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An Analysis Of Energy Transitions At Different Scales: Fossil Fuel Divestment In Higher Education And Individual Behavior

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AN ANALYSIS OF ENERGY TRANSITIONS AT DIFFERENT SCALES:
FOSSIL FUEL DIVESTMENT IN HIGHER EDUCATION
AND INDIVIDUAL BEHAVIOR

A Dissertation Presented

by

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ABSTRACT

A sociotechnical energy transition requires both a shift to new technologies and attention to social issues like political movements, policy and human behavior. This dissertation investigates social elements of the renewable energy transition occurring at different scales. The core research questions are: How are universities creating and responding to the shifting language of fossil fuel investments? How and for whom do behavioral interventions work? And finally, do in-home displays (IHDs) change behaviors and attitudes of millennial energy users?

The three studies covered here occurred within higher education and reflect the importance of colleges and universities as dynamic players in energy transitions. These spaces encourage learning and organizational change on the inside while also pushing outward, challenging social norms. Using a coding approach and text analysis software, this research identifies common frames of language used by colleges and universities who have released formal statements rejecting or adopting divestment policies. This study provides a quantitative assessment of themes and an early overview of this dynamic movement.

The second and third study describe the outcomes of a behavioral energy experiment with off-campus students at the University of Vermont testing real-time feedback and financial incentives on individual’s behavior. The second study analyzes the results of a survey conducted with participants in the experiment, investigating changes in attitudes and self-reported behaviors and correlations with actual energy usage. Applying Wilcoxon-signed rank tests and a repeated measures marginal model, showed a minimal effect from the behavioral interventions in survey responses. The results also raise questions about surveys as a reliable predictor for behavior-based outcomes. In the third study, interview data from participants sheds light on questions of how and for whom behavioral interventions work. A within-households split-incentive is discovered, describing one factor contributing to the limited effect of in-home displays on household energy usage. Other factors affecting household energy use are also discussed. This dissertation concludes with recommendations for utilities and policy makers.
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CHAPTER 1: INTRODUCTION

We see climate change impacts everywhere, threatening the stability of Earth’s systems. Among the many effects of a warming global climate, recent and alarming research finds that in the last decade, the melting of the Antarctic ice sheet has tripled, increasing concerns about sea level rise and related consequences (Shepherd et al., 2018). These impacts are due to rapidly increasing greenhouse gas emissions in the atmosphere, caused largely by the burning of fossil fuels for energy (Galford et al., 2014; “IPCC Fifth Assessment Report,” 2014; Shepherd et al., 2018). Renewable energy technologies to reduce fossil fuel use can contribute to greenhouse gas reductions, but to achieve the level of reductions required, significant change is needed at multiple scales (Meadowcroft, 2011; Pacala & Socolow, 2004). Research indicates that the technology exists for wide-scale renewable energy implementation (Jacobson et al., 2013), but individual behavior change is necessary to achieve the level of reductions needed and a shift in political power is a necessary condition for change (Bodenheimer, 2018; Burke & Stephens, 2017; Meadowcroft, 2011). Rather than a technological problem, a renewable energy transition is inherently a social challenge.

Behavioral science has been applied widely but sporadically to environmental challenges and is a promising area for research and policy development (Byerly et al., 2018; Thaler & Sunstein, 2009). In the area of energy and human behavior, research has found that individual households have the potential to reduce up to 20% of their overall emissions over 10 years with behavioral adjustments inside the home and “little or no reduction in household well-being” (Dietz, Gardner, Gilligan, Stern, & Vandenbergh,
2009). Extending the impact of individual decisions to societal change, Bodenheimer connects individual behavior directly to sustainability transitions in a new white paper with a “behavioral model of sustainability transitions” (Bodenheimer, 2018). This paper combines individual behavior change and the Multi-level perspective to build a broad model of change for sustainability, addressing both the role of individual decisions and the influence of system-wide factors like global modes of production policies.

Universities and colleges grapple with the challenges of individual behavioral change through education and the role of higher education in influencing policy and supporting activism. For this reason, these institutions are important and dynamic players in energy transitions that push learning and organizational change on the inside while also looking outward and challenging social norms (Stephens, Hernandez, Roman, Graham, & Scholz, 2008). This is especially true in the fossil fuel divestment movement, a vigorous and resilient activist effort both pushing universities to modify standard operating procedures related to investments (Stephens, Palchak, & Reese, 2017) and fundamentally changing the influence of fossil fuel companies (Ansar, Caldecott, & Tilbury, 2013).

Social science offers an essential lens and important contributions to effecting energy transitions (Sovacool, 2014). The “energy transition” refers to shifting from a fossil fuel-based system to one driven by renewable energy technology. Much of the scholarship in this area has focused historically on the technological aspects of a transition (Araujo, 2014; Stern, 2017). However, researchers have more recently
emphasized the role of individual actors, social movements and communities (Miller, Iles, & Jones, 2013).

The overarching aim of this dissertation explores energy system change at two different scales in university settings. Universities and colleges are dynamic spaces in society, generating knowledge and empowering students with information and tools to question norms. The millennial generation, in particular, is the first generation to “grow up” with climate change (Accenture, 2016). This experience is clear in the fossil fuel divestment movement, begun by millennial generation students on college campuses. By challenging the status quo of investing in fossil fuels regardless of the social and environmental consequences, students have fundamentally changed the discourse around fossil fuel companies. How are universities creating and responding to the shifting language of fossil fuel investments? Chapter three, which is the first study in this dissertation, examines this language through an analysis of statements from universities. An examination of formal statements from universities and colleges highlights clear patterns of language used repeatedly to defend decisions to divest or not. The following two studies test the effect of behavioral interventions on energy conservation and specifically capture changes in the “energy culture” of the home, shedding light on how and for whom behavioral interventions are effective at changing energy use behavior. The participants in these studies are university students who are off-campus renters and millennials, highlighting unique characteristics of the millennial generation. Millennials are as likely to rent homes as to own them and are often characterized by a facility with
digital devices (SECC, 2017). In these studies, individual responses to real-time feedback delivered via in-home displays are measured and characterized.

Studies two and three answer two key research questions: How and for whom do behavioral interventions work? Do IHDs change behaviors and attitudes of millennial energy users? The collection of survey data gathered using an online platform and qualitative data gathered through interviews, sheds light on the effects of real-time feedback and specifically, in-home display technology. This work will be useful by contributing to knowledge of behavioral strategies for reducing energy use, addressing gaps in academic research, and is also for utilities implementing behavioral strategies. In addition, insights from behavioral research supports policy makers investigating behavior-based energy efficiency. For instance, the effect of information disclosed to consumers on their energy usage, depends critically on how this information is communicated (Allcott & Mullainathan, 2010).

Energy transitions literature offers a broad architecture in which to situate two different phenomena pressuring the fossil fuel system in different ways. The role of universities is the connecting thread that gave rise to the divestment movement and enabled the energy behavior research on millennial energy consumers. This energy culture, with similar knowledge, attitudes and behaviors, is unique in its relationship to a fossil fuel based energy system, and is demanding a cleaner energy future. This dissertation highlights the ways this pressure is evolving both at an organizational level, as students pressure institutions, and at the individual level in response to behavioral interventions.
CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

A renewable energy transition necessitates both technological and social change at multiple scales (Araujo, 2014; Berkhout, Marcotullio, & Hanaoka, 2012). Energy transitions are one element of sustainability transitions, which is an emerging field of research originating in Europe, investigating the multidimensional nature of shifting systems towards more sustainable modes of production (Farla, Markard, Raven, & Coenen, 2012; Markard, Raven, & Truffer, 2012). Most of the research in this area has focused predominantly on the technological aspects of a transition, but socio-technical transitions like the one necessary for a renewable energy transition, are defined by a broad shift in systems over long time horizons, emphasizing the role of actors, social movements and communities (Kern & Smith, 2008). This field of change research integrates systems framing and includes the multi-level perspective, refined most recently by Geels (Geels, 2010) to capture the complexity of energy system change. Several strains of work related to socio-technical transitions have informed this dissertation and are covered in this literature review.

The literature on energy cultures explores the factors that might contribute to individuals' ability to change behavior and effectively expands the focus of energy behavior research to explore the contexts of these changes like attitudes and physical elements like the size of a home (Barton et al., 2013; Stephenson et al., 2010). This framework is operationalized with the inclusion of survey data and qualitative data to
supplement energy use data and is being applied by utilities\textsuperscript{1} to expand an understanding of customers with the goal of increasing conservation behaviors (Karlin, Ford, & Frantz, 2015). Research on real-time feedback, social norms and financial incentives are also highlighted.

The role of the university in transitions is also highlighted, as an example of an institution facilitating the development of “niche” level innovations, defined by the Multi-level perspective (MLP). The MLP is a theory of change that highlights the importance of small-scale developments that gain strength through numbers or power, scaling up to support a broader transition. It’s a useful conceptual framing, and when combined with other concepts can contextualize energy transitions. Specifically, literature in this area emphasizes the importance of communities and individual actors (Dóci, Vasileiadou, & Petersen, 2015), as in the fossil fuel divestment movement. Similarly, millennial generation students are responding to technological innovations designed for households, like real-time feedback devices, with implications for utilities and policy makers.

\textbf{2.2 Energy Cultures}

Energy cultures is a framework that expands the conventional view of energy decisions to include a systems perspective that integrates the physical contexts of decisions and cognitive limitations of individuals (Stephenson, 2018). This conceptualization grounds the theoretical work of energy use behavior change to the practical considerations of appliances in a household, knowledge of energy and mundane

\textsuperscript{1} I have also applied this framework in my work at VEIC to generate insights about our customers.
actions like closing curtains (See Fig. 2.1). Social norms and habits are also of
consideration in capturing the elements of an energy culture (Stephenson et al., 2015).

The earliest references to “cultures of energy” is found in Lutzenhiser’s work in
the early 1990’s (Lutzenhiser, 1992). Here, he calls into question the rational actor model
of *homo economicus* that assumes perfect information and logical decision-making by
consumers. In describing a culture of energy, he references Stern’s heavily cited paper
that frames energy use as a psychological problem (Stern, 1992), to be understood from
the perspective of the user, not solely from a technological perspective. Lutzenhiser goes
on to discuss the opportunity for social science in uncovering how individuals think about
energy use. Here, he nods to anthropology and sociology as streams of literature that
offer insights to energy behavior questions. “Do group characteristics and dynamics have
anything to do with energy-use? Do the social sciences have any unique insights to offer
to energy and behavior research? The answer is ‘yes’…” (Lutzenhiser, 1992, p. 52).

From this early introduction to energy cultures as a way to understand household
energy use decisions, little exists in the literature until Janet Stephenson’s first paper on
energy cultures, published in 2010 (Stephenson et al., 2010). A separate collection of
ethnographies was published in 2016, titled *Cultures of Energy: Power Practices and
Technology*, highlighting various societal interpretations of energy across the globe
through storytelling (Strauss, Rupp, & Love, 2013). The lives of fossil fuel energy
workers in Wyoming are explored, as is the politics of energy at the Mexico-U.S. border
and electrification issues in Tanzania, highlighting the differences among energy issues in
various cultures and locations.
Originally designed to inform policy decisions, this body of energy cultures research has gained global attention in the last seven years, for its ability to capture a broad picture of energy use that extends beyond a technological focus. An ‘energy cultures’ framing supports collaboration between interdisciplinary teams of scholars, including physicists, economists and anthropologists (Barton et al., 2013; Lawson & Williams, 2012; Stephenson et al., 2015, 2010).

The ‘Energy Cultures’ literature has moved from studying household energy use to transportation (Stephenson, Hopkins, & Doering, 2014), broad mobility issues and also water issues (Stephenson, 2018). This framework presents multiple components contributing to energy use, including demographics, social norms, habits and variation in living structures and appliances that influence outcomes.

![Energy Cultures framework from Scott et al., 2016.](image)

Figure 2.1: Energy Cultures framework from Scott et al., 2016.
The premise is that various “cultures” exist related to three discreet factors: think (cognitive norms), have (materials like infrastructure and appliances), and do (behaviors and actions). Research in this field of study has been used to make policy recommendations at the federal level in New Zealand and this work is increasingly referenced by energy scholars as a useful framework promoting interdisciplinary approaches to understanding energy use (Barton et al., 2013; Karlin, Sanguinetti, et al., 2015; Maréchal & Holzemer, 2015). The ‘Energy Cultures’ framework can also be useful in investigating elements like consumer decisions and behavior that the marketing industry has leveraged for decades to reach particular segments of the population. Identifying niche markets representing various types of customers, is of great interest to the energy efficiency industry as utilities search for answers to “how and for whom” behavioral interventions work (Karlin et al., 2015). These small, less defined markets may have the potential to scale, creating new social norms and broader societal patterns (Dóci et al., 2015). Energy Cultures research is being operationalized by a new stream of work, applying the theoretical “think, have, do” framework to questions and analyses of behavioral interventions in households. Scholars Karlin and Ford, whose research has focused on the impact of real-time feedback in households, have partnered to develop methods of addressing the question; *how and for whom do behavioral interventions work?* (Karlin et al., 2014). This team, in addition to others, is bringing insights from psychology to better inform the development of measurement techniques for describing the impacts of behavioral interventions (Karlin et al., 2015). Karlin and others are currently developing a “toolkit” with the goal of developing a more precise accounting of
changes in households exposed to behavioral interventions. The theoretical basis for this new field has also been described, highlighting practice theory as a form of cultural theory that focuses on the “smallest unit” of measurement possible - in this case, the habits, mental states and knowledge of individuals (Stephenson, 2018). Importantly, this also broadens the frame of energy cultures to “sustainability cultures” for the first time, proposing that a “sustainability cultures” framework can support an understanding of the scale, aspects, actors and structures that are needed for sustainable change to occur.

The focus on the “smallest unit” in the Energy Cultures literature is highly relevant to this dissertation. Individual attitudes and behaviors related to energy use in households, combine and scale to patterns of energy use by millennials. Individuals are also at the heart of the divestment movement at universities, as actors within a social movement.

2.3 Universities as agents for change

2.3.1 Campus sustainability

Universities are dynamic and complex organizations that provide unique and important spaces in society for innovation and change (Buys & Bursnall, 2007; Palchak, Nash, & Galford, 2015; Stephens et al., 2017; Stephens et al., 2008; Thomashow, 2016). Sustainability efforts at colleges have become an increasingly relevant metric for students evaluating schools for post-secondary education and each year the Association for the Advancement of Sustainability in Higher Education (AASHE) publishes sustainability ratings that are also used to inform the Princeton Review’s Guide to Green Colleges (“2017 Guide to 375 Green Colleges,” 2017). Academic institutions are considered
thought leaders within society, addressing urgent social issues (Vorley, 2008) while also acting as businesses and places for learning within communities (Stephens et al., 2017). This is a unique and powerful role with multiple stakeholders and opportunities for influence (Stephens et al., 2008).

Posner and Stuart explore ways for universities to test and evaluate organizational sustainability efforts on campus by applying a systems framework to sustainability challenges (Posner & Stuart, 2013). In applying Donella Meadow’s famous framework on leverage points (Meadows, 2008), Posner and Stuart identify multiple places to intervene within a university system, thereby advancing sustainability. Meadow’s framework is developed from complex systems science and theorizes that in any complex system there are high impact points, which when adjusted or changed, can heavily influence outcomes of the entire system. For example, the authors point to programs like EcoReps2 that increase learning and reinforce behavioral feedback loops and highlight the process of self-organization existing in grassroots movements on campuses that give rise to many forms of activism. This paper also highlights the ability of these organizations to influence research and policy outside of institutional boundaries, for instance in signing the University President’s Climate Commitment and through education. Former Unity College President, Mitch Thomashow’s important contribution synthesizes these concepts even further in a comprehensive book, and he breaks a campus system into nine elements that can be influenced to reduce waste, increase participatory

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2 EcoReps is a program at the University of Vermont and on campuses across the country that highlights the power of the messenger effect, by using peer to peer education (students to students), to encourage responsible behaviors related to waste, energy use, food and transportation.
governance, increase wellness, reduce energy use, teach more effectively and align investments with values (Thomashow, 2016). He argues that creating a model system that tests ideas related to sustainability can be remarkably influential in developing citizens with tools to advance these goals.

Aside from the operational focus on structural sustainability efforts, sustainability education offers a critically important path for developing leaders and thinkers who understand broad challenges to both a healthy environment and society (Svanström, Lozano-García, & Rowe, 2008). Debra Rowe’s work as a speaker, educator and theorist has been influential in advocating for sustainability education requirements and for pioneering energy education in higher education that is rigorous, practical and carries a social justice orientation (Rowe, 2003; Svanström et al., 2008). University-community partnerships have been the catalyst for the first state-level climate assessment in the country (Palchak et al., 2015), the development of an innovation, energy and sustainability institute in Worcester, MA (Stephens, Hernandez, & Boyle, 2009) and climate change adaptation efforts in New Hampshire and Minnesota (Gruber et al., 2017). Universities have a unique opportunity to test ideas, develop research and inform new societal patterns (Thomashow, 2016) and can bring significant positive benefits to both communities and higher education (Buys & Bursnall, 2007).

2.3.2 Fossil fuel divestment

As universities attempt to address climate change and other sustainability challenges, they are also finding new and different societal roles and ways to have an impact (Stephens & Graham, 2010; Stephens, Hernandez, Roman, Graham, & Scholz,
Considering the social impact of their investment portfolio provides an additional opportunity for universities to have influence and has been called campus sustainability’s “last frontier” (Peterson & Wood, 2015) as sustainability efforts push into new territory in higher education. In addition, scholars have highlighted the “energy justice” implications of the fossil fuel divestment movement, as the divestment discourse shifts the focus “upstream” to the production of fossil fuels and the responsibility of the producers, and away from the end users (Healy & Barry, 2017). The movement has received considerable attention in major media outlets, also indicating a robust conversation outside of academia about the role of universities in addressing climate change (Stephens, Frumhoff, & Yona, 2018). The Guardian has followed the divestment movement closely, covering many major divestment decisions (Carrington, 2015; Goldberg, 2015; Murray, 2016; Tutu, 2014), particularly as divestment decisions increase in Europe (Carrington, 2018). In addition, the New York Times has printed several high profile editorials on the topic and The Economist has included several stories on divestment and the valuation of fossil fuels (“Fight the Power,” 2015; “Unburnable fuel; Energy firms and climate change,” 2013; Fleischer, 2015; Mandery, 2014; Welch, 2014).

Commencing in higher education, the fossil fuel divestment movement can be viewed as a component of the renewable energy transition. The field of energy transitions has emerged from an integration of research on socio-technical transitions and transition management to better understand the global shift from a fossil fuel-based energy system to renewables. This contribution is particularly relevant to the call for broader efforts from the social sciences to more fully understand energy transitions (Araujo, 2014;
Sovacool, 2014). Globally, renewable energy development is increasing rapidly, with investments in solar and wind power at record highs in 2015 (McCrone & Finance, 2015). Alongside growing investments in renewable energy, the fossil fuel divestment movement has been called, “the fastest growing social movement in history” (Ansar, Caldecott, & Tilbury, 2013) and divestment decisions from 985 institutions around the world have influenced the shift of approximately $6.24 trillion away from the fossil fuel industry (Fossil Free, 2018). In 2014, the Rockefeller Brothers Foundation shocked the investment community by taking $860 million out of fossil fuel investments and The Guardian Media Group, publisher of the Guardian newspaper, made headlines by pulling $1 billion away from fossil fuel stocks. The country of Norway declared their sovereign wealth fund would be fossil free following The Guardian’s announcement in 2015 (Carrington, 2015). In June 2018 Ireland became the first country in the world to pass legislation fully divesting from fossil fuels (Sengupta, 2018).

Divestment as a strategy for change is not new. The most famous example is the boycott of South African companies during the 1970s and 80s that some scholars connect to the eventual fall of apartheid (McDonnell & King, 2013; McDonnell, King, & Soule, 2015). Though divestment campaigns rarely affect the immediate market value of targeted (Carrington, 2015) firms, the effect of stigmatization over time can be significant (Ansar et al., 2013; McDonnell & King, 2013; Siew Hong Teoh, Ivo Welch, & C. Paul Wazzan, 1999). In addition, a new line of research finds very short-term impacts on stock prices of fossil fuel companies, directly following divestment announcements from universities (Weber, Dordi, & Saravade, 2017). Campus divestment campaigns in
particular, have created the impetus for major initiatives within higher education, including the development of new investing strategies and new investments in renewable energy (Finnegan, 2016; Hirji, 2016).

Despite growing activity and awareness of fossil fuel divestment throughout the world, this field of research is just emerging. While campus divestment has been largely led by students, recent research on the role of university faculty in the divestment movement demonstrates that faculty have been more active and supportive than is generally perceived (Stephens, Frumhoff, & Yona, 2018). Other research is calling for the inclusion of an energy democracy lens on the divestment movement to increase the politicization of this effort and draw attention to the inherent injustices of a fossil fuel regime (Healy & Barry, 2017). The most comprehensive overview of divestment decisions to date examines arguments to support divestment decisions, focusing on Pitzer College’s path to divestment from the author’s unique perspective as a student activist at Pitzer. Grady-Benson’s work covers divestment movement victories to February 2014 (Grady-Benson & Sarathy, 2015). Alex Lenferna is developing a book on divestment and published a related paper on the ethical and economic elements of the movement, and builds a case in favor of fossil fuel divestment (Lenferna, 2013). Cleveland and Reibstein offer a guidebook to the goal of divestment for universities, and methodically catalogue the arguments against divestment (Cleveland & Reibstein, 2015). There has also been an effort to map the divestment movement (“Map: Tracking Academia’s Fossil Fuel Divestment,” 2015). Other scholars have focused on the impact of divestment movements in various historical campaigns (McDonnell & King, 2013; McDonnell et al., 2015;
Welch, 2014). In the literature on social movements, the framing perspective has been studied at depth, in building a more complete picture of how activists communicate issues and mobilize particular movements (Benford & Snow, 2000; Fuller & McCauley, 2016; Snow, Rochford Jr, Worden, & Benford, 1986).

Universities are important institutions in socio-technical transitions like the energy transition and have been the foundation of the fossil fuel divestment movement, now in foundations, businesses, cities and countries. This movement is fundamentally shifting the discourse around fossil fuel energy.

**2.4 Energy use and individual behavior**

Traditional measures of efficacy focus on energy savings, and almost exclusively on kilowatt hours saved. However, this single metric offers no information on who the intervention worked for or why. In an early review of social aspects of energy use, Lutzenhiser quotes “Lee” Schipper, a renowned energy efficiency expert, who states, “those of us who call ourselves energy analysts have made a mistake…we have analyzed energy. We should have analyzed human behavior” (Lutzenhiser, 1993, p. 248).

A 2014 call for more involvement in energy studies from the field of social science has inspired new research (Sovacool, 2014). A meta-analysis conducted by the same author and connected to the launch of a new academic journal titled, “Energy and Social Science”, identified several themes for contributions from the social sciences. “Centering energy discussions back on people – and not necessarily resources, technology or prices – can show us just how much the energy intensity of communities and lifestyles vary…individuals and their choices matter” (Sovacool, 2014, p.11). Calls
for more scholarship from the social sciences have elicited a rapidly growing body of
work investigating the societal elements of a renewable energy transition (Araujo, 2014;
Fri & Savitz, 2014; Geels, 2014; Meadowcroft, 2011; Miller, Iles, & Jones, 2013;
Sovacool, 2014)

Research on behavior and energy use began in the 1970s (Seligman & Darley,
1977; Walker, 1979). Previous to that time, the bulk of research conducted in fields of
energy studies focused on the technical aspects of energy use. Only in the last two
decades has work from the fields of psychology, marketing and economics been applied
to the energy sector to better understand the “human factors” of energy use. The impact
of “energy literacy” was tested extensively in the first studies on consumer behavior and
energy conservation, largely with information campaigns touting the benefits of energy
Experiments investigating the decisions made by residents began in the 1980s with one
initial study testing feedback, incentives and information on energy in university dorms,
concluding that scarce evidence exists for the influence of information campaigns
(Hayes & Cone, 1977). Throughout the 1980s, experimental work began accumulating,
testing the effect of feedback and incentives on household energy use.

As a domain for behavioral interventions, residential energy use is unique. As
scholars have noted, energy is invisible, abstract and measured in kilowatts - units
unfamiliar to many consumers (Buchanan, Russo, & Anderson, 2015; Burgess & Nye,
2008; Hargreaves, Nye, & Burgess, 2010). In addition, the actions that drive energy use
occur inside the home and are hidden from researchers. The impact of energy use is not
immediately obvious to users, making it difficult to connect to habitual, everyday actions. Most of the empirical work in energy use behavior began in the 1980s and has been conducted with various interventions that are referred to as “feedback”. These studies often combine feedback with other interventions for behavior change like financial incentives, norms and goal setting (Buchanan et al., 2015; Burgess & Nye, 2008; Faruqui, Sergici, & Sharif, 2010; Hargreaves et al., 2010; Hayes & Cone, 1977). Utilities have been slower to adopt behavioral programs, but one program in particular stands out. The highly visible and popular OPower program, combines feedback and social norms, and is frequently cited within utilities as the energy behavior program in the program portfolio (Allcott, 2011; Laskey, 2013). This famous program\(^3\) leverages information on neighbors’ energy use to nudge consumers to lower their own use. Other iterations of feedback programs target the energy use of entire buildings, as in a dorm or apartment setting. In-home displays (IHDs) have been heavily tested as tools to increase the salience of feedback by displaying real-time energy use information via digital monitors in the home (Buchanan, Russo, & Anderson, 2015; Karlin, Zinger, & Ford, 2015). The majority of these studies combine this treatment with either social norms or incentives and show mixed results (Abrahamse, Steg, Vlek, & Rothengatter, 2007; Delmas, Fischlein, & Asensio, 2013; Faruqui et al., 2010; Karlin, et al., 2015).

Research on the use of incentives to nudge energy consumption behaviors have also shown mixed results. Jessoe and Rapson found that price signals were effective at reducing energy use only when real-time feedback was also present (Jessoe & Rapson,

\(^3\) In 2016, Opower was acquired by Oracle, a software company.
Using incentives as a behavioral intervention is often complicated by the cost of energy; electricity in particular, is considered low-cost for most consumers, and can create “boomerang effects” in consumers. For instance in one analysis, Jessoe et al. found that consumers reduced electricity use when prices were reduced – the opposite of what might be expected (Jessoe, Rapson, & Smith, 2014).

Clarity on the impact of household level behavioral interventions is muddied by complications related to intra-household dynamics (Hargreaves et al., 2010a; Hargreaves, Nye, & Burgess, 2013; Maréchal, 2009) and actions that can be habitual or occasional (Lavelle, Rau, & Fahy, 2015). As mentioned by several scholars, behavior and energy research centers on terms such as “incentives, feedback, discounting and efficiency”, but energy use happens inside homes through mundane activities such as cooking, doing laundry and showering (Karlin, Zinger, et al., 2015; Maréchal & Holzemer, 2015). Studies emphasizing qualitative work via interviews provide the foundation for the exploration of intra-household dynamics (Hargreaves et al., 2010; Hernández & Phillips, 2015; Nye & Hargreaves, 2010). In the last decade, work from the fields of psychology (Abrahamse, Steg, Vlek, & Rothengatter, 2005; Abrahamse et al., 2007), marketing (Brounen, Kok, & Quigley, 2012) and economics (Allcott, 2011) has been applied to the energy sector to better understand why and how people use energy.

The role of perceived control, sometimes referred to as “attitude” has received significant attention, particularly in various models attempting to capture environmental behavior (Abrahamse et al., 2005; Brandon & Lewis, 1999; Loren Lutzenhiser, 1993; Pothitou, Hanna, & Chalvatzis, 2016). However, the variation in study designs, the
problem of self-selection bias and the short study timelines leave many questions about the efficacy of information feedback and behavioral approaches to energy conservation in general (Buchanan et al., 2015b; Delmas et al., 2013a; Karlin, Zinger, & Ford, 2015b).

2.4.2 Experiments to Inform Efforts to Reduce Energy Consumption

Information feedback and social norms are two areas of energy behavior research that include multitudes of studies and several meta-analyses referred to here, including one that focuses primarily on feedback studies. One of the most cited and largest natural studies ever conducted on behavior and energy is from the OPower program (Allcott, 2011) but does not include an experimental design. Sample sizes found in the literature review vary from a few to tens of thousands of subjects.

Frederiks et al. (Frederiks, Stenner, & Hobman, 2015) review the empirical evidence that consumer behavior deviates from rational economic theory due to certain cognitive biases and suggests interventions in the energy domain. While cost-benefit calculations should reveal materially effective choices, people predictably – yet irrationally – tend to follow certain heuristics. Understanding how to take advantage of these rules of thumb may increase more economical and environmentally benign behaviors. This work highlights that in certain sustainability domains, there has been substantial experimental work done to understand how to leverage insights from behavioral economics to reach environmentally desirable goals. However, the work is not yet complete, and the answers are still not clear. More research is needed to rigorously test the current evidence for broad applicability outside this research. Many of these studies were non-randomized and/or non-experimental studies (thus, more randomized
controlled trials are needed) and lack evidence of cost-effectiveness. Furthermore, there is value in developing a consistent framework to synthesize these behavioral anomalies, evaluate scalable, large-scale interventions, and test short- and long-run changes in behavior that are durable and persistent.

A 2013 meta-analysis (Delmas et al., 2013) captured all energy conservation experiments between 1975 and 2012 utilizing "information" to promote behavior change. This assessment was the first quantitative assessment of its kind, analyzing 156 published trials and 534,479 participants. Overall, this paper found an overall weighted average effect size of 7.4% from information strategies on energy savings. The researchers broke "information" into several categories and tested hypotheses for each category. Energy audits, essentially a “messenger” treatment, demonstrated the highest energy savings with an average reduction of 13.5%. Social comparison, or norms, was the next most effective intervention with a savings of 11.5%. Perhaps the most interesting finding of the analysis was that studies exposing participants to "individual feedback" - or simply education without another mediating effect - showed an increase in energy use. Thus, "information feedback alone may be a necessary but not a sufficient condition to produce conservation" (Delmas, Fischlein, & Asensio, 2013, p. 735). The authors speculate that simply gaining information about how much energy is being used and the financial cost, can create a "moral licensing" effect, particularly because electricity costs in most places are low when compared to other household expenses. The role of these information-based strategies has received significant attention in the literature. Karlin, Zinger & Ford (Karlin, Zinger, et al., 2015b) conducted a meta-analysis of theoretical and empirical
evidence evaluating the influence of information feedback on pro-environmental behavior. This review of 42 experiments showed general evidence of a positive effect but there was significant variation in individual experimental results, leading the authors to conclude that feedback was likely to increase pro-environmental behavior, but depended on moderating variables including frequency, medium, comparison message, duration, and interacting treatments like goal-setting and incentives. More recently, researchers (Lynham, Nitta, Saijo, & Tarui, 2016) attempt to unpack why and how information feedback works by exploring whether a salience effect (constant reminders by feedback) or learning effect (information from feedback changes knowledge) has a stronger influence on energy consumption. Their results indicate that frequent reminders from in-home displays play an insignificant role in changes in energy consumption, but there is a demonstrated learning effect by having feedback, suggesting that keeping energy information top-of-mind is not as important as using information to increase awareness and learning about personal energy consumption.

In one study on the role of incentives (Jessoe & Rapson, 2014) investigated how price signals (an increase in electricity rates for a set amount of time) influence energy consumption, and also evaluate whether real-time information feedback changes the price signal response. Their findings – that price signal responses were significant when real-time feedback was present – suggest that there are limits to how effective financial incentives like electricity rate structures are without adequate information feedback. Other work describes the benefits time-of-use rates (TOU) for electricity customers (Potter, George, & Jimenez, 2014). In randomized controlled trial (RCT) of
approximately 52,000 customers over 2 years, researchers found that 98% of customers given time of use rates by default stayed in the program while 20% of customers given a choice, joined. Considering marketing costs, opt-outs (i.e. default time-of-use customers) were more cost-effective than recruiting volunteers for the program. In a further analysis of this experiment by Cappers et al. (2016), scholars found that customer response varied based on whether they could be segmented as “always-takers”, “complacents”, or “never-takers”.

Vine and Jones (2016) conducted a meta-analysis of twenty energy reduction competitions, reviewing a representative selection of ongoing and completed programs. The authors determine that competitions are an effective approach for changing behavior, resulting in an average electricity savings of 5% and up to 25%. Though competitions are often referred to and thought of as intervention strategies, other behavior-change mechanisms are the actual strategy and most competitions integrate several interventions. Not all competitions involve creating competitiveness between participants, however. In studies testing competition as a behavior-change strategy, "local messenger", and "information" and "norms”, were most often used. Social diffusion was also referenced heavily as an intervention to communicate via social networks about competitions. The competitions surveyed used different designs and metrics, so comparison is difficult. Very few used experimental designs. However, gaps in understanding exist in the duration of behavior change, like many other studies in energy/behavior research. Most programs included in this analysis ran for less than a year and several ran for only a few
months. The authors also call for more rigorous and simplified study designs to better test the discrete effects of each behavioral intervention.

Norms have also been tested in various ways, notably on college campuses, where it is possible to more tightly control demographic differences and housing structure differences by conducting experiments in college dorms. However, norms are almost always combined with another intervention, often information feedback. Delmas and Lessam (2014) found a difference between public and private information for energy conservation with public information that played on social norms and ego (cultivating a green reputation) generating a statistically significant outcome. Private information on energy use that was not shared with peers, did not elicit a statistically significant outcome.

Osbaldiston and Schott (2011) reviewed studies of various interventions and this analysis references Steg and Vlek's 2009 study on informational strategies and structural strategies and also Abrahamse et. al's 2005 study on information. Abrahamse's comprehensive study concluded with similar themes conducted on other meta-analyses related to feedback and information strategies. Generally, information, sometimes referred to as “education” elicits behavior change but is most effective when given frequently. Osbaldiston and Schott’s analysis includes differences between energy use in public places and private homes and finds that experiments testing public-energy use have the largest effect sizes. The largest effect sizes in the category of home energy conservation were in commitments, like a public statement in which a customer makes a
promise to enact a certain behavior to reduce energy in the home. Social modeling, like learning of neighbors’ energy use and financial rewards also showed effect sizes.

While there have been extensive efforts to understand and influence behavioral dimensions of energy use, there is still room to expand and innovate research in this area. Several gaps exist in the literature and are highlighted consistently in studies, including meta-analyses by Abrahamse et al. (Abrahamse et al., 2005) and Karlin et al. (Karlin, Zinger, et al., 2015). These gaps leave remaining questions about the persistence of behavior change over longer periods of time, between-home variation and the need for more studies integrating factorial experimental designs to isolate treatment effects.

Karlin’s work found a large body of evidence supporting the effect of feedback on residential energy use. The variation between homes suggests however, that we understand little about who is most affected by feedback and what kind of feedback is most effective. Further study then, is needed on demographic and psychographic variables related to feedback. In addition, many studies are conducted as if all feedback is the same. But there are many options related to graph layout, units displayed (e.g. kWh, cents per hour) and timing of feedback. Buchanan explores this in-depth in her critiques of IHDs, two key studies for this dissertation (Buchanan, Russo, & Anderson, 2014; Buchanan et al., 2015a). Further, both Abrahamse and Karlin emphasize a limited demonstration in the literature of exactly which interventions caused the behavior change. Few studies utilize a multi-factorial analysis or regression model to isolate and analyze relationships between variables.
The tight coupling of the energy field with industry has led to many industry pilot studies, projects, and natural field experiments that may fail to approach behavior with sufficient academic rigor capable of disentangling different behaviors and drivers relating to energy. When not published in a peer-reviewed journal, this work often ends up published in industry conference proceedings or reports tailored to a program’s funding agency where the emphasis may be on outcome evaluation (e.g. cost-effectiveness or energy reduction) and leaves out discussion of a theoretical behavioral aspect. This complicating factor in energy studies supports the call for more rigor (e.g. more reported statistics, larger sample sizes, evaluation of persistence, and RCTs) and is almost universally included as an opportunity for further research.

2.5 The Multi-level Perspective

In a time of rapid climate change, the shift to a renewable energy system is urgent work. Socio-technical transitions like the energy transition underway now, involving profound societal and infrastructure changes, have occurred throughout history (Sovacool, 2016; Verbong & Geels, 2007). Despite the general notion that energy transitions occur over decades, new research indicates that in some countries, “quick” energy transitions have occurred in less than 15 years (Sovacool, 2016). Investigations of these changes can provide ways to understand societal movement towards sustainability (Araujo, 2014a). The Multi-level perspective (MLP) offers one way to conceptualize how a broad scale socio-technical energy transition might occur from radical innovations and gives researchers a way to think about their work within the context of a global system. The MLP is intended as a dynamic working map of a global energy transition as scholars
attempt to capture and define the multitudes of actors and effects contributing to the development of new socio-technical systems. The field of renewable energy has focused heavily on the technology necessary to generate renewable energy. However, the integration with policies and people is a critical component of gathering a more accurate understanding of how, why and when transitions occur.

The shift from horse-drawn carriages to automobiles is one example of such a transition, occurring over decades, that facilitated profound changes in infrastructure and in society (Geels, 2010). The MLP (Geels, 2010; Geels, 2005, 2014) extends the field of socio-technical transitions to create a more cohesive and reflexive theory of sustainability transitions. As a broad framework for energy transitions, the scope allows for conceptualizations of interacting elements that take shape in the form of levels. (See Fig. 2.2). At the uppermost level of the MLP, “landscape” changes represent shifts in macro-level environments like global policy or major conflicts. The Kyoto Protocol or new climate change guidelines from COP 21 are examples. The meso-level of the MLP represents regimes and is the level at which “lock-in” of a socio-technical system occurs (Genus & Coles, 2008). Regimes act as “rule” setting bodies and refer to the knowledge base, governance structures and social groups that are interacting and interdependent (Rip & Kemp, 1998). Sociotechnical regimes create stability in sociotechnical systems. Examples include the digitization of information, the fossil fuel regime and social media platforms. The micro-level is comprised of niches. Niches represent spaces for innovation protected from market forces that have the ability to generate solutions that can apply upward pressure on the regime level. The social elements of niche development have not
been examined as extensively as technical innovations, like horse-drawn carriages (Geels, 2010) or electricity adoption (Verbong & Geels, 2007), but comprise an essential element. A gap exists in the development of the MLP for better understanding the social factors of niche development, particularly “demand side factors [and] the role of civil society in transitions” (Dóci et al., 2015, p.86). These “niches” are spaces where consumer decisions and behavior, including social movements, create new patterns and norms that have the potential to ultimately affect broader elements in society, sometimes pressuring a “regime” to change (Dóci et al., 2015). Higher education provides such a “niche” space in its ability to protect innovations from market forces.

![Figure 2.2: The Multi-Level Perspective (Geels, 2002).](image)

The multi-level perspective is a theory of change that highlights the importance of niche level innovations supporting a broader transition. This broad view can help connect actions and policies developed at smaller, more limited scales to broader efforts at
change. However, critiques of the MLP underscore the challenge of accurately reflecting the complexity of socio-technical transitions.

Several critiques of the MLP have been covered in the literature. A central problem relates to the use of case studies to illustrate the relevance of the MLP. This approach has been criticized as “unsystematic” and applied haphazardly, to parts of a transition or using parts of the MLP (Genus & Coles, 2008). Similarly, the dates of transitions covered in the MLP literature are difficult to confirm, leading to various start and end points. This is related to the problem of using secondary historical data to illustrate various examples of transitions, without covering the debates around the interpretation of these historical events (Genus & Coles, 2008). Finally, the MLP has also been criticized for an oversight of the politics of transitions and the influence of individual actors (Shove & Walker, 2007). This dissertation, addresses a critique of the MLP with research exploring how individual actors, like millennial students, might collectively influence energy system change. In the first study, the divestment movement can be seen as a “radical innovation” (Genus & Coles, 2008), fundamentally changing the narrative of fossil fuel energy and applying upward pressure to the fossil fuel regime at the meso-level of the MLP. Similarly, in studies two and three the in-home displays can be seen as technical innovation that may be experiencing a failure, a necessary element of some innovations in a socio-technical transition. The complexity of these transitions calls for diverse methods of analysis to investigate the various elements at play.
2.5.1 Methods to study energy consumption

In a broad review of energy behaviors literature and methods, Lopes et al. (Lopes, Antunes, & Martins, 2012) explores the approaches available to understanding energy use. Qualitative approaches have been frequently used to model energy behaviors, sometimes referred to as “frameworks” as in the “Energy Cultures Framework” (Stephenson et al., 2010). In the research on socio-technical energy transitions many theoretical frameworks exist, including most notably, the multi-level perspective (Geels, 2010). The challenge with qualitative frameworks is that they are difficult to ground in experience and difficult to test empirically. One researcher acknowledges this in a white paper referencing the energy cultures framework writing, “while appealing theoretically, the challenge has been to find support for this empirically” (Lawson and Williams, 2012). Quantitative approaches from engineering and economics also attempt to “capture” energy consumption and have proved extremely useful in understanding scale and scope of energy use. It becomes difficult to insert behavioral factors like beliefs and social influence into energy models. Therefore, Lopes (Lopes et al., 2012) highlights “energy behavior modeling” as the most relevant approach to understanding the complexities of individuals energy use. This is a hybrid approach including qualitative and quantitative approaches that can aid in identifying patterns to support increased understanding of energy use. This approach captures both behavior and consumption and creates richer opportunities for testing hypotheses. More recently, Stern makes a bold call for energy data in social science research on energy transitions. He argues that for social science to impact energy transitions, energy use must be part of the assessment (Stern, 2017).
Within this hybrid approach two specific lines of research are identified by Lopes. One approach involves the use of a time-geographic diary to gain insights into participants’ daily patterns and habits related to energy use. This could involve sharing energy use data with participants during a focus group and asking them to loosely define their activities during a typical day. The most rigorous approach would occur during the study itself but would need to be considered seriously for the potential to affect behavior and in some way contaminate the data. Another approach involves mining of historical data to extract information that might show patterns in use.

2.6 Conclusion

This dissertation investigates energy system change at two different scales in university settings. Energy transitions literature offers a broad architecture in which to situate both the fossil fuel divestment movement and individual behavior changes in the households of millennial renters. Fossil fuel divestment is a movement created by many individuals, and is now creating pressure on corporate decision-makers at fossil fuel companies. Individual behavior in households also scales to broader patterns of energy use and by applying the energy cultures framework, this research finds commonalities in millennials’ response to real-time feedback technology.

Three studies comprise this dissertation. The first is an analysis of the fossil fuel divestment movement at universities and covers the language used to defend decisions made by institutions responding to students’ calls for divestment. Studies two and three cover the findings from a university experiment on real-time feedback in off-campus student housing. Study two presents the evidence from a survey investigating changes in
attitudes and self-reported behaviors after exposure to in-home displays and financial incentives. The final discussion chapter offers synthesizing ideas and suggestions for future research.
A social movement to divest from fossil fuels has been growing rapidly in the past five years. Fossil fuel divestment campaigns are emerging in countries around the world and are particularly visible on college and university campuses. Beyond higher education, several foundations, companies, public entities, pension funds, and many individuals are also divesting from fossil fuels through fossil-fuel-free investment portfolios. As pressure to divest increases, higher education organizations are responding in different ways. This paper reviews this dynamic movement through analysis of the justifications of colleges and universities that have made public statements regarding divestment. This analysis of the framing and discourse used to defend divestment decisions among both organizations that are committed to divestment as well as organizations that are not committing to divestment, reveals dynamic communication strategies and evolving institutional priorities as the fossil fuel divestment movement expands and the transition to more renewable-based energy systems accelerates. The divestment movement is shifting cultural assumptions regarding fossil fuel reliance and highlighting the potential for intentional consideration of broad social impact of investment decisions.

3.1 Introduction

The fossil fuel divestment movement has been developing throughout the past decade, with particularly rapid growth since 2012 (Grady-Benson & Sarathy, 2015; Lenferna, 2013). Within this dynamic social movement, higher education, foundations,
private companies, public entities, pension funds, and many individuals are making decisions to move investments out of companies based upon fossil fuel extraction and production. Fossil fuel divestment campaigns are emerging in countries around the world and are particularly visible on college and university campuses. As of April 2018, divestment campaigns are active at over 450 campuses while over 95 colleges and universities have committed to some form of fossil fuel divestment. While 70 are committed to full fossil fuel divestment, others are divesting from coal or both coal and oil tar sands. By linking investments in fossil fuel companies to global climate change, activists have created urgency and momentum, and contributed to a growing stigmatization of the industry, especially within higher education.

Major events in the fossil fuel industry demonstrate that the landscape for fossil fuel investments is shifting. In June 2018, the country of Ireland became the first to divest from fossil fuels. In 2017, following a five-year campaign by students and faculty, Harvard Management Company announced it would “pause” some investments in fossil fuels and in February 2018, Harvard announced a plan to move the campus operations away from fossil fuel use (“Harvard makes climate pledge to end fossil fuel use,” 2018). Following this statement a member of the Board of Overseers publicly called for full divestment (“Harvard Board Member Calls for Endowment to Divest Fossil Fuels,” 2018). At the International Climate Talks in Paris in November 2015, fossil fuel divestment gained attention as activists from around the world staged protests in Paris during the climate negotiations. In the weeks preceding the Paris Climate Change Talks, French economist Thomas Piketty publicly called on investors to divest from fossil fuels
and the organization 350.org reports commitments totaling $6.2 trillion in divested assets (“Commitments,” 2018). The movement began in higher education, now reaching state pension funds, municipalities and philanthropic organizations. California’s large $291 billion state pension fund, CalPERS divested from coal in October 2015 (Kozlowski, 2015). New York City announced full divestment of the pension funds in January 2018, pledging to sue fossil fuel companies for obfuscating scientific information on climate change (“New York sues fossil fuel majors, plans divestment from pension funds,” 2018) and Portland, Oregon and Providence, Rhode Island have also committed to divestment (350.org, 2016). The Rockefeller Family Fund divested from fossil fuels after a related family charity, The Rockefeller Brothers Fund, divested in 2014 (Wade & Driver, 2016). The economic rationale for fossil fuel divestment is strengthening, particularly in the wake of the Paris climate change talks. The theory of stranded assets asserts that with increasing regulations related to carbon emissions, some fossil fuels will lose value or become a liability before their value matures (Ansar et al., 2013; Initiative, 2011; Paun, Knight, & Chan, 2015). A small, forthcoming whitepaper found a small, statistically significant effect on fossil fuel stocks during the ten days following a major divestment decision, before the stocks rebounded (Dordi, 2016). Though short-lived, this potential dip in stock prices is notable. The launch of an investigation in 2015 into Exxon Mobil’s mishandling of climate change data and the subsequent litigation efforts by New York City, represents another shift in the financial and political power of the fossil fuel industry (Gillis & Krauss, 2015; Ramey & Gay, 2018). The potential for stranded assets in fossil fuel companies, a disruption in
the legitimacy and stability of fossil fuel corporations and a growing divestment movement, is changing the discourse on fossil fuel energy and contributing to a different public perception of fossil fuels. The fossil fuel divestment movement is an example of social change within the renewable energy transition. As a global movement, fossil fuel divestment can be viewed as a strategic component of a shift toward more efficient renewable-based infrastructures and institutions. For the first time in history, the reputation of the fossil fuel industry is under attack. Though it’s difficult to connect reputational effects with the financial value of these corporations, the divestment movement marks a broad shift in the narrative around fossil fuel energy use.

With climate change and other sustainability challenges, universities are finding new and different societal roles and ways to have an impact (Stephens & Graham, 2010; Stephens et al., 2017). Campus divestment campaigns in particular, have created the impetus for major initiatives within higher education, including the development of new investing strategies and new investments in renewable energy. Considering the social impact of their investment portfolio provides an opportunity for universities to have influence and has been called campus sustainability’s “last frontier” (Peterson & Wood, 2015). The movement on college campuses has received considerable attention in major media outlets, also indicating a robust conversation outside of academia about the role of universities in addressing climate change. The Guardian has followed the divestment movement closely, covering many major divestment decisions (Murray, 2016; Telemacque, 2015; Tutu, 2014). The New York Times has printed several high profile editorials on the topic and The Economist has included several stories on divestment and
the valuation of fossil fuels ("Fight the Power," 2015; "From green theory to contentious green action - Faith and fossil fuels,"; Fleischer, 2015).

Despite growing activity and awareness of fossil fuel divestment throughout the world, analysis of this movement is still new. Recently, Stephens et al. reviewed the role of universities in the divestment movement and evaluated the role of tenured faculty involved in divestment efforts (Stephens, Frumhoff, & Yona, 2018). Divestment has also been analyzed as a movement promoting elements of a “just” energy transition (Healy & Barry, 2017). The most comprehensive overview of divestment decisions to date examines arguments to support divestment decisions, focusing on Pitzer College’s path to divestment from the author’s unique perspective as a student activist at Pitzer. Grady-Benson’s work covers divestment movement victories to February 2014 (Grady-Benson & Sarathy, 2015). There have been various efforts to capture the scope of the divestment movement including a book (Lenferna, 2013), a guidebook to the goals of divestment targeted at universities, (Cleveland & Reibstein, 2015) and an effort to map the divestment movement (“Map: Tracking Academia’s Fossil Fuel Divestment,” 2015).

The divestment movement is attempting to shift cultural assumptions regarding fossil fuel reliance and highlighting the potential for intentional consideration of broad social impact of investment decisions. As pressure to divest increases, institutions are responding in different ways. This paper reviews this dynamic movement and reports on analysis of the justifications of universities and colleges that have made public statements regarding divestment. This analysis of framing in discourse (Benford & Snow, 2000) used to understand social movements, reveals dynamic communication strategies within
the divestment discourse. It also highlights the politics of sustainability transitions. Social science research can uncover where sustainability policies are being implemented – and at what level, allowing for discovery of patterns and themes among those both supporting and opposing sustainability transitions. Three main problem areas for engagement with sustainability politics have been identified: “a) there are many other things to worry about b) uncertainties overwhelm action; and c) change disrupts established interests.” (Meadowcroft, 2011b, p. 72). These themes arose clearly during our content analysis of statements from universities on fossil fuel divestment.

This paper will first provide background on the use of framing in social movements. We will then review divestment as a strategy. Then we will review the chronology of the divestment movement. This analysis addresses the research question of how organizations frame their justification of whether or not to divest.

3.2 The Use of Framing in Social Movements

Social movement activists strategically “frame” concepts with language and images to communicate various messages associated with building and maintaining a movement (Benford & Snow, 2000; Johnston & Noakes, 2005; Snow et al., 1986; Snow, Benford, McCammon, Hewitt, & Fitzgerald, 2014). Robert Goffmann was an early developer of frame creation, calling it a “schemata of interpretation” and a way for individuals make meaning from the multitudes of experiences in daily life (Goffman, 1974). This concept has been applied in media studies (Gamson & Modigliani, 1989; Stauffacher, Muggli, Scolobig, & Moser, 2015), business leadership development (Fairhurst, 2005; Fairhurst & Sarr, 1996) and to understand environmental controversies
including nuclear power and renewable energy (Stauffacher et al., 2015; Watts & Kaza, 2013; Wilson & Stephens, 2009). We apply this method of analysis to statements made by universities in response to calls for fossil fuel divestment. This analysis offers context for how frames developed by divestment movement activists are interpreted and reframed by administrative leaders in higher education. We do not assert that social movement frames 

*cause* the frames we identify in university statements. However, the statements are crafted (almost always) in response to directed campaigns for fossil fuel divestment. Social movement activists are interacting, sometimes quite literally, with members of administrative leadership teams as frames are simultaneously developed to support divestment decisions – both against and in favor of taking action on investments. This framing scholarship addresses calls for further work of social movement framing that includes transnational movements and empirical analyses (Snow et al., 2014, p. 2). The fossil fuel divestment movement has been dubbed the “fastest growing social movement in history” (Brooks, 2014). Scholars acknowledge that it’s difficult to keep track of this movement, but a report comparing fossil fuel divestment to apartheid in South Africa found that the numbers of people trying to get investments out of the fossil fuel industry has grown more quickly than similar actions in other movements in history (Ansar et al., 2013). The strategic use of frames plays a critical role in a movement’s direction and success in securing desired outcomes (Gamson & Modigliani, 1989; Lakoff, 2010; D. Snow et al., 2014).
3.3 A Review of Divestment as a Strategy

Divestment as a strategy is not new (Ansar et al., 2013; Schueth, 2003; Siew Hong Teoh, Ivo Welch, & C. Paul Wazzan, 1999). Many participants in the fossil fuel divestment movement cite the success of targeting investments in South Africa during the anti-apartheid movement of the 1960s to the 1980s (Gelles, 2015; Solomon, 2015; Tutu, 2014). Evidence shows that divestment from South African firms had little effect on market valuation of those firms (Siew Hong Teoh et al., 1999), instead ending apartheid by stigmatizing companies invested in South Africa, particularly Barclay’s Bank (Ansar et al., 2013; Telemacque, 2015).

A comprehensive study by Oxford’s Smith School for the Environment analyzed the effect of divestment movements and identified three distinct waves in the South African boycott, tobacco divestment, and now fossil fuel divestment (Ansar et al., 2013). These findings demonstrate that the financial consequences of divestment on targeted companies is generally not significant enough to prompt organizational changes. Instead, the authors emphasize the impact of indirect consequences of stigmatization (Ansar et al., 2013). Stigmatization can result in various outcomes including uncertainty about future cash flows, reduced political power and difficulty attracting top job candidates (Ansar et al., 2013; Durand & Vergne, 2015). The influence of stigmatization lags behind the rise of a divestment campaign unlike a leading indicator, though lagging indicators have been used understand and track business cycles since the 1930s (Cobb & Rixford, 1998; Mitchell & Burns, 1938). As a result of the fossil fuel divestment movement, Ansar et. al. highlights the possibility of disruptive innovation in energy supplies over time,
potentially paving the way for renewable technologies. The fossil fuel divestment movement has now moved beyond college campuses in the United States to international universities, the Rockefeller Brothers Fund, the Guardian Media Group and Norway’s Sovereign Wealth Fund (Carrington, 2015; Schwartz, 2014). Within this context, fossil fuel divestment is squarely into a second wave and moving into a third wave, defined by dissemination into this wider market. Our research demonstrates a rapidly shifting discourse around climate change, renewable energy investments and the fossil fuel sector in Board of Trustees meetings, administrative offices on college campuses and within a new generation of college students. While of varying intensity, this discourse is ongoing at many institutions. This can be seen in several key instances of universities issuing statements in formal opposition to divestment and then subsequently making major decisions to divest in some form. This occurred at both Columbia and Yale. Middlebury College released a formal decision against divestment in 2013, and yet in spring of 2018, the Student Government voted on divestment and requested that the Board of Trustees do the same (Okazaki, 2018).

3.4 Chronology of Highlights in the Divestment Movement

Many identify Swarthmore College as the seed of the current fossil fuel divestment effort, beginning in 2011 (Gelles, 2015; Grady-Benson & Sarathy, 2015). In 2012, the international climate action group 350.org, strategically aligned with the fossil fuel divestment movement to bring more focus to the impact of fossil fuels on climate change (350.org, 2016). The divestment movement gained further attention and momentum following a 2012 article in Rolling Stone magazine by Bill McKibben, a
scholar in residence at Middlebury College. The high profile piece, “Do the Math”, linked the role of fossil fuel corporations to global climate change and McKibben implicated fossil fuel companies writing, “we have met the enemy and they is Shell”, a reference to Shell oil corporation) (McKibben, 2013). A 2012 report from Carbon Tracker introduced the concept of the “Carbon Bubble”, which has become a cornerstone of the divestment argument (Initiative, 2011).

The year following the publication of the Rolling Stone article was very active for divestment on college campuses. In spring of 2013, early adopters were the College of the Atlantic, Unity College and Green Mountain College all divested from fossil fuels after short campaigns on campus. Naropa University and Hampshire College followed with decisions to divest from fossil fuels later that year. In the latter half of 2013, two major decisions were made rejecting calls for divest by Middlebury and Harvard. Both were high profile decisions and Harvard’s decision continues to earn attention (Berwick, 2015; Mandery, 2014; Rocheleau, 2015). It is an important landmark and referenced in several subsequent university statements defending decisions not to divest. In Harvard’s case, President Drew Faust’s official statement on the divestment decision prompted Harvard faculty to pen an open letter criticizing President Faust’s decision (Faculty, 2014). A subsequent sit-in by students prevented Faust from entering her office for a day. Middlebury’s decision not to divest was made following several public community forums attended by many students and faculty. It’s possible that the transparent process Middlebury engaged in during decision-making led to less frustration than in Harvard’s case. A robust divestment campaign still exists on Harvard’s campus, despite the failure
of law students to sue the university for climate change impacts (Ellement, 2016). In December 2013 after a lengthy campaign by students, the University of Vermont chose not to divest from fossil fuels and Tufts University followed suit in February 2014. Several other decisions from Prescott College and Pitzer College in favor of divestment preceded a decision in May 2014 by Stanford University to divest from coal. With an endowment of $22.2 billion⁴, Stanford became the largest endowment to divest from coal or fossil fuels. Coal divestment also marked a focus on a new tactic. Though San Francisco State University divested from coal in 2013, Stanford’s endowment size marked a shift in scale. Georgetown University, a Catholic university, divested from coal the following month in June 2014. Georgetown described the influence of religious values in its decision-making. When the University of Dayton released a statement the same month, it also referenced the importance of Catholic values in influencing the decision to completely divest from fossil fuels. The Rockefeller Brothers Fund, a private charitable foundation released a statement in September 2014 announcing full divestment from coal and tar sands and staged divestment from fossil fuels over four years. This was a very significant decision for the fossil fuel movement, as it extended the divestment conversation beyond higher education. Immediately following the Rockefeller Brothers Fund’s decision, in October and November 2014, divestment decisions at international universities increased. Australian National University, University of Glasgow and Victoria University in New Zealand all released statements declaring divestment from fossil fuels. In April 2015, The Guardian Media Group launched an international

campaign in support of fossil fuel divestment by pulling the €800m investment fund out of fossil fuels and SOAS University in London announced fossil fuel divestment. At almost the same time, Syracuse University became the largest university endowment in the world ($1.18 billion) to divest from fossil fuels. In the month following, the country of Norway, a major fossil fuel energy producer in Europe, divested its $900 billion sovereign wealth pension fund from coal, becoming the first country to divest. Several major coal divestment decisions occurred in 2015. The Church of England and the University of Washington announced decisions to divest from coal. Oxford University and the London School of Economics both divested from companies extracting coal and tar sands oil along with The University of California, also announcing efforts to influence policy related to climate change and committed $1 billion to renewable energy development. This new emphasis on policy also marked a shift in language in response to calls for fossil fuel divestment. In May 2015, Swarthmore College announced a decision rejecting calls for divestment citing fiduciary responsibility and a desire to keep the endowment free from connections to “social objectives”. In September 2015, Williams College framed their rejection of divestment as a move towards new investments, employing and emphasizing the phrase, “not divest, invest” in their statement, and including a series of actions to address climate change. In May 2016, the University of Massachusetts became the first public university in the United States to divest from fossil fuels as the momentum of the movement shifted from the United States to the United Kingdom. The first half of 2017 was very active for the divestment movement in Europe, with the University of Liege, Kings College in London, NUI Galway in Ireland and
Canterbury Christ University in the UK committing to fossil fuel divestment. In early 2018, Lewis and Clark College shifted focus back to the United States in an announcement that it would divest fully from fossil fuels.

As the movement grows in size and influence, the discourse and frames justifying institutions’ decisions on divestment are shifting. This paper examines the language used to defend decisions to divest from fossil fuels or not divest in the 137 colleges and universities that have made public statements on divestment to date. It examines divestment strategies separately, analyzing full divestment, coal divestment and coal and tar sands divestment, identifying themes that are specific to each approach. This analysis of language used by institutional leaders to justify their response to pressure to divest identifies patterns and themes regarding universities’ justification for their institutional divestment decisions. Announcements from media outlets or activist organizations were not included in this analysis unless verified by a statement from the institution.

3.5 Methodology

This research analyzes the public statements of 137 colleges and universities justifying their institutional decision to divest or not from 2011 to spring 2018. This list was compiled using resources available from 350.org and Go Fossil Free, both containing the most current data on fossil fuel divestment decisions, and cross referencing this with media reports and official university statements. Most of these statements were issued by senior administrators in response to student-run divestment campaigns on campus. Text of the public statements were retrieved most often from institutions’ websites. Non-divestment decisions were collected from media sources and university websites. As
there is no comprehensive list of non-divestment decisions, these are much more difficult to track. In several cases, an author made a request to a communications team to receive access to an unpublished statement. Text was coded using HyperRESEARCH text analysis software identifying a set of specific themes developed iteratively by the research team. Through an inductive process an initial set of “thought elements” were identified including fiduciary responsibility, mission and values, and leadership (Watts & Kaza, 2013, Creswell, 2013). Each statement was read multiple times, and researchers discussed and compared emergent themes. In subsequent reviews of each statement on divestment and an examination of the context of each theme, the initial set of thought elements was reduced to 8-14 primary themes associated with each category of full divestment, coal divestment, coal and tar sands divestment or no divestment. The figures were developed with SPSS version 24.

3.6 Results

Of the 137 colleges and universities we analyzed, ninety-five have made a decision in support of some form of divestment. Of those supporting divestment, most elect full divestment of fossil fuels from direct holdings within the portfolio, which are easier to manipulate than holdings within commingled funds.\(^5\) Sixty-nine of these committed to full divestment of fossil fuel stocks. Nine universities committed to divest exclusively from coal stocks and nine have made commitments to divest from coal and

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\(^5\) The difference between commingled funds and direct holdings has been at the heart of divestment discussions. Some universities and colleges claim that owning commingled funds makes divestment very difficult. Commingled funds are investment vehicles combined to diffuse risk and diversify holdings. Most institutions electing to divest do so only from directly held investments that are easier for the investor to manipulate. This is only one portion of most endowments.
tar sands stocks. Eight institutions agreed to partial divestment, selecting specific companies or characteristics. For instance, Australian National University, committed to divestment from seven specific companies engaged in coal and mining activities. Forty-two institutions officially stated that they will not divest from any fossil fuel companies. Two American universities, Columbia University and Yale University issued two different statements on divestment, first refusing to divest and several years later, moving to divest.

![Figure 3.1: Justifications for Divestment](image)

### 3.6.1 Justifications for full fossil fuel divestment

In statements from institutions choosing to divest from all fossil fuels, the most frequently mentioned themes relate to mission and values or leadership. (See Fig. 3.1) A reference to mission, values or an institution’s ideals was included in fifty-one percent of the statements released by schools committing to divestment from fossil fuels. The
president of Green Mountain College, one of the first colleges to issue a divestment statement, said, “We see this as another step in an ongoing effort to connect our investment decisions with our ideals.” The president of Unity College, officially the first school to adopt a divestment pledge made a similar statement. “I can think of no stronger statement [fossil fuel divestment] about the mission of Unity College.” Leadership on climate change, social justice or a new investing approach was included by forty-nine percent of the institutions divesting from fossil fuels. Forty-three percent of these schools tie their decisions to social justice issues related to climate change. For instance, the New School included discreet references to the effects of climate change on people. “Climate change, the effects of which are already being felt by our most vulnerable populations, is one of the greatest challenges we are facing in the 21st Century” (“The New School Submits Bold Plan to Tackle Climate Change,” 2015).

The University of Maine and Peralta University, while not explicitly highlighting “mission or values” both highlight a commitment to sustainability or a commitment to the environment. Statements from Green Mountain College, Prescott College, Unity College and Sterling College, all among the first colleges to divest from fossil fuels, make multiple references to their school’s mission as justification for divestment.

Two final themes arose in our analysis of justifications for fossil fuel divestment. Twenty-six percent of schools included a reference to “future generations” as a reason for divestment. “Risk” was also identified as justification for divestment by ten schools, citing the risk of climate change or of fossil fuel investments themselves. The University of Dayton addressed the financial risk of fossil fuels several times in its statement on
divestment. “More and more people are understanding the financial risk underlying fossil fuels in the stock market and taking the appropriate action. It’s not only values, but valuation risk associated with owning fossil fuel companies” (Press release, University of Dayton).

3.6.2 Justifications for divestment from coal

Coal stocks have also been targeted for divestment by some institutions. Coal is widely viewed as the “dirtiest” fossil fuel and produces more carbon dioxide per unit than petroleum or natural gas.\(^6\) Nine institutions divested from coal. Stanford University was the first university to divest from coal and is the most visible of this group with the largest endowment, reporting $22.4 billion in August 2016.

When analyzing isolated institutions divesting only from coal, similar themes were found to those that emerged among all institutions divesting from fossil fuels and also some new themes. Mission or values was the most cited reason for divestment from coal, with fifty-six percent of institutions divesting from coal emphasizing this justification. Thirty-three percent emphasized that the existence of renewable energy resources exist as viable alternatives to coal combustion. The same number (n=3) referenced the social injustice of climate change. Two institutions highlighted coal combustion as the most egregious form of fossil fuel combustion in exacerbating climate change.

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\(^6\) http://www.eia.gov/environment/emissions/ghg_report/ghg_overview.cfm
3.6.3 Justifications to divest from coal and tar sands

Eight institutions identified coal and tar sands combined as particularly problematic investments, choosing to divest from these sectors. Within this group, San Francisco State University and the London School of Economics released very short statements without highlighting reasons for divestment. The other five institutions divesting from coal and tar sands released long, nuanced statements on the decision to divest. Four of these schools, Boston University, University of California, University of Edinburgh and Oxford University emphasize a commitment to their institution’s research on climate change or sustainability as a driving factor in their divestment decisions. Similarly, each university commits to new investments in renewable energy development and solutions to climate change. The University of Boston, University of California and the Oxford University identify the risk of climate change as a driving factor in the decision to divest and the University of California makes several statements about financial risks associated with coal and tar sands investments. Oxford University, in a statement announcing coal and tar sands divestment, highlights specific investments in a management company focused on resource use efficiency strategies. The University of California’s statement, along with Unity College in Maine, is particularly unique in addressing policy associated with fossil fuel investments and climate change. In their statement, the University of California’s chief investment officer also announces a partnership with the Obama Administration to support research and communication efforts on investments that address climate change.

7 Osmosis Investment Management analyzes companies’ use of energy, water and waste.
3.6.4 Partial divestment

Eight colleges elected partial divestment, from a select group of companies. The most prominent theme, cited by three colleges, was a desire for consistency with university led research on the effects of climate change. Other justifications were similar to those found in statements on fossil fuel divestment. Barnard College released a decision for partial divestment in December 2017 and became the first college to target companies, “that dispute evidence of climate science or otherwise seek to thwart efforts to mitigate the impact of climate change”. Yale University also committed to partial divestment in 2016, highlighting the risk of fossil fuel investments and a decision to divest from three companies. "The Investments Office [at Yale] believes the risks of climate change, like any risks, should be incorporated in the evaluation of investment opportunities.”

3.6.5 Research themes in Europe, Australia and New Zealand

The most prominent theme from universities outside of the United States, releasing statements on divestment in any form was a commitment to science. Figure 3.2 delineates justifications by country. Many schools referenced their own research on climate change and renewable energy in announcing divestment from fossil fuels. Over thirty percent of UK universities reference climate change science. Oxford University and University of Edinburgh - both in the UK, and Victoria University in New Zealand, used this justification. In contrast, twenty percent of American Universities reference climate science. Harvard University is the most famous university to not divest and references the
importance of research as one of the reasons. “[Harvard] exists to serve an academic mission – to carry out the best possible programs of education research.”

Fourteen percent of European universities reference the importance of leadership, far fewer than American universities, who reference leadership in almost half of the statements on divestment. Fifty percent of Australian universities also include leadership as a justification for divestment. Queen Mary University in London was the only university to acknowledge that the decision to divest related to a fear of deterring financial donors and students.

![Figure 3.2: Justifications for Divestment by Country](image)

3.6.6 Justifications for not divesting

Of the colleges and universities choosing not to divest in response to pressure from divestment groups, a reference to financial results of the portfolio was the most
cited justification. Forty-eight percent of the schools that did not divest described concern about the financial consequences of divestment. Out of twenty-one schools citing financial issues with divestment, sixteen invoked the phrase, “fiduciary duty”. Fiduciary duty or responsibility was cited by thirty-eight percent of institutions choosing not to divest. A fiduciary duty is the “legal duty to act solely in another party’s interests” (“Fiduciary Duty,” 2015). The University of Vermont emphasized fiduciary responsibility throughout its statement rejecting fossil fuel divestment.

“[The Board of Trustees’] primary duty is to invest the endowment to maximize returns, minimize risk, and provide funds to support the academic mission of UVM. They noted their concerns that the purpose of the endowment and, therefore, its fiduciary responsibility does not include attempting to use the endowment as a tool in setting policy or exercising political influence.”

Fiduciary responsibility was also referenced by ten schools announcing decisions for divestment. Three of these schools used fiduciary duty to justify divestment by citing the volatility of fossil fuel stocks and the potential for increased regulation of greenhouse gas emissions that could decrease stock value. The strongest statement was from the University of California, who included fiduciary duty as a justification for divestment from coal and tar sands. “We believe that fiduciary duty now requires systematic attention to sustainability factors.” The University of Dayton referenced fiduciary duty in its announcement of fossil fuel divestment and included financial risk calculations, “Fossil fuel companies have a valuation that assumes every single drop of oil, everything they have in the ground, will be taken out. More and more people are understanding the
financial risk underlying fossil fuels in the stock market and taking the appropriate action. "Thirty-one percent of institutions choosing not to divest highlight the political implications of divestment. In several statements, we identified variations of the phrase, “[the endowment] is not social change tool”. Harvard’s president included this reasoning in Harvard’s formal statement. “The endowment is a resource, not an instrument to impel social or political change.” Swarthmore College also stated this several times in a formal statement. “In 1991 the Board adopted the policy of not using our endowment to take positions on social issues…” Three institutions quote Harvard in their non-divestment statements declaring that the endowment is not for social change.

Investment or reinvestment in campus infrastructure, socially responsible investments or renewable energy was also a strong theme among colleges and universities refusing to divest. Thirty-six percent of schools electing not to divest included a plan to invest in renewable energy or energy efficiency. A related commitment to establish a “green investing fund”, free of fossil fuel stocks was included in twenty-one percent of the statements issued by schools not divesting. Williams College’s statement from its Board of Trustees highlights a commitment to investment with the phrase, “we will invest not divest”. Middlebury College also emphasized investments over divestment by committing to increase “the amount of the endowment directed toward ESG investments, including those focused on clean energy, green building projects, and other efforts.” MIT emphasized investments and “engagement with industry”, committing $5 million of the school’s research funds towards environmental research. In MIT’s statement, university President L. Rafael Reif states, “Fossil fuel companies have
consistently been among our most productive research partners.” MIT also calls the
divestment movement an act of “public shaming” as a justification for not divesting
(“MIT announces five-year plan for action on climate change,” 2015).

Twenty-three percent of institutions not divesting emphasized the symbolism or
lack of impact of divestment as justification. Duke University included this reasoning.
“The committee was also not persuaded that divestiture by this university would have the
impact on company conduct or the world climate and energy consumption that the
proposal envisions.” Like Harvard University, Amherst College uses its mission to
defend not divesting and to support a new investment strategy – a justification used most
often in alignment with divestment. “The Board believes that a strategy of inquiry,
analysis, and engagement with our investment managers, and of broadening the criteria
by which managers are evaluated, is consistent with Amherst’s values.”

3.6.7 Actions by non-divesting universities and colleges

Many institutions choosing not to divest from fossil fuels are committing to a
number of actions related to new investments, new campus infrastructure, different
investing policies and the creation of fossil free funds for donors. Forty-three percent of
the colleges or universities rejecting divestment are committing to new actions addressing
climate change, responsible investing and renewable energy development. Harvard
University hired a new Vice President for sustainable investing and signed the United
Nations Principles for Responsible Investments after releasing a statement rejecting fossil
fuel divestment (Harvard University, 2013). Harvard also has made a commitment to be
fossil fuel free in its campus operations (“Harvard makes climate pledge to end fossil fuel
use,” 2018). Swarthmore College created a fossil free fund for donors and has instructed its investing managers to “describe [the] approach to climate change”. Both Tufts University and the University of Vermont created a fossil free fund for donors and Wellesley College developed a Green Revolving Loan Fund for energy investments on campus. In its statement initially rejecting divestment, Yale University committed $21 million to capital investments in energy conservation over three years and initiated an experiment on campus with carbon pricing, led by economist William Nordhaus. Williams College released a commitment to engage five other peer colleges to procure more renewable energy for their campuses. Middlebury College placed $150,000 under student management for investment in socially responsible companies and earmarked $25 million from the endowment to be used for positive investments, targeting companies with high ESG (environmental, social, governance) ratings.

Several American universities make major commitments to new research on climate change, notably MIT and Yale. Yale University committed to a new carbon pricing experiment on campus and MIT committed to finding $8 million every year for five years to build innovation centers committed to low-carbon energy development.

3.7 Discussion

The frames we identify here highlight discreet ways that institutions in higher education are contributing to a shifting discourse around the fossil fuel industry. Our analysis shows that this is a rapidly advancing movement, with an evolving discourse, moving into the “third wave” (Ansar et al., 2013) and still growing, particularly with movement into countries outside the United States. This discourse is a critical element of
a renewable energy transition and reflects responses to an entrenched industry. The statements analyzed have been made by university spokespersons, board presidents, chief financial officers or presidents of the institutions themselves, demonstrating that conversations about fossil fuel divestment are occurring at the highest levels of some of the most respected institutions in the world. We identify a temporal element to the shifting discourse, with both requests for divestment and responses to divestment requests becoming more nuanced, more sophisticated and increasingly committing to investments in renewable energy. In addition, Fig. 3.2 shows a distinct shift in the geographical center of the divestment movement from the United States to Europe.

A loose application of diffusion theory (Rogers, 1976) indicates that the early adopters of divestment were small, environmentally focused colleges that most often mentioned mission and values as justifications for divestment. The first three colleges to issue statements were Unity College, College of the Atlantic and Green Mountain College. These schools all have small endowments and are renowned for their focus on environmental studies.

The divestment movement’s focus on investments in fossil fuel energy sources demonstrates a sophisticated approach to addressing global climate change, built on the financial theory of stranded assets and the moral imperative for action. These institutions have been moved to carefully consider the language used in relation to fossil fuels, climate change and renewable energy and many new conversations have occurred between various stakeholders within higher education, including those in leadership positions.
Some institutions are clearly leading the way and contributing to renewable energy development through innovative investment strategies and commitments. Other institutions are defending the status quo, most often highlighting financial considerations and the risk of lower returns on investments. Three statements released in the fall of 2015 come from Williams College, MIT and the University of California. All three institutions’ statements mark a shift in higher education’s response to fossil fuel divestment. Williams College and MIT both rejected calls for divestment and the University of California is divesting from coal and tar sands. Williams College includes the phrase, “we will invest not divest” and repeats this several times in its statement. This language marks a sharp pivot from the divestment conversation to a discreet new framing. Though other colleges previous to Williams committed to new investments without divesting, like Reed College and Middlebury College, this language explicitly connecting two seemingly opposing ideas, represents the movement’s shift to the tactical “divest-invest” approach. A new consortium of groups including leaders in the fossil fuel divestment movement now describes the movement as the “divest-invest” movement, highlighting individual and philanthropic commitments to divest from fossil fuels and reinvest in clean energy (Divest-Invest, 2015). MIT’s statement and approach is also innovative and highlights the framing of a university that benefits in extraordinary ways from partnerships with the fossil fuel industry. After a year of discussion, research and open forum events on how MIT will address climate change, and after receiving encouragement to divest from the investment advisory committee, the leadership of the university argued against divestment. The resulting statement explained that MIT would
be engaging with the fossil fuel industry to push forward innovation on renewable energy. MIT has committed to pursuing billions of dollars over five years towards the development of new research centers devoted to renewable energy research and innovation and undoubtedly very attractive to potential students. Middlebury College experienced a very similar pattern of open forums, public debates and subsequent votes from university leadership against divestment that nonetheless produced outcomes that increased the college’s investments in renewable energy and positive investments by $50 million. These statements indicate that the divestment movement is creating a disruptive shift in some instances, related to discourse and investments, pushing institutions – some with extraordinary financial resources - to commit to financially supporting a renewable energy transition. The University of California was the first school to tie financial risk to fossil fuel investments, a justification employed by Yale University when it divested in 2016. Pushing the discourse further, Barnard College’s decision at the end of 2017, to target companies obfuscating climate change science, reflects a deep understanding of the aims of the divestment movement, the choices available to the Board of Trustees and again sets a new level of sophistication in divestment decisions.

Yale University and Columbia University released statements in 2014 and 2015 respectively, defending decisions for no divestment. In 2016, both universities released statements supporting divestment. Yale University’s endowment was reported at $27.2 billion in 2017 and Columbia reports an endowment of $10 billion. The largest endowment sits with Harvard University and for the first time, in March 2018, a member of the Board of Overseers at Harvard publicly called for fossil fuel divestment, generating
another round of controversy and discussion at Harvard. The largest endowments in the world are important markers on the progress of the divestment movement.

This analysis provides details on a critical element of the energy transition occurring during a decline in the reputation of the fossil fuel sector. This decline, exemplified by several major events in the last two years, is strengthening the case for fossil fuel divestment. In July 2018, the country of Ireland announced it would be the first country in the world to plan for divestment. In January 2018, New York City announced plans to sue five fossil fuel companies for their role in exacerbating climate change and obscuring climate science. In 2017, five cities in California pursued similar litigation.

3.8 Conclusion

This research on divestment identifies a critical component of the renewable energy transition gaining strength as various factors including recent layoffs, bankruptcies, criminal investigations and financial losses contribute to the declining value and increased risk of fossil fuel investments.

The most significant limitation of this study is the difficulty of securing every statement released by universities on non-divestment decisions. For this reason, most of the statements made in this paper emphasize language seen in statements from colleges and universities that have moved forward with divestment. In addition, this research captures broad trends in the statements on divestment, but does not analyze the value of fossil fuel companies, or attempt to rigorously quantify the impact of fossil fuel divestment.
Future research on divestment could advance this area of scholarship by connecting the stigmatization of companies more closely to the valuation of fossil fuel companies. A more quantitative analysis of the outcomes of divestment decisions would also be a timely contribution with the maturity of the movement. In addition, mapping the geographical diffusion of the divestment movement is a useful contribution and could illuminate interesting trends.
CHAPTER 4: MILLENNIALS’ ENERGY USE ATTITUDES AND BEHAVIORS: EVIDENCE FROM A UNIVERSITY EXPERIMENT

To be submitted to: Energy Research and Social Science

Abstract

Millennial energy consumers and renters are of great interest to utilities and policy makers and will soon be the largest segment of energy customers. This paper offers insights on millennial college students living in rental housing and investigates how this group responds to behavioral interventions. A behavioral experiment tested the influence of in-home displays (IHDs) and financial incentives on energy use and examined the associated attitudes and self-reported behaviors with survey data. Associations between survey questions and energy use across three different treatment groups and a control group were tested. Limited evidence was found correlating energy use and survey questions. A pre to post comparison of survey answers by treatment group found limited changes in self-reported behaviors. The treatment group that received the IHDs demonstrated the most dramatic changes compared to respondents in other treatment groups for some self-reported behaviors. This study finds that self-reported attitudes and behaviors might not accurately reflect energy use behavior, but can demonstrate intention to act, a key step to behavior change. The paper concludes with suggestions for stakeholders (e.g. utilities, technology companies) on ways to improve behavioral interventions and contribute towards a better understanding of this customer segment.
4.1 Introduction

While energy consumption in households comprises approximately one-third of the overall energy use profile in the United States, little is known about the intra-household dynamics that influence household energy use (Bell et al., 2015; US EPA, 2015). A more complete understanding of household energy consumption can inform program development for utilities and policy design at local and national levels (Fri & Savitz, 2014). This study combines outcomes from an experimental design testing real-time feedback delivered with digital in-home displays and financial incentives with the outcomes of pre and post survey data testing attitudes and self-reported behaviors of participants.

4.1.1 Behavioral science and household energy use

Research on behavior and energy use began in the 1970s. Previous to that time, the bulk of research conducted in fields of energy studies focused on the technological aspects of a transition towards increased efficiency and more renewable energy sources. Only in the last two decades has work from the fields of psychology, marketing and economics been applied to the energy sector to better understand the “human factors” of energy use. In an early review of the social science literature on energy, Lutzenhiser quotes a colleague who states, “those of us who call ourselves energy analysts have made a mistake…we have analyzed energy. We should have analyzed human behavior” (Loren Lutzenhiser, 1993, p. 248). The impact of “energy literacy” was tested extensively in the first studies on consumer behavior and energy conservation, largely with information campaigns touting the benefits of energy efficiency (Dyer & Maronick, 1988; Loren
Experiments investigating the decisions made by residents began in the 1980s with one initial study testing feedback, incentives and information about energy in university dorms and once again concluding that scarce evidence exists for the influence of information campaigns (Hayes & Cone, 1977). Throughout the 1980s, experimental work began accumulating, testing the effect of feedback and incentives on household energy use.

As a domain for behavioral interventions, residential energy use is unique. As scholars have noted, energy is invisible, abstract and measured in kilowatts, units unfamiliar to many consumers (Buchanan et al., 2015b; Burgess & Nye, 2008; Hargreaves et al., 2010a). In addition, the actions that drive energy use occur inside the home and are hidden from researchers. The impact of energy use is not immediately obvious to users, making it difficult to connect to habitual, everyday actions. Most of the empirical work in energy use behavior began in the 1980s and has been conducted with various interventions that are referred to as “feedback”. These studies often combine feedback with other interventions for behavior change like financial incentives, norms and goal setting (Faruqui et al., 2010; Karlin, et al., 2015a). The highly visible and popular OPower program, combines feedback and social norms, and is frequently cited within utilities as the energy behavior program in the program portfolio (Allcott, 2011; Laskey, 2013). This famous program leverages information on neighbors’ energy use to nudge consumers to lower their own use. Other iterations of feedback programs target the energy use of entire buildings, as in a dorm or apartment setting. In-home displays

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8 OPower was acquired by Oracle in 2016 and is now called Oracle.
(IHDs) have been heavily tested as tools to increase the salience of feedback by displaying real-time energy use information via digital monitors in the home. The majority of these studies combine this treatment with either social norms or incentives and show mixed results (Abrahamse et al., 2007; Delmas et al., 2013a; Faruqui et al., 2010; Karlin, et al., 2015a).

Costs of energy are often a primary driver of interest in real-time feedback technology to reduce household energy use. Several studies highlight the role of energy bills in motivating users to change behaviors (Buchanan et al., 2014; Faruqui et al., 2010). Research on the use of financial incentives to nudge energy consumption behaviors have also shown mixed results. Jessoe and Rapson found that price signals were effective at reducing energy use only when real-time feedback was also present (Jessoe & Rapson, 2014). Using financial incentives as a behavioral intervention is often complicated by the cost of energy; electricity in particular, is considered low-cost for most consumers, and can create “boomerang effects” in consumers. For instance in one analysis, Jessoe et al. found that consumers reduced electricity use when prices were reduced – the opposite of what one might expect (Jessoe et al., 2014). The authors lay out several hypotheses for this effect, highlighting the possibility that a letter received by households in the study, reporting that their energy use was high, may have nudged consumers to use less energy. The authors speculate that households responded to the influence of a social norming effect, and not the financial incentive. This points to the various ways consumers can be influenced to change behaviors.
Clarity on the impact of household level behavioral interventions is muddied by complications related to intra-household dynamics (Hargreaves et al., 2010a, 2013; Maréchal, 2009). As mentioned by several scholars, behavior and energy research centers on terms such as “incentives, feedback, discounting and efficiency”, but energy use happens inside homes through mundane activities such as cooking, doing laundry and showering (Karlin, Zinger, et al., 2015a; Maréchal & Holzemer, 2015).

The role of perceived control, sometimes referred to as “attitude” has received significant attention, particularly in various models attempting to capture environmental behavior (Abrahamse et al., 2005; Brandon & Lewis, 1999; Loren Lutzenhiser, 1993; Pothitou, Hanna, & Chalvatzis, 2016). It is a central component of Azjen’s Theory of Planned Behavior and also the Norm Activation Model, and both models have been shown to predict aspects of household energy use (Sarkis, 2017; van der Werff & Steg, 2015). However, the variation in study designs, the problem of self-selection bias and the short study timelines leave many questions about the efficacy of information feedback and behavioral approaches to energy conservation in general (Buchanan et al., 2015; Delmas et al., 2013; Karlin, Zinger, & Ford, 2015).

4.1.2 Energy Cultures

Intra-household dynamics are only one component of the various factors influencing household energy use. In 1991, Lutzenhiser originally explored the question of “culture” in household energy use, advocating for a social science perspective, inspecting group characteristics and dynamics (Lutzenhiser, 1992). He suggested that energy use takes place within various cultures of relationships, social norms and belief
systems. It does not appear that he expanded on this literature thread. Now, a growing and influential body of research out of New Zealand exploring “energy cultures” has been applied to behavioral work for its ability to capture the broader picture of energy use (Barton, 2013; Lawson & Williams, 2012; Stephenson et al., 2015). This framework asserts that many factors contribute to energy use including demographics, social norms, habits and variation in living structures and appliances. Various “cultures” exist related to three discreet factors: norms, materials (infrastructure, etc.), and practices (see Fig. 4.1). To create a useful heuristic, these elements are also referred to as: “think, have, do”.

Research in this field of study has been used to make policy recommendations at the federal level in New Zealand and this work is increasingly referenced by energy scholars as a useful framework promoting interdisciplinary approaches to understanding energy use (Barton, 2013; Karlin, et al., 2015; Maréchal & Holzemer, 2015). The Energy Cultures framework can be instructive by focusing on elements such as consumer decisions and behavior that the marketing industry has leveraged for decades to reach particular segments of the population. Identifying niche markets is of great interest to the energy efficiency industry as utilities search for answers on “how and for whom” behavioral interventions work (Karlin, et al., 2015). Traditional measures of efficacy focus on energy savings, and almost exclusively on kilowatt hours saved. However, this metric offers no information on who the intervention worked for or why.
In addition, utilities are grappling with the growing “split incentive” problem in rental housing. Because renters are short term residents, purchasing energy efficiency upgrades is not viewed as a good investment (Bird & Hernández, 2012). The same is true for landlords, who generally do not pay the energy bills. Investing in energy efficiency is not a logical investment because landlords do not reap the benefits of lower utility bills. In addition, the number of renters is growing rapidly, with millennials outpacing all other demographic groups in moving into rental housing, with the exception of Baby Boomers, who are also set to drive growth in rental markets (“Joint Center for Housing Studies of Harvard Report on Rental Housing,” 2016).

Accenture Consulting Group conducted a study in 2015 and found that millennial age energy consumers are highly demanding customers with strong environmental values who demand more individualized information on their energy use, and are radically
shaping markets for renewable energy (Accenture, 2016). Research on this customer segment is of great interest to utilities.⁹

4.1.3 Aim of the Study

This study examines the impact of real-time feedback and incentives on millennial renters in an off-campus university setting in Vermont, USA. This group can be viewed as a discreet energy culture, with comparable material cultures (appliances, house characteristics) and cognitive norms. Similar work has been done on energy consumers in other areas of the world, and this study contributes to an understanding of a customer segment of great interest to utilities. The goal here is to contribute to an understanding of “the underlying determinants of energy use and energy-related behaviors” identified by scholars as needing more exploration (Abrahamse et al., 2005).

The Energy Cultures framework expands a singular focus on energy use behaviors to include attitudes and physical materials, like appliances, as germane to questions of how energy is used in the household. In this study, the following questions are investigated, related to the heuristic model of “think, have, do” from the Energy Cultures literature (Fig. 4.1). How do self-reported behaviors shift after exposure to the behavioral intervention? How do perceptions of energy shift after exposure to the behavioral intervention? Can self-reported behaviors predict actual energy usage?

This study focuses on differences in “cognitive norms” before and after participation in the experiment with an online survey. Though research shows potential

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⁹ This was clear at the 2016 Renewable Energy Vermont Conference, where an entire session was devoted to “Understanding Millennial Energy Consumers”. This was also a prominent theme at the 2016 Behavior, Energy, Climate Change Conference.
for savings from behavioral programs, there is still significant variation in results (Byerly et al., 2018). These findings will help us better understand how millennial renters might respond to real-time feedback and incentive-based behavioral interventions, who will be a large segment of the renter population over the next ten years.

Figure 4.2 : Changing Energy Cultures through an Intervention (Karlin, Ford, et al., 2015).

4.2 Methodology: The Off-Campus Energy Study

4.2.1 Participants and procedure

The study took place in Burlington, Vermont with students from the University of Vermont, a public university with 10,500 undergraduate students and 1,500 graduate students, plus a medical school. The University is widely recognized as a leader in sustainability in higher education and all students are required to complete a ‘sustainability requirement’ prior to graduation. The Off-Campus Energy Study, funded by a grant from the University of Vermont’s Clean Energy Fund, tested the effect of real-
time feedback and incentives on household energy use using electricity data and survey data. The experimental component of this project uses a two by two full-factorial design, with two different treatments (incentives and feedback technology) and a treatment group combining feedback and incentives, referred to going forward as IHD + incentive. A control group was developed for comparison (see Fredman, forthcoming). Households were randomly assigned to treatment groups and a survey conducted before and after the Off-Campus Energy Study experiment tested how perceptions of energy use change after engagement with real-time feedback, incentives and IHD + incentive. As part of this mixed-methods study, interviews conducted post-study gathered qualitative data on intra-household dynamics focused around three themes that comprise the Energy Cultures framework; materials, norms and practices. (The results of the interviews are discussed in the next chapter.) This mixed-methods approach to understanding energy use integrates multiple dimensions of energy behavior. Lopes et. al calls this combination of approaches “energy behavior modelling” and this synthesis of self-reported data and energy use data is still a limited area of research (Lopes et al., 2012), though calls have increased for more energy data in social science studies (Stern, 2017). The Off-Campus Energy Study launched the pre-survey in late December 2015 and closed the study May 2016, collecting three total months of smart meter electricity use data in February, March and April and also post-survey data.

4.2.2 Study design

To recruit participants for the study, emails were sent to approximately 7,000 University of Vermont students living off-campus. These emails encouraged completion
of a survey by entering participants in a cash prize drawing. In addition, classes were visited across various majors, announcing the ‘Off-Campus Energy Study’. In total, 771 students completed the pre-survey during the fall semester. Another 539 students started but did not complete the survey. The final sample consisted of 120 participants with complete energy use data and who completed both the pre and post survey. Figure 4.2 depicts a visual representation of the study design and a way to distinguish differences between pre survey responses and post survey responses while accounting for the impact of the behavioral treatment.

The survey instrument was created using a LimeSurvey software tool available from the University of Vermont and collected information on knowledge, attitudes and self-reported behaviors using mostly Likert Scale items. It contained 50 questions, including screening questions and 28 of those questions were subsets of main questions. For example, “With what frequency do you perform the following actions?” included four sub-questions focused on energy-saving behaviors. The post-survey contained 40 questions focusing primarily on knowledge, attitudes and behaviors that changed over the course of the study. Survey questions also collected information on housing size and type, the number of residents in each home and demographic data. Self-selection bias is probable in this population, since individuals with interest in their energy use were the most likely to enter the study. This possible bias was unavoidable due to the necessity of gaining permission for access to private electricity data in the study. See Appendix A for survey questions.
The behavior experiment was conducted from January to May 2016, but study participants took the initial survey during six weeks from October to November 2015. After selecting for participants’ eligibility in the energy use experiment, (this included living off-campus, a high-speed internet connection, smart energy meter and a customer relationship with Burlington Electric Department), participants were randomly assigned to one of four treatment groups.

To design the survey, questions were drawn from several heavily cited studies investigating knowledge, attitudes and behaviors related to household energy use. The development of this survey was largely informed by questions in a behavioral “toolkit” developed by scholars working in the energy industry to standardize the measurement and analysis of psychographic elements that contribute to behavior change (Karlin, Ford, et al., 2015). In Abrahamse et. al, pre and post surveys were used to test the effect of information and goal setting on energy use (Abrahamse et al., 2007). In Attari et. al (Attari, DeKay, Davidson, & De Bruin, 2010), survey questions were used to gauge participants’ understanding of effective strategies for energy conservation. In a similar study to the Off-Campus Energy Study, Brandon and Lewis (Brandon & Lewis, 1999) used interviews and post-study focus groups to investigate the effects of demographic features, environmental attitudes and feedback on energy consumption. Several questions in the Off-Campus Energy Study survey were pulled from a study in New Zealand on various “energy cultures”, defined as the “norms, practices and material culture shaping energy behavior” (Stephenson et al., 2010). Survey questions also asked about existing attitudes towards the environment, climate change and energy consumption, explored
participants’ understanding of energy, and captured data like numbers of appliances in
the household, and socio-demographic features of the household.

Dependent variables were grouped into three general categories from the energy
cultures framework: knowledge, materials, and practices. Based on the existing literature,
it was hypothesized that the participants exposed to the behavioral interventions would
increase their self-reported knowledge of energy efficiency (Attari, DeKay, Davidson, &
De Bruin, 2010) (Hypothesis 1), would increase their sense of control (Karlin et al.,
2014) (Hypothesis 2), importance of energy costs would increase (Hypothesis 3) and the
frequency of reported energy efficient behaviors would increase (Abrahamse et al., 2005,
2007; Lopes et al., 2012) (Hypothesis 4).

To understand the relationship between treatments and participants’ awareness of
their own energy use, we tested four distinct hypotheses.

- **H1**: Self-reported knowledge of energy efficiency will increase after participants’
exposure to behavioral interventions.

- **H2**: A sense of control over energy use will increase in participants after exposure to
  behavioral interventions.

- **H3**: Self-reported importance of energy use costs will increase after exposure to
  behavioral interventions.

- **H4**: Self-reported energy efficiency behaviors will increase after exposure to behavioral
  interventions.
4.2.3 Statistical analysis methods

To generate an understanding of differences in pre and post survey responses, two non-parametric statistical tests were applied using IBM/SPSS Statistics version 24 for Windows. Initially, descriptive statistics were run to test the normality of the data. Some data were distributed normally, some were not, and based on these mixed results, non-parametric tests were chosen for the final analyses. A Wilcoxon-Signed Rank test was conducted to investigate statistical relationships, against the null hypotheses, between pre and post survey data. The Wilcoxon test was chosen to be a more accurate test for non-normally distributed data with dependent samples.

Data were then arranged into a repeated measures design for a mixed marginal model to test both between and within subjects’ changes from pre to post survey answers. A marginal model does not assume independence of all observations, as in a linear model, instead assuming the residuals from single subjects are related. This is sometimes referred to as Population Averaged approach. This also allowed for testing the relationship between energy usage before and after the behavioral interventions and the survey responses. Kilowatt hour (kWh) usage gathered as AMI (automated metering infrastructure) data was the dependent variable and five survey questions, selected based on outcomes from descriptive outputs, were applied as covariates. Household AMI data was also divided by the number of people living within each residence to more accurately account for individual behaviors.
Table 4.1: Changes in pre to post survey responses

<table>
<thead>
<tr>
<th>Group</th>
<th>Knowledge of energy efficiency</th>
<th>Concern about climate change impacts</th>
<th>Sense of control over energy use</th>
<th>Frequency of discussions with family, friends and neighbors</th>
<th>Importance of energy costs</th>
<th>Spoke to landlord or property owner about energy efficiency</th>
<th>Frequency of pulling curtains to retain heat</th>
<th>Frequency of turning off lights</th>
<th>Frequency of switching off lights</th>
<th>Future likelihood of seeking information on energy efficiency</th>
<th>Future likelihood of changing thermostat settings</th>
<th>Future likelihood of reducing shower time to conserve energy</th>
<th>Future likelihood of using additional clothing when cold</th>
</tr>
</thead>
<tbody>
<tr>
<td>control</td>
<td>-1.34a</td>
<td>-1.00a</td>
<td>-2.33b</td>
<td>-0.42b</td>
<td>-1.722b</td>
<td>0.06a</td>
<td>-1.00a</td>
<td>0.00a</td>
<td>-1.562b</td>
<td>-0.973b</td>
<td>-0.632b</td>
<td>-0.616b</td>
<td></td>
</tr>
<tr>
<td>p-value</td>
<td>0.257</td>
<td>0.317</td>
<td>0.029</td>
<td>0.967</td>
<td>0.083</td>
<td>1.000</td>
<td>0.290</td>
<td>1.000</td>
<td>0.117</td>
<td>0.327</td>
<td>0.527</td>
<td>0.414</td>
<td></td>
</tr>
<tr>
<td>lhd</td>
<td>-0.632b</td>
<td>-1.38b</td>
<td>-4.47c</td>
<td>-3.33b</td>
<td>-2.065b</td>
<td>-1.065b</td>
<td>-2.665b</td>
<td>-2.590b</td>
<td>-2.338b</td>
<td>0.000b</td>
<td>-2.801b</td>
<td>-1.513b</td>
<td></td>
</tr>
<tr>
<td>p-value</td>
<td>0.527</td>
<td>0.166</td>
<td>0.855</td>
<td>0.739</td>
<td>0.099</td>
<td>0.286</td>
<td>0.004</td>
<td>0.132</td>
<td>0.042</td>
<td>1.010</td>
<td>0.005</td>
<td>0.130</td>
<td></td>
</tr>
<tr>
<td>lhd_incentive</td>
<td>-0.577a</td>
<td>-0.37b</td>
<td>-1.96c</td>
<td>-0.45b</td>
<td>-2.569b</td>
<td>-0.707b</td>
<td>-0.003</td>
<td>-0.832b</td>
<td>-0.303b</td>
<td>-0.006</td>
<td>-1.628b</td>
<td>-1.604b</td>
<td></td>
</tr>
<tr>
<td>p-value</td>
<td>0.504</td>
<td>0.705</td>
<td>0.058</td>
<td>0.519</td>
<td>0.011</td>
<td>0.490</td>
<td>0.034</td>
<td>0.527</td>
<td>0.278</td>
<td>0.744</td>
<td>0.009</td>
<td>0.108</td>
<td></td>
</tr>
<tr>
<td>incentive</td>
<td>-0.372b</td>
<td>0.00a</td>
<td>-0.71b</td>
<td>-0.90b</td>
<td>-3.33b</td>
<td>-1.414b</td>
<td>-1.286b</td>
<td>-1.414b</td>
<td>-1.678b</td>
<td>-0.361b</td>
<td>-1.408b</td>
<td>-0.570b</td>
<td></td>
</tr>
<tr>
<td>p-value</td>
<td>0.705</td>
<td>1.000</td>
<td>0.477</td>
<td>1.000</td>
<td>0.739</td>
<td>0.157</td>
<td>0.390</td>
<td>0.157</td>
<td>0.084</td>
<td>0.725</td>
<td>0.159</td>
<td>0.332</td>
<td></td>
</tr>
</tbody>
</table>

a. Wilcoxon Signed-Ranks Test
b. Based on negative ranks.
c. Based on positive ranks.
d. The sum of negative ranks equals the sum of positive ranks.
4.3 Results

In this sample, women were slightly overrepresented (61%), compared to the ratio of women to men at the University of Vermont (55.6%) ("Undergraduate Gender Diversity at University of Vermont," 2013). Most of the participants in the study were undergraduate students (59%), 31% were graduate students, and the remaining participants were either medical students, faculty or staff at the university (9%). Most students who enrolled in the study were from the Arts and Sciences College at UVM (24%) with 17% of the participants enrolled in the Agriculture and Life Sciences College and similarly, 16% from the Nursing and Health Sciences College. Students from the Natural Resources School comprised 10% of the study sample. This sample is mostly white, middle-upper class students and is relatively non-diverse by traditional measures. Property types in the study varied somewhat, with most participants living in apartment buildings with 5 units or more (34%) or apartments with 4 units or less (33%). Twenty-five percent of survey respondents lived in a duplex during the study. Only 9% lived in a single-family home. Regardless of property type, all participants were independently metered. On the survey, we requested an estimate of the size of each participant’s home. It is nearly impossible to verify the answers, but most respondents (51%) estimate their home to be between 1,000 and 2,000 square feet. Another 38% of participants estimate their home is between 500 and 1000 square feet in size. In addition, most homes (66%) were heated with natural gas, 14% of homes have electric baseboard heat and 13% are heated primarily by wood.
The results of the Wilcoxon-signed Rank tests are displayed in Table 4.1. Attitudes about home energy costs changed in the IHD and IHD + incentive treatment group and significant changes were also seen when participants were asked about their sense of control over home energy use in both the IHD and control group. In addition, results in the IHD group and IHD + incentive group indicate participants’ increased concern about the costs of energy use prices.

4.3.1 Self-reported knowledge of energy efficiency

H1: Self-reported knowledge of energy efficiency will increase after participants’ exposure to behavioral interventions.

When asked to rate their own knowledge of energy efficiency before and after the experiment, participants’ responses changed very little. No indication of statistically significant differences by treatment groups was found, with all p-values well over 1%. The overall pre-intervention mean was 3.47 (s = .777), while the post-survey mean was 3.60 (s=.706), both scores indicating an answer of “somewhat knowledgeable” when asked about their own knowledge of energy efficiency. Overall, participants’ self-reported knowledge increased somewhat, but not enough to indicate significant change.

4.3.2 Sense of control over energy use

H2: A sense of control over energy use will increase in participants after exposure to behavioral interventions.

Perceived behavioral control, widely studied in connection with Azjen’s Theory of Planned Behavior, holds great interest for researchers in the field of pro-environmental behavior (Klöckner, 2013; Langevin, Gurian, & Wen, 2013; Parag, Zur, & Raz, 2017;
Sarkis, 2017). Azjen’s theory posits that the perception of one’s ability to influence an outcome might be a predictor for action. Here, changes were tested in participants’ perceived ability to change energy use in their home.

There was a significant effect at the .05 level in the IHD + incentive treatment group ($p = .050, Z = -1.964$). The other treatment groups did not produce a significant effect (IHD: $p = .655, Z = -.447$; Incentive: $p = .477, Z = -.711$). The overall mean from the pre-survey was 2.18 ($s = .547$) and the post-survey mean was 2.32 ($s = .554$) on a 3-point Likert scale, indicating that most participants answered “yes, somewhat” when questioned about whether they had control over their energy usage. The control group also changed significantly from pre to post survey ($p = .020, Z = -2.33$). The control group in this sample is quite small ($n = 17$) due to difficulties in acquiring post-survey responses from participants. Obviously, this impacts our ability to draw conclusions about the differences between the control group and the treatment group.

A sense of control is considered a prerequisite for action in both The Theory of Planned Behavior and Paul Stern’s Values, Beliefs and Norms framework (Stern, 2000). Both treatment groups (IHD and IHD + incentive) that received the in-home displays had an increased sense of control over energy use.

### 4.3.3 Importance of home energy costs

H3: Self-reported importance of energy use costs will increase after exposure to behavioral interventions.

When I analyzed changes by treatment group from the pre to post survey, I discovered an outcome supporting the hypothesis that costs of energy use would increase
in importance. Both the IHD treatment ($p = .04, Z = -2.07$) and the IHD + incentive treatment groups ($p = .01, Z = -2.56$) produced a significant change in answers at the .05 level. Neither the control group nor the incentive group produced significant change. The overall mean of the pre-survey responses was 3.47 ($s = .53$), indicating a high level of importance and 3.63 ($s = .52$) for the post-survey responses. In contrast, the post-survey mean for the incentive group, while not statistically significant ($p = .739$) was 3.42 ($s = .607$), much closer to the answer, “[costs are] somewhat important” than “[costs are] very important”. Receiving real-time feedback, opposed to just financial incentives, seems to increase participants’ concern about the costs of their energy.

### 4.3.4 Likelihood of developing new behaviors

$H_4$: Self-reported energy efficiency behaviors will increase after exposure to behavioral interventions.

Several survey questions inquired about self-reported energy-saving behaviors. Two of the questions analyzed focus on present behaviors and four inquire about the likelihood of adopting new behaviors in the future.

Some research highlights an “intent to act” or “sense of obligation” as essential for behavior change (Lindén, Carlsson-Kanyama, & Eriksson, 2006; Sarkis, 2017). Of the six questions about energy-saving behaviors, the participants who received IHD’s were the only ones to produce significant changes in self-reported behaviors during the experiment. When asked about the frequency of closing curtains to conserve heat, the IHD group was the only treatment group to show a statistically significant effect ($p = .004, Z = -2.869$). When asked about the future likelihood of seeking more information
on energy efficiency, the IHD group was again the only treatment group with a significant effect \( (p = .042, \ Z = -2.036) \). The question on the likelihood of changing thermostat settings did not yield significant results for any treatment group, though to be clear, this would not necessarily save electricity in each household, depending on the fuel source. However, when asked about the future likelihood of shortening showers to save hot water and electricity, the IHD group again showed a significant effect \( (p < .005, \ Z = -2.801) \) when other treatments did not.

No group produced a significant effect related to turning off lights in rooms. This could be due to already engaging in this simple behavior. The overall mean of the treatment group in the pre-survey was 4.55 \( (s = .569) \) and the mean post-survey was 4.71 \( (s = .588) \). Both scores indicate a survey answer that most often was, “always” turning off lights.

These results partially support the hypothesis that exposure to real-time feedback via IHDS will increase self-reported energy efficiency behaviors. The IHD + incentive group did not display any significant effects related to the behaviors we inquired about in the survey.

### 4.3.5 Energy use data by treatment group

The research combining energy use data and self-reported data is growing, but still limited. Several recent calls for more work on the overlap between survey data and energy experiments point to the expanding interest in feedback as a tool to catalyze energy conservation (Hargreaves, 2018; Khosrowpour et al., 2018). Connecting self-reported behaviors to empirical evidence will increase the understanding of how intra-
household dynamics inform energy use data. To investigate the relationships between self-reported behaviors and energy use data, a repeated measures design was applied and a mixed marginal model was run with kWh usage as the dependent variable. Treatment group and time (pre and post measures) were examined both separately and as an interaction effect. A significant number of outliers were generated from the data, however examination of the standardized residuals (most were .00) indicate that the model is a strong fit for the data. I found no significant effect in the relationship between energy use data and self-reported behaviors. Table 4.2 describes the outputs of the marginal model. In order to not over fit the model, five covariates were used, representing discreet survey questions. These were: “ability to change”, “knowledge of energy use”, “importance of costs”, “how often do you close curtains?”, and “how often do you turn lights off?”.

Participants’ sense of control, labeled “Ability to Change” in Table 4.2 does show an effect across treatment groups, indicating a relationship with the dependent variable. Self-reported behaviors, (Close curtains and Turn lights off) show no significant relationship with energy use.
Table 4.2: Results of repeated measures mixed marginal model testing interactions between kWh and survey questions.

<table>
<thead>
<tr>
<th>Source</th>
<th>Numerator df</th>
<th>Denominator or df</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1</td>
<td>118.898</td>
<td>26.171</td>
<td>.000</td>
</tr>
<tr>
<td>Group</td>
<td>3</td>
<td>111.931</td>
<td>1.905</td>
<td>.133</td>
</tr>
<tr>
<td>Time</td>
<td>1</td>
<td>78.581</td>
<td>3.295</td>
<td>.073</td>
</tr>
<tr>
<td>Group * Time</td>
<td>3</td>
<td>78.858</td>
<td>.159</td>
<td>.923</td>
</tr>
<tr>
<td>Ability to change</td>
<td>1</td>
<td>91.801</td>
<td>7.850</td>
<td>.006</td>
</tr>
<tr>
<td>Knowledge of energy</td>
<td>1</td>
<td>119.345</td>
<td>.291</td>
<td>.591</td>
</tr>
<tr>
<td>Importance of costs</td>
<td>1</td>
<td>92.655</td>
<td>.026</td>
<td>.873</td>
</tr>
<tr>
<td>Close curtains</td>
<td>1</td>
<td>96.723</td>
<td>.738</td>
<td>.392</td>
</tr>
<tr>
<td>Turn lights off</td>
<td>1</td>
<td>107.827</td>
<td>1.329</td>
<td>.252</td>
</tr>
</tbody>
</table>

a. Dependent Variable: kWh.

4.4 Discussion

These findings suggest that although some perceptions changed in the treatment groups who received the IHDs, specifically a sense of control and importance of energy costs, real-time feedback as delivered by this IHD, does not guarantee a change in either self-reported behaviors or intentions to change behavior. In this sample, the results also generate questions about self-reported behaviors as a reliable proxy for actual energy use. This leaves questions about the accuracy of self-reported behaviors when used to predict actual energy use in the home. However, these findings indicate that some participants changed their perceptions of the importance of home energy costs, potentially opening a doorway for new behaviors. A utility trying to maximize the effect of programs (for example, subsidies for weatherization efforts), might consider targeting these customers.
The IHD group was the only treatment group to report increases in self-reported behaviors. Two of these questions both related to future actions, (“In the future, with what frequency will you…”) related to intentions to act, not current actions. These reported changes did not correlate with overall reduced energy use in this treatment group. This suggests that their perceptions of importance for employing certain energy conservation measures lags behind or may be totally disconnected to actual behavior.

In the IHD + incentive group, concern about costs increased, but this did not translate to reporting more frequent energy efficiency behaviors. Concern about costs also increased in the IHD group who also reported increased frequency of energy use behaviors. However, the IHD group did not actually reduce energy use (see Fredman et al., forthcoming).

Significant literature exists connecting self-reported behavior with real-time feedback technology, however without clear energy use data to support participants’ reports, it is difficult to confirm the actions [86, 96,104,171,189]. Nonetheless, answers to the questions on “future likelihood” of adopting new behaviors indicate interest and perhaps a willingness to adopt new behaviors.

These findings highlight three issues with behavioral interventions and energy use research. First, limited evidence was found that self-reported behaviors predict energy use for this sample. This discrepancy may be related to misperceptions and biases that influence the accuracy of self-reported behaviors in households. For example, significant misperceptions were found within the general public when participants
were surveyed on strategies for energy conservation [179]. In an experiment testing participants’ knowledge of energy used by appliances, the authors found that most people overestimated the amount that small appliances use and underestimated the amount that larger appliances use. This research highlights a knowledge gap and the misunderstandings most people have about household energy use. Availability bias [190] may also influence individuals' ability to accurately account for actions connected to energy use. People often misjudge the frequency of certain behaviors, and relying on memory can distort perceptions, favoring the actions taken most recently. This phenomenon is closely related to the role of habits in household energy use behaviors. The importance of habit formation as a determinant of behavior is sometimes referred to as "behavioral lock-in" [90]. Habits are deeply engrained behaviors that are difficult to change and unconscious. Unconscious behaviors are of course, difficult to track. The make-up of the households may also influence the reliability of these reports. In this study, the influence of roommates could have significantly affected the accuracy of self-reporting. One individual in each household reported their behavior on the surveys, but in some cases up to six other students were living in the same household.

More broadly, it is very difficult to disentangle the Hawthorne effect from the intervention effect, whereby participants in a study change their behavior simply as a result of being observed. For example, in one study, sending postcards to participants, reminding them of their presence in a study, caused a 2.7% reduction in energy use (D. Schwartz, Fischhoff, Krishnamurti, & Sowell, 2013). It is possible this effect is
also at play in this study. In particular, the control group showed a statistically significant change in response to questions about a sense of control over energy use.

In response to challenges of predicting energy use using self-reported behaviors, studies on household energy use must include actual energy data. Several scholars have issued the call for more energy use data in behavior studies [109] and this has recently been highlighted in the social sciences. A new paper emphasizes the critical need for energy use data in forthcoming studies on residential behavior and energy to supplement self-reported data [110].

The second key issue that this study highlights is the importance of impact. The behaviors targeted in this experiment yield very small changes in energy use compared to behaviors like energy efficiency upgrades in the home or changes in transportation choices. This is further supported by Dietz et al, who analyzed the various actions possible in a household to reduce greenhouse gas emissions [191]. Weatherization and thermostat setbacks yielded the largest impact inside the home and transportation choices were the most impactful decisions a household can make. Weatherization is not a logical investment for a student renter and thermostat setbacks are unrelated to electricity use. In addition, the average daily household kWh usage in this study of student renters was approximately 10 kWh. The average daily use for homes in the United States is 30 kWh [192]. The opportunity for reduced emissions in this sample is relatively low compared to other households.
In addition, behavioral interventions must be designed with users in mind. Other studies cover this point extensively [77,104], raising questions about the ability of current IHDs on the market to influence behavior.

The participants in this study were college students and renters, and largely of the millennial generation. While relatively homogenous as a sample, key differences within this group could influence results. Though the students who took the survey were responsible for the energy bill, it is not possible to know exactly how the bill was paid. For example, it is possible that parents or relatives financed the bills. It is also likely that the bills were split among members of the household. In this way, one person sees and physically pays the bill, but several are contributing to the cost. This changes the influence of natural financial incentives that are an assumption of this study design. This is somewhat similar to single-family rentals in which a parent might be responsible for a bill, but children or others in the home contribute to energy use and thus, the cost. However, it is likely that the dynamic in single-family homes is different than those in homes of friends or acquaintances. This leads to the complicating issue of income and the motivation to save money on utility bills. Though the students in this study might be technically considered low-income due to lack of full-time employment, college students receive different levels of financial support, sometimes from parents and relatives. Therefore it is difficult, and likely not accurate, to draw conclusions from this study that are wholly representative of other low-income renters.

Finally, this study is comprised largely of people born between 1982 and 1999 and referred to as the “millennial generation”. The academic literature on millennials and
energy use is scarce, but two industry reports in the last three years highlight the importance of this demographic group in shaping the energy industry (Accenture, 2016; “Research Release: SECC’s Spotlight on Millennials | Smart Energy Consumer Collaborative,” n.d.). According to industry research, this is the first generation to grow up in a world discussing the impacts of climate change and the connection to fossil fuel energy. Perhaps because of this influence, millennials tend to support renewable energy policies more often than non-millennials and more than half interviewed in a consumer insights study claimed they plan to install solar panels in the next five years (Ollangier, 2016). This is also a group comfortable with digital technology and highly demanding as digital customers. Further, millennials are renters at higher rates than other age groups and are almost as likely to own their home as they are to rent (SECC’s Spotlight on Millennials, 2017). This sample is largely representative of typical millennials, demonstrating concern about climate change, interest in digital technology and also salient critiques of IHD technology.

This study has several significant limitations. Recruiting and data challenges led to a small sample size overall, and in particular in the control group. A small sample size and the influence of the Hawthorne effect leaves questions about the generalizability of these outcomes. As mentioned, the unique make-up of these households, including the fact that the participants are students, also limits the generalizability to low-income renters. Specific to experiments testing real-time feedback technology, lies the challenge of accurately tracking the application of the intervention. Several participants reported
not looking at the IHD or even physically hiding the device, rendering the treatment irrelevant. Further, the kWh data was not weather normalized.

Further research should examine in-home displays carefully with other demographic groups, applying a broad frame, such as the energy cultures framework to understand the contributing factors to changes, or the lack of changes in household energy use. The outcomes of this study are only relevant to IHDs and not to other forms of real-time feedback. Digital smartphone apps as a tool to deliver real-time feedback are an area of growing research and should continue to be tested as an alternative or compared to the effect of IHDs.

4.5 Conclusion

Behavioral interventions, and particularly real-time feedback mechanisms, are of great interest to researchers and utilities. It is important then, to accurately state the benefits and the problems that may compromise the efficacy of the treatment. Some research indicates that the “tremendous faith” being placed in feedback should be tempered with a more detailed look at the evidence (Buchanan et al., 2015b). The literature on IHDs highlights several problems with feedback, including limited evidence of efficacy and the potential for unintended consequences, and proposes that new in-home displays must be designed with users in mind (Buchanan et al., 2014, 2015b). At least some of the research supporting the efficacy of feedback does not incorporate a randomized control group against which to compare results (Delmas et al., 2013).
Finally, there are still many questions about the efficacy of feedback mechanisms in residential settings. The mixed results in this study also leave questions about the reliability of this particular intervention. Even in a highly educated demographic, living in an environmentally conscious state, feedback and incentive treatments were not perfectly reliable interventions. Future research should continue to investigate the relationship between self-reported behaviors and perceptions and actual energy use, but more importantly, researchers should be cautious about using self-reported behaviors to predict energy use. The research indicates real-time feedback has potential in households as an effective intervention, but more work needs to be done to understand where impact can occur. It is possible that feedback devices could be more impactful in single-family homes of homeowners. This calls for more research, with quantitative and qualitative work, to better understand how householders are interacting with these devices.
CHAPTER 5: LIMITATIONS AND OPPORTUNITIES FOR REAL-TIME
FEEDBACK AMONG UNIVERSITY STUDENTS IN RENTAL HOUSING

To be submitted to: Energy Research and Social Science

Abstract

The results of an experiment testing the effects of real-time feedback and incentives on millennial energy users showed limited evidence for the effect of in-home displays on participants’ energy use. Experimental results of behavioral interventions on household energy use are complicated by the influence of the Hawthorne effect, sample size issues and the persistence of effects. In particular, in-home displays raise questions about the information displayed on the devices and the layout of the display for users. The results of qualitative data collected post-experiment from interviews with participants, investigate responses to the in-home displays and potential reasons for inconclusive outcomes on household energy use from the experiment. Following a discussion of the results, several recommendations are made, including that IHDs be used sparingly and strategically with millennial energy users and renters. As utilities look for cost effective behavioral interventions, it’s likely that greater opportunity for energy savings can be found in other customer segments, and with other forms of feedback technology.

5.1 Introduction

Behavioral interventions, such as influencing social norms, installing feedback mechanisms and encouraging public commitments, show promise for reducing household energy use (Abrahamse & Steg, 2013; Abrahamse, Steg, Vlek, & Rothengatter, 2007;
Byerly et al., 2018; Faruqui, Sergici, & Sharif, 2010; Karlin, Zinger, & Ford, 2015a; Osbaldiston & Schott, 2011). This is important for utility companies across the country who are urgently investigating avenues for additional energy savings as energy costs rise, climate change impacts accumulate, and the simplest efficiency opportunities dwindle.¹⁰ These combined factors promote a growing interest in behavioral strategies to nudge residential customers towards reduced energy use. However, despite the promising research in this space, there is still much to uncover (Byerly et al., 2018). Some studies report energy savings from 3% to 20% (Abrahamse, Steg, Vlek, & Rothengatter, 2005; Fischer, 2008) while others find methodological problems and point to 2% savings as a more reliable estimate (Delmas et al., 2013a). Other lines of research highlight the complexities of household dynamics, individual preferences and schedules as critical patterns to uncover for a more accurate understanding of household consumption (Bell et al., 2015).

As a domain for behavioral interventions, residential energy use is unique. The electricity use of an appliance is not readily visible like water use, for example, and is measured in kilowatt hours, units unfamiliar to most consumers. The perceived benefit of real-time feedback is that it “makes energy visible” (Hargreaves et al., 2013). However, the elements of real-time feedback, like frequency, units displayed, and the technology used, vary greatly. These elements contribute to varying levels of efficacy (Buchanan et al., 2015b; Hargreaves et al., 2010a, 2013).

¹⁰ In the energy efficiency industry, this phenomenon is colloquially referred to as the “lighting cliff”. Much of the low-cost, relatively easy energy efficiency measures have been achieved by selling and installing LED light bulbs and CFL light bulbs. Other measures are more expensive to implement.
This paper will describe the influence of real-time feedback devices on household energy use in off-campus student rental housing in a university community. After analyzing eleven interviews conducted following an experimental study on the impact of IHDs and financial incentives, several key themes arose and are discussed. A mixed-methods approach, like the one used in this study, offers many perspectives and tools for social science in understanding energy cultures and the impacts – both intended and unintended – of behavioral interventions.

In this study, millennial renters are the focus to develop an understanding of how this customer segment influences the development of new technologies designed to reduce or shift household usage energy use to renewable sources. Several scholars call for a better understanding of the influence of demographics, pre-existing knowledge, attitudes and behaviors on behavioral interventions. This is true particularly regarding feedback, perhaps the most tested behavioral intervention available, showing promise for household energy reductions (Ford, Karlin, & Frantz, 2016; Karlin, Zinger, et al., 2015b).

Most of the empirical work in behavioral energy studies has been conducted with various interventions that are referred to as “feedback” and is often combined with other interventions for behavior change like financial incentives, norms and goal setting (Faruqui et al., 2010; Karlin, Zinger, et al., 2015a). The highly visible and popular OPower program, combines feedback and social norms, and is frequently cited within utilities as the energy behavior program in the program portfolio (Allcott, 2011; Laskey, 2013). Using a report that compares the customer’s use to those in the surrounding area,
the famous program\textsuperscript{11} takes advantage of a sense of responsibility in consumers, swaying people to reduce their own use, when compared to their neighbors. Other iterations of feedback programs target the energy use of entire buildings, as in a dorm or apartment setting. In-home displays (IHDs) have been investigated as tools to increase the salience of feedback by displaying real-time energy use information via digital monitors in the home (Buchanan et al., 2014, 2015b; Faruqui et al., 2010; Karlin, Zinger, et al., 2015a). The majority of these studies combine this treatment with either social norms or incentives and show mixed results (Abrahamse et al., 2007; Delmas et al., 2013a; Faruqui et al., 2010; Karlin, Zinger, et al., 2015a).

Research on incentives have also shown mixed results. One study found that price signals were effective at reducing energy use only when real-time feedback was also present (Jessoe & Rapson, 2014a). Using incentives as a behavioral intervention is often complicated by the cost of energy; electricity in particular, is considered low-cost for most consumers, and can create “boomerang effects” in consumers. For instance in one analysis, researchers found that consumers reduced electricity use when prices were reduced – the opposite of what we might expect (Jessoe et al., 2014).

Clarity regarding the impact of household level behavioral interventions is muddied by complications related to intra-household dynamics (Hargreaves et al., 2010a, 2013; Maréchal, 2009). As mentioned by several scholars, energy research and discussions center on terms such as “incentives, feedback, discounting and efficiency”, but energy use happens inside homes with mundane activities such as cooking, doing

\textsuperscript{11} In 2016, Opower was acquired by Oracle, a software company.
laundry and showering (Karlin, Zinger, et al., 2015a; Maréchal & Holzemer, 2015). In a review of pro-environmental behavior, Klockner found that the most influential factor in behavior change was intention, followed by habits and perceived control (Klöckner, 2013). He finds that interventions addressing perceived behavioral control are as important as changing attitudes. Giving consumers information on energy use is not enough, people must also know what to do and how to do it.

Intra-household dynamics are one component of the various factors influencing household energy use. This can be described as an “energy culture”, and provides a useful framing for the broader picture of energy use like appliances in the household, perceptions of energy and daily habits (See Figure 1) (Barton, 2013; Lawson & Williams, 2012; Stephenson et al., 2015). The figure reflects the influence of outside factors on behavior and highlights the complexity of energy use as influenced by cognitive elements of the user and physical elements like buildings. Measuring “think, have, do” before and after a behavioral experiment by assessing cognitive norms (think), materials (have) and behaviors (do), may offer insights on how and for whom interventions work. More recently, this framing has broadened to include other domains like water use and has been referred to as “sustainability cultures” (Stephenson, 2018). Multiple components contribute to energy use including demographics, social norms, habits and variation in living structures and appliances, and a more comprehensive understanding of these elements may improve our ability to target behavioral interventions and programs to specific energy users. This broad framing also promotes interdisciplinary research, extending our understanding of human behavior (Barton, 2013; Karlin, Zinger, et al.,
2015a; Maréchal & Holzemer, 2015). More traditional measures of efficacy focus on energy savings, and almost exclusively on kilowatt hours saved.

The energy culture of focus in this study is comprised of renters, an important group for utilities with energy reduction goals, and a challenging market to reach due to the “split-incentive problem” (Dyson, Inc, Chen, & Samiullah, 2010; Gichon, Cuzzolino, Hutchings, & Neiger, 2012). The “split-incentive” is traditionally described between the landlord and tenant. A landlord has limited motivation to provide energy efficiency upgrades because she is not paying the energy bills. Similarly, a tenant has limited motivation to invest in energy efficiency of the property, because she does not own it. In addition, two other forms of the split-incentive exist. A temporal split-incentive exists when renters don’t know how long they will stay in the current residence and a “decoupling” exists when utilities are motivated to sell the most electricity (Bird & Hernández, 2012). This study most directly addresses the traditional landlord-renter aspect of the split-incentive problem.
This study directly addresses the challenge of reaching millennial-age energy consumers and renters, critical target markets for the future of energy utilities (Accenture, 2016; Gichon et al., 2012). Millennials (generally defined as those born between 1982 and 1999) are now the largest demographic in the United States and based on new research from Accenture, are a different type of energy consumer that is more demanding, highly engaged, tech-savvy and generally in support of renewable energy (Accenture, 2016). These findings align with a report released in 2017 by the Smart Grid Consumer Collaborative (SECC’s Spotlight on Millennials, 2017). Despite industry research on this important group, the academic literature is thin. This study fills an important gap in the behavioral literature. As more utilities unveil behavioral interventions and feedback technology, how might millennials respond? This study asks this question in relation to the use of IHDs.
5.2 Methods

5.2.1 Population and data collection

This study describes the interviews conducted as part of a mixed-methods experiment with off-campus student renters at the University of Vermont (UVM), a public university with 10,500 undergraduate students and 1,500 graduate students, plus a medical school. UVM has a strong commitment to environmental issues and sustainability initiatives and is situated in Burlington, Vermont, in a region known for a robust sustainable food movement, a commitment to environmental ethics and progressive politics. The Gund Institute for the Environment at UVM published the first state-level climate change assessment in the country (Galford et al., 2014), and the state of Vermont adopted an aggressive set of renewable energy targets in 2011 to achieve 90% of the state’s energy needs from renewable sources by 2050 (Vermont Department of Public Service, 2016). Undergraduate students from the university meet course requirements in diversity and sustainability, one of the first such undergraduate education requirements in the country. In addition, the university has been rated in the top tier of colleges in the country for its institutional commitments to sustainability (“Green Colleges | The Princeton Review,” 2017; “UVM Receives STARS Gold Rating for Sustainability Efforts | UVM Office of Sustainability,” 2017). This includes the creation of the Clean Energy Fund (CEF), a student-generated fund at the University of Vermont supporting student-led clean energy research projects and clean energy development on campus. The CEF was granted status by the Board of Trustees in 2007 and provided the funding for this study.
The Off-Campus Energy Study began in late December 2015 and closed in May 2016, collecting three total months of smart meter electricity use data in February, March and April through an agreement with Burlington Electric Department, a municipal utility in Burlington. Burlington Electric Department is interested in behavioral interventions as strategies to reduce energy use and costs and supported the collection of smart meter data required for this study in exchange for information on how behavioral interventions affect its customers. Because nearly 1 in 4 residents in Burlington, Vermont is a college student at the University of Vermont or Champlain College, this customer segment is critical for Burlington Electric Department (Woolf, 2016). The overall goal of the Energy Choices Challenge was to test the effects of real-time feedback and IHDs in addition to financial incentives in off-campus student housing. In this convenience sample, eleven interviews occurred within three weeks of the close of the experiment, at participants’ homes. Interviewees are a self-selected group who responded to requests for interviews in exchange for gift cards to the local market. Burlington’s fraction of renters is just below the national average, but in the last three years has increased by 1.88%, while the national average has stayed almost constant (+.038%). In Burlington, close to 35% of households are rented (“Residential Rent Statistics for Burlington Vermont | Department of Numbers,” 2017). For this reason, Burlington’s local municipal utility is interested in effective strategies to reduce the split-incentive problem.

The study also included a pre and post experiment survey evaluating self-reported knowledge, attitudes and behaviors and administered through Limesurvey, an online platform (See forthcoming Palchak et al.). The experimental component of this project
uses a two by two full-factorial design, with two different treatments. The incentive treatment group (n=24) and feedback treatment (n=50) and a treatment group combining feedback and incentives (n=52). A control group was developed for comparison. Households were randomly assigned to treatment groups and a survey conducted before and after the Off-Campus Energy Study experiment tested how perceptions of energy use change after engagement with real-time feedback and incentives. See Figure 5.1 for a visual description of this mixed methods approach. Lopes et. al calls this combination of approaches “energy behavior modelling” and though growing, is still a limited area of research (Lopes et al., 2012).

Following the close of the experiment, participants were sent an email requesting participation in the post-survey. Students who completed the post-survey were again emailed with an offer for a $25 gift card to the local natural foods store in exchange for an hour of time in an interview. The largest number of respondents were in the IHD treatment group.
The interviews were conducted over a three week period in May 2016. Most interviews were conducted in participants’ homes, and lasted for approximately an hour, with two interviews occurring on campus. Four interviews included the participants’ live-in partner or spouse. There are several references to the financial incentives in the interviews, but largely the participants and the researcher discussed the effect of the Ceiva In-home displays (See Figure 5.2). This focus allows for conclusions on the impact of a specific type of real-time feedback. Particular attention was paid to intra-household dynamics focused around three themes that comprise the Energy Cultures framework; norms, materials, practices – or more often referred to as, “think, have, and do”. Norms reference opinions and knowledge related to energy use; materials refer to items in the home, specifically appliances; practices are habits and daily living patterns (Stephenson, 2018; Stephenson et al., 2010).

5.2.2 Data analysis procedures

The central question for the development of the interview guide was, “How and for whom do in-home displays work?” This refers to the influence of behavioral interventions in reductions of household energy use. The interview guide was developed with questions from several key studies on behavioral interventions and feedback technology. While the type of data may limit the generalizability of the results, these interviews directly address gaps in the literature highlighted by Sovacool and others, who call for more social science in energy studies (B.K. Sovacool, 2014) and specifically, a more robust investigation of the efficacy and variation in real-time feedback interventions (Buchanan et al., 2014, 2015b; Hargreaves, 2018). With the rise of smart meter data,
Qualitative data is often overlooked in energy studies, but is crucial for effectively targeting utility customers with specific behavioral interventions. In the words of one researcher, qualitative research is less about generalized hypotheses, but is concerned with meaning behind phenomenon (Mason, 2010).

Eleven interviews were conducted using a convenience sample of study participants who responded to requests for interviews. Interviews were recorded and transcribed using a transcription service. The interviews were then coded using HyperRESEARCH 3.5.1, a qualitative text analysis tool. To examine associated survey data, data were exported from LimeSurvey and analyzed using SPSS software. In this paper, survey data are primarily used to describe the sample.

Qualitative research is a search for patterns in the data and the process of coding enables the researcher to uncover these patterns (Saldana, 2015). The interviews were coded by highlighting themes related to cognitive norms from the Energy Cultures literature and a grounded theory approach discussed by Creswell and described by Saldana as “codifying, categorizing, recoding and recategorizing” the data (Creswell, 2013; Saldana, 2015).

Energy use data was generated from smart meters and access was made possible by a partnership with Burlington Electric Department, the local municipal utility. To generate a change in energy use value, 12 weeks of pre-study data was averaged and compared with the data generated after the start of the study. Qualitative data are presented in quotes and the emergent themes identified through the coding process along with unintended consequences can be seen in Table 1.
5.3 Results

Initially, transcribed interviews were read several times to familiarize the researcher with each document. Phrases and words “with meaning” were captured and coded. At the time of the interviews, all of the interviewees had participated in the post-experiment survey and had returned their IHDs. The themes covered below represent the clustering of four to five distinct codes discovered during the coding process, representing similar ideas that were seen multiple times in the interview data. These themes arose in response to the questions that were asked in interviews and were informed by the literature on real-time feedback.

Four of the interview participants were women, seven were men. Nine of those interviewed lived with at least one other person and three of these participants had at least three people in their household. Participant #11 lived in a large apartment with six other renters, also millennial-age university students. All of the participants interviewed were university students except one, who was a recent graduate working in Student Services at the university. A variety of academic majors are represented in this sample, from engineering to medicine to food systems. This fact is notable, demonstrating a potential interest in energy efficiency from students across a variety of academic interests. Every participant interviewed except #9 installed an IHD in their home. Five of those interviewed reduced their energy use from the twelve weeks preceding the behavioral intervention to the period following the intervention. Two of these reductions were very minimal reductions less than .25 kWh. Almost all of the participants had natural gas heating systems and lived in small apartments or duplexes near downtown Burlington.
Table 5.1 provides an overall description of this sample, describing each participant and codes associated with their interviews.

Table 5.1: Coded themes in interview data

<table>
<thead>
<tr>
<th>Interview Participant ID Number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
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<tbody>
<tr>
<td>Treatment</td>
<td>HD and $</td>
<td>HD and $</td>
<td>HD</td>
<td>HD</td>
<td>HD and $</td>
<td>HD</td>
<td>HD</td>
<td>HD</td>
<td>HD</td>
<td>HD</td>
<td>HD</td>
</tr>
<tr>
<td># of men in household</td>
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<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td># of women in household</td>
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<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Daily average energy use change</td>
<td>-.25 kWh</td>
<td>-.75 kWh</td>
<td>-.75 kWh</td>
<td>-.25 kWh</td>
<td>-.65 kWh</td>
<td>+1.24 kWh</td>
<td>+.51 kWh</td>
<td>+.64 kWh</td>
<td>-.97 kWh</td>
<td>-.22 kWh</td>
<td>-.12 kWh</td>
</tr>
<tr>
<td>Property type</td>
<td>Duplex</td>
<td>Duplex</td>
<td>Medium apartment building</td>
<td>Small apartment building</td>
<td>Duplex</td>
<td>Medium apartment building</td>
<td>Small apartment building</td>
<td>Single-family home</td>
<td>Small apartment building</td>
<td>Small apartment building</td>
<td>Small apartment building</td>
</tr>
<tr>
<td>Estimated eq. ft. of home</td>
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<td>1800</td>
<td>600</td>
<td>1000</td>
<td>600</td>
<td>1000</td>
<td>800</td>
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<td>1800</td>
<td>750</td>
<td>600</td>
</tr>
<tr>
<td>Main heat source</td>
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<td>Don’t know</td>
<td>Natural Gas</td>
<td>Natural Gas</td>
<td>Natural Gas</td>
<td>Electricity</td>
<td>Oil</td>
<td>Natural Gas</td>
<td>Natural Gas</td>
<td>Natural Gas</td>
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</tr>
<tr>
<td>Field of study</td>
<td>Radiation Therapy</td>
<td>Food Systems</td>
<td>Physical Therapy</td>
<td>Civil Engineering</td>
<td>Civil and Env. Engineering</td>
<td>Mechanical Engineering</td>
<td>Student Services</td>
<td>Medicine</td>
<td>Medicine</td>
<td>Computer Science</td>
<td>Biology</td>
</tr>
</tbody>
</table>

Interview Themes

- Convenience is very important
- Can’t change lifestyle
- Cost of energy is low
- Renting limits options
- Live with roommates
- Feedback reinforced
- New habits developed
- RDD should disaggregate data
- RDD increased
- RDD increased awareness of cost
- RDD increased awareness of use
- RDD could be more intuitive
- Limited sense of control
- Connected to use action
- Motivated by cost of energy
- Smells or noises were motivating
- Awareness of use increased
- Technology oriented
- High sense of control
- Unplugged or stopped using device

a: HD = single display, $ = incentive

b: calculated using average daily kWh data from pre-experiment period and average daily kWh data following the start of the study
5.3.1 Increased readiness for change

Participants who indicated a readiness for change referenced the cost of energy use as motivation for reducing use or increased awareness of energy use behaviors. Two participants in particular, displayed a high degree of interest in feedback technology and indicated a strong sense of engagement with the in-home display.

Five of the participants interviewed acknowledged that the IHD increased their awareness of energy use. Three participants directly connected an action in the household to the display on the IHD.

Participant #3 displayed a unique excitement about the IHD that was notable, when compared to other participants. She was highly engaged with the technology and during the interview mentioned several times that she unplugged appliances when leaving for the day. In describing this habit, she explained that this was an action she took before receiving the IHD, but it was reinforced by the persistent feedback on energy use. During the course of the study, her daily average energy use was reduced very slightly (-.73 kWh). Representing those who engaged with the IHD, participant #3 spoke about how she used the device to process feedback:

*It definitely made me more aware of the energy I was using. I would notice it especially when leaving on vacation or if I was going away for the weekend, I would not only make sure that everything was turned off, but I would unplug most things around here.* – 3, IHD
Participants who highlighted a specific energy reduction action often referred to the financial cost of the action, rather than the energy use. Participant #6 tested several methods for bringing costs down and described taking shorter showers and testing new cooking methods.

*Cooking in the slow-cooker, it usually cost between a dollar and two, and cooking on a stove, it was sometimes even $5 or $6. – 6, IHD*

Participant #8 was pragmatic in her approach to energy use and acknowledged that though she cared “about the environment and things”, cost was a central motivator for change.

*It was interesting to look at it when I was running both the washer and dryer. It’ll tell you how much an hour you’re using. Sometimes it would be eight cents, but if everything was running it was higher than that. – 8, IHD*

The themes identified here indicate that these participants were, to some degree, engaged by the technology and connecting their actions to the information they saw on the IHD. In this small sample, interest, excitement and effort did not reliably translate to lower energy use following the introduction of the behavioral intervention.

### 5.3.2 Examples of behavior change

Participants were asked directly about the changes they made in their homes during the study and responded by discussing different cooking habits and unplugging devices. Two participants pointed out that the IHD reinforced pre-existing habits. This research also found some evidence for the creation of a new norm in a household of
roommates who, after several weeks with the IHD in their home, began pointing out wasteful energy use to one another. The following quote highlights a household of seven students with one renter (quoted) who has high motivation to reduce energy use. The other renters in the household resist his efforts to influence their daily usage. He describes watching a housemate walk in the house and turn on lights while others were sitting in the living room.

We watched him just walk through the house and turn all of the lights and someone called him out on it. And so I mediated this argument, and used the IHD to be like, “Yeah, well, obviously, we’re using this much electricity. It’s pretty high.” ...He became more inclined to not leave all the lights on, but it was just a funny argument that I don’t think would have happened without the IHD. – 11, IHD

The participant quoted below described unplugging lamps and other appliances before leaving on vacations and was particularly engaged with the study.

Then there was also a period where my landlord was working on the heat, and I didn’t have heat for a couple of hours, so I plugged in a portable heater thing, and I noticed the electricity skyrocket. So that was a little terrifying, so I shut it off right away and just grabbed more blankets and sweatshirts and all that. - 3, IHD

However, there is also some evidence that participants were discouraged by the feedback they received on the IHD showing minimal energy use reductions, particularly when they were highly engaged with the study. Participant #3 reduced energy use minimally during the study but expected to save more.
I think because of this study, the fact that I was doing all these things, and they didn’t really affect my energy bill a whole lot, I’d say that I’m just going to keep on doing what I do anyway. – 3, IHD

Similarly, another participant noted the limited change in energy use, and indicated that it reinforced existing practices. He saved slightly during the study, but also expected to see a more observable difference in his bill.

I don’t think it changed very much. I basically just went about my usual routine, saw what was going on the energy monitor and tried to pay attention for anything that would spike it. And as mentioned, the only thing that I could pinpoint as being a large draw of electricity was my oven. Basically, I just did what I always do. – 10, IHD

Four participants reported either physically moving the device out of view or simply no longer watching the device. The quote below is from an engineering student who indicated that initially he was very interested in the IHD, however after a short time he and his fiancé decided to hide the device due to the design of the digital display and the aesthetics of another screen in their small apartment.

We both felt the same way, that we didn’t like the in-home display and we had it turned off for probably the majority of the time after, say, the first week. It was plugged in...and I would say it sat on that bookshelf for maybe a week. And then after that, we turned it off and hid it behind the chair. – 4, IHD

Similarly, participant #8 was excited to install the IHD but after a short amount of time, the impact of the display on her behavior was minimal. In her interview, she
highlighted a limited sense of control after initially adjusting her behavior and not seeing a dramatic change in her overall energy use. She highlights the impact of this in the following quote.

_The first week, I was like, “Oh, I wonder what it’ll be like if I turn the lights off more or shift that around” And it didn’t seem like it made a huge difference to do small changes, so then I just, over time, completely forgot about it._ – 8, IHD

These actions highlight the importance of designing feedback technology with users in mind. A device that is not salient and easy to use, or is perceived as ugly has a high likelihood of being discarded. In addition, it’s possible that the participants quoted here are not ideal users for this technology.

### 5.3.3 Ambivalence due to marginal cost and living complexities

Participants referenced several challenges to impactful behavior change, including the low cost of electricity and the complications of renting. Living with housemates, and convenience were also noted as challenges for further reducing energy use.

The low cost of energy use, displayed as cents per kWh per hour, on the IHD was the most frequently cited challenge to increased energy conservation. This is enhanced by the relatively small structures that most of the participants lived in. The challenges of renting were also cited frequently. In at least one household with an IHD, the reaction to the low cost of energy use may have created disincentives for conservation. The household referenced below had several acquaintances living together to save money, with similar values. The woman interviewed (#2) agreed to participate in the study to
support research efforts in academia but had difficulty persuading her housemates to engage strongly with the behavioral interventions.

*It actually encouraged us to not conserve, because it’s really low. It’s about $21 per month, so it’s $7 per person. Even if I were to really change my habits, I don’t think that I would see that reflected in more than a couple of dollars’ worth of difference.* – 2, IHD/Inc

Living in a houseful of students created unique challenges for energy use behaviors. Through interviews, we learned that the student who enrolled in the study was often living with other students were uninterested in the study. Below, a particularly motivated young man describes his frustration with his housemates. Throughout much of the interview, he discussed his commitment to save energy and his excitement about the IHD, only to see his efforts thwarted by his friends.

*With so many people in my house, someone’s always using the TV, there’s always people around, and there’s a constant demand for light, because everyone’s always over in the evening. I try to influence them, but I can’t really change their behaviors. And I did everything I could to reduce my electricity usage, but I would still come home to the house when the lights are always on.* – 11, IHD

Overall, this household’s electricity use went up slightly during the study (+1.28 kWh). While it’s possible that energy use could have increased further without the IHD, the complicating factor of multiple roommates and varying opinions on the importance of conservation compromised the efforts of one highly motivated student.
5.3.4 Limited sense of control over energy use

When asked about their sense of control over their electricity use, most of the people interviewed indicated that they did not feel a strong sense of control ($n=8$). Even participants who were heavily engaged with the technology had reservations about their level of influence over the energy consumption of their households. Below, a participant describes his commitment to reducing use but highlights the minimal impact he has due to the constraints of his situation as a renter. In this case, he reduced use almost unperceptively (-.22 kWh).

*Being a renter, the large appliances are provided for me. And the upkeep of the apartment is not entirely in my hands, so I would say that’s definitely two limiting factors. It leaves in my control most of the smaller objects. I think the largest user of electricity that I brought into the apartment is probably the microwave. And I don’t use it. I don’t feel there’s anything in here that I have direct control over that is excessively wasting power.* – 10, IHD

This study also found evidence for the presence of a split-incentive within households and between housemates. The quote below describes the challenges highlighted by three participants interviewed. Living with housemates complicates the influence of a single, motivated person in household and can create conflicts of behavior whereby one person who is motivated to reduce energy use is thwarted by others in the home who are not motivated.
I live with two roommates, so I feel like within my household, which is three people in my apartment, including me and two people downstairs, there’s five of us, ... I can change my own behaviors, and I can ask my roommates to change, but I don’t feel like I have a huge amount of control over our output as a household. – 2, IHD/Inc

Overall, despite the impact of real-time feedback, 73% of those interviewed – all of whom had an IHD in their home - indicated a lack of full control over electricity use. This is an interesting finding, because the Theory of Planned Behavior proposes that a sense of control or sense of agency is a necessary prerequisite to behavior change (Ajzen, 1991). In this sample, a sense of control was influenced by a hesitation by these renters to invest in infrastructure that they do not own. Living with other renters also seems to reduce a sense of control and both of these issues represent the confounding factors experienced by the IHD treatment group participants.

5.3.5 Implications for IHD displays

Some participants welcomed the addition of a digital monitor in their home while others were opposed to it. Several participants commented on the usefulness of the rotating photos and the weather reports.

The quote below highlights the irrelevance of the IHD in some households. This particular quote is an example of the Hawthorne Effect, whereby a person’s behavior is influenced simply by the knowledge that they are under observation. The Hawthorne Effect is very difficult to untangle from the effects of a specific behavioral intervention (D. Schwartz et al., 2013).
The household aesthetic is very hippie, and an electronic display was completely not okay with one of the people I live with. And so it was in a common place, and I saw it, and I thought about it, but it was pretty much just a Pavlovian thing, for me personally, to be reminded that it was there and it was tracking us, because the display itself was off. – 2, IHD

Six participants stated that the IHD needed more interactive functionality or disaggregation to increase users’ understanding of the feedback. Three users indicated that the functionality of the design was problematic or clunky. These findings are consistent with other research stating that not all feedback is alike and not all IHDs are alike (Buchanan et al., 2015b; Hargreaves et al., 2010a, 2013). Buchanan et al. argue that manufacturers must keep customers in mind when designing feedback technology because the design can directly affect the efficacy, as we see in these interviews. If users don’t like the device, it can end up “behind the bookshelf”. In this case, a company (Ceiva) is repurposing a product originally designed for rotating photos, so although it’s an innovative use for the product, the product was not designed with energy users in mind.

Highly specific designs for particular customer segments may be especially important for millennial users who are sometimes referred to as “digital natives”, comfortable with technology and holding high expectations for their digital experience (Prensky, 2001). A large project by Accenture Consulting in 2016 found similar characteristics in millennial age energy users, characterizing this group as willing to
experiment with new technologies, highly interested in renewable energy and “much more demanding” (Accenture, 2016). This means that products intended to attract this energy culture must be designed with input from these users.

5.4 Discussion

Generally, the evidence from these interviews indicate that challenges caused by renting, low electricity rates, and living with roommates may complicate opportunities for large energy savings through information feedback. This supports statistical data from the experiment which finds no effect in the IHD treatment group and a very small effect in the IHD + incentive group (Fredman, forthcoming). Almost every participant interviewed expounded upon one of these challenges. In general, this population of millennial college students who are renting, may not be the ideal group for this real-time feedback technology. Several possible reasons for this are discussed below.

Though not all of those interviewed are easily categorized, two distinct types of users were identified during the analysis phase of the study. The first type of user was strongly motivated to save energy, excited about a digital interface in their home and frequently engaged with the technology. The second type of user, while self-selected to be in the study and interested in energy conservation, was not regularly engaged with the technology once it was installed, and either stopped using it or physically removed it and generally did not view the device as having significant benefits.
5.4.1 Cybersensitives

The first type of user displays some qualities that have been referred to in other work as “cybersensitive” (Indica Consulting, 2017; Reeves & Rai, 2018). This name was developed by Foster and Mazur-Stommen after an extensive mixed-methods analysis of real-time feedback studies that included energy use data, surveys and interviews (Foster & Mazur-Stommen, 2012). They identified a small subset of consumers who were uniquely connected their personal digital devices and had formed a relationship that seemed to generate positive emotions. The authors define cybersensitivity as, “a personality trait whereby an individual responds more intensely to feedback provided by an electronic device than their peers (Indica Consulting, 2017, p. 4).”

Participants #3 and #7 displayed qualities that align with the definition of cybersensitives. Both of these participants were very engaged with the IHD, kept it in a prominent location in the home without moving it and modified daily habits based on the feedback. In the interviews, one question inquired about the participants’ relationship with their phone and whether they owned a Fitbit, a wrist-worn device that is used primarily for tracking steps walked during the day as a method to monitor weight loss. Fitbits deliver a form of feedback similar to IHDs. When asked about their relationship with Fitbit technology, one participant answered:

*I got [my Fitbit] right around the time this study started. I use it every single day. It really motivates me to meet my step goal, especially when I do the competitions with friends, and we go a little crazy with it. But I love it.* – 3, IHD
After describing a very engaged experience with the IHD, another participant described her relationship to her Fitbit and to her phone.

_We duel each other in steps. We do Workweek Hustle [a competition]. We use it a lot, actually, We have a lot of friends on Fitbit. I do the goal challenge with my family members who don’t get a lot of steps...I’m getting really excited about the fact that if it were to give me my energy usage currently, I would definitely check that on my phone...

_I do MyFitnessPal for tracking calories, which is a social app for managing weight management. I used iXpenselt for a very long time, not realizing Mint existed, which is amazing, because iXpenselt, you had to build all of your budget. You would have to log every single expense and everything like that, and Mint does that for you.”_

Interestingly, her partner added: “She’s tech pushy.” – 7, IHD, Inc

Identifying customers with characteristics of cybersensitivity might allow for more strategic use of the limited resources utilities have available to subsidize or install in-home-displays and other feedback technology. This type of segmentation is already being applied in other ways in the energy industry. For example, researchers in California are using cybersensitivity characteristics to understand photovoltaic adoption patterns in customers (Reeves & Rai, 2018).

5.4.2 Split-incentives

Two types of the split-incentive problem are highlighted in this study; the tenant-landlord relationship is mentioned several times in the interviews and is a clear barrier to efficiency investments for households. Another identified split-incentive relates to renters
not knowing how long they will live in a household and is amplified by the transient nature of student life (Bird & Hernández, 2012). Students renting homes have even less motivation than an average renter to make efficiency upgrades of any kind because their short time in these places is fixed. This research indicates there might also be a third variation of the split-incentive at work in these households, related to multiple residents not always aligned in living styles or values. I found several examples of highly motivated individuals whose efforts to conserve energy or change behaviors were compromised by a roommate who did not have interest in energy efficiency behaviors or had an opposition to the feedback technology itself.

5.4.3 Lock-ins

Finally, a theme identified in several interviews was the behavioral effect of very low levels of electricity use in these households and the limited opportunities to reduce use. An earlier version of this paper was titled, “squeezing water from stones”, a useful metaphor for the energy use of many of the participants in this study. The interview data describes stories of students not cooking in their ovens to find a marginal savings, or simply ignoring the data on the IHD because energy use was so low. This might reinforce behaviors, a phenomenon known as “lock-in” and noted as a problem with IHDs (Buchanan et al., 2015b). This may also indicate the presence of a “boomerang effect”, which can occur when energy users see that they use very little energy and it reinforces existing behaviors or gives license to conserve less (Schultz, Nolan, Cialdini, Goldstein,
& Griskevicius, 2007). Further, discouraging behaviors like cooking generates questions. Are these the behaviors that these technologies are intended to change?

5.5 Limitations of study

When asked about the motivation to participate in this study, almost every participant noted the financial rewards for participation. While the researchers saw this as a necessary element of recruiting a sufficient sample size, it’s possible that financial incentives outside the reward of saving money on energy bills, created an incentive that affected the profiles of the participants. While appropriate for a study, this has potential to skew results by not accurately capturing the effects of financial savings as the result of the IHD, unless the “real-life” implementation of this intervention involves utilities ability to pay customers. This problem with the literature on IHDs is also noted by Buchanan et al. (Buchanan et al., 2015b). We recommend that future studies make every effort to separate the impacts of incentives for installing an IHD in the home, from other motivations of the users like reducing the cost of energy bills.

In addition, the energy use data referenced in this study should be viewed as a rough indication of changes in energy use. The most rigorous analysis for an experimental design is a difference-in-difference calculation comparing the results from the control group to those of the treatment group (Kurnik, Stewart, & Todd, 2017) and also including weather effects. When this analysis was conducted on the IHD treatment group in the associated study, no significant effect of the treatment was detected (see
Fredman et al. forthcoming). A small effect was discovered in the combined IHD and incentive treatment group.

5.6 Conclusion

This study applied a mixed-methods approach to investigate how millennial renters in a university town respond to IHDs. The Energy Cultures framework applied here offers a theoretical model to support the integration of quantitative and qualitative data and continues to advance as a useful heuristic for generating insights on how and for whom behavioral interventions work. The mixed-methods approach to energy research and social science combines essential streams of data for the purpose of gaining a more complete picture of household energy use (Jain, Gulbinas, Taylor, & Culligan, 2013; Stern, 2017). Following an experiment that found no statistically significant effect from this treatment, these interviews illuminate several possible paths for further study and recommendations.

As noted several times in this paper, feedback technology shows promise both in experimental trials and in full-scale programs. However, there are persistent questions of who can best utilize this technology and how it works. In this case, the how is related to the design of the IHD or web interface. This research found indications that the details of the design matter greatly, particularly to millennial energy consumers who have been identified as more demanding and tech savvy than previous generations. A user-focused design process, also encouraged by others (Buchanan et al., 2015b; Hargreaves et al., 2013), is essential for effective interventions. Further research should explore user-
centered design processes and strategically target energy cultures and demographic groups to increase the effectiveness of the design. Some of this research is currently underway in industry settings (Karlin et al., 2017) and could also be generated in academic settings.

Utilities under financial pressure to lower acquisition costs and maximize the effects of these technologies might be best served by targeting customers who show evidence of “cybersensitivity”. Research is currently underway to test the predictors that might indicate cybersensitivity, but can be expanded further (Indica Consulting, 2017). Finally, big questions remain about the efficacy of IHDs, particularly for this energy culture. Unless designed specifically for millennial renters, this technology may not generate the desired outcomes. Further research on IHDs should target single-family homes and higher energy users. Additionally, in this study most participants did not use the smartphone application associated with the IHD, but other research should more specifically test the effect of this feedback technology. Smartphones are ubiquitous and sophisticated. A persistent challenge of real-time feedback technology is an accurate assessment of how frequently the “treatment” is applied. It is very difficult to measure the number of times a resident looks at an in-home display. However, it might be possible to generate a more accurate calculation of how often a resident pulls up a smartphone application to check their home’s energy usage. Many companies are already leveraging apps for real-time feedback. It’s possible that this is a much more effective method of treatment than IHDs.
CHAPTER 6: DISCUSSION AND CONCLUSION

This dissertation explores the role of higher education in socio-technical energy transitions by highlighting two examples that began in university settings, with university students. In both the fossil fuel divestment movement and work in behavioral interventions, a relationship to technology is in question. Students apply pressure to a fossil fuel-based system in the fossil fuel divestment movement while in the Off-Campus Energy Study, the role of in-home digital displays is investigated. In applying methods and perspective from social science, this dissertation highlights the roles and experiences of people. In this final chapter I will discuss the limitations of this work, the major findings as tied to the literature, and paths for further research.

The multi-level perspective (MLP) offers a theoretical framing for the more practical work of activism, energy research and policy development (F. Geels, 2010; F. W. Geels, 2005). This framework is not meant to guide policy decisions or research agendas, but rather offers a way to conceptualize how a broad scale energy transition might occur and gives researchers a way to think about their work within the context of a global system. In this case, higher education is a crucial actor in energy transitions, creating “niche” spaces where innovations can occur, without the pressure of market forces. In this dissertation, administrators and thus institutions’ response to a student-movement and a student-generated funding source prompted a plan for testing behavioral science. Finally, social science offers the tools and perspectives for a reflexive
investigation of the impacts of energy transitions on society. In this dissertation, the focus is squarely on human actors and their role in an energy transition.

6.1 Limits to Research

While the MLP offers a useful theoretical image, it is not able to or meant to be operationalized. It does not offer guidance for policy or research and does not consider the social justice implications of energy transitions on communities and individuals. I briefly reference the growing energy justice literature (Burke & Stephens, 2018; Healy & Barry, 2017), but do not extend into that research space, though it provides a crucial critique of energy transitions research that often leaves out important impacts on society.

The scale of energy transitions requires an assessment of financial aspects and policy implications. My research does not consider in depth the financial implication of the fossil fuel divestment movement or the policy implications for higher education. Nor does it extend beyond higher education, into foundations, cities or countries divesting from fossil fuels. In mapping the language associated with fossil fuel divestment decisions, a picture of the movement in higher education develops and contributes to an understanding of this element of the energy transition. However, I do not make recommendations to the movement or to universities. Other research investigates the role of individual actors in the divestment movement, (Stephens et al., 2018a) and energy democracy implications (Healy & Barry, 2017).

In the Off-Campus Energy Study, the parameters of the funding source required that the participants all be university students. This led to a homogenous sample of
students living in the same city, receiving similar educations, with no comparison group. As such, the generalizability to other populations has limits. Other research could compare the outcomes from a similar experiment on single-family homes, in non-rental housing, with larger energy footprints. However, in my analysis, I find little reason to continue using resources to implement studies with this particular IHD when there are likely other opportunities for more significant impacts on energy use with feedback technology. In the interviews I conducted, requests for disaggregation of energy use data were highlighted several times as was the desire for a more “interactive” experience. Finally, adding another digital screen to homes was unattractive to several participants.

The Off-Campus Energy Study was challenging in other ways, too. Working closely with a talented and generous colleague, and sharing knowledge was highly useful, but created unique challenges in divisions of labor and divisions of the outcomes of the study. In addition, recruiting students to participate in the study was difficult, leading to small sample sizes. The timeline of the study shifted when problems with data exchanges from Burlington Electric Department dramatically slowed our progress. This particular situation reflects the challenges for municipal utilities in adapting to the smart grid and behavior-based programs in energy use. Finally, this was a large, multi-stakeholder and complex study to complete with two graduate researchers.

6.2 Major contributions

Reflections on energy system research are framed around three main themes: multi-level perspective insights, implications for research in behavioral science, and
social science contributions. I synthesize my work along these three lines of research and provide comments on new lines of thinking.

In this dissertation, of the role of higher education is explored, both in the effort to disrupt power held by fossil fuel companies as in the divestment movement, but also as a laboratory for testing ideas in behavioral science. Both of these efforts began on college campuses but have transcended those boundaries to effect change more broadly.

Millennials are at the core of the divestment movement and as consumers, are re-envisioning the fossil fuel energy system (Accenture, 2016; Ollangier, 2016). Millennials are graduating from colleges and universities, institutions in which sustainability has become a business imperative and part of the curriculum (Krizek, Newport, White, & Townsend, 2012; Vellani & Nanjee, 2016). As products of a higher education system, these students and former students are questioning norms about the dominance of fossil fuel energy and generating important insights on the role of technology to address the consequences.

In the case of divestment, a small group of students at Swarthmore College began an effort that caught fire and has been adopted by major foundations like The Rockefeller Foundation, by companies like The Guardian Media Group and implemented by entire countries, as in the case of Ireland, this summer. Divestment from fossil fuels has also been acknowledged as a way for individuals to take agency in the wake of the United States’ withdrawal from the Paris Accord on Climate Change (Velasquez-Manoff, 2018).
In addition, new research finds a slight dip in fossil fuel stock prices in the days following a major divestment decision (Weber et al., 2017).

This highlights the critical role of higher education in providing a space for innovation, discourse and radically challenging the status quo. It’s difficult to speculate on the factors that empowered the first students to engage with the divestment effort, but it has become a sophisticated movement with investment knowledge and climate change science providing the foundation. This “niche” level action within the MLP has been described by several scholars as a space in need of more investigation (Dóci et al., 2015; Seyfang & Haxeltine, 2010). The “niche” actions discussed in this dissertation are heavily influenced by a combination of a growth in sustainability efforts in higher education (curriculum, infrastructure, etc.) and the perspectives of a generation that “grew up” (“Research Release: SECC’s Spotlight on Millennials | Smart Energy Consumer Collaborative,” 2017) with climate change. This generation may be uniquely positioned to question an unsustainable system.

Research that questions how and by whom energy transitions can be facilitated, is useful and developing a theory of behavioral sustainability transitions offers a practical grounding for conceptual theories of change. The model below refers to recent work proposing that behavior change, supported by behavioral science, is a potential lever for change in socio-technical transitions (See Figure 6.1) (Bodenheimer, 2018).
This dissertation investigated household-level behaviors and the role of feedback, widely considered a promising strategy for behavioral change in households (Abrahamse et al., 2007; Karlin, Zinger, et al., 2015b). Buchanan et al. refers to the “increasingly entrenched view” that feedback via in-home displays are an effective method for reducing energy use (Buchanan et al., 2015b), but still little is known about for whom (Karlin, Ford, et al., 2015). This dissertation raises questions about millennial renters as the right customer segment for IHD technology. This work also raises questions about how behavioral interventions work. The style of feedback presented is crucial to its acceptance by customers. Smartphones offer an innovative way to provide real-time feedback and are being leveraged by many companies. Should kWh data be displayed at all? Should financial data be displayed? Should IHDs be used at all? The answer to all of
these questions might be “no”. In the interviews conducted, at least one person stated, “I have no idea what kilowatt hours mean” and several others alluded to this sentiment. This is discussed in the literature (Buchanan et al., 2015b; Hargreaves, Nye, & Burgess, 2010b) and confirmed in this research.

Calls for going “beyond energy feedback” (Hargreaves, 2018) exist in the research and some scholars propose disaggregating energy use by appliances, giving residents a more accurate picture of what behaviors can be taken to effect savings (Stankovic, Stankovic, Liao, & Wilson, 2016). In addition, more work can be done to inform policy makers about the insights generated by behavioral science. Hargreaves offers the example of a behavioral insights team working on the rollout of the smart grid in the UK as one instance where behavioral science informed energy policy (Hargreaves, 2018). Buchanan et al (Buchanan et al., 2015b) calls for increasing salience in the design of IHDs and extending the reach and impact of feedback. One way to operationalize these recommendations is to strongly integrate human-centered design into programs and technology development aimed at reducing energy use. This begins at product conception and the design of any real-time feedback device would be heavily informed by the people intended to use it. VEIC in Burlington, Vermont utilizes human-centered design processes in the development of many programs. Design Thinking is a formal framework of human-centered design developed by the Stanford Business School and advanced by
IDEO\textsuperscript{12} to enhance problem-solving with mini-market tests and an essential focus on the end-user.

The role of social science in energy transitions has been covered throughout this dissertation. Early calls for this work have advanced into the creation of an entire journal dedicated to this body of research (Araújo, 2014; B.K. Sovacool, 2014) and it grows rapidly. As noted by Meadowcroft, energy transitions are fundamentally political processes, not technical processes (Meadowcroft, 2011a), as some research indicates that the technology exists for an energy system driven by renewables (Jacobson et al., 2013).

The social science research agenda is opening new pathways to understanding the role of people, communities and politics in energy transitions. A mixed-methods approach to answering questions about the social aspects of energy usage helps to uncover the “underlying determinants of energy behavior” (Abrahamse & Steg, 2013) and sheds light on the nuances of people and their choices. This dissertation emphasizes the need for social science. In the first study on divestment, I highlight the role of political influence from university students in shifting trillions of dollars away from fossil fuel companies (Carrington, 2016). In analyzing this resilient movement, I show the power of political activism in shaping a new narrative for the fossil fuel industry and effectively staining a brand. In tracking the trajectory of the fossil fuel divestment movement in higher education, I present one of the first studies to attempt to situate divestment in a broad energy transition and synthesize the impacts.

\textsuperscript{12} IDEO is a company specializing in Design Thinking for problem-solving, www.ideo.com.
In the second and third study, the IHDs represent an exciting new technology enabled by smart meter data. However, many questions have arisen and are echoed here, about the impact of this technology on complicated, “irrational” humans (Ariely, 2008). In this research on the role of millennial renters, their critiques of technology are nuanced and they have a desire to save energy. However, the device we tested did not yield significant results. Millennials’ impact on the energy system has not yet been studied extensively in the academic literature, aside from one study on mobility (Hopkins & Stephenson, 2014). However, there is growing evidence that this generation will cause disruption in the current energy system by demanding sophisticated technology and renewable energy sources.

The interviews in study three also unveil the potential for the “boomerang effect”, which can occur when energy users see that they use very little energy and it reinforces existing behaviors or gives license to conserve less (Schultz et al., 2007). This research also discovered significant design flaws of the IHD leading at least one household to turn off the IHD and another household, to hide it behind a shelf. This again points to the importance of developing technology with a laser focus on the end user. As the role of technology in energy transitions intensifies, social science offers a critical frame for uncovering how technology affects the humans it’s designed to help. The combination of quantitative energy use and qualitative data is a best practice in energy research, and is at the leading edge of this scholarship (Stern, 2017).
6.3 Future Research

There is still much to uncover about the role of behavioral science in energy research. Lines of future research should further investigate the most impactful forms of feedback to facilitate reduced energy use and investigate the differences between various energy cultures and the disparate responses to feedback technology. Policy-makers and government agencies should consider communicating energy use information in units other than kilowatt hours (Allcott & Mullainathan, 2010). The field of behavioral science should also be hyper-focused on impact. Exactly which behaviors are we targeting? If impact is of interest, turning off lights and unplugging devices may be secondary to nudging consumers on weatherization efforts, insulating hot water heaters or leasing electric vehicles (Dietz et al., 2009).

Millennial consumers will be the largest demographic in 2020 in the United States and are of great interest to energy utilities. Currently, the academic literature on millennials’ preferences, attitudes and behaviors is thin. However, some industry research indicates that millennials are unique in their relationship to climate change and energy. This is a population that has grown-up with climate change and been educated on its causes, thus fundamentally changing their relationship to fossil fuels (Accenture, 2016; SECC’s Spotlight on Millennials, 2017). This is an energy culture generally motivated to take action and change behavior if the right levers can be pulled by identifying the interventions that are most salient.
In addition, important questions exist on the effect of real-time feedback on low-income residents, renters and particularly women. Other social scientists have also called for more investigation into the role of gender in energy transitions (Clancy & Roehr, 2003; Elnakat & Gomez, 2015). As technology is increasingly seen as a solution to unsustainable behavior, the role of the social scientist is critical in developing a full account of the benefits and costs of a society fully integrated with technology.

Finally, along the lines of the divestment work, further research could yield great insights on how divestment decisions are made in higher education or other institutions. There are complex and interesting questions related to governance structures and political power within institutions that would be of great benefit for others to understand.


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Interactive Experience Design (pp. 368–379). Springer International Publishing. https://doi.org/10.1007/978-3-319-20889-3_35


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APPENDIXES

Appendix A: Interview Questions

Focus Group/In Home Interview Question for the Off-Campus Energy Study

How do intra-household dynamics affect energy use in the student-renter population?
Men and women use energy differently
The households with IHDs will more accurately discuss their energy patterns when presented with visualizations of daily energy use
Households will greatly differ in the ways they use energy and engage with the various treatments

(This study is exploring a somewhat homogeneous "energy culture" of student-renters in Vermont. Interviews will explore their interactions with and perceptions of In-home Energy Displays (IHDs) to understand the usefulness of these devices with this population. Representatives from all four treatment groups will be recruited for focus groups or in-home interviews to draw comparisons.)

Themes have been developed from the Energy Cultures Framework.

Questions

Practices

1. How did your behavior change during the course of the study?
   o borrowed from Hargreaves study on intra-household dynamics
2. How did your habits - either individually or as a household - change during the study?
   o from Marechal 2015 and Shove: "how do certain practices come to demand recurrent, habitual reproduction?" and "what are the characteristics of habit-demanding practices?" on the importance of habitual practices
3. How much control do you feel you have in changing your energy use? **H: homes w/ IHDs will have a greater sense of control
   o from Karlin study p. 444 - higher perceived control correlates with higher reductions of energy use
4. What were limiting factors in your ability to affect your electricity use?
   o from Stern study p. 420 - "principles related to intervening to change environmentally destructive behavior "use multiple intervention types to address the factors limiting behavior change"
   o also from Hargreaves study
5. How much does the cost of your energy bill affect your home energy use?
   o from Karlin study p. 436 - energy bill consciousness affects energy use
6. How did you make decisions about energy use during the study?

Norms

7. Who performs which tasks in this household?
   - from Bell et al. - many interviewees raise this issue unsolicited in response to questions regarding household energy use

8. What or who was most influential in determining this household's energy use during the study?
   - challenges notion of women not being thought leaders...(paper?)

Material

(Next display average daily pattern of energy use for household)

9. Have you seen something like this before?
10. What is happening during these peaks and valleys of energy use?

(Specific to houses with IHDs)

11. How did you use the IHD?
   - from Hargreaves study on IHDs: "who, what when and where"

12. Which features were most helpful on the IHD?
13. What improvements could be made to make the IHDs more useful?

Ask all participants to state their academic major.
Appendix B: Survey

Please read these details carefully.

This is a study on household energy use. You will be asked to grant permission to share your household's energy data from your electricity meter with the researchers. No other information about your account will be shared. If you are not authorized to make decisions about your home's electricity account (for example, the bill is in your roommate's name), you will need to get permission from that person.

When you complete this form, you will be entered in a prize drawing. If your name is drawn, you and a UVM friend of your choosing will each receive $100. Ask your friends to also complete the form and designate you as their prize partner - this will increase your odds of winning!

If you are eligible and selected, you may be asked to participate in some easy activities to earn rewards. You may also be provided a device to see your home electricity use. All groups can earn compensation for their participation - from $25 to $250.

This research is conducted by doctoral students in the UVM Rubenstein School of Environment & Natural Resources affiliated with the Gund Institute for Ecological Economics and the UVM Smart Grid IGERT. The study is supported by the UVM Clean Energy Fund.

To begin the form, click "Next" below.
Section A: Study Eligibility
This section contains questions to assess your eligibility for participation in the full study.

It looks like you said you live on campus. Unfortunately, you are not eligible for the full study.

However, you are still eligible for the prize drawing if you complete this form, so please feel free to continue.

Looks like you said you don’t know who pays your electric utility bill. You won’t be able to continue the study unless you determine that person!

A1. What is your relationship to the University of Vermont?
Choose the answer you identify with the most. For example, if you are a full-time student and also take graduate courses, choose Faculty/Staff.
Undergraduate Student
Graduate Student
Medical Student
Faculty/Staff
Alumni
Living with a current UVM student
No relationship to UVM
Other:

Other:

A2. Do you live off-campus?
“Off-campus” means you do not pay UVM room & board fees.
Yes
No

A3. Do you rent or own your home (your local residence)?
Rent
Own

A4. Do you have wireless internet in your home?
Yes
No

A5. Do you have access to an iOS or Android smartphone or tablet?
Yes
No
A6. Who is listed as the account holder on your electric utility bill?

This is an important question for the study. If you don’t know the answer, please take a moment to check a recent bill or ask someone who lives with you.

- I am listed as the electric utility account holder.
- A parent or guardian who does not live in my home.
- The landlord/owner of my home.
- Someone who lives with me is the utility account holder.
- I don’t know who pays my electric utility bill.

Section B: Electricity Data Access

It looks like you are still eligible to be selected for the study, but there are a few more questions.

By continuing (and completing the information in this form), you agree to allow your electricity utility to share your household’s energy usage with the researchers to assess the impact of incentives and technology on consumption.

Remember, the researchers will keep your information private, any personal information will be removed at the end of the study, and your energy use will never be traced back to you directly.

B1. On the last page, you indicated that you are not listed as your electric utility account holder.

To be considered for the study, the electric utility needs permission from that person to share your home’s energy consumption data.

Since you are not listed as the utility account holder, please get that person’s permission and enter their name:

First Name:

Last Name:
Section C: About Your Home

This section contains questions about your local home. Think of this as where you currently live while interacting with UVM.

C1. What best describes your home’s property type?

- Single-family home
- Duplex
- Apartment/condo, 4 units or less in building/community
- Apartment/condo, 5 or more units in building/community
- Boarding house/individual room rental
- Recognized Fraternity/Sorority Chapter House
- Other

Other

C2. Where do you live? (If your home does not have a unit number, enter "NA" in that field.)

Street: ____________________________
Unit: ____________________________
City: ____________________________
Zipcode: ____________

C3. Estimate the size of your home, in square feet.

If you live in a building or property with multiple units, just estimate the size of your unit.

Estimated square footage of a two-car garage is between 400-500 square feet. Estimated square footage of a 3 bedroom, 2 bedroom house is about 1500 square feet. A one bedroom apartment is usually between 400 and 800 square feet.

__________ square feet

C4. How many people live in your home, including you?

- Adult males (18+): ____________
- Adult females (18+): ____________
- Children: ____________

C5. Of the following appliances and devices, indicate how many are in your home.

If you use an appliance in your building (e.g. washer/dryer in a common basement) that is not associated with your utility bill, do not count it here.

Dishwasher ____________
### C6. Are the following utilities and services included in your rent?

<table>
<thead>
<tr>
<th>Service</th>
<th>Yes</th>
<th>Unsure</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heating Fuel (other than electricity, e.g., Gas)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Television</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phone</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### C7. What is the primary source of heating fuel for your home?

- Natural Gas
- Propane
- Oil
- Electricity
- Firewood/Stove
- No heating fuel
- I don't know
- Other
Section D: Influences

This section is to help understand where you get your information about energy and what influences your use of energy.
Please answer to the best of your ability.

D1. How knowledgeable are you on the topic of energy efficiency?

- Very knowledgeable
- Somewhat knowledgeable
- About average
- Not very knowledgeable
- Not knowledgeable at all

D2. How helpful have you found the following sources for information about energy efficiency?

- Internet
- Friends or family
- Local utility company - Burlington Electric or Green Mountain Power
- Professors or classes
- Efficiency Vermont (local organization)
- Newspapers (including digital)
- Magazines (including digital)
- Television
C8. Have you ever been exposed to information or education about home energy efficiency (in class, through the media, from your electric company, etc.)?

Yes ☐
No ☐

Section D: Influences

This section is to help understand where you get your information about energy and what influences your use of energy. Please answer to the best of your ability.

D1. How knowledgeable are you on the topic of energy efficiency?

Very knowledgeable ☐
Somewhat knowledgeable ☐
About average ☐
Not very knowledgeable ☐
Not knowledgeable at all ☐

D2. How helpful have you found the following sources for information about energy efficiency?

Internet ☐ ☐ ☐ ☐ ☐
Friends or family ☐ ☐ ☐ ☐ ☐
Local utility company - Burlington Electric or Green Mountain Power ☐ ☐ ☐ ☐ ☐
Professors or classes ☐ ☐ ☐ ☐ ☐
Efficiency Vermont (local organization) ☐ ☐ ☐ ☐ ☐
Newspapers (including digital) ☐ ☐ ☐ ☐ ☐
Magazines (including digital) ☐ ☐ ☐ ☐ ☐
Television ☐ ☐ ☐ ☐ ☐
D3. How often do you discuss energy efficiency with friends, family or neighbors?

- Never
- Rarely
- Sometimes
- Often
- Very Often

D4. How helpful are the following people in helping you make decisions about your energy use?

- Friends
- Someone in my household (not in my immediate family)
- Someone in my immediate family
- Neighbors
- A professor or teacher
- Work colleagues

D5. How important are your home’s energy efficiency and energy costs to you?

- Very important
- Somewhat important
- Not very important
- Not at all important

D6. Right now, do you believe you have the capacity to change to your home’s energy use?

- Yes, definitely
- Yes, a little
- No
- I don’t know
**Section E: Energy Use and Your Home**

These questions will help us understand how you are using energy in your home.

**E1. In your opinion, how energy efficient is your home?**

<table>
<thead>
<tr>
<th>Not efficient at all</th>
<th>Somewhat inefficient</th>
<th>About average</th>
<th>Somewhat efficient</th>
<th>Very efficient</th>
<th>I don’t know</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**E2. Have you spoken to your landlord or property manager about the efficiency of your rental unit?**

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**E3. Typically, how many times/week do YOU perform the following actions?**

*If you live with others, do not count their actions in your response.*

<table>
<thead>
<tr>
<th>Dry clothes in the clothes dryer</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry hair with hair dryer</td>
<td></td>
</tr>
<tr>
<td>Watch an hour or more of T.V.</td>
<td></td>
</tr>
<tr>
<td>Run the dishwasher</td>
<td></td>
</tr>
</tbody>
</table>

**E4. How often do you ...**

<table>
<thead>
<tr>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Pull the window curtains at night to retain heat?
- Switch off lights in empty rooms?
- Add layers or a blanket to stay warm at home?
- Shorten showers to conserve hot water?
- Change thermostat settings to conserve energy?
- Unplug devices not in use?
E5. Rank, in your opinion, what most influences the amount (and thus, costs) of energy used in your home.

- Home size and construction
- My own behaviors and actions
- The behaviors and actions of others in the home
- Weather
- Government policies or rules of the property
- The electric company’s rates
- Landlord or property manager

E6. Rate how likely you are in the future to...

- Seek out information on how to conserve energy at home
- Talk to a Landlord or Property Manager about efficiency upgrades
- Change home thermostat settings to conserve energy
- Insulate windows with plastic
- Unplug devices not in use
- Turn off lights when leaving a room
- Reduce shower time to conserve hot water
- Use additional clothing or blankets when cold

E7. In your opinion, rank which of the following uses the most energy in one hour.

- A compact fluorescent light bulb
- An LED light bulb
- A desktop computer
- A laptop computer
- A stereo
Section F: About You

This set of questions gathers necessary contact information and verifies you are eligible to participate in the Home Energy Study. We'll contact you about the prize drawing and further participation in the study.

Once verified, and your participation is confirmed by the study organizers, this information will be removed from the survey records.

F1. What’s your name?
   First Name: 
   Last Name: 

F2. Email address: 

F3. UVM Netid: 
   This will verify your affiliation with UVM. E.g., "maizepoodle" 

F4. Are you a US citizen? 
   Yes 
   No
F11. When do you expect to graduate?

F12. How long do you expect to remain in your current residence?
   - Until the end of my lease
   - At least until the end of 2015
   - At least until May 2016
   - Other

Other

Thank you for completing the sign-up form.

Should be selected for the study, or if you win the prize drawing, we'll contact you soon. In the meantime, encourage your friends to sign up too and list you as their designated friend in the prize drawing!

The link for the form is http://go.uvm.edu/energystudy