐ I agree to share relevant information from my energy assessment.
☐ I do NOT agree to share relevant information from my energy assessment.

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RISKS

No risks are anticipated for involvement with this program.

BENEFITS

The indirect benefits to society from the information gained in this study could impact your own community. Benefits might be that we gain a greater understanding of the effectiveness of programs such as Green Business Leaders, and also of the energy monitoring system currently available to you. This could allow policy makers and utility companies to assess what needs to be changed to make energy consumption more understandable to the average consumer, and how we can create motivational tools in the future.

PARTICIPANT CONFIDENTIALITY

Your name will not be associated in any publication or presentation with the information collected about you or with the research findings from this study. Instead, the researcher will use a study number or a pseudonym rather than your name. Your identifiable information will not be shared unless (a) it is required by law or university policy, or (b) you give written permission.

Permission granted on this date to use and disclose your information remains in effect indefinitely. By signing this form you give permission for the use and disclosure of your information for purposes of this study at any time in the future.

REFUSAL TO SIGN CONSENT AND AUTHORIZATION

You are not required to sign this Consent and Authorization form and you may refuse to do so without affecting your right to any services you are receiving or may receive from the University of Kansas or to participate in any programs or events of the University of Kansas. However, if you refuse to sign, you cannot participate in this study.

CANCELLING THIS CONSENT AND AUTHORIZATION

You may withdraw your consent to participate in this study at any time. You also have the right to cancel your permission to use and disclose further information collected about you, in writing, at any time, by sending your written request to: *Casey Franklin, 12804 W 124th St., Overland Park, KS 66213*

If you cancel permission to use your information, the researchers will stop collecting additional information about you. However, the research team may use and disclose information that was gathered before they received your cancellation, as described above.

QUESTIONS ABOUT PARTICIPATION

Questions about procedures should be directed to the researcher(s) listed at the end of this consent form.

PARTICIPANT CERTIFICATION:

I have read this Consent and Authorization form. I have had the opportunity to ask, and I have received answers to, any questions I had regarding the study. I understand that if I have any additional questions about my rights as a research participant, I may call (785) 864-7429 or (785) 864-7385, write the Human Subjects Committee Lawrence Campus (HSCL), University of Kansas, 2385 Irving Hill Road, Lawrence, Kansas 66045-7568, or email irb@ku.edu.

I agree to take part in this study as a research participant. By my signature I affirm that I am at least 18 years old and that I have received a copy of this Consent and Authorization form.

_______________________________ _____________________

Type/Print Participant's Name Date

____

Participant's Signature

Researcher Contact Information

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c469f986@ku.edu	785 864 1446

Appendix C: Interview Questions

The following description and interview questions were approved by the University of Kansas' Institutional Review Board.

The focus of these interview questions will be to gain insight into building occupants perceptions of energy usage in buildings, and in the way that this information is communicated to them, as well as their behaviors. Of particular interests are motivations, level of understanding of energy and information communication, and energy behaviors and perceptions throughout the program.

<u>Proposed Questions:</u>

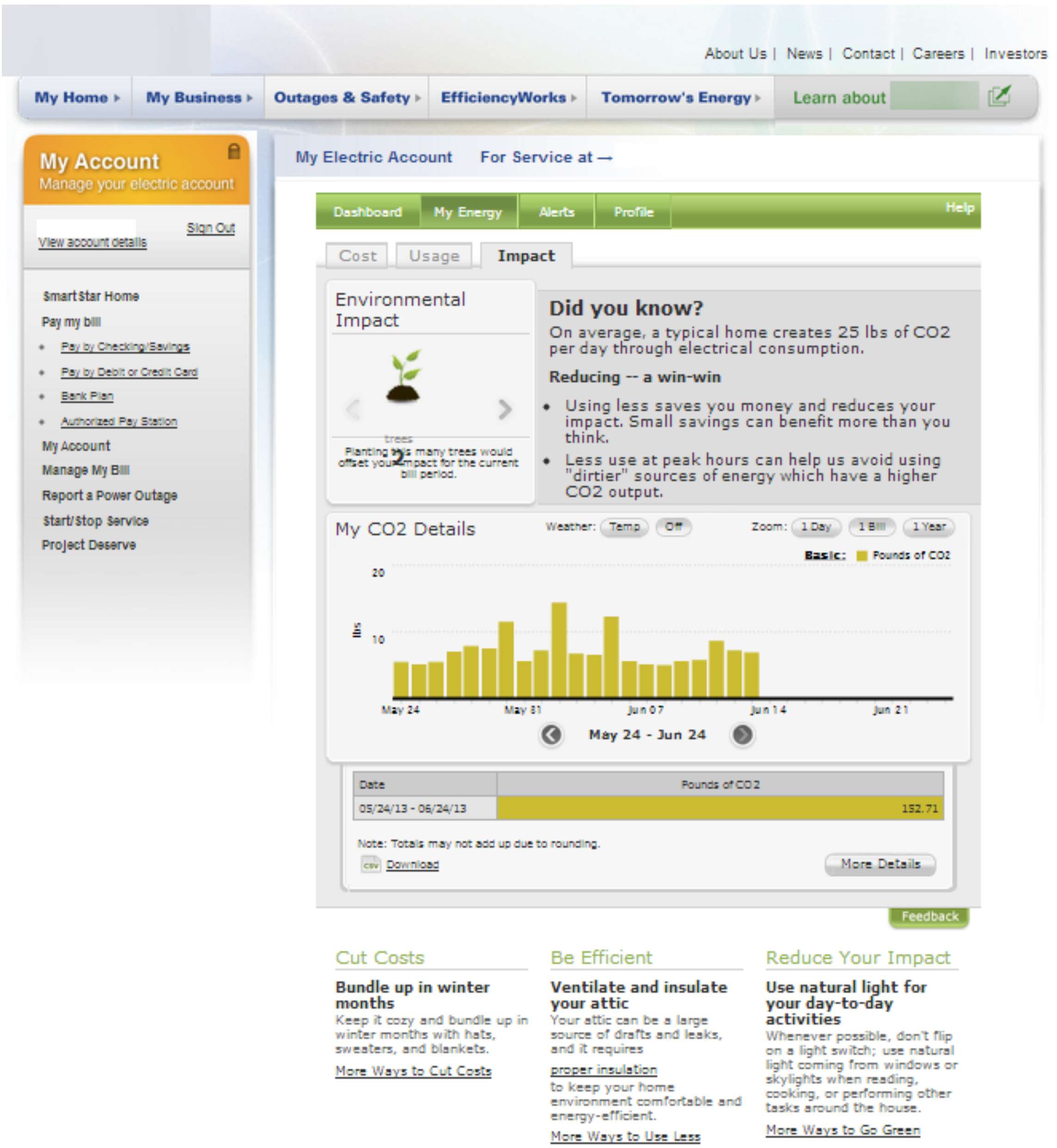
Note: Will ask why/why not with many questions in order to probe for answers with greater depth.

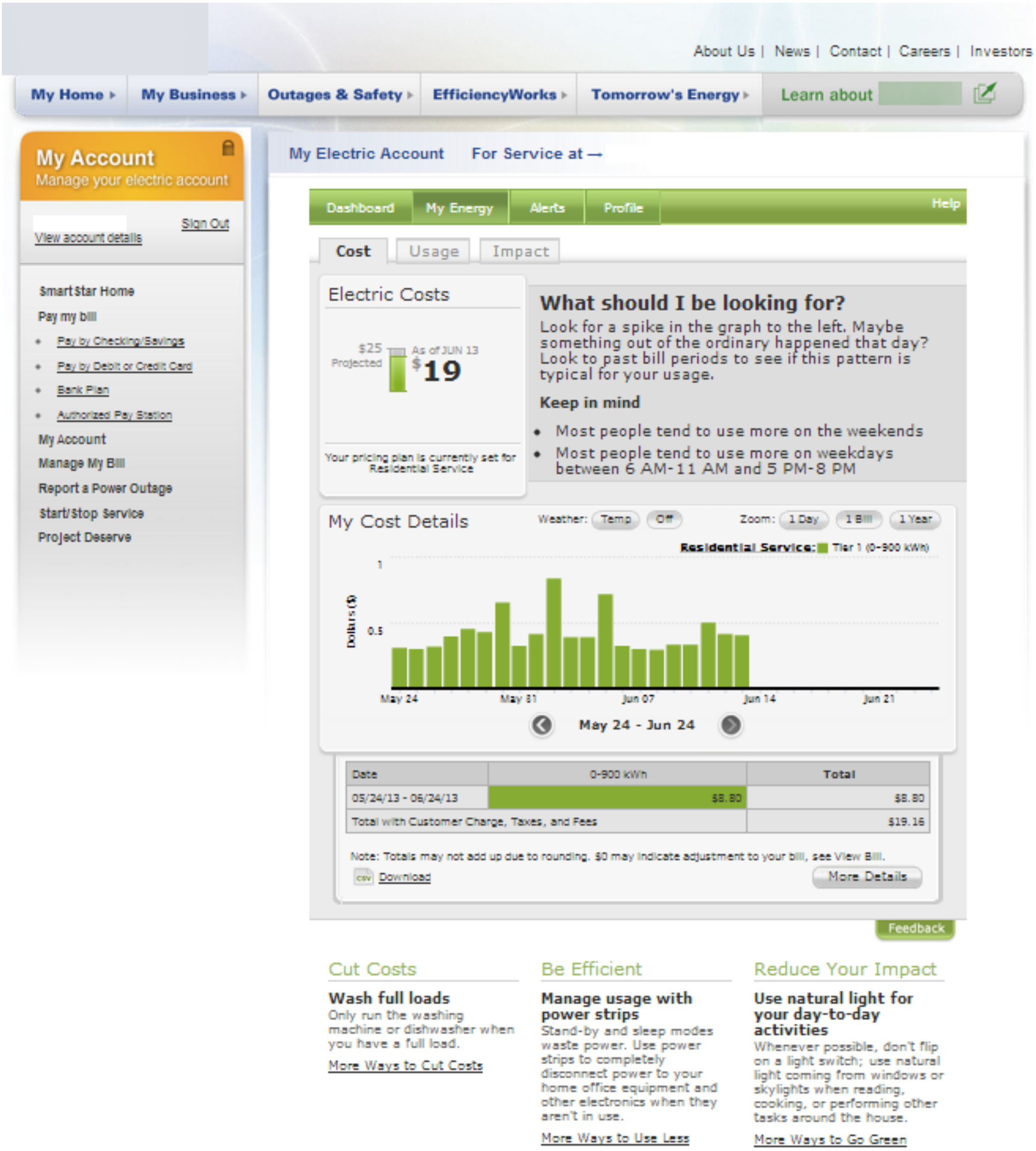
1. What is your business?
2. What is your role?
3. What was your role in the Green Business Leaders Program?
4. What motivated you originally choose to participate in the Green Business Leaders Program?
5. Before the program how did you perceive energy use in your building?
6. How much of your energy consumption did you assume was based on your building (building systems equipment, building construction quality, business operations related equipment), and how much on behaviors (employee or customer)?
7. What do you think gave you that perception?

8. Before the program did you have any energy saving behaviors (preventative - ex: replace lights, or behavioral - turning lights off)? What about your customers or employees?
9. How was information about energy consumption communicated to you before the program (ex. bills, online, through another person)?
10. Did you understand the way that energy use was communicated to you previously?
11. Did you know what the fuel sources of your energy might be?
12. Did you feel like you had control over your energy consumption?
13. How did you perceive the difficulty in making changes that might lower your energy consumption before the program? And afterwards?
14. Did you have any motivation to make changes?
15. After the audit and program how did you perceive energy use in your building?
16. What about the program most changed the way you perceived energy usage in your building?
17. Did you understand the way that energy use was communicated to you through out the program?
18. Which part of the program had the largest impact on your view of energy consumption in your building?
19. Do you plan to make changes, if so what? Why?
20. What was your biggest challenge in making changes? What obstacles did you face?
21. Did you know about the online energy-monitoring dashboard before the program?

22. Had you used it before the program?
23. Do you use it now?
24. How often did you access your energy use information?
25. Who accesses that information?
26. Do you communicate it to employees? If so, how?
27. Then I would like to have them go through the screen shot of the program with me whether they used it or not.
28. Do you understand the way information is presented about your consumption?
29. Do you understand the units used to communicate energy consumption?
30. Did you like the way energy use was presented?
31. What did and didn’t you like about the dashboard?
32. Did this motivate you to change your energy consumption?
33. Overall, do you think the dashboard helped you save energy?
34. What would make it easier for you to save energy?
35. Did you set your own personal goals for energy consumption?
36. How do you think being in a program like this impacted you?
37. What would help you understand the environmental impacts of your energy consumption?

Appendix D: Additional Monitoring Dashboard Screenshots

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Sign Out
View account details
SmartStar Home
Pay my bill
Pay by Checking/Savings
Pay by Debit or Credit Card
Bank Plan
Authorized Pay Station
My Account
Manage My Bill
Report a Power Outage
Start/Stop Service
Project Deserve
My Electric Account
For Service at →
Dashboard
My Energy
Alerts
Profile
Help
Cost
Usage
Impact
Electric Costs
$25 Projected
As of JUN 13
$19
Your pricing plan is currently set for Residential Service
What should I be looking for?
Look for a spike in the graph to the left. Maybe something out of the ordinary happened that day? Look to past bill periods to see if this pattern is typical for your usage.
Keep in mind
Most people tend to use more on the weekends
Most people tend to use more on weekdays between 6 AM-11 AM and 5 PM-8 PM
My Cost Details
Weather: Temp Off
Zoom: 1 Day 1 Bill 1 Year
Residential Service: Tier 1 (0-900 kWh)
Dollars ($)
1
0.5
May 24
May 31
Jun 07
Jun 14
Jun 21
May 24 - Jun 24
Date
0-900 kWh
Total
05/24/13 - 06/24/13
$8.80
$8.80
Total with Customer Charge, Taxes, and Fees
$19.16
Note: Totals may not add up due to rounding. $0 may indicate adjustment to your bill, see View Bill.
Download
More Details
Feedback
Cut Costs
Wash full loads
Only run the washing machine or dishwasher when you have a full load.
More Ways to Cut Costs
Be Efficient
Manage usage with power strips
Stand-by and sleep modes waste power. Use power strips to completely disconnect power to your home office equipment and other electronics when they aren't in use.
More Ways to Use Less
Reduce Your Impact
Use natural light for your day-to-day activities
Whenever possible, don't flip on a light switch; use natural light coming from windows or skylights when reading, cooking, or performing other tasks around the house.
More Ways to Go Green


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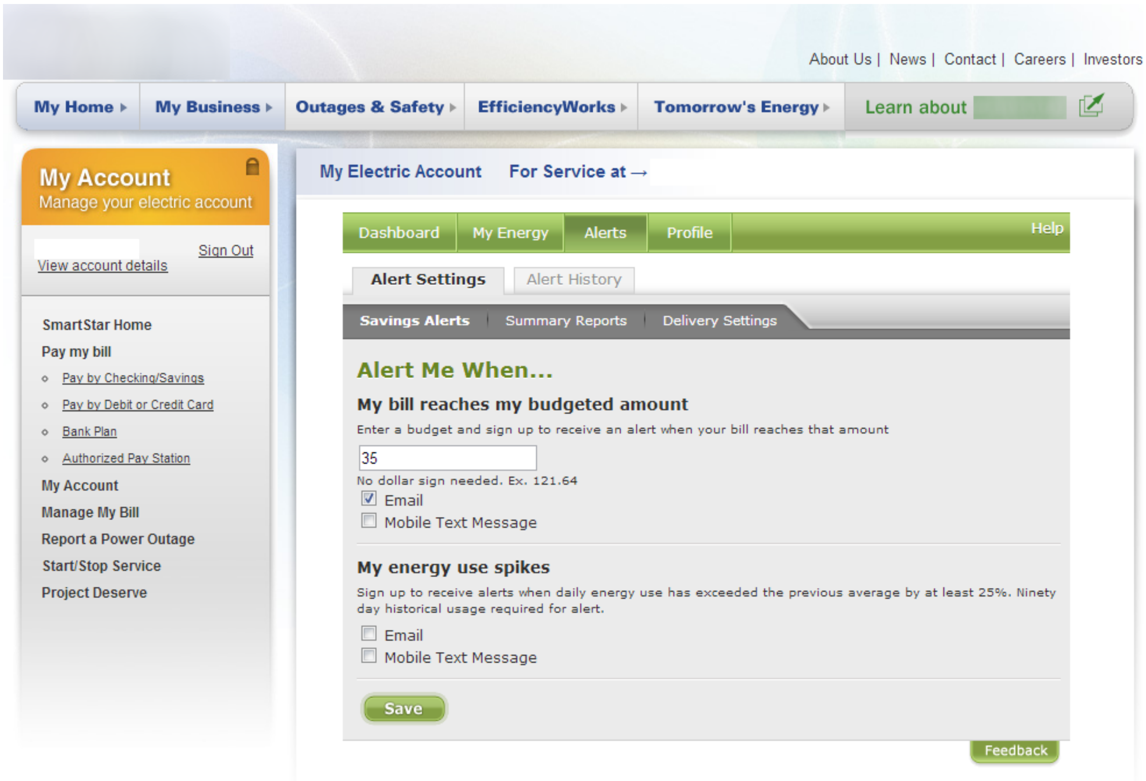
View account details
Sign Out
SmartStar Home
Pay my bill
Pay by Checking/Savings
Pay by Debit or Credit Card
Bank Plan
Authorized Pay Station
My Account
Manage My Bill
Report a Power Outage
Start/Stop Service
Project Deserve
My Electric Account
For Service at —
Dashboard
My Energy
Alerts
Profile
Help
Cost
Usage
Impact
Electric Usage
Usage is down
19 %
Current average daily usage compared to last bill period.
How do appliances use energy?
Nationally, most usage breaks down like this:
Heating and Cooling = 56%
Fridge, Lighting and Electronics = 31%
Water Heating = 13% (if applicable)
My Usage Details
Weather: Temp Off
Zoom: 1 Day 1 Bill 1 Year
Residential Service: Tier 1 (0-900 kWh)
10
5
kWh
May 24
May 31
Jun 07
Jun 14
Jun 21
May 24 - Jun 24
Date
0-900 kWh
Total
05/24/13 - 06/24/13
86.87
86.87
Note: Totals may not add up due to rounding.
Download
More Details
Feedback
Cut Costs
Weatherproof your windows
Re-glaze leaky, broken window panes.
More Ways to Cut Costs
Be Efficient
Ventilate and insulate your attic
Your attic can be a large source of drafts and leaks, and it requires
proper insulation
to keep your home environment comfortable and energy-efficient.
More Ways to Use Less
Reduce Your Impact
Use eco-friendly, carbon-neutral products
Purchase products produced by companies that reduce carbon emissions wherever possible and offset any remaining emissions emitted during the manufacturing and shipping of their product.
More Ways to Go Green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Manage your electric account
Sign Out
View account details
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Pay my bill
Pay by Checking/Savings
Pay by Debit or Credit Card
Bank Plan
Authorized Pay Station
My Account
Manage My Bill
Report a Power Outage
Start/Stop Service
Project Deserve
My Electric Account
For Service at →
Dashboard
My Energy
Alerts
Profile
Help
Alert Settings
Alert History
Savings Alerts
Summary Reports
Delivery Settings
Alert Me When...
My bill reaches my budgeted amount
Enter a budget and sign up to receive an alert when your bill reaches that amount
35
No dollar sign needed. Ex. 121.64
Email
Mobile Text Message
My energy use spikes
Sign up to receive alerts when daily energy use has exceeded the previous average by at least 25%. Ninety day historical usage required for alert.
Email
Mobile Text Message
Save
Feedback