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Consumer Engagement With Efficient And Renewable Energy Technology: Case Studies On Smart Meter Utilization And Support For A Community Anaerobic Biodigester System In Vermont

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CONSUMER ENGAGEMENT WITH EFFICIENT AND RENEWABLE ENERGY TECHNOLOGY: CASE STUDIES ON SMART METER UTILIZATION AND SUPPORT FOR A COMMUNITY ANAEROBIC BIODIGESTER SYSTEM IN VERMONT

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ABSTRACT

Residential electricity consumption in the United States has many adverse impacts, such as greenhouse gas emissions, dependence on fossil fuels, and costs. Efficient and renewable energy technologies have the potential to help mitigate some of these impacts, but appear to be under-utilized in the United States. One major barrier to expanding the deployment of these kinds of technologies and maximizing the benefits they can provide is a lack of consumer engagement. The overall purpose of this thesis is to better understand the extent to which efficient and renewable energy technologies are being engaged with and what factors may influence such engagement (or lack thereof) through case studies on smart meters and a community anaerobic digester system (CADS) in Vermont. In this thesis, engagement involves awareness, support, and utilization. Additionally, a subset of awareness (a precursor to awareness for many) was examined in each of these studies, which is interest in receiving additional information on the technology. While each case study focuses on different aspects of engagement that are unique to each smart meters and CADS, there is some overlap on the topics explored, especially when it comes to awareness of the technology, potential concerns about the technology, and interest in receiving additional information on it.

The focus of the first study is on how efficiently smart meters have been utilized by residential electricity customers in Vermont and what factors may influence this. This study was conducted via a statewide telephone survey in Vermont and involved a sample that was statistically representative of the state. These data were analyzed via quantitative analysis. The focus of the second study is on local support of a CADS in Vermont and what factors may influence this. This study was conducted via a mailout survey to houses located in or near the area where the community anaerobic digester was located, and the data were analyzed via quantitative and qualitative analysis.

In both studies, limitations to engagement with the technologies were found. In the smart meter study, less than 50% of the surveyed customers reported having a smart meter and, for those who did report having a smart meter, less than 20% of them thought that the smart meter had reduced their electricity use. In the CADS study, 52.1% of respondents reported being familiar with the CADS project, and 69.8% reported support for the project. However, other forms of support for the project, such as WTP for the Cow Power program or willingness to drop of food scraps to the CADS, were more limited. Additionally, a variety of demographic and other factors were found to have a statistically significant impact on or relationship to consumer engagement with these technologies. Overall, the results show that there is some engagement with these technologies, but more can be done to bolster engagement with them. One potential strategy to increase engagement with these technologies may be to tailor outreach according to factors that correspond to different levels of engagement. It is hoped that the results from these studies can be used to help improve consumer engagement with these and other efficient and renewable energy technologies, thus hopefully expanding their utilization and benefits they can provide in the process.

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CHAPTER 1: INTRODUCTION

This first chapter helps build a case for why consumer engagement with efficient and renewable energy technology is important and worthy of study. From there, further explanation is given for why smart meters and CADS, two such forms of these technologies, should be studied. A brief description of each smart meters and CADS is then given, in addition to an explanation for why Vermont is a good location in which to study these technologies, followed by an explanation of study objectives and research questions. Last, the organization of the thesis is described.

1.1. Background and Motivation

Around 65% of the electricity generated in the United States is produced via the combustion of fossil fuels (U.S. Energy Information Administration, 2016b), and about 25% of the energy produced in the United States is consumed by the residential sector (U.S. Energy Information Administration, 2018). In turn, 19.3% of the United States' CO_2 emissions are due to residential energy generation (U.S. Energy Information Administration, 2017). Residential electricity consumption not only has adverse environmental impacts, but also has financial impacts. In 2012, Americans spent approximately $750 per year, per capita on residential electricity consumption (Wood, 2014), and inefficiencies associated with the electric grid may cost well over $1 trillion (Cook et al., 2012). Decreasing energy consumption, increasing energy efficiency (doing the same with less), and increasing the use of renewable or "green" sources of energy, such as solar, wind, biomass, and farm and landfill methane, can help the United States mitigate adverse impacts associated with residential electricity consumption, such as greenhouse gas emissions, dependence on fossil fuels, and costs.

One such way to promote energy efficiency and the use of renewables is through increasing consumer engagement with efficient and renewable energy technologies (throughout this thesis, the words consumer and customer are used interchangeably). Consumer engagement in this thesis is defined as awareness, support, and utilization of such technology. Of course, while each of these elements of engagement is distinct from one another, they do still influence each another. For example, awareness of a green energy technology certainly does not guarantee support or utilization of this technology. However, awareness will typically be a necessary precursor to these other forms of engagement.

Increasing such engagement not only contributes to the benefits that have already been discussed, but often also provides additional benefits for the environment and electricity consumers alike. The purpose of this thesis is to better understand the extent to which efficient and renewable technologies are being engaged with and what factors may influence such engagement (or lack thereof). More specifically, case studies on consumer engagement with smart meters and on-farm community anaerobic digester systems (CADS), two such forms of these technologies, were conducted in Vermont. The reason for studying smart meters and CADS is that they appear to be under-utilized and under-studied, despite the many benefits they can provide. The major goal of this work is to produce information that will be useful to those who are working to increase engagement with smart meters and CADS specifically and also for those who hope to increase the implementation of energy efficiency and renewable energy technology more generally.

1.2. An Overview of Smart Meters and CADS

In contrast to traditional analog electricity meters, which only record the total amount of electricity a costumer consumes, digital smart meters allow for two-way communication between utility companies and households and for electricity consumption to be measured hourly or even more frequently. Smart meters, and the larger system of advanced metering infrastructure (AMI) of which they are a part, are anticipated to reduce inefficiencies associated with the electric grid. Since the cost of electricity varies throughout the day, being most costly to produce during times of peak demand, smart meters have the potential to correlate when electricity is consumed to the cost of consumption at that time, and utility companies can then transmit this information back to electricity consumers. The thought is that when consumers have more granular information about their electricity consumption habits and how these might be tied to costs, they will be encouraged to shift electricity consumption away from times of peak demand (which is called demand response) or even reduce total consumption all together (Cook et al., 2012; Darby, 2010; Smith, 2009). However, a major assumption underlying this anticipated behavior change seems to be that dynamic electricity pricing structures will be in place, where the cost of electricity for consumers varies throughout the day according to when it is most costly to produce. Unfortunately, such pricing structures appear to be limited (Behr, 2010), which might deter customers from changing their electricity consumption behavior.

Smart meters also have the potential to benefit utility companies by helping them to reduce congestion in transmission lines, limit the severity of blackouts (Cook et al., 2012), and lower labor costs associated with sending meter readers out to homes (Smith, 2009). Smart meters may also yield environmental benefits, as they can enable utility companies and customers to use electricity more efficiently, thus reducing carbon dioxide emissions (Cook et al, 2012). Due to their anticipated benefits, around $8 billion has been spent on smart meter installation (U.S. Department of Energy, 2016), over 50 million smart meters have been installed, and around 43% of homes now have a smart meter (The Edison Foundation, 2014).

Despite these anticipated benefits, not much is known about how electricity customers at-large are engaging with smart meters. Smart meters are relatively less studied than other forms of energy efficient technologies, likely due in no small part to not being widely deployed until 2009 (U.S. Department of Energy, 2016). There also appear to be challenges when it comes to engaging electricity customers with smart meters (Behr, 2010), with some people even vehemently opposing them (Hess, 2014). This engagement is a very important, as many of the anticipated benefits of smart meters depend upon electricity customers changing their behavior in regard to the information they provide.

CADS, on the other hand, which are a specific subset of anaerobic digester systems (ADS), break down organic materials, typically manure and food scraps, in the absence of oxygen. (At times in this thesis, ADS in general will be discussed, as they encompass CADS, and CADS-specific information can be hard to attain. Additionally, the term “biodigester” may also be used at times.) During this process, a methane-rich biogas is produced that can be captured and combusted as a form of renewable energy. Not only do ADS provide a renewable source of energy, but they can also help farms with manure management, which has significant environmental benefits. Two such benefits come from the reduction of nutrient runoff into waterways and of greenhouse gas emissions, especially methane (U.S. Environmental Protection Agency, 2016). ADS can also help farms diversify their revenue streams, as they can sell the biogas produced and other by-products created through the digestion process, such as fertilizer and animal bedding (Bracmort, 2010).

Despite these benefits, ADS are not widely deployed in America, especially when compared to an international context. For example, while there are about 8,000 total on-farm ADS operating in Germany (IEA Bioenergy Task, 2015), there are only 249 on-farm ADS operating in the United States, with an additional 15 in construction (AgSTAR, 2017a). It seems that only a small portion of these ADS are CADS, though attaining information on the exact number of CADS in America is very challenging. The AgSTAR (2017a) website, which details a list of all ADS projects that are located on livestock farms in the United States, shows that there are 16 ADS that are “centralized/regional” (3 of which are labeled as being under construction). This category of ADS would seem to fit the specifications for a CADS, though it is not clear whether other categories of ADS (such as “farm scale”) might also be considered a CADS.

On-farm ADS implementation is constrained in the United States especially due to financial viability. While large-scale farms have seen positive returns from ADS, small and medium farms (SMDFs) have struggled to do the same, thus constraining the expansion of ADS technology in the United States (Wang, Thompson, Parsons, Rogers, & Dunn, 2011). However, a community model of ADS (CADS), where manure and other organic wastes are accepted from off-farm sites, may help spread the cost of the ADS between multiple entities, in addition to helping meet the need for organic inputs (Babcock, Leong, Lowe, & Teach, 2016). CADS, therefore, may help make ADS technology more viable, especially for SMDFs, thus expanding their implementation. While consumer support is an important part of CADS and ADS viability, literature on consumer support of on-farm ADS in America is hard to attain, and information on consumer support for CADS is even more difficult to find. Additionally, some work has shown that farm methane is less supported than other forms of renewable energy, such as solar and wind (Borchers, Duke, & Parsons, 2007), thus posing additional challenges for engaging consumers with ADS technology.

1.3. Vermont as a Study Location

Vermont provides a good environment in which to study these technologies, as they are somewhat more prevalent here as compared to other states, thus giving consumers a chance to engage with them and the research team to test whether they have in fact been engaged with. Approximately 92% of electricity meters in Vermont are now smart meters, and less than 5% of electricity customers have opted out of having a smart meter installed (E. Goldman, personal communication, February 9, 2016). In comparison, nationally, only around 43% of homes now have a smart meter (The Edison Foundation, 2014). In terms of ADS, though they are relatively scarce in America (with a seemingly very low proportion of these being CADS), there are 18 of them operating in Vermont, one of which is a CADS and was studied for this thesis. There is also an additional CADS being built in Vermont, construction on which was expected to start in the summer of 2017. Additionally, the technical college that operates Vermont's sole CADS was willing to provide a tour of the CADS and provide crucial insights on the CADS study's development. (The technical college's name is Vermont Technical College (VTC) and is referred to as technical college, VTC, and community partner throughout this thesis.)

1.4. Research Objectives

As has been stated, the overall purpose of this thesis is to better understand the extent to which efficient and renewable technologies are being engaged with and what factors may influence such engagement (or lack thereof) through case studies on smart meters and a CADS in Vermont. Again, engagement involves awareness, support, and utilization. Additionally, a subset of awareness (a precursor to awareness for many) was examined in each of these studies, which is interest in receiving additional information on the technology. While each case study focuses on different aspects of engagement that are unique to each smart meters and CADS, there is some overlap on the topics explored, especially when it comes to awareness of the technology, potential concerns about the technology, and interest in receiving additional information on it. To help achieve the purpose of this thesis, the following study objectives have been developed:

The objectives for the study on smart meters are as follows: (1) to examine to what extent and which consumers are engaging with smart meters (awareness and utilization are the primary forms of engagement focused on in this study) and (2) to understand the prevalence of concerns on smart meters and how these might affect engagement with them. The objectives for the study on the CADS are as follows: (1) to understand to what extent CADS technology is being engaged with (awareness and support are the primary forms engagement focused on in this study), (2) to explore how attitudinal and demographic characteristics are related to CADS support, and (3) to examine how communication has influenced CADS support.

In order to meet these objectives and to achieve the purpose of the thesis and its overarching goal, the following were steps were taken: (1) surveys were conducted and primary data were collected on consumer engagement with each smart meters and CADS, (2) these data were analyzed to assess the extent to which these technologies have been engaged with and what factors had a relationship to or may have influenced this engagement (or lack thereof), and (3) recommendations were made on how to improve engagement with smart meters and CADS for interested parties, such as policymakers, utility companies, and other entities working on energy efficiency and/or renewable energy issues.

1.5. Research Questions

The study on smart meters contained questions that covered the following areas: (1) whether respondents thought they had a smart meter, (2) whether respondents thought that having a smart meter reduced their electricity use, (3) whether respondents were concerned about any potential impacts on health due to smart meters, (4) whether respondents were concerned about any potential impacts on privacy due to smart meters, (5) whether respondents were interested in receiving additional information on smart meters, and (6) demographic information. The study on smart meters utilizes data from surveys that took place in 2015 and 2016. Question areas 1 – 4 were covered in both surveys, and question area 5 was covered in the 2016 survey. Full-text survey questions for this study can be seen in Appendix A. “Engagement” in this study was covered by question areas 1 (awareness), 2 (utilization), and 5 (interest in additional information). The analysis focused especially on looking at which factors covered by question areas 3 (health concerns), 4 (privacy concerns), and 6 (demographics) shared a relationship to or may have influenced utilization of smart metes (which required that respondents first reported being aware of them).

The study on CADS contained more questions than the smart meter study. There were five broad groups of questions that covered the following areas: (1) renewable energy issues, (2) knowledge of, opinions on, and attitudes towards the CADS, (3) communication and interest in additional information, (4) composting of food scraps, and (5) demographics. Full-text survey questions for this study can be seen in Appendix B.

“Engagement” in this study was covered by questions on the following areas: (1) awareness of the CADS, (2) support for the CADS, (3) willingness to support the CADS financially and/or through using it for composting, and (4) interest in receiving additional information on it. The analysis focused especially on looking at which factors shared a relationship to or may have influenced support for the CADS. These factors were covered by questions on the following: (1) support for pro-environmental policy, (2) attitudes towards the CADS and its potential outcomes, (3) the amount and type of communication that was received on the CADS, and (4) demographics.

1.6. Thesis Organization

The rest of this thesis is organized as follows: Chapter two is the literature review, which further contextualizes and justifies this work. Chapter three covers the study on smart meters. The fourth chapter covers the study on the CADS. Each of these chapters contains roughly the following sections (they may be worded slightly differently in each article, but the following content is covered in each article): abstract, introduction/literature review, data collection/methods, results and analysis, discussion, and conclusions, and references. The fifth chapter involves a discussion of how the findings of each article compare to one another, and the sixth chapter contains conclusions and recommendations based on what was found in these studies.

CHAPTER 2: LITERATURE REVIEW

This chapter provides additional background on the development and deployment of smart meters and CADS in America. It also describes some trends that have been found among consumers who tend to support energy consumption with pro-environmental outcomes, which will provide further context for these studies' results, as those who are more engaged with smart meters and CADS could be likened to those who tend to be supportive of more environmentally friendly energy consumption.

2.1. Smart Meters

This section provides a more in-depth overview of what smart meters are, in addition to further describing and contextualizing their development and deployment in America.

2.1.1. Smart Meters: An Overview

In contrast to traditional analog electricity meters, which only record the total amount of electricity a costumer consumes, digital smart meters allow for two-way communication between utility companies and households and for electricity consumption to be measured hourly or even more frequently. This information is then transmitted to utility companies and electricity consumers, ranging from once a day to instantaneously (U.S. Energy Information Administration, 2016a). Smart meters, and the larger system of advanced metering infrastructure (AMI) of which they are a part, are anticipated to reduce inefficiencies associated with the electric grid. Since the cost of electricity varies throughout the day, being most costly to produce during times of peak demand, smart meters have the potential to correlate when electricity is consumed to the cost of consumption at that time, and utility companies can then transmit this information back to electricity consumers. The thought is that when consumers have more granular information about their electricity consumption habits and how these might be tied to costs, they will be encouraged to shift electricity consumption away from times of peak demand (which is called demand response) or even reduce total consumption all together (Cook et al., 2012; Darby, 2010; Smith, 2009). The hope is that utility companies and electricity consumers would use the information provided by smart meters to use electricity more efficiently, which could have financial and environmental benefits.

Due to the anticipated benefits of more efficient electricity consumption, $4.5 billion was dedicated to modernizing the electric grid as part of the American Recovery and Reinvestment Act (ARRA), which became law in February of 2009. Of this money, $3.4 billion went to the Smart Grid Investment Grant (SGIG) program, which is comprised of 99 individual projects that have a total budget of about $8 billion (U.S. Department of Energy, 2016). The federal government supplies up to 50% of the total cost of each project, with the rest of the money being supplied by various organizations, typically comprised of utility companies and energy-related enterprises. A very large component of smart grid projects involves the installation of smart meters. Of the types of projects that the federal government lists as being potentially eligible for a SGIG grant, all of them seem to depend upon an initial installation of a smart meter (U.S. Department of Energy, n.d.-b). As of 2013, the U.S. Department of Energy reports that 14.2 million smart meters have been installed in the United States. This is 92 percent of the expected

15.5 million smart meters that are expected to be installed (U.S. Department of Energy, 2013).

In Vermont, an organization called Vermont Transco filed, on behalf of all Vermont utility companies, an application for a SGIG (State of Vermont, 2015b). The utility companies were awarded this grant, and they had a goal of installing smart meters in over 90% of households in Vermont (State of Vermont, 2015a). The total budget for smart grid projects in VT is $137,857,302, with federal money supplying $68,928,650 of this (U.S. Department of Energy, n.d-c) and the remaining funding being supplied by various Vermont utility companies (Merriam, 2011). At least 305,464 smart meters have been installed in VT so far (U.S. Department of Energy, n.d.-c). Approximately 92% of electricity meters in Vermont are now smart meters, and less than 5% of electricity customers have opted out of having a smart meter installed (E. Goldman, personal communication, February 9, 2016).

2.1.2. Opposition to and Benefits of Smart Meters

Despite significant investments made to the installation of smart meters by both the federal government and utility companies, this process has not been occurring without criticism. Some of the most outspoken opponents of smart meters have focused on health concerns, but consumers may also oppose smart meters due to concerns over costs, privacy, and security (Hess, 2014).

Health is the most commonly cited concern related to smart meters and has to do with the electromagnetic radiation they produce (Baird, 2012; Hess, 2014), although the risks from such radiation appear to be low and are comparable to or less than those experienced by using common everyday objects, such as a microwaves or cellphones (American Cancer Society, n.d.). In terms of costs, customers sometimes incur some or all of the costs of having a new smart meter installed. Often, this takes the form of an additional monthly fee that is tacked on to an existing bill (Smith, 2009). If customers elect not to have a smart meter installed, they might be charged an additional monthly fee. For example, some residents in Burlington, Vermont are electing to pay an additional $7.50 a month so that they can keep their electromechanical meters and the human meter readers that these require (Baird, 2012). In terms of privacy concerns, some people are upset that utility companies will have information on what kinds of appliances are being used and when. In regard to security concerns, since smart meters have the potential to collect information about electricity consumption throughout the day, consumers may worry that this information could be hacked and then used to infer when people are or are not home (thus allowing burglars to know when a good time to break in would be) (Hess, 2014). Groothuis & Mohr (2014) also referenced the work of Samuelson & Zeckhauser (1988) to help explain that inertia, or, a bias towards maintaining the status quo, might also inhibit customers from accepting smart meters. Samuelson & Zeckhauser (1988) define the status quo as “doing nothing or maintaining one's current or previous decision” (p. 8).

While opposition to smart meter installation tends to increase when no opt-out provision is available, the existence of an opt-out provision may simply focus consumers’ opposition to smart meters on another area, especially if this opt-out provision is accompanied by a fee. Customers may then focus on lobbying for a no-fee opt-out provision. Overall, public opposition to smart meters has been prevalent at times, sometimes even bringing together unlikely social groups to oppose their installation. In Vermont, public opposition was strong enough to result in the passage of a state law that allows electricity users to opt out of having a smart meter for no additional fee. Despite this law, not many Vermont residents have opted out of having a smart meter installed (Hess, 2014).

Despite these criticisms, there is a lot of literature which discusses the benefits of smart meters. Very generally, smart meters can help utility companies and electricity consumers save money. Since smart meters transmit information about electricity usage directly from the home to the utility company, either through wireless technology or transmitting information via power lines (Smart meters, n.d.), they help save utility companies money by greatly reducing labor and transportation costs associated with sending meter readers out to manually collect information on electricity usage (Smith, 2009).

In addition to this, smart meters help reduce other inefficiencies associated with the electric grid. During times of peak demand, electricity transmission lines are heavily congested, resulting in a higher risk of blackouts, greater amounts of electricity lost from transmission lines, and higher prices for customers. Smart meters can help utility companies lessen the extent of or even prevent blackouts (Baird, 2012; Cook et al, 2012). Also, around 58.5% of electricity is simply wasted, as customers often do not need the readily available minimum supply of electricity that utility companies maintain. The real-time pricing information smart meters can provide is expected to incentivize customers to shift some of their electricity consumption to off-peak demand times, thus flattening the demand curve, reducing congestion and wasted electricity, and potentially saving customers money. In addition to this, real-time pricing information may even encourage an overall reduction in electricity consumption, further saving customers money and lessening inefficiencies in the electric grid. Along with reduced electricity consumption, carbon dioxide emissions associated from electricity generation would be reduced. The value of these benefits to the United States could be around $436 billion, after the costs of smart meter installation are subtracted (Cook et al., 2012). Overall, smart meters have the potential to offer significant financial and environmental benefits to the United States.

When discussing the benefits of smart meters though, there are two important notes that must be made: (1) Many of the benefits that can be realized from smart meters depend on consumers changing their electricity consumption in response to the pricing information provided by smart meters. Without this behavior change, the demand curve will not be flattened and many of the benefits discussed above will not be realized. (2) This behavior change is expected to be largely motivated by consumers' ability to save money by switching electricity consumption to off-peak demand times. When shifting consumption, consumers can only save money if their utility offers a differential electricity pricing structure, where electricity costs vary depending on the time of day. These kinds of pricing structures are not often in place though (Behr, 2010), which would diminish consumer incentives to shift electricity consumption and therefore the myriad of benefits that are associated with this.

2.1.3. Potential Barriers to Electricity Consumption Behavior Change

Some research suggests that consumers (also sometimes referred to as customers) are not sufficiently educated on the benefits of having a smart meter installed. As a result, they may not realize the full benefits from having a smart meter installed, may not be supportive of smart meter installation, or may even opt out of having a smart meter installed (Honebein, 2010; Smith, 2009). Honebein (2010) notes the frustrating experience he had when trying to work with his utility company to figure out whether he was saving money with his smart meter. In order to improve the acceptance of smart meters, he calls for an improved customer experience, such as more training for those working at utility companies on how to answer customers' questions and more proactive customer education, such as a more comprehensive, transparent billing system. The bill, he notes, is paramount:

> Out of all the education and information that utilities can provide customers, the bill is the touchpoint that will have the greatest impact on customer adoption and behavior change. The smart meter bill…must be something more. It should embed customer education, enhanced feedback, and comparison. (p. 79)

Gram (2014) provides an example of proactive customer education that is taking place in Vermont. A non-profit called Efficiency Vermont partnered with utility company Green Mountain Power and sent out mailings to 100,000 homes with information on how to use an online tool to access information obtained from smart meters.

Though implementing policy regarding customer education on smart meters is a necessary component of improving their acceptance, some authors (Groothuis & Mohr, 2014; Hess, 2014) have noted that there may be limits to how much education can improve such acceptance. As was mentioned earlier, Groothuis and Mohr (2014) apply Samuelson and Zeckhauser's (1988) work to smart meters and note that there may be a bias towards maintaining the status quo in regard to the acceptance of smart meters, which means that customers may not want smart meters because that option requires less action and change than wanting or having a smart meter installed. In this regard, effective education on smart meters would have to show customers that the benefits of using a smart meter outweigh the benefits of maintaining the status quo of not having or using a smart meter. Furthermore, increasing education on smart meters may not be sufficient because customers may not trust the source of the information, namely, utility companies or the government. Effective education, in this regard, is not just about disseminating information, but also, about building trust (Lineweber, 2011; Wynne, 2006 as cited in Hess, 2014).

Last, consumers may be unmotivated or unable to change their electricity consumption behavior. Some consumers have reported that they are unable or unwilling to shift their electricity consumption to off-peak times (Groothuis & Mohr, 2014). Furthermore, again, a major premise behind the idea that consumers will shift electricity consumption in light of the information they receive from smart meters is that there are dynamic electricity pricing structures in place. Under such pricing structures, the cost of electricity for consumers varies throughout the day, being most expensive during times of peak demands. With these structures in place, consumers could save money by shifting some of their electricity consumption to off-peak times. Unfortunately, such pricing structures appear to be limited in the United States (Behr, 2010), which might deter customers from going out of their way to change their electricity consumption behavior.

2.2. Community Anaerobic Digester Systems

This section provides a more in-depth overview of what CADS are, in addition to further describing and contextualizing their development and deployment in America.

2.2.1. Anaerobic Digester Systems: An Overview

On-farm anaerobic digester systems (ADS) have the potential to help mitigate greenhouse gas emissions, diversify farms' revenue streams, and assist with manure management, especially for dairy cows and swine (Bracmort, 2010). ADS break down manure and other organics in a closed system in the absence of oxygen (anaerobically) and produce a methane-rich biogas in the process. This biogas is then captured and combusted as a renewable form of energy, which farms can either use or sell. Heat is also produced during this process, which farms can use to heat water, buildings, or the ADS systems themselves (AgSTAR, 2011). In contrast, when manure breaks down in open systems, or closed (anaerobic) systems without methane capture capabilities, methane emissions are produced and released directly into the atmosphere. Additional byproducts of anaerobic digestion include liquid effluent, which can be used as fertilizer, and digested solids, which can be used as animal bedding or soil amendment. Farms can use these byproducts or sell them to diversify their revenue streams (Bracmort, 2010). ADS can also help reduce odors associated with manure production and improve air and water quality more generally, especially through the reduction of greenhouse gas emissions, destruction of pathogens, stabilization of volatile organic compounds, and facilitation of nutrient management (AgSTAR, 2017b; Lazarus, 2008). Despite the many benefits ADS could provide, on-farm ADS implementation in the United States is very limited, especially when compared to an international context. For example, while there are about 8,000 total on-farm ADS operating in Germany (IEA Bioenergy Task, 2015), there are only 249 on-farm ADS operating in the United States, with an additional 15 in construction (AgSTAR, 2017a).

2.2.2. Barriers to ADS Viability and the Importance of CADS

On-farm ADS implementation is constrained in the United States especially due to financial viability. While large-scale farms have seen positive returns from ADS (Wang et al., 2011), small and medium farms (SMDFs) have struggled to do the same, thus constraining the expansion of ADS technology in the United States. In fact, the EPA gives the general guideline that farms will need 500 or more dairy cows or 2,000 or more swine in order for their ADS to be profitable (AgSTAR, 2011). This is because ADS involve an economy of scale: Construction costs do not decrease proportionate to ADS size, and revenues depend upon the quantity of output. Thus, larger numbers of livestock generate revenue that helps cover the high initial fixed costs of ADS construction and operation. In one estimate, initial capital costs per cow were $3,116 for a herd of 100, which dropped down all the way to $805 for a herd of 500 (Lazarus, 2008 using AgSTAR, 2006 data). However, some have argued that the view that ADS, in general, need to operate at a large-scale in order to be viable, is due to a “scale bias...[that] has social and political, not engineering origins” (Welsh, Grimberg, Gillespie, & Swindal, 2010, p. 178), as evidenced partly by the fact that small-scale ADS have been viable in other nations, including developing and European nations (Lazarus, 2008; Welsh, Grimberg, Gillespie, & Swindal, 2010). Luckily, a community model of ADS (CADS), where manure and other organic wastes are accepted from off-farm sites, may help spread the cost of the ADS between multiple entities, in addition to helping meet the need for organic inputs (Babcock et al., 2016). CADS, therefore, may help make ADS technology more viable, especially for SMDFs, thus expanding their implementation.

2.2.3. Barriers to CADS Viability and the Importance of Community Support

Despite the potential of the CADS model to expand ADS implementation in the United States, the number of successful CADS projects in the United States remains low. In fact, even attaining a number for how many community (sometimes called centralized) ADS are operating in the United States is difficult. The AgSTAR (2017a) website, which details a list of all ADS projects that are located on livestock farms in the United States, shows that 16 ADS are "centralized/regional," and 3 of these are labeled as being under construction. This category of ADS would seem to fit the specifications for a CADS, though it is not clear whether other categories of ADS (such as "farm scale") might also be considered a CADS. In contrast, though the exact number is hard to track down, Germany has many more CADS operating, with one estimate that there are over 2,500 ADS operating on a community level ("Pursuing the Concept," 2007). On a larger scale, various parts of Europe have seen success in implementing CADS (Woughter, 2014). One reason Germany may have more CADS is because their policy environment is more favorable to CADS development. For example, the United States and Germany have varied greatly in their use of Feed-in-Tarrifs (FiTs), which subsidize renewable energy production. Among other things, Germany's FiT system is more widespread, legally binding, and amenable to small-scale energy production and bioenergy production than the United States' FiT system (Thibault, 2014).

The viability of CADS also depends on a number of additional factors (some of which are related to FiTs), including, but not limited to, the following: The number of participating community partners contributing manure and/or organic wastes, whether those contributing food wastes pay a tipping fee, the location of the CADS and how far off-farm partners need to travel to contribute inputs, governmental investment, the price electricity generated from the CADS can be sold to utilities for, public participation in green pricing programs where a premium is paid for energy generated from ADS, and whether other CADS-generated products, namely fertilizer and animal bedding, are sold (Babcock et al., 2016; Hurley, Ahern, & Williams, 2006; Lazarus, 2008; Thompson, Wang, & Li, 2013). Understanding the way these barriers affect CADS is an important component of ensuring their viability; however, work that discusses these barriers in the context of CADS specifically (as opposed to ADS more generally) is rare and tends to focus especially on financial challenges to viability (Hurley et al., 2006; Lazarus, 2008). One challenge that is largely absent from these discussions is the role that public support plays in CADS viability.

While there has been some work on farmers' interest in ADS (Welsh et al., 2010) and public support of ADS (Sanders, Roberts, Ernst, & Thraen, 2010), including the importance of consumer participation in green pricing programs for ADS-generated electricity (Babcock et al., 2016; Wang et al., 2011), more information on public support for CADS specifically is needed. Although Swindal, Gillespie, and Welsh (2009) examined farmers' interest in CADS, the researcher was not able to find a study dedicated to understanding public support for CADS specifically. Though willingness to pay (WTP) for electricity generated from ADS surely encompasses an element of support for CADS, it is a bit removed from the context in which CADS occur, which is that they are sited within actual communities. Not only is public support of CADS in general important, but, more granularly, support from the specific communities in which they are located is also likely very important. Though finding formalized discussion of the role community support plays in CADS implementation is difficult, the research team was informed by the technical college that was partnered with for this study that garnering community support for their CADS was one of the biggest challenges to ensuring its viability (M. O'Leary, personal communication, November 21, 2016). Understanding how community members feel about CADS that are actually located in their community, therefore, could be an integral component of understanding potential barriers to (and perhaps opportunities for) CADS implementation.

2.2.4. CADS Support

Public support for CADS can take a variety of forms. As has been mentioned, SMDFs often struggle to be financially viable, especially due to high start-up costs, and require multiple forms of funding. Public investment is an important part of this funding and may take the form of tax-based grants that help farms purchase ADS. Public support of pro-environmental policy may also help support CADS. Additionally, electricity customer participation in green pricing programs, where a premium is paid for energy produced from renewable sources, can also help cover some of the CADS' costs (Babcock et al., 2016). This is due, at least in part, to the fact that renewable energy is often more expensive to produce than non-renewable energy (U.S. Department of Energy, n.d.-a). Unfortunately, participation in green pricing programs remains relatively low in America, with average participation rates reported at 1.5% in 2005 (Bird & Brown, 2005) and 2.1% in 2012 (Institute for Energy Research, 2013).

In Vermont, one such green pricing program is the Cow Power program, where electricity customers can elect to pay a premium of $0.04 per kWh on top of the regular rate on a portion of their electricity use to support electricity generated from cow manure by Vermont dairy farms. This program has helped with ADS viability in VT, but in late 2011, the supply of Cow Power eclipsed consumer demand, thus decreasing a potential revenue stream for ADS in Vermont (Babcock et al., 2016). Wang et al. (2011) highlighted the importance of this revenue stream. In their study of four dairy farms with ADS, they found that revenue from Cow Power comprised a significant source of income for ADS. This revenue, in conjunction with premium rates paid by utility companies for ADS-generated electricity, accounted for 64.6% of these ADS' income in 2008. Though it is not exactly certain why participation in the Cow Power program has declined, some have found that consumers may prefer solar energy over wind, biomass, and farm methane (Borchers et al., 2007). In all, while these forms of public support for ADS contribute to CADS support, there are a number of other facets of public support that are CADS-specific.

Two such additional forms of support are community members' willingness to have a CADS located in their community and composting behaviors. In order to garner the former, the technical college launched extensive outreach efforts, including bringing community members to Europe and Montreal, Canada to view successful ADS, disseminating various educational materials, such as through the newspaper, and holding open houses where the public could see the CADS while it was being constructed (Vermont Tech, 2015). In addition to this, though community members may not know it, their willingness to compost using the CADS can contribute to its viability. In fact, the community partner mentioned that it would like to receive "as much food waste as possible," though food wastes cannot exceed 49% of the inputs to the CADS (M. O'Leary, personal communication, November 21, 2016). The reason for this cap at 49% is Vermont's Act 250. Under this act, if the CADS' food waste inputs exceeded 49% of the total inputs, it would cease being an agricultural operation and would instead be deemed a commercial one (M. O'Leary, personal communication, November 21, 2016). Restrictions aside, one reason more food wastes are desired is because increasing the proportion of food scrap inputs for ADS can increase the amount of energy they produce (Babcock et al., 2016).

Currently, the community partner uses a variety of on-farm and off-farm sources to help meet its need for organic inputs. On-farm inputs include manure, grass clippings, leaves, shredded waste paper, spoiled silage, and garden refuse. Off-farm inputs include brewery wastes, glycerol from biodiesel producers, grease wastes from local restaurants, food scraps from a local college, and a few other compounds, such as calcium carbonate, in relatively small quantities that help ensure the proper operation of the biodigester. From March of 2014 to June of 2015, about 19.3% of the CADS inputs came from off-farm sources, which gives the approximate percentage of food scrap inputs as well, as most of the on-farm inputs are not food wastes and most of the off-farm inputs are (Vermont Tech, 2015). Waste generators either bring these food wastes to the CADS or pay a hauling company to bring them to the CADS for them. Currently, VTC neither pays for these food scraps, nor charges waste generators for using the CADS to dispose of their wastes (M. O'Leary, personal communication, February 3, 2018). Ideally, people and organizations who contributed organic wastes to the CADS would pay a charge, also called a tipping fee, to do so (M. O'Leary, personal communication, November 21, 2016), although the volatility of the organics market may prevent this from being the best option in the real world (Vermont Tech, 2015). While the technical college has not charged such a fee, there are some instances of consumers paying to have their organic wastes collected and composted (e.g., Bennett Compost, 2010), which, in the context of the CADS, could diversify its revenue streams and promote its viability.

2.2.5. Exploring Factors That Influence CADS Support

This study not only looks at the multifaceted ways in which the CADS could be supported, but also seeks to describe who CADS supporters may be. Other work has done something similar in the context of profiling the average green energy consumer, in which several demographic and socialpsychological trends have been found. A positive correlation has been found between willingness to pay for energy with less adverse environmental impacts and the following demographics: higher levels of education (Roe, Teisl, Levy, & Russell, 2001; Rowlands, Scott, & Parker, 2003; Zarnikau, 2003), younger ages, and higher salaries (Rowlands, et al., 2003; Zarnikau, 2003), and lower electricity costs (Zarnikau, 2003; Hansla, Gamble, Juliusson, & Gärling, 2008). Examples of socialpsychological characteristics that have been found to be positively correlated with willingness to pay a premium for green energy include the following: awareness of environmental consequences (Hansla et al., 2008), environmental concern, altruism (Rowlands et al., 2003; Hansla et al., 2008), and liberalism (Rowlands et al., 2003). In the single study that was found that examined public support for ADS in the form of WTP a premium for ADS-generated electricity, four distinct groups emerged: The group that was the most WTP was, on average, the most educated, second wealthiest, most politically liberal, and reported the highest level of environmental stewardship and proactiveness. The group that was least WTP, on the other hand, was, on average, the oldest, least educated, least wealthy, most politically conservative, and had the lowest environmental stewardship (Sanders et al., 2010).

Everett Rogers' (2003) Diffusion of Innovation (DOI) Theory can also help frame the exploration of what CADS supporters look like. DOI helps describe the process by and rate at which an innovation is adopted over time. Among other things, innovations can take the form of technology (like CADS). Now, it may seem that there are limited ways in which an individual could adopt a CADS, but Rogers did talk about how an innovation could be an idea, which, in turn, could be adopted. Rogers' lens is extended here, and support for the CADS is looked at as a form of adopting the idea that the CADS is beneficial for and should operate in the community. Additionally, people's use of the

CADS for composting could constitute an adoption of the innovation – it is just not an innovation people necessarily find easily accessible to them in a day-to-day context.

In DOI, there are five main segments of adopters, divided according to when they adopt the innovation as compared to the mean time of adoption. They are as follows: 1) innovators, 2) early adopters, 3) early majority, 4) late majority, and 5) laggards. A sixth group of non-adopters is sometimes also included (Kaminski, 2011). DOI predicts that, among other things, early adopters of an innovation will be more highly educated, wealthier, have greater exposure to mass media and interpersonal forms of communication, and be more positive towards science and change as compared to later or non-adopters. Though this study did not have a time element (other than change in attitude towards the CADS over time) and did not focus on categorizing which type of adopter respondents were (innovators, early adopters, early majority, late majority, laggards, or non-adopters), the idea here is that "adopters" (supporters) of the CADS could be considered, if nothing else, earlier, as opposed to later or non-, adopters. This is due, at least in part, to the fact that the CADS had only started operation three years prior to the study, meaning that supporters of the CADS could be viewed as adopting it relatively early on. The view that the CADS is relatively new to the community is also bolstered by the fact that nearly half of the respondents did not report being familiar with the CADS. Thus, the analysis of who CADS supporters are included variables that the DOI describes as influencing adoption.

Of particular analytic relevance is that DOI influenced the decision to look at how communication influenced CADS support, as the theory details the importance communication plays in influencing people's adoption of an innovation. DOI describes a five-step innovation-decision process during which someone decides whether he or she would like to adopt an innovation. The five steps are as follows: (1) knowledge, (2) persuasion, (3) decision, (4) implementation, and (5) confirmation. Rogers says that during the knowledge phase, where people become aware of and understand the innovation, indirect communication (mass media) is particularly important, whereas during the persuasion phase, where people form a positive or negative attitude towards the innovation, direct (interpersonal) communication is particularly important. Though this study did not assess where respondents were in the innovation-decision process, the theory's insights on communication still informed the analysis on communication. Specifically, by providing the idea that there are two distinct communication types (mass media and interpersonal) and that those may have different effects on the adoption of an innovation. Furthermore, the influence of beliefs about the CADS' outcomes on CADS support was tested, which speaks to the importance of the persuasion phase, where people form positive or negative attitudes towards the innovation.

2.3. Consumer Support for Energy Consumption With Pro-Environmental Outcomes

This section provides a brief overview of some of the more current literature that describes traits of those who tend to support energy consumption with pro-environmental outcomes. It adds further context for later discussions of the relationship between demographics and engagement with smart meters and the CADS, both of which could be considered to support pro-environmental outcomes.

2.3.1. Positive Willingness to Pay for Less Impactful Energy

Numerous studies confirm that presently there exists, on average and among a variety of populations, a positive willingness to pay (WTP) for green and less impactful energy, such as through decreased emissions, increased efficiency, or greater use of renewables (Borchers et al., 2007; Hansla et al., 2008; Roe, et al., 2001; Rowlands et al., 2003; Zarnikau, 2003). These values have been presented in different ways, but some examples are as follows: an average WTP 1.3 cents per kWh for a marginal unit of green electricity (Borchers et al., 2007), about half of study respondents reporting that they would pay at least an additional $1 per month to support green and/or efficient energy (Zarnikau, 2003), and 45% of respondents indicating that they would be WTP an additional $10 per month for all their electricity to be green, with only 6% of respondents indicating that they would not be WTP anything to have all of their electricity be green (Rowlands et al., 2003). Around 20% of utility companies in the United States offer green energy programs for their customers, where customers can voluntarily elect to pay a premium for electricity that has been generated from renewable energy sources. Though average participation in these programs remains low, with an average of 1.5% of eligible electricity customers participating in said programs in 2005 (Bird & Brown, 2005) and 2.1% in 2012 (Institute for Energy Research, 2013), some American electricity customers do still exhibit an observed willingness to pay for green energy.

When interpreting these findings, however, there are several considerations that should be taken into account. First, there may be some selection bias among those filling out these surveys. For example, they may already be more interested in energy issues than the average consumer (Rowlands et al., 2003). Second, consumers tend to overstate their (WTP) for green/less impactful energy as compared to their actual marketplace behavior (Roe et al., 2001). While consumers may intend to support what they see as more environmentally conscious energy consumption, they may employ a number of rationalization strategies to assuage guilt they may feel over not supporting such consumption in practice (Eckhardt, Belk, & Devinney, 2010), thus perpetuating the dichotomy between stated and actual willingness to pay.

Still, the consistency with which a positive willingness to pay for less impactful forms of energy was found suggests that marketers, utilities, and other educational entities may be able to tap into this in order to increase sales of such energy. What may be helpful for this process, in turn, involves marketing to certain demographic profiles of green energy purchasers. There have been different arguments in this regard, however, with some calling on educators and marketers to focus efforts on those who are not as likely to purchase green energy (Hansla et al., 2008), with others making a call to market green energy in a way that speaks to the demographics most likely to support it (Rowlands et al., 2003). Zarnikau (2003) did find that an educational intervention, which provided consumers with more information on green and efficient energy, increased consumers' WTP a small premium for such energy.

2.3.2. Who Is Willing to Pay for Less Impactful Energy

When seeking to profile the average green energy consumer, several demographic and socialpsychological/attitudinal trends have been found. Here is a summary of these findings from a few key studies. A positive correlation has been found between willingness to pay for energy with less adverse environmental impacts and the following demographics: higher levels of education (Roe et al., 2001; Rowlands et al., 2003; Zarnikau, 2003), younger ages, and higher salaries (Rowlands et al., 2003; Zarnikau, 2003), and lower electricity costs (Hansla et al., 2008; Zarnikau, 2003). Examples of socialpsychological/attitudinal characteristics that have been found to be positively correlated with willingness to pay a premium for green energy include the following: awareness of environmental consequences (Hansla et al., 2008), environmental concern, altruism (Hansla et al., 2008; Rowlands et al., 2003), and liberalism (Rowlands et al., 2003). When comparing the impact of demographic factors on energy consumers to that of socialpsychological/attitudinal factors on energy consumers, some have found socialpsychological/attitudinal factors to be better predictors of WTP for green energy than demographics (Rowlands et al., 2003). This by no means serves as an exhaustive list of the traits that those who support green energy tend to possess, of course, but it does give an idea of some factors one may want to include when conducting similar studies.

Last, it is important to note some of the inconsistencies in the literature when it comes to testing for the significance of these variables' impact on WTP for green electricity. For example, in contrast with the studies about that found higher incomes to be positively associated with WTP for green energy, Hansla et al. (2008) did not find this to be the case. There have been similar inconsistencies with gender. For example, Rowlands et al. (2003) did not find gender to be a significant factor associated with WTP for green energy, while Zarnikau (2003) found that males were more WTP for green energy than females. In all, these findings lend support to the idea that understanding demographic and socialpsychological/attitudinal characteristics is an important component of bolstering support for green and efficient energy.

Overall, the content in this section has helped inform the inclusion of various independent variables in these studies and has added further context in which the results of each study can be discussed. The next chapter will be on consumer engagement with smart meters in Vermont.

CHAPTER 3. EXAMINING WHETHER SMART METERS HAVE BEEN USED SMARTLY: A CASE STUDY OF RESIDENTIAL ELECTRICITY CUSTOMERS IN VERMONT

This chapter presents the smart meter study in full, which consists of the following sections: Introduction, Data Collection, Analysis and Results, Discussion and Implications, and Conclusions and Recommendations.

3.1. Introduction

In the United States, around $8 billion has been spent on smart meter installation, with $3.4 billion from federal funds and $4.6 billion from other sources (U.S. Department of Energy, 2016). Over 50 million smart meters have been installed, and around 43% of homes now have a smart meter (The Edison Foundation, 2014). While traditional analog electric meters are capable of only recording the total amount of electricity a customer consumes, digital smart meters allow for two-way communication between utility companies and households and for electricity consumption to be measured hourly or even more frequently. This information is then transmitted to utility companies and electricity consumers, ranging from once a day to instantaneously (U.S. Energy Information Administration, 2016a). Smart meters have the potential to benefit utility companies by reducing congestion in transmission lines, limiting the severity of blackouts (Cook et al., 2012), and lowering labor costs associated with meter readers (Groothuis & Mohr, 2014). For consumers, the thought is that when they have more granular information about their electricity consumption habits and how these might be tied to costs, they will be encouraged to shift electricity consumption away from times of peak demand (which is called demand response) or even reduce total consumption altogether (Cook et al., 2012; Darby, 2010; Smith, 2009). The hope is that utility companies and electricity consumers would use the information provided by smart meters to use less electricity more efficiently, which could have financial and environmental benefits. In terms of environmental benefits, if smart meters enabled utility companies and customers to use electricity more efficiently, carbon dioxide emissions would be reduced (so long as total consumption from non-renewable sources did not increase) (Cook et al., 2012).

Despite the significant investments made in smart meters and the many benefits they could provide, not much is known about how effectively customers are using smart meter information. The purpose of this study is to better understand how smart meters are utilized by electricity customers, using primary data from two statewide surveys conducted in Vermont in 2015 and 2016. Vermont provides an excellent case for studying the utilization of smart meters, as around $137 million has been spent to install 305,464 smart meters in the state (U.S. Department of Energy, n.d.-b), approximately 92% of electricity meters in Vermont are now smart meters, and less than 5% of electricity customers have opted out of having a smart meter installed (E. Goldman, personal communication, February 9, 2016). Specifically, primary data collected from the statewide surveys are used to assess the self-reported effects of smart meters on electricity use, the demographic differences between those who reported having a smart meter and those who did not, consumer concerns about smart meters' potential impacts on health and privacy, and consumers' interest in receiving additional information on smart meters. In light of the huge public investment in smart meters and limited information on how consumers have used this technology, the results from this paper are expected to be helpful for utility companies and other entities that are working on energy-related issues in their communities.

3.2. Data Collection

Data used in this study were collected by the Center for Rural Studies at the University of Vermont as part of the 2015 and 2016 Vermonter Polls. For the 2015 survey, 2,354 households were contacted by telephone, and 619 people completed the survey, yielding a response rate of 26.3%. In 2016, 2,547 households were contacted by telephone, and 684 people completed the survey, yielding a response rate of 26.9%. The 2015 and 2016 surveys had margins of error of plus or minus 4% and 3.9%, respectively, and both surveys had a confidence interval of 95%. Included in these surveys were four questions on smart meters that assessed the following: (1) whether respondents thought they had a smart meter, (2) whether respondents thought that having a smart meter reduced their electricity use, (3) whether respondents were concerned about any potential impacts on health due to smart meters, and (4) whether respondents were concerned about any potential impacts on privacy due to smart meters. In addition to these four questions, the 2016 survey also included a question on whether customers were interested in receiving additional information on smart meters. The full-text survey questions can be viewed in Appendix A.

It should be noted that the Likert-type scales used for question areas (3) and (4) varied slightly between the 2015 and 2016 surveys. In 2015, the response choices were “not concerned at all,” “not concerned,” “concerned,” “very concerned,” and “not sure.”

In 2016, the response choices were “not concerned at all,” “a little concerned,” “concerned,” “very concerned,” and “not sure.” These variables were examined singularly in each year and were also recoded into binary form (1 = expressed some level of concern and 0 = otherwise) so that the data from 2015 and 2016 could be aggregated and used in further analysis.

The data for these five questions and relevant demographic variables were analyzed through descriptive analysis, Chi-square tests, and binary logistic regressions. The survey data were coded and analyzed in SPSS (Statistical Package for the Social Sciences).

3.3. Analysis and Results

The results are presented in six subsections: (1) respondents’ lack of awareness of installed smart meters, (2) impacts of smart meter installation on electricity consumption, (3) respondents’ concerns about smart meters’ potential impacts on health and privacy, (4) respondents’ interest in receiving additional information on smart meters, and a further examination of who reported having a smart meter as compared to those who did not via (5) summary statistics on differences between respondents who reported having smart meters and respondents who did not, and (6) binary logistic regression analysis of the factors affecting whether respondents reported having a smart meter

3.3.1. Lack of Awareness About Installed Smart Meters

Many Vermont residents have a smart meter installed, but do not know it. Although about 92% of Vermont’s electricity meters were smart meters by 2015 (E. Goldman, personal communication, February 9, 2016), only 45% of survey respondents in 2015 and 48.6% in 2016 reported having a smart meter. This means that close to half of Vermont's electricity customers were unaware that they had a smart meter at the time of the surveys. Although the percentage of respondents who reported having a smart meter was still relatively low in 2016, it did increase by 3.6 percentage points from 2015. However, obviously, to maximize the benefits from smart meters, electricity customers must first be aware that they have them. Many of the benefits of smart meters depend on electricity customers changing their electricity consumption in response to the nearly real-time pricing information that smart meters provide, which would be very difficult to do if customers are unaware that they have a smart meter. One possible exception to this would be if customers are nonetheless accessing the nearly real-time pricing information that smart meters provide, but are not changing their electricity consumption in response to this information.

3.3.2. Impacts of Smart Meter Utilization on Electricity Consumption

Having a smart meter has not reduced the electricity consumption of many Vermont residents. In 2015, among respondents who knew that they had a smart meter, only 2.2% reported that having a smart meter "significantly reduced" their electricity use, and 9.6% reported that having a smart meter reduced their electricity use "a little bit." The percentage of respondents who reported that the smart meter did not change their electricity use was 63.7%, and 24.5% of respondents were unsure whether the smart meter affected their electricity use. In 2016, among respondents who knew that they had a smart meter, only 3.1% reported that having a smart meter "significantly reduced" their electricity use, 14.1% reported that having a smart meter reduced their electricity use "a little bit," 72.4% of respondents reported that the smart meter did not change their electricity use, and 10.4% of respondents were unsure whether the smart meter affected their electricity use. In 2016, as compared to 2015, an additional 5.4 percentage points of respondents reported that the smart meter had reduced their electricity use, and an additional 8.7 percentage points of respondents also reported that the smart meter had not changed their electricity use. The year of the survey did have a significant impact (x^2=3.27, p=0.07) on whether one reported electricity reduction as the result of having a smart meter, with those in 2016 being more likely to report a reduction in electricity consumption as the result of having a smart meter than those in 2015.

There may be several reasons why reduced electricity consumption among those who report having smart meters has not been prevalent. First, smart meter customers may be shifting when they consume electricity, but not necessarily reducing their consumption. Another possible reason is that those who have smart meters are not accessing the information they provide (Honebein, 2010; Smith, 2009) and are not changing their behavior as a result. Ensuring that the information provided by smart meters is easily accessible—e.g., via in-home displays, the electricity bill, and online tools and apps—can help to promote a greater change in consumers' electricity consumption (Gram, 2014; Honebein, 2010; Smith, 2009). In-home displays seem especially promising, with research showing that the most effective way to get smart meter users to shift and reduce electricity consumption may be through combining in-home displays that show real-time pricing information with dynamic electricity pricing (Jessoe & Rapson, 2014; Mooney, 2015). However, dynamic pricing structures and in-home displays appear to be limited in Vermont (D. Fredman, personal communication, April 22, 2016; P. Hines, personal communication, September 1, 2016), thus reducing incentives for electricity customers to shift or reduce their electricity consumption.

3.3.3. Concerns About Smart Meters' Potential Impacts on Health and Privacy

As Figs. 1 and 2 show, while some Vermont residents were concerned about the potential impacts of smart meters on their health and privacy, a majority of them were not. Previous research by Hess (2014) has shown that, nationally, some of the most outspoken opposition to smart meters arises from health and/or privacy concerns. Respondents in each year were more likely to report being concerned about potential privacy impacts than health impacts. In 2015, respondents were a little over 2 times more likely to report being concerned about the potential impacts of smart meters on their privacy (18.8%) than health (9.2%). In 2016, respondents were around 1.5 times more likely to report being concerned about the potential impacts of smart meters on privacy (24.2%) than health (16.5%). Overall though, respondents were much more likely to be unconcerned or unsure about potential impacts on health and privacy due to smart meters.

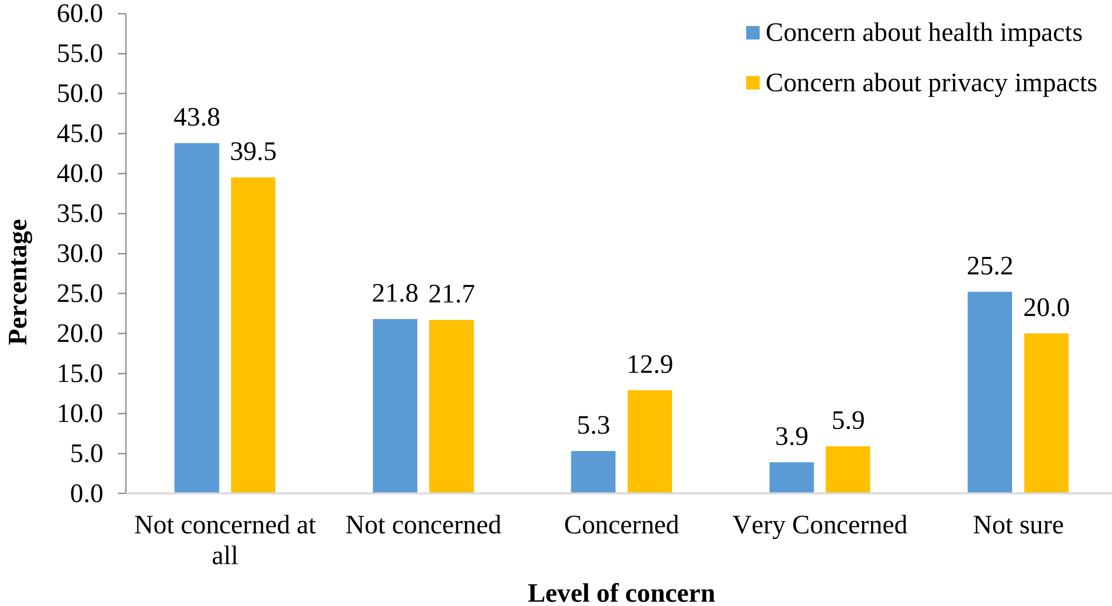

Figure 1. *Concerns about the potential impact of smart meters on health (n = 609) and privacy (n = 612) in 2015.*

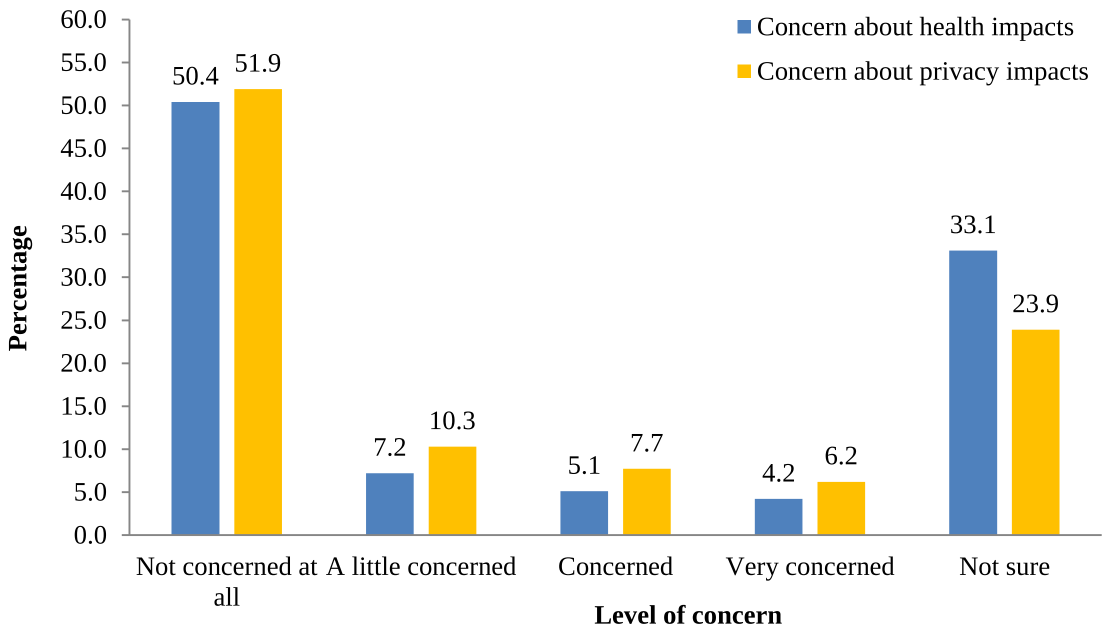

Figure 2. *Concerns about the potential impact of smart meters on health (n = 681) and privacy (n = 679) in 2016.*

3.3.4. Interest in Additional Information on Smart Meters

Fig. 3 shows the interest that 2016 survey respondents had in receiving different kinds of information on smart meters. The most requested type of information (31.3%) was on how smart meters may help to reduce the electricity price, and the least requested type of information was on how smart meters may help to reduce power outages (26.5%). Despite this degree of variation shown by respondents though, the fact that no more than 31.3% of respondents wanted any one kind of information on smart meters may indicate a general lack of interest in or knowledge of smart meters. Increased education on smart meters and the benefits they can provide may help to pique customers' interests in smart meters.

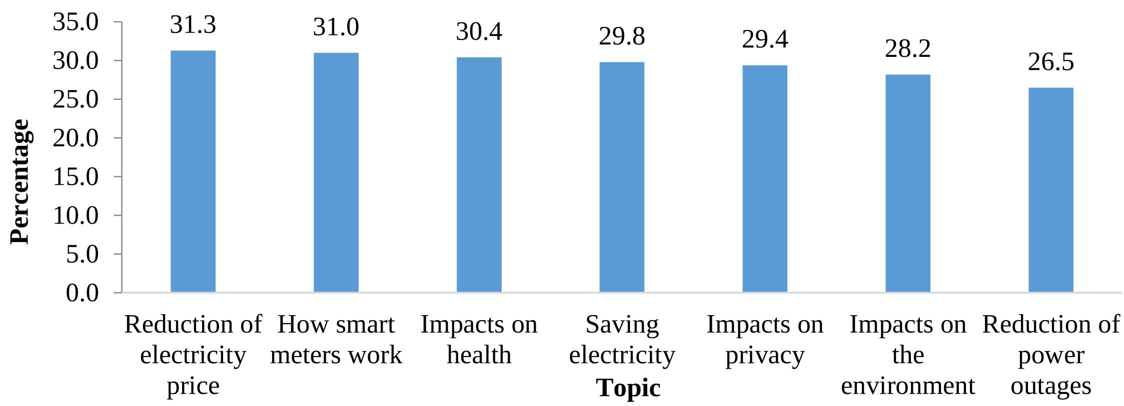

Figure 3. *Additional information wanted on smart meters by topic (n = 684).*

3.3.5. A Descriptive Analysis

Table 1 reports the summary statistics for the merged data of years 2015 and 2016, except for three variables: housing type, which was only included in the 2015 survey, and concern about potential privacy and health impacts, which were included in both the 2015 and 2016 surveys, but used slightly different Likert-type scales and so could not be combined into one variable. Please see the Methods section or Appendix A for more information on the Likert-type scales that were used in each year. Privacy and health concerns reported in the table are from 2016 data only. Summary statistics are provided for the whole sample and two subgroups: those who reported having a smart meter (Group A) and those who did not (Group B).

The summary statistics reported in Table 1 and the results of Chi-square tests for determining whether the difference between Group A and Group B is significant suggest the following five findings: First, those who reported having a smart meter were more likely to be male (55.2%) than female (44.8%). This result suggests that Vermont males are more likely to report that they have a smart meter than Vermont females.

Second, those who reported having a smart meter (Group A) were more likely to live in single-family dwellings and be home-owners than those who did not report having a smart meter (Group B). In Group A, 78.4% lived in single-family dwellings, as compared to 70.0% in Group B. Additionally, 90.4% in group A owned their homes, as compared to 78.9% in Group B. A potential driver of this relationship is that those who live in single-family dwellings may be more likely to own than rent and therefore live in one place for longer periods of time than those living in apartments. Home ownership and longer duration of occupancy may lead to greater awareness of meter type. The overall rate of homeownership in Vermont for 2015 was 71.3% (U.S. Census, 2016b).

Third, those who reported having a smart meter were more likely to be 41 or over (89.2%) as compared to those who did not report having a smart meter (82.4%). Conversely, those who did not report having a smart meter were more likely to be 18-40

(17.5%) as compared to those who reported having a smart meter (10.8%). This finding suggests that those who report having a smart meter are slightly older than those who do not.

Fourth, those who reported having a smart meter (Group A) were more likely to be “not concerned at all” about smart meters’ potential health impacts than those who did not report having a smart meter (Group B), and Group B was more likely to be unsure about the meters’ potential health impacts than Group A. In Group A, 64.5% of respondents were “not concerned at all” about potential health impacts, as compared to only 36.9% of respondents in Group B. Additionally, respondents in Group B were a little more than 2.5 times as likely (47.1%) as those in Group A (18.5%) to report that they were “not sure” whether they were concerned about possible health impacts of smart meters.

Fifth, those who reported having a smart meter were more likely to be “not concerned at all” about the potential privacy impacts of smart meters than those who did not report having a smart meter, and those who did not report having a smart meter were more likely to be unsure about the smart meter’s potential privacy impacts than those who reported having a smart meter. In Group A, 63.2% reported being “not concerned at all” about smart meters’ potential impacts on their privacy, as compared to 41.3% of Group B. Additionally, Group B was much more uncertain about privacy concerns, with 37.2% reporting being “not sure,” compared to only 9.7% of Group A respondents. The findings on respondents’ concern about potential privacy impacts due to smart meters were similar to those on concern about potential health impacts due to smart meters. The percentage of electricity customers who have opted out of smart meter installation in Vermont is only 3% to 5% (E. Goldman, personal communication, February 9, 2016), but concerns that smart meters could adversely impact health and privacy represent two possible reasons for opting out.

Table 1. *Summary Statistics by Respondent Groups*

	Whole sample (n = 1297)	**Group A: Respondents who reported having a smart meter (n = 608)**	**Group B: Respondents who did not report having a smart meter (n = 689)**	**Chi-square (x^2)**
Gender				x^2=26.10***
Female	52.3	44.8	59.2	
Male	47.7	55.2	40.8	
Education				x^2=4.65
No diploma	2.0	2.4	1.7	
HS graduate or GED	18.9	17.5	20.1	
Some college	15.5	15.9	15.2	
Associate/technical degree	10.7	12.1	9.2	
Bachelor's degree	26.3	26.0	26.7	
Graduate/professional	26.6	26.1	27.1	
Housing Type[I]				x^2 = 6.87**
Single-family dwelling	73.9	78.4	70.0	
Unit in multi-family dwelling	19.8	15.3	23.8	
Other	6.3	6.3	6.2	
Housing Tenure				x^2=30.34***
Own	84.4	90.4	78.9	
Rent	15.6	9.6	21.1	
Age Group				x^2=16.12***
18–30	5.1	3.1	6.8	
31–40	9.3	7.7	10.8	
41–50	13.3	15.6	11.2	
51–60	22.4	22.7	22.2	
61 and over	49.9	50.9	49.0	
Concern about health impacts[II]				x^2=71.28***
Not concerned at all	50.4	64.5	36.9	
A little concerned	7.2	8.5	6.0	
Concerned	5.1	5.5	4.9	
Very concerned	4.2	3.0	5.1	
Not sure	33.1	18.5	47.1	
Concern about privacy impacts[III]				x^2=73.37***
Not concerned at all	51.9	63.2	41.3	
A little concerned	10.3	12.8	8.0	
Concerned	7.7	8.2	7.2	
Very concerned	6.2	6.1	6.3	
Not sure	23.9	9.7	37.2	

**The difference between the two groups is significant at the 0.95 significance level.
*** The difference between the two groups is significant at the 0.99 significance level.
[I]These results are only for 2015 data, as this variable was not included in the 2016 survey (n = 592).
[II]These results are only for 2016 data, as slightly different Likert-type scales were used in the 2015 survey (n = 680).
[III]These results are only for 2016 data, as slightly different Likert-type scales were used in the 2015 survey (n = 678).

3.3.6. A Regression Analysis

While the descriptive analysis reported above provides useful information on the factors for those who reported having a smart meter and those who did not, one limitation of such results is that the impact of each variable is analyzed without controlling for the impacts of other variables. Regression analysis can overcome this limitation by estimating the impact of each independent variable on the dependent variable while other independent variables are controlled. A binary logistic regression is used in this study because the dependent variable is a binary variable. The estimation results of the binary logistic regression model are reported in Table 2. For the dependent variable, Y=1 indicates that the respondent reported having a smart meter, and Y=0 denotes "otherwise," meaning that the respondent did not report having a smart meter, either by responding "no" or that she or he did not know whether she or he had one.

Table 2. *Logit Regression Results (Y=1 indicates reporting having a smart meter and Y=0 indicates otherwise) (n = 1139)*

Variable	Definition	B	Exp (B)
Gender	1 for female and 0 for male	-0.574***	0.563
Year	1 if 2016 and 0 if 2015	0.096	1.100
Health impact	1 if yes (some level of concern) and 0 otherwise	-0.459**	0.632
Privacy impact	1 if yes (some level of concern) and 0 otherwise	0.371**	1.450
Rentorown	1 if rent and 0 if own	-0.996***	0.369
Pplhh	Number of people in household	-0.027	0.974
Education	Level of education		
	1 if no diploma and 0 otherwise	0.837*	2.309
	1 if HS graduate/GED and 0 otherwise	-0.005	0.995
	1 if some college and 0 otherwise	0.168	1.183
	1 if associate/technical degree and 0 otherwise	0.205	1.228
	1 if bachelor's degree and 0 otherwise	-0.011	0.989
Area	Living in a rural, suburban, or urban area		
	1 if rural and 0 otherwise	-0.016	0.984
	1 if suburban and 0 otherwise	0.035	1.035
Age	1 if 18-30 and 0 otherwise	-0.374	0.688
	1 if 31-40 and 0 otherwise	-0.240	0.786
	1 if 41-50 and 0 otherwise	0.324	1.382
	1 if 51-60 and 0 otherwise	0.011	1.011
Constant		1.331**	3.786

*The difference between the two groups is significant at the 0.90 significance level.
**The difference between the two groups is significant at the 0.95 significance level.
*** The difference between the two groups is significant at the 0.99 significance level.

While SPSS software provides several statistics on the goodness of fit of binary logistic regressions, the most relevant statistics are those concerning the power of prediction. This estimated model correctly predicts whether one reports having a smart meter for 61.5% of respondents (59.8% for the respondents who reported having a smart meter and 63.0% for the respondents who did not report having a smart meter). Though this prediction power is not very high, it is within the range of many empirical studies using cross-sectional survey data (e.g., Wang, Trent, & Parsons, 2009). Exp (B) in the last column of Table 2 is the exponentiation of the βs and can be interpreted as the marginal impact of the independent variables on the odds for the dependent variable to be 1. The results from this regression analysis suggest five major findings: (1) The odds of females reporting having a smart meter are 43.7% less than the odds of males reporting having a smart meter. (2) For those who have health concerns about smart meters, their odds of reporting having a smart meter are 36.8% less than those who did not report having such concerns. (3) In contrast, for those who have privacy concerns about smart meters, their odds of reporting having a smart meter are 45.0% greater than those who did not report having such concerns. The reason those who have health concerns about smart meters are less likely to report having them, while those who have privacy concerns about smart meters are more likely to report having them (as compared to those who did not express such concerns), is unclear. This contrast was not expected, and more primary data are needed to examine the possible reason(s) behind these results. (4) The odds of those renting a home reporting having a smart meter are 63.1% less than the odds of those owning a home reporting having a smart meter. (5) Last, the odds of those who did not have a diploma reporting having a smart meter are 131% greater than the odds of those with a higher level of education reporting having a smart meter.

3.4. Discussion and Implications

The results of this study indicate a need for improved education on smart meters to bolster the benefits they can provide to utilities and electricity customers. Though theoretical modeling of consumers changing their behavior in response to information provided by smart meters has shown that significant cost savings and reductions in CO_2 emissions could be realized (Cook et al., 2012), this modeling presupposes that (1) consumers are aware that they have a smart meter and (2) that they shift their electricity consumption to off peak times in response to the information provided by smart meters. While most electricity meters in Vermont are now smart meters (E. Goldman, personal communication, February 9, 2016), this research shows that many electricity customers may not even be aware that they have a smart meter. Additionally, a majority of those who did report having a smart meter did not report electricity reduction as the result of having a smart meter. Thus, those who are aware that they have a smart meter might not be accessing the information it provides, and, if they are, they may not be changing their electricity consumption in response to this information. Education on smart meters should first raise electricity customers' awareness of the presence of smart meters. Next it is necessary to educate customers on how to access and use the information that smart meters can provide. However, education alone may not be effective if customers do not trust the source of information, which, in the case of smart meters, would tend to be utility companies. Effective education, in this regard, is not just about disseminating information, but also about building trust (Lineweber, 2011; Wynne, 2006).

One entity that may be particularly well-suited to educate electricity customers on smart meters is Extension, as Extension is often seen as an unbiased disseminator of information and thus is regarded as a trustworthy source (Laquatra, Pierce, & Helmholdt, 2009; Romich, 2015). Currently, University of Vermont Extension is not doing any work in regard to smart meters (University of Vermont Extension, 2016). A partnership between Vermont's Extension educators and utility companies could facilitate dissemination of information regarding smart meters, including how to identify whether one has a smart meter and how to access the information it can provide. Unfortunately, Extension has faced funding challenges over the years and so there are limited resources to implement programs (R. Parsons, personal communication, December 18, 2017). While Extension is, in theory, a potentially ideal educational partner for utility companies due to its status as a trusted source of information, this partnership in practice may not be that easy due to the limited resources of Extension, and utility companies may need to find other educational entities to partner with.

Extension (if it was to work on smart meter outreach) and other potential educators on smart meters may find benefit in tailoring their outreach according to demographics. For example, these data indicate that those who live in units in multi-family dwellings and rent their homes are less likely to know that they have a smart meter than those who live in single-family dwellings and own their homes. Educational efforts focused on renters and those living in units in multi-family dwellings would be an effective way to increase awareness of smart meters. Additionally, Vermont residents are more concerned about potential privacy impacts of smart meters than they are potential health impacts. If Extension and other educators can learn what customers' concerns are about smart meters and why they have such concerns, they can provide educational materials that will help address these concerns.

Beyond education, there may need to be more action on the behalf of utility companies to incentivize customers to change their electricity consumption in response to the information provided by smart meters. Even once consumers are aware of having a smart meter and the information it can provide, they may be unmotivated or unable to change their electricity consumption. In fact, one study found that some consumers reported being unable or unwilling to shift their electricity consumption to off-peak times (Groothuis & Mohr, 2014). Furthermore, a major premise behind the idea that consumers will shift electricity consumption in light of the information they receive from smart meters is that there are dynamic electricity pricing structures in place. Under such pricing structures, the cost of electricity for consumers varies throughout the day, being most expensive during times of peak demand. With these structures in place, consumers could save money by shifting some of their electricity consumption to off-peak times. Unfortunately, such pricing structures appear to be limited in the United States (Behr, 2010), as they are in Vermont (D. Fredman, personal communication, April 22, 2016), which might deter customers from going out of their way to change their electricity consumption behavior.

Utility companies may also want to consider implementing display tools, harnessing additional behavioral science insights, and increasing transparency to increase the efficacy with which smart meters are used. First, in-home displays (IHDs) that show how much electricity is being used and how costly it is could bolster incentives to change electricity consumption behavior, especially when connected to dynamic pricing structures (Behr, 2010). Two other interventions that have been shown to motivate electricity reduction/shifting consumption away from peak demand are to have customers pre-pay for electricity and see on a display how much "credit" they have remaining (Mooney, 2015) and also to provide information on their bill where their electricity use is compared to that of their neighbors (Behr, 2010). There has also been an idea of for putting an "energy orb" in homes, which changes colors depending on the demand for and cost of electricity, with red indicating high cost, high demand times, and green indicating low cost, low demand times (see, for example, Ambient Products, n.d.). Since humans tend to be visually oriented, this kind of visual cue may be more likely to produce a behavioral response.

Additionally, utilities may tout benefits of smart meters for consumers, but then be able to provide "little evidence of tangible benefits" the meters will bring them (Navetas, 2011, para. 10). Some may even find some of the education and promotion around smart meters to be downright misleading. For example, the website for a non-profit called Smart Grid Consumer Collaborative describes, in a section about the benefits of smart meters, that smart meters can help "you schedule your most energy-intensive tasks for low-demand periods when you pay less" (Smart Grid, n.d.). This unfortunately just simply may not be true – many consumers are not purchasing electricity from a utility that has differential electricity pricing throughout the day. In fact, only about 8 million Americans are connected to an electricity pricing structure that allows them to save money by shifting electricity consumption to off-peak times (Edison Foundation's Institute for Electric Innovation as rfd. in Mooney, 2015).

Utilities may find it efficacious to be transparent about their pricing structures and how this relates to anticipated consumer benefits from smart meter utilization. If dynamic pricing structures are not in place, utilities can then focus on discussing other reasons people may want to use smart meters, such as by appealing to their "sense of responsibility as energy consumers" (Behr, 2010, para. 11). However, as Behr (2010) puts it, "[U]nless consumers see, and pay for, the true cost of power when demand peaks, they won't have the financial motivation to turn off appliances or shift thermostat settings in the heat of the day, or run the laundry at night, when prices fall" (para. 9). In all, doing additional education for consumers on smart meters is only part of the solution to seeing greater benefits realized from them. There is also a responsibility on the behalf of utility companies to take greater initiative in facilitating and incentivizing such behavior change.

Although some work has been done in Vermont to increase electricity customer engagement with smart meters (Gram, 2014), it is unclear how widespread and effective these efforts have been. In addition to increased efforts to engage electricity customers with smart meters, more research is needed to better understand the following areas:

1. What baseline information, if any, electricity customers have on smart meters and where they obtained this information,

2. How the source of information on smart meters affects how electricity customers view and use them,
3. How information in different formats, such as in-home displays, affects electricity customers' electricity consumption,
4. What barriers electricity customers face in regard to changing their electricity consumption,
5. How different electricity pricing structures affect electricity customers' use of smart meters and electricity consumption, and
6. How different educational campaigns and programs on smart meters affect electricity customers' behavior.

In all, additional information in these areas can aid the development of interventions, such as educational campaigns, updates to how smart meter information is relayed to customers, and pricing structures, that increase the efficacy of smart meter utilization and the benefits they can provide.

3.5. Conclusions and Recommendations

Smart meters as a new technology have the capacity for many benefits, including reduced CO_2 emissions and cost savings for electricity customers and utility companies. While some benefits have been realized from smart meter installation, such as decreased labor costs for utility companies and decreased severity of power outages, other benefits, such as reduced electricity use and cost for electricity customers, may not have been fully realized. Many of these benefits will depend on electricity customers changing their behavior in response to the real-time, or nearly real-time, pricing information that smart meters provide. If electricity customers are not aware that they have a smart meter, are not accessing the information that smart meters provide, and are not changing their behaviors in response to the information that smart meters provide, the benefits realized from this advanced technology are likely to remain limited.

As the results from this study show, smart meter technology in Vermont appears to be underutilized. Many residential electricity customers appear to be unaware that they have a smart meter, and many of those customers who do have a smart meter have not changed their electricity consumption as a result. Additionally, some residents report being concerned about smart meters' potential impacts on their health or privacy.

When doing educational outreach, utility companies may want to partner with other reputable educators to build trust in smart meter technology and spread knowledge of how to maximize its benefits. However, the onus of behavior change in light of this information does not fall on consumers alone. Instead, there also needs to be greater action on the behalf of utility companies to incentivize such behavior change, such as through implementing dynamic pricing structures and/or providing homes with IHDs. Additional research on smart meters will help to improve the efficacy of outreach and interventions in regard to smart meters. The underutilization of smart meters means that many more benefits are available to be obtained from them. Providing additional information on smart meters and incentives to change electricity consumption behavior in response to the information they provide, especially when informed by additional research on smart meters, can play an important role in helping these benefits to be realized.

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CHAPTER 4. ASSESSING LOCAL SUPPORT FOR AN ON-FARM COMMUNITY ANAEROBIC BIODIGESTER SYSTEM

This chapter presents the CADS study in full, which consists of the following sections: Introduction, Background, Methods, Results and Analysis, Discussion and Implications, Study Limitations, and Conclusions and Recommendations.

4.1. Introduction

On-farm anaerobic digester systems (ADS) have the potential to help mitigate greenhouse gas emissions, diversify farms' revenue streams, and assist with manure management, especially for dairy cows and swine (Bracmort, 2010). ADS break down manure and other organics in a closed system in the absence of oxygen (anaerobically) and produce a methane-rich biogas in the process. This biogas is then captured and combusted as a renewable form of energy, which farms can either use or sell. Heat is also produced during this process, which farms can use to heat water, buildings, or the ADS systems themselves (AgSTAR, 2011). In contrast, when manure breaks down in open systems, or closed (anaerobic) systems without methane capture capabilities, methane emissions are produced and released directly into the atmosphere. Additional byproducts of anaerobic digestion include liquid effluent, which can be used as fertilizer, and digested solids, which can be used as animal bedding or soil amendment. Farms can use these byproducts or sell them to diversify their revenue streams (Bracmort, 2010). ADS can also help reduce odors associated with manure production and improve air and water quality more generally, especially through the reduction of greenhouse gas emissions, destruction of pathogens, stabilization of volatile organic compounds, and facilitation of nutrient management (AgSTAR, 2017b; Lazarus, 2008). Despite the many benefits ADS could provide, on-farm ADS implementation in the United States is very limited, especially when compared to an international context. For example, while there are about 8,000 total on-farm ADS operating in Germany (IEA Bioenergy Task, 2015), there are only 249 on-farm ADS operating in the United States, with an additional 15 in construction (AgSTAR, 2017a).

On-farm ADS implementation is constrained in the United States especially due to financial viability. While large-scale farms have seen positive returns from ADS, small and medium farms (SMDFs) have struggled to do the same, thus constraining the expansion of ADS technology in the United States. In fact, the EPA gives the general guideline that farms will need 500 or more dairy cows or 2,000 or more swine in order for their ADS to be profitable (AgSTAR, 2011). This is because ADS involve an economy of scale: Construction costs do not decrease proportionate to ADS size, and revenues depend upon the quantity of output. Thus, larger numbers of livestock generate revenue that helps cover the high initial fixed costs of ADS construction and operation. In one estimate, initial capital costs per cow were $3,116 for a herd of 100, which dropped down all the way to $805 for a herd of 500 (Lazarus, 2008 using AgSTAR, 2006 data). However, some have argued that the view that ADS, in general, need to operate at a large-scale in order to be viable, is due to a “scale bias...[that] has social and political, not engineering origins” (Welsh, Grimberg, Gillespie, & Swindal, 2010, p. 178), as evidenced partly by the fact that small-scale ADS have been viable in other nations, including developing and European nations (Lazarus, 2008; Welsh, Grimberg, Gillespie,

& Swindal, 2010). Luckily, a community model of ADS (CADS), where manure and other organic wastes are accepted from off-farm sites, may help spread the cost of the ADS between multiple entities, in addition to helping meet the need for organic inputs (Babcock et al., 2016). CADS, therefore, may help make ADS technology more viable, especially for SMDFs, thus expanding their implementation and the benefits they can provide.

Despite the potential of the CADS model to expand ADS implementation in the United States, the number of successful CADS projects in the United States remains low. In fact, even attaining a number for how many community (sometimes called centralized) ADS are operating in the United States is difficult. AgSTAR's (2017a) Livestock Anaerobic Digester Database, which provides a detailed list of all ADS projects that are located on livestock farms in the United States, shows that 16 ADS are "centralized/regional," and 3 of these are labeled as being under construction. This category of ADS would seem to fit the specifications for a CADS, though it is not clear whether other categories of ADS (such as "farm scale") might also be considered a CADS. In contrast, though the exact number is hard to track down, Germany has many more CADS operating, with one estimate that there are over 2,500 ADS operating on a community level ("Pursuing the Concept," 2007). On a larger scale, various parts of Europe have seen success in implementing CADS (Woughter, 2014). One reason Germany may have more CADS is because their policy environment is more favorable to CADS development. For example, the United States and Germany have varied greatly in their use of Feed-in-Tarrifs (FiTs), which subsidize renewable energy production. Among other things, Germany's FiT system is more widespread, legally binding, and amenable to small-scale energy production and bioenergy production than the United States' FiT system (Thibault, 2014).

The viability of CADS depends on a number of additional factors (some of which are related to FiTs), including, but not limited to, the following: the number of participating community partners contributing manure and/or organic wastes, whether those contributing food wastes pay a tipping fee, the location of the CADS and how far off-farm partners need to travel to contribute inputs, governmental investment, the price electricity generated from the CADS can be sold to utilities for, public participation in green pricing programs where a premium is paid for energy generated from ADS, and whether other CADS-generated products, namely fertilizer and animal bedding, are sold (Babcock et al., 2016; Hurley, Ahern, & Williams, 2006; Lazarus, 2008; Thompson et al., 2013). Understanding the way these barriers affect CADS is an important component of ensuring their viability; however, work that discusses these barriers in the context of CADS specifically (as opposed to ADS more generally) is rare and tends to focus especially on financial challenges to viability (Hurley et al., 2006; Lazarus, 2008). One challenge that is largely absent from these discussions is the role that public support plays in CADS viability.

While there has been some work on farmers' interest in ADS (Welsh et al., 2010) and public support of ADS (Sanders et al., 2010), including the importance of consumer participation in green pricing programs for ADS-generated electricity (Babcock et al., 2016; Wang et al., 2011), more information on public support for CADS specifically is needed. Although Swindal et al. (2009) examined farmers' interest in CADS, the researcher was not able to find a study dedicated to understanding public support for CADS specifically. Though willingness to pay (WTP) for electricity generated from ADS surely encompasses an element of support for CADS, it is a bit removed from the context in which CADS occur, which is that they are sited within actual communities. Not only is public support of CADS in general important, but, more granularly, support from the specific communities in which they are located is also likely very important. Though finding formalized discussion of the role community support plays in CADS implementation is difficult, the research team was informed by this study's community partner that garnering community support for their CADS was one of the biggest challenges to ensuring its viability (M. O'Leary, personal communication, November 21, 2016). Understanding how community members feel about CADS that are actually located in their community, therefore, could be an integral component of understanding potential barriers to (and perhaps opportunities for) CADS implementation.

The purpose of this study was to better understand community support for CADS and what factors may influence this through a case study on a Vermont community in which a CADS is located. Vermont makes a good location in which to study CADS because, although CADS are limited in America, one of Vermont's technical colleges, which was the community partner for this study, actually has a CADS operating. (This technical college is called Vermont Technical College (VTC) and will be referred to as either VTC, community partner, or technical college in this chapter.) Furthermore, VTC was willing to provide a tour of the CADS and offer crucial insights that helped shape the development of this work. The study's objectives were to assess the following: (1) the extent to which respondents expressed support for ADS in general (for context) and the CADS in their community, (2) what attitudinal and demographic characteristics influenced respondents' support for the CADS, (3) how communication has influenced CADS support, and (4) how and why respondents' attitudes have changed towards the CADS over time. The results of this study are expected to be beneficial to those seeking to support and expand the implementation of CADS in the United States, in addition to those wishing to better understand the public's renewable energy attitudes and support.

4.2. Background

After being informed by VTC that garnering community support for the CADS was one of the biggest challenges to ensuring its viability (M. O'Leary, personal communication, November 21, 2016), further consideration needed to be given to what forms such support could take. In all, a multifaceted concept of CADS support was developed. As has been mentioned, SMDFs often struggle to be financially viable, especially due to high start-up costs, and require multiple forms of funding. Public investment is an important part of this funding and may take the form of tax-based grants that help farms purchase ADS. Public support of pro-environmental policy may also help support CADS. Additionally, electricity customer participation in green pricing programs, where a premium is paid for energy produced from renewable sources, can also help cover some of the CADS' costs (Babcock et al., 2016). This is due, at least in part, to the fact that renewable energy is often more expensive to produce than non-renewable energy (U.S. Department of Energy, n.d.-a). Unfortunately, participation in green pricing programs remains relatively low in America, with average participation rates reported at 1.5% in 2005 (Bird & Brown, 2005) and 2.1% in 2012 (Institute for Energy Research, 2013).

In Vermont, one such green pricing program is the Cow Power program, where electricity customers can elect to pay a premium of $0.04 per kWh on top of the regular rate on a portion of their electricity use to support electricity generated from cow manure by Vermont dairy farms. This program has helped with ADS viability in VT, but in late 2011, the supply of Cow Power eclipsed consumer demand, thus decreasing a potential revenue stream for ADS in Vermont (Babcock et al., 2016). Wang et al. (2011) highlighted the importance of this revenue stream. In their study of four dairy farms with ADS, they found that revenue from Cow Power comprised a significant source of income for ADS. This revenue, in conjunction with premium rates paid by utility companies for ADS-generated electricity, accounted for 64.6% of these ADS' income in 2008. Though it is not exactly certain why participation in the Cow Power program has declined, some have found that consumers may prefer solar energy over wind, biomass, and farm methane (Borchers et al., 2007). In all, while these forms of public support for ADS contribute to CADS support, there are a number of other facets of public support that are CADS-specific.

Two such additional forms of support are community members' willingness to have a CADS located in their community and composting behaviors. In order to garner the former, VTC launched extensive outreach efforts, including bringing community members to Europe and Montreal, Canada to view successful ADS, disseminating various educational materials, such as through the newspaper, and holding open houses where the public could see the CADS while it was being constructed (Vermont Tech, 2015). In addition to this, though community members may not know it, their willingness to compost using the CADS' drop-off compost container can contribute to its viability. In fact, the community partner mentioned that it would like to receive "as much food waste as possible," even though food wastes cannot exceed 49% of the inputs to the CADS. The reason for this cap at 49% is Vermont's Act 250. Under this act, if the CADS' food waste inputs exceeded 49% of the total inputs, it would cease being an agricultural operation and would instead be deemed a commercial one (M. O'Leary, personal communication, November 21, 2016). Restrictions aside, one reason more food wastes are desired is because increasing the proportion of food scrap inputs for ADS can increase the amount of energy they produce (Babcock et al., 2016). Additionally, gaining inputs from sources that are relatively close to the CADS, such as community households, could also help address some of the logistical challenges of long-distance transport of food scraps, such as the build-up of gasses in food storage bags and the carbon footprint associated with transportation (M. O'Leary, personal communication, November 21, 2016).

Currently, the community partner uses a variety of on-farm and off-farm sources to help meet its need for organic inputs. On-farm inputs include manure, grass clippings, leaves, shredded waste paper, spoiled silage, and garden refuse. Off-farm inputs include brewery wastes, glycerol from biodiesel producers, grease wastes from some local restaurants, and some food scraps from a local college (M. O'Leary, personal communication, February 3, 2018; Vermont Tech, 2015). From March of 2014 to June of

2015, about 19.3% of the CADS inputs came from off-farm sources, which gives the approximate percentage of food scrap inputs as well, as most of the on-farm inputs are not food wastes and most of the off-farm inputs are (Vermont Tech, 2015). Off-farm waste generators either bring these food wastes to the CADS or pay a hauling company to bring them to the CADS for them. Currently, VTC neither pays for these food scraps, nor charges waste generators for using the CADS to dispose of their wastes (M. O'Leary, personal communication, February 3, 2018). Ideally, people and organizations who contributed organic wastes to the CADS would pay a charge, also called a tipping fee, to do so (M. O'Leary, personal communication, November 21, 2016), although the volatility of the organics market may prevent this from being the best option in the real world (Vermont Tech, 2015). While the technical college has not charged such a fee, there are some instances of consumers paying to have their organic wastes collected and composted (e.g., Bennett Compost, 2010), which, in the context of the CADS, could diversify its revenue streams and promote its viability. Additionally, the passage of Vermont's Universal Recycling Law (Act 148), which mandates that by 2020 all food scraps (in addition to recyclables, clean wood, and yard organics) be kept out of landfills, could present an opportunity for the community partner to leverage in order to collect more food scraps. Under this act, trash haulers will be required to provide compost collection services alongside recycling and regular trash collection services (Agency of Natural Resources, 2018). As food scraps will need to go somewhere other than a landfill, VTC could position the CADS as a potential repository for such food scraps.

This study not only looks at the multifaceted ways in which the CADS could be supported, but also seeks to describe who CADS supporters may be. Other work has done something similar in the context of profiling the average green energy consumer, in which several demographic and socialpsychological trends have been found. A positive correlation has been found between willingness to pay for energy with less adverse environmental impacts and the following demographics: higher levels of education (Roe et al., 2001; Rowlands et al., 2003; Zarnikau, 2003), younger ages, and higher salaries (Rowlands et al., 2003; Zarnikau, 2003), and lower electricity costs (Hansla et al., 2008; Zarnikau, 2003). Examples of socialpsychological characteristics that have been found to be positively correlated with willingness to pay a premium for green energy include the following: awareness of environmental consequences (Hansla et al., 2008), environmental concern, altruism (Hansla et al., 2008; Rowlands et al., 2003), and liberalism (Rowlands et al., 2003). In the single study that was found that examined public support for ADS in the form of WTP a premium for ADS-generated electricity, four distinct groups emerged: The group that was the most WTP was, on average, the most educated, second wealthiest, most politically liberal, and reported the highest level of environmental stewardship and proactiveness. The group that was least WTP, on the other hand, was, on average, the oldest, least educated, least wealthy, most politically conservative, and had the lowest environmental stewardship (Sanders et al., 2010).

Everett Rogers' (2003) Diffusion of Innovation (DOI) Theory can also help frame the exploration of what CADS supporters look like. DOI helps describe the process by and rate at which an innovation is adopted over time. Among other things, innovations can take the form of technology (like CADS). Now, it may seem that there are limited ways in which an individual could adopt a CADS, but Rogers did talk about how an innovation could be an idea, which, in turn, could be adopted. Rogers' lens is extended here, and support for the CADS is looked at as a form of adopting the idea that the CADS is beneficial for and should operate in the community. Additionally, people's use of the CADS for composting could constitute an adoption of the innovation – it is just not an innovation people necessarily find easily accessible to them in a day-to-day context.

In DOI, there are five main segments of adopters, divided according to when they adopt the innovation as compared to the mean time of adoption. They are as follows: 1) innovators, 2) early adopters, 3) early majority, 4) late majority, and 5) laggards. A sixth group of non-adopters is sometimes also included (Kaminski, 2011). DOI predicts that, among other things, early adopters of an innovation will be more highly educated, wealthier, have greater exposure to mass media and interpersonal forms of communication, and be more positive towards science and change as compared to later or non-adopters. Though this study did not have a time element (other than change in attitude towards the CADS over time) and did not focus on categorizing which type of adopter respondents were (innovators, early adopters, early majority, late majority, laggards, or non-adopters), the idea here is that "adopters" (supporters) of the CADS could be considered, if nothing else, earlier, as opposed to later, adopters. This is due, at least in part, to the fact that the CADS had only started operation three years prior to the study, meaning that supporters of the CADS could be viewed as adopting it relatively early on. The view that the CADS is relatively new to the community is also bolstered by the fact that nearly half of the respondents did not report being familiar with the CADS. Thus, the analysis of who CADS supporters are included variables that the DOI describes as influencing adoption.

Of particular analytic relevance is that DOI influenced the decision to look at how communication influenced CADS support, as the theory details the importance communication plays in influencing people's adoption of an innovation. DOI describes a five-step innovation-decision process during which someone decides whether he or she would like to adopt an innovation. The five steps are as follows: (1) knowledge, (2) persuasion, (3) decision, (4) implementation, and (5) confirmation. Rogers says that during the knowledge phase, where people become aware of and understand the innovation, indirect communication (mass media) is particularly important, whereas during the persuasion phase, where people form a positive or negative attitude towards the innovation, direct (interpersonal) communication is particularly important. Though this study did not assess where respondents were in this process, the theory's insights on communication still informed the analysis on communication. Specifically, by providing the idea that there are two distinct communication types (mass media and interpersonal) and that those may have different effects on adoption of an innovation. Furthermore, the influence of attitudes towards the CADS on CADS support was tested, which speaks to the importance of the persuasion phase, where people form positive or negative attitudes towards the innovation, which in turn influences whether they adopt it.

In all, the insights garnered from the community partner and supporting literature helped shape the ways in which CADS support was conceptualized and how CADS supporters were analyzed. Namely, in addition to questions on explicit support for the CADS and attitude change towards the CADS over time, questions on support for public investment in ADS, support for Cow Power, and composting behaviors were included to broaden the concept of CADS support. Also, the analysis of CADS supporters involved looking at adopter characteristics as detailed by the DOI, in addition to those brought up in the literature on green energy consumers. The influence of communication and attitudes towards the CADS on CADS support were also examined.

4.3. Methods

As has been mentioned, this work was grounded in a partnership with VTC, which operates the CADS mentioned in this study. The impetus for this work came from an initial meeting with this college where the UVM researchers learned that garnering community support for the CADS was one of the biggest challenges to ensuring its viability (M. O'Leary, personal communication, November 21, 2016). The survey used in this study was developed with this key challenge in mind, and VTC offered insights on drafts of questions and also approved the final version of the survey. Please see Appendix B for the full list of survey questions.

The target respondent group for this study was those who lived in the city where the CADS is located, and there was additional interest in being able to ascertain respondents' relative proximity to the CADS. In order to help assess whether those responding met these criteria, the following demographic questions were asked: (1) whether the respondent was a resident of the city where the CADS is located and (2) how far away the respondent lived from the CADS, with answer choices given in terms of ranges of miles. Additionally, the survey was only distributed to those households in the zip code of where the CADS is located. Though unexpected, fifteen respondents did write in on their surveys that they lived in the town next to the one the CADS is located in. These responses were included due to their proximity to the CADS and ability to provide some additional insight from those who lived a bit further from it.

The survey was distributed to 1,900 households via the local newspaper. The survey was four pages total and had a prepaid return envelope attached to it that respondents could use to mail their surveys back. Respondents were informed that, if they wished, they could be entered in a random drawing to win one of three $50 gift cards for completing the survey. The paper copy of the survey also provided a link to an online version of the survey that respondents could fill out if they preferred. The week before the survey went out, a press release was published in the local newspaper letting residents know that the survey was coming in next week's paper. The press release also described the purpose of the survey and the gift card drawing incentive. The surveys were sent out the following week, and the survey instructions stated that respondents had two weeks to get their surveys in the mail. About 125 surveys had been received when the research team decided to extend the time period during which respondents could get their surveys in. A follow-up press release was published in the local newspaper three weeks after the initial survey had gone out, reminding respondents that they had received this survey and what its purpose was. The link to the online version of the survey was also provided in this press release, especially in case people had not seen or had lost the hard copy of their survey. Instructions in this press release asked that respondents mail their surveys back within approximately the following two weeks.

In total, 140 hardcopy surveys were returned, and 4 were completed online, for a total sample of 144 and a response rate of 7.6% (the percentage of households that returned the survey). As compared to U.S. Census data for the study area (U.S. Census, 2010a, 2010b, 2016a, 2016c), the sample had a greater proportion of females and was older, wealthier, and better educated, on average. Despite these differences from U.S. Census data, the survey data were not weighted due to the relatively small sample size. The survey contained five broad groups of questions that covered the following areas: (1) renewable energy issues, (2) knowledge of, opinions on, and attitudes towards the CADS, (3) communication and interest in additional information, (4) composting of food scraps, and (5) demographics. Full-text survey questions can be found in Appendix B.

The data from these questions were analyzed using SPSS (Statistical Package for Social Sciences), specifically, through descriptive analysis, Chi-square tests, t-tests, and regression analysis (including binary logistic regression and linear regression), and qualitative analysis.

To assist in understanding question area (2), several data analysis choices were made that should be noted here. A series of 13 statements about possible outcomes of the CADS were provided (sometimes referred to as "outcome statements"), with response choices on a Likert scale, and respondents could state the extent to which they agreed with them. Response choices ranged from 1 to 5, with 1 = strongly disagree, 2 = disagree, 3 = not sure, 4 = agree, and 5 = strongly agree. There were 8 statements about positive outcomes and 5 statements about negative outcomes. The summary statistics for these statements are given in Table 3. Please note that in order to make comparison between the statements easier in this table, strongly disagree has been combined with disagree and strongly agree has been combined with agree.

In order to examine the relationship between the extent of agreement that the CADS brought about positive or negative outcomes and CADS support, a composite variable was created from the responses of the 13 outcome statements. Negative statements were recoded to be given an inverse scale so that someone who strongly disagreed with a negative outcome statement would receive a 5 instead of a 1. This composite variable created a kind of "positivity" score towards potential CADS outcomes, with 0 being the lowest value someone could have and 65 being the highest value someone could have.

Additionally, the survey contained two questions on how respondents' attitude towards the CADS had changed over time (since they first learned about it). The first was a Likert-type question, which asked respondents to select how their attitude towards the CADS had changed over time (the exact wording of the response choices can be viewed in Figure 9). The following question was open-ended and asked respondents to explain why they had answered the preceding question as they did, which was analyzed via qualitative analysis.

For the binary logistic regressions, the dependent variable was recoded into two choices: 1 = respondent indicated some level of support for the CADS (the "event" category) and 0 = respondent did not indicate some level of support for the CADS (the “nonevent” category). Unfortunately, the predictive power of these models was limited. One major challenge with these data was the sample size. After several independent variables were included in the model, the sample size often dropped to around 110, with many more cases belonging to the “support” category (around 80) than the “did not indicate support” category (around 30). As other work has shown, a major limiting factor in including independent variables in a binary model is the number of cases that belong to the “event” or “non-event” group, whichever has fewer cases. The smaller of these two groups can be thought of as the “limiting” group.

In this case, there were only about 30 cases in the non-event group, and other work has recommended that only one predictor be included per every 10 to 15 cases in the limiting group (for a further discussion of these methodological considerations, please see Babyak (2004)). Therefore, not all of the predictors of interest could not be included in the model, otherwise overfitting of the model would occur, and the results would not be accurate. Additionally, the independent variables often needed to have their response choices collapsed (such as into binary variables) so as to not have too many degrees of freedom in the model. Suggestions on how to strengthen the methods of future CADS studies are included in the Discussion and Implications section.

4.4. Results and Analysis

4.4.1. CADS Support

The concept of “support” for ADS and CADS can take several forms. This study examines several ways support could be measured: (1) level of support for increasing public investment in ADS, (2) participation in and WTP for electricity generated by the

Cow Power program, (3) stated level of support for the CADS, and (4) composting behaviors. Area (1) could help with viability for future CADS, and area (2) could help the current CADS and future CADS to be viable. Area (3) is the most direct measure of support for the CADS that the survey contained. Area (4) is the least direct measure of CADS support, though it is a very important component. As the community partner told us, it would like to receive more food scraps for the CADS, and these need to be kept separate from other household wastes, which is also called clean stream collection (M. O'Leary, personal communication, November 21, 2016). However, respondents may not have been aware that composting and dropping off food scraps to the CADS would benefit it, and so whether respondents reported a willingness drop off food scraps to the CADS may or not may not be related to their level of support for it.

4.4.1.1. General Support for ADS

Public investment in renewables is an important component of their viability, as renewable energy is often more expensive to produce than non-renewable energy (U.S. Department of Energy, n.d.-a). In this study, the highest percentage of respondents, at 71.0%, indicated that they would support increasing public investment to generate more electricity from solar panels. Increasing public investment in biodigesters was the next most preferred option, with 63.4% of respondents reporting that they would support this. Increasing public investment in wind turbines was the least preferred option, with 59.9% of respondents indicating that they would support this.

In addition to supporting public investment in biodigesters, community members' voluntary participation in the Cow Power program is an additional (and more direct) way in which they can help to financially support Vermont's biodigesters (and farms with livestock by proxy). Although 68.1% of respondents had heard of the Cow Power program, 21.3% had never heard of the program before, and only 10.6% had participated in it. In a follow-up question, a description of the Cow Power program was provided, and respondents were asked what percentage of their electricity bill they would like to pay (on top of their regular electricity bill) to support the program. (Please see Appendix B for full question wording). Overall, as seen in Figure 4, there was not much interest in supporting the program. Of respondents reporting some level of interest in the program, 50.0% reported not being interested in the program, and 22.5% reported not being sure whether they were WTP anything to support the program. Of respondents who indicated being WTP some amount for the program, 13.8% of respondents indicated that they would be WTP 5.0% of their electricity bill to support the program, 12.3% reported being WTP 10.0%, and there was only one respondent (0.7%) in each of the WTP 20% and 30% categories. Though there were other WTP categories respondents could choose from (15%, 25%, 40%, 50%, and more than 50%), none of the respondents selected these categories. In total, only 27.5% of respondents reported that they would be WTP some amount to support the Cow Power program, indicating respondents' limited support for the program overall.

There was a statistically significant relationship between familiarity with the Cow Power program and WTP to help support it, with those who had participated in the program being more likely to indicate that they would be WTP for Cow Power (23.7%) than those who did not (5.2%), $\chi 2$ (2, n = 135) = 10.29, $p < 0.001$. In contrast, those who were not WTP for Cow Power were more likely to have only heard about the program (71.1%) or never have heard of it (23.7%) than those who were WTP for it. For those who were WTP for Cow Power, 60.5% had heard of the program before, and 15.8% had never heard of the program before.

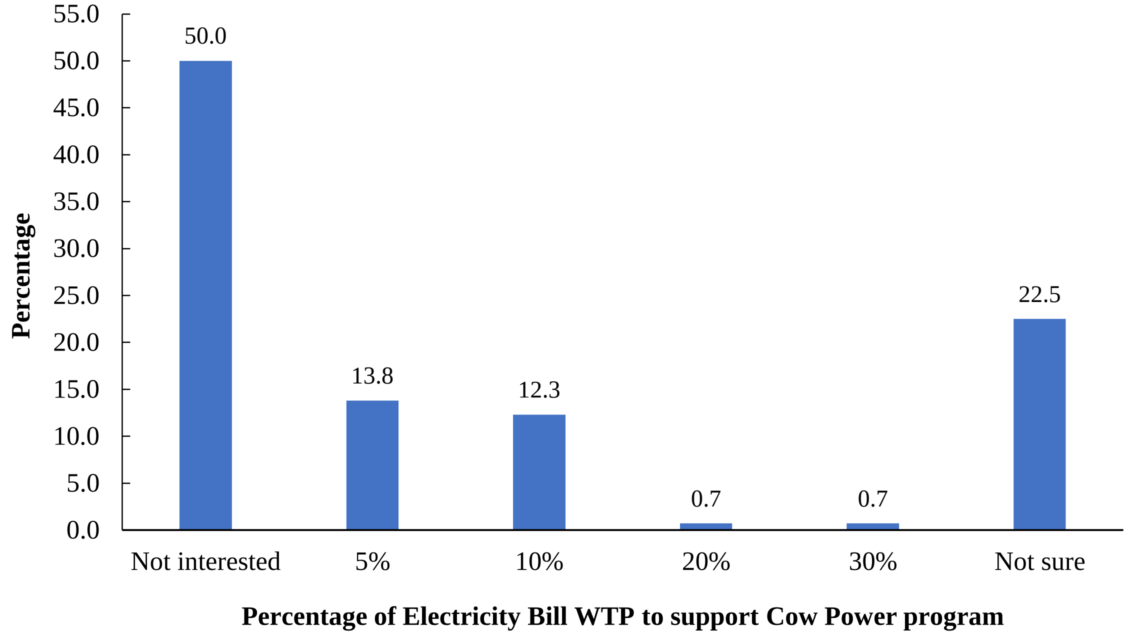

Figure 4. Maximum premium as percentage of electricity bill willing to pay to support electricity generated from Cow Power (n = 138). WTP categories of 15%, 25%, 40%, 50%, and more than 50% not shown because no respondents chose these.

4.4.1.2. Familiarity With and Support for the Local CADS

A majority of respondents indicated being familiar with the local CADS project and supporting it. As Figure 5 shows, 52.1% of respondents indicated some level of familiarity with the local CADS project, 39.6% of respondents reported some level of unfamiliarity with the project, and 8.3% were unsure. As seen in Figure 6, the proportion of respondents indicating support for the local CADS project was even greater than the proportion of those who reported being familiar with the project, with 69.8% of respondents reporting some level of support for the project, 7.2% indicating some level of opposition to the project, 14.4% reporting being neutral, and 8.6% being unsure.

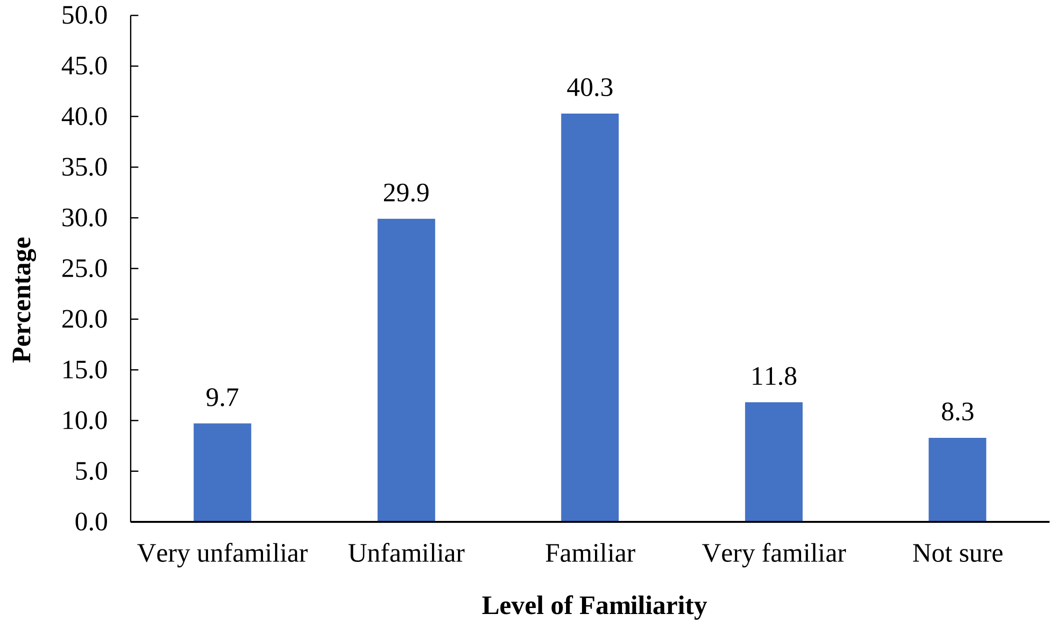

Figure 5. Level of familiarity with the local CADS project (n = 144).

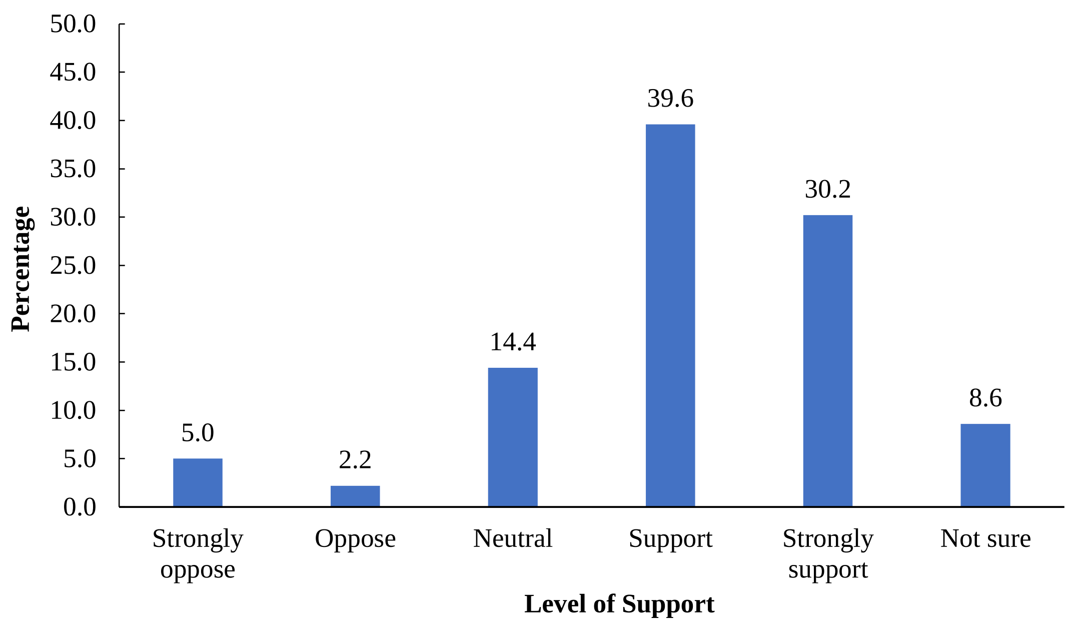

Figure 6. Level of support for the local CADS (n = 139).

4.4.1.3. Composting Behaviors

Since the community partner informed the research team that it would like to receive more food scraps from off-farm sites as inputs for the CADS, this survey contained four questions on composting behaviors. One such question was on clean stream collection, which is important because if the CADS receives food scraps with other materials mixed in, such as plastic utensils, this can negatively impact the operation of the CADS (M. O'Leary, personal communication, November 21, 2016). As can be seen in Figure 7, nearly half of the respondents (48.3%) reported that they would always practice clean stream collection, and 31.2% said that they would practice this very often, meaning that nearly 80% of respondents reported that they would engage in this practice frequently, if not always.

However, in order for the community partner to benefit from this practice though, community members must not only practice clean stream collection, but also be willing to give their food scraps to the community partner. The community partner has a drop-off container at the CADS where people can bring their food scraps, but only 37.3% of respondents knew that this container existed. A greater proportion of respondents, at 44.6%, said that they would use this container to drop off their food scraps. The community partner explained that the most ideal situation would be that it gets paid to accept food scraps from off-farm sites. Though this may surprise some, there are actually programs where people pay to have their compost collected (e.g., Bennett Compost, 2010). The existence of these, in addition to the community partner's interest in receiving food scraps, inspired the research team to ask a question about people's WTP to have their food scraps collected and dropped off at the biodigester. Though 59.4% of respondents reported that they would not pay for this service (n = 101), the mean WTP of the 40.6% who said they would be WTP some amount was $4.71 (*SD* = 7.77).

Interestingly, many respondents (29.2%, n = 144) wrote on their survey next to the composting questions that they already compost at home. Of the respondents who wrote this, 60.5% (n = 40) reported that they would never use the drop-off container for their food scraps. The respondents who wrote this note in may or may not have known that contributing food scraps to the CADS would benefit it. Of those who reported that they supported the CADS, only 40.2% said that they knew that the drop-off container existed (n = 137), and 51.6% said that they would like to use it (n = 135).

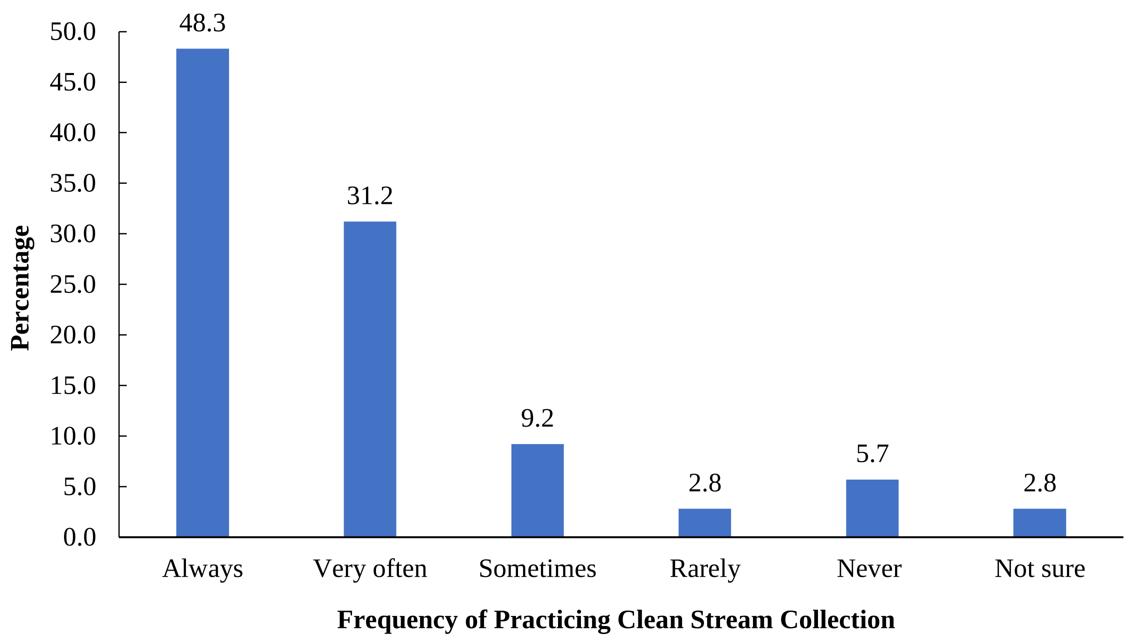

Figure 7. How often respondents said they would practice clean stream collection of food wastes at their households (n = 141).

4.4.2. How Attitudinal and Demographic Characteristics Are Related to CADS Support

The outcome statements helped reveal the extent to which respondents thought the CADS brought about positive or negative outcomes, or, how uncertain they were about its outcomes. The "positivity" score was created from these statements, allowing for the relationship between the level of positivity towards CADS outcomes and CADS support to be tested. Chi-square and regression analyses were also run to further test the relationship between attitudinal and demographic characteristics on CADS support.

4.4.2.1. Attitudes Towards the CADS

The summary statistics for the outcome statements are provided in Table 3. The statements here have been sorted according to percentage of agreement, from the highest levels of agreement to the least (as opposed to appearing in the same order as they did in the survey).

As can be seen in Table 3, every statement about a positive potential outcome of the CADS had a higher level of agreement with it than did any of the negative statements. In terms of positive statements, respondents were most likely to agree that the CADS "produces renewable energy from wastes" (80.0%) and least likely to agree that it "reduces odors produced by manure" (31.9%). In terms of the negative statements, respondents were most likely to agree that the CADS "reduces community aesthetics" (17.0%) and least likely to agree that it "lowers water quality" (3.9%). Respondents were most uncertain about whether the CADS "raises noise levels" (63.5%). In general, respondents tended to be more uncertain about the negative statements than those that were positive, responses of not sure ranging from 52.3% to 63.5% for these statements, as opposed to ranging from 17.8% to 58.5% for the positive statements. The only positive statement that had more uncertainty associated with it than the negative statements was "reduces odors produced by manure." The percentage of uncertainty for this statement was higher than the percentage of uncertainty for three of the five negative outcome statements

Table 3

Extent of Agreement with Statements About Potential Outcomes of the CADS

	Disagree (D + SD)	Not sure	Agree (A + SA)
Produces renewable energy from wastes	2.2%	17.8%	80.0%
Reduces food wastes going into landfills	2.2%	21.3%	76.5%
Serves as teaching tool on sustainable agriculture	2.2%	25.4%	72.4%
Helps with manure management	1.4%	28.2%	70.4%
Decreases dependence on fossil fuels	6.0%	25.9%	68.1%
Reduces nutrient runoff into waterways	3.0%	36.6%	60.4%
Reduces methane emissions from agriculture	4.6%	45.8%	49.6%
Reduces odors produced by manure	9.6%	58.5%	31.9%
Reduces community aesthetics	28.8%	54.2%	17.0%
Lowers air quality	33.8%	52.3%	13.9%
Lowers property values	29.9%	58.2%	11.9%
Raises noise levels	29.8%	63.5%	6.7%
Lowers water quality	36.7%	59.4%	3.9%

Note. The n-value varied for each statement, but ranged from n = 131 to n = 136.

Additionally, as was suspected, those who expressed support for the CADS were more likely to have a higher positivity score (believe that it brought about positive outcomes and disagree that it brought about negative outcomes) than those who did not express support for the CADS. This was indicated by the results from an independent samples t-test. The mean value of the positivity score for those who answered this question (n = 128) was 46.67 (*SD* = 7.50), with a range of 18 – 65. Those who supported the CADS tended to have a higher average positivity score than those who did not, and the difference between these groups was statistically significant ($p < 0.001$). The average score for those who indicated some level of support for the CADS was 49.29 (n = 89, *SD* = 6.67), while the average score for those who did not indicate support for the CADS (including those who indicated they were neutral or not sure about their support of the CADS) was 40.49 (n = 37, *SD* = 5.75).

4.4.2.2. Comparing Those Who Support the CADS to Those Who Do Not: A Chi-Square Analysis

Table 4 details summary statistics for the whole sample and results from a Chi-square analysis (and some independent samples t-tests) examining whether the difference between those who indicated some level of support for the CADS (Group A) as compared to those who did not (Group B) was statistically significant in regard to various factors. The results from this analysis helped inform later regression analysis.

The statistically significant findings from this analysis are as follows: (1) Group A was more likely to report being familiar with the CADS (58.8%) than Group B (40.5%). (2) Group A was more likely to report support for Vermont's pro-environmental policies than Group B. In Group A, 92.7% reported some level of support for Vermont's goal of producing 25% of its energy from renewables by 2025, in comparison to 73.7% of Group B who reported the same. While 82.9% of Group A reported support for

Vermont's Universal Recycling Law, only 47.5% of Group B reported the same. (3) Group A was also more likely to report support for Vermont increasing public investment in each biodigesters (84.8%), solar (84.4%), and wind (70.6%) as compared to group B. Within Group B, respondents more likely to indicate support for solar (48.8%) and wind (48.7%) than biodigesters (37.2%). (4) Perhaps unsurprisingly, Group A was more WTP some amount for the Cow Power program (33.3%) than Group B (14.6%). (5) Group B was over two-and-a-half times as likely (34.1%) as Group A (12.4%) to report living within two miles of the CADS. Group A, on the other hand, was more likely to live between two to five miles of the CADS than Group B, with 71.1% of Group A living within this range, as compared to 46.4% of Group B living within this range. However, the trend of Group B being more likely to live relatively closer to the CADS and less likely to live relatively further from it was not seen for the category of living over five miles away from the CADS, with Group B being more likely to live over five miles away from the CADS (19.5%) than Group A (16.5%). (6) Last, the difference between these groups was also found to be statistically significant in regard to political affiliation: 37.6% of respondents in Group A reported being Independent, as opposed to 18.4% of respondents in Group B; 29.0% of Group A reporting being Democrat, as compared to 15.8% of Group B; and 10.8% of respondents in Group A reporting being Republican, as compared to 26.3% in Group B.

Table 4

Summary Statistics Comparing Those Who Support the Local CADS to Those Who Do Not

	Whole sample (n = 139)	Group A: Respondents who reported support for the local CADS (n = 97)	Group B: Respondents who did not report support for the local CADS (n = 42)	Chi-square (x^2)
Whether reported being familiar with biodigester				$x^2 = 3.94^{**}$
Yes	52.1%	58.8%	40.5%	
No	47.9%	41.2%	59.5%	
Level of support for Vermont's goal of producing 25% of its energy from renewable sources by 2025				$x^2 = 13.26^{***}$
Support	87.0%	92.7%	73.7%	
Neutral	10.1%	7.3%	15.8%	
Oppose	2.9%	0.0%	10.5%	
Level of support for Vermont's Universal Recycling Law				$x^2 = 17.93^{***}$
Support	69.9%	82.9%	47.5%	
Neutral	16.5%	11.4%	27.5%	
Oppose	13.5%	5.7%	25.0%	
Level of support for Vermont increasing public investment in biodigesters				$x^2 = 28.98^{***}$
Support	69.6%	84.8%	37.2%	
Neutral	17.6%	10.5%	31.4%	
Oppose	12.8%	4.7%	31.4%	
Level of support for Vermont increasing public investment in solar panels				$x^2 = 24.16^{***}$
Support	72.6%	84.4%	48.8%	
Neutral	8.9%	7.8%	7.3%	
Oppose	18.5%	7.8%	43.9%	
Level of support for Vermont increasing public investment in wind turbines				$x^2 = 13.07^{***}$
Support	63.1%	70.6%	48.7%	
Neutral	13.8%	16.5%	9.8%	
Oppose	23.1%	12.9%	41.5%	

Table 4, Continued

	Whole sample	Group A: Respondents who reported CADS support	Group B: Respondents who did not report CADS support	Chi-square (x^2)
Familiarity with Cow Power Program				$x^2 = 0.13$
Participated in Program	10.6%	10.3%	10.0%	
Heard of Program	68.1%	67.0%	70.0%	
Never heard of program	21.3%	22.7%	20.0%	
Whether WTP for electricity generated by Cow Power Program				$x^2 = 4.99^*$
Yes	27.5%	33.3%	14.6%	
No	50.0%	46.3%	58.6%	
Not sure	22.5%	20.4%	26.8%	
Average electricity cost per month	$88.26	$87.18	$91.38	
Whether a resident of Randolph				$x^2 = 0.12$
Yes	82.5%	83.3%	81.0%	
No	17.5%	16.7%	19.0%	
How far away lives from VTC				$x^2 = 10.60^{**}$
Less than 1 mile	10.5%	6.2%	19.5%	
1 – 2 miles	8.4%	6.2%	14.6%	
2.01 – 3 miles	16.8%	19.6%	9.8%	
3.01 – 5 miles	46.8%	51.5%	36.6%	
More than 5 miles	17.5%	16.5%	19.5%	
Level of education				$x^2 = 4.84$
Less than high school (no diploma)	0.7%	1.0%	0.0%	
High school graduate (incl. GED)	14.1%	5.2%	7.3%	
Associate's/technical	5.6%	10.3%	22.0%	
Some college (no degree)	15.5%	22.7%	24.4%	
Bachelor's	23.2%	16.5%	9.8%	
Post-graduate/professional	40.9%	44.3%	36.6%	
Number of years lived in place of residence (mean)	30.57	30.17	29.65	

Table 4, Continued

	Whole sample	Group A: Respondents who reported CADS support	Group B: Respondents who did not report CADS support	Chi-square (x^2)
Housing type				$x^2 = 0.83$
Single-family home	91.6%	92.8%	90.2%	
Townhouse, condo, or apartment	2.8%	2.1%	2.4%	
Mobile home	2.8%	2.1%	4.9%	
Other	2.8%	3.1%	2.4%	
Income				$x^2 = 4.81$
Less than $25,000	14.3%	13.5%	14.7%	
$25,000 - $49,999	27.8%	22.5%	38.2%	
$50,000 - $74,999	28.5%	31.5%	23.5%	
$75,000 - $99,999	12.7%	12.4%	14.7%	
$100,000 or more	16.7%	20.2%	8.8%	
Political orientation				$x^2 = 12.17$**
Independent	32.9%	37.6%	18.4%	
Democrat	24.7%	29.0%	15.8%	
Republican	14.9%	10.8%	26.3%	
Progressive	6.7%	5.4%	10.5%	
No political affiliation	10.4%	8.6%	13.2%	
Other	10.4%	8.6%	15.8%	
Gender				$x^2 = 2.55$
Female	57.7%	57.9%	57.9%	
Male	41.6%	42.1%	39.5%	
Other	0.7%	0.0%	2.6%	
Age (in years)	67.1	65.68	69.51	

*The difference between the two groups is significant at the 0.90 significance level.
**The difference between the two groups is significant at the 0.95 significance level.
*** The difference between the two groups is significant at the 0.99 significance level.

4.4.2.3. A Regression Analysis

A regression analysis was also run on these data to try to expand upon the Chi-square analysis. Chi-square analysis is good for helping to describe the relationship between the individual variable (CADS support here) and individual independent variables, but it does not account for potential impacts from other independent variables that may be influencing the observed relationship. Regression analysis, on the other hand, helps overcome this limitation by allowing for the impact of multiple independent variables on the dependent variable to be tested at once, where the potentially mediating influence of other variables is controlled for, thus isolating the impact of each independent variable on the dependent variable.

Several binary logistic regression models were run, and the results from one of the strongest models can be seen in Table 5. This model did a fairly good job correctly predicting whether someone would indicate support for the CADS, with 80.4% of the cases predicted correctly. However, this model was much better at predicting who would report support for the CADS (90.1% of cases predicted correctly) than those who would not report support for the CADS (54.8% of cases predicted correctly). Additionally, the omnibus test of model coefficients did show that the model is explaining significantly more variance than the base model, which had no independent variables in it ($\chi^2 = 50.41$, $p < 0.001$).

The following independent variables were found to be statistically significant: (1) The most statistically significant independent variable was the "positivity score," with the odds of someone reporting support for the CADS increasing around 30% for every 1-unit increase in the score ($p < 0.001$). That the positivity score had a positive impact on the odds of someone reporting CADS support was not surprising.

Distance from the CADS and income were also found to be statistically significant ($p = 0.05$). (2) The odds of those who made under $50,000 reporting support for the CADS were 73.3% less than the odds of those who made $50,000 or over reporting support for the CADS. (3) The odds of those who lived between 2.01 and 5 miles from the CADS reporting support for the CADS were 392.9% greater than the odds of those who reported living over 5 miles away from the CADS. The finding that distance from the CADS affects support for it is not surprising; but, the finding that those who lived a mid-range away from the CADS were more likely to support it than those who lived further away is a bit surprising. In all, this model, while able to offer some insights, is more exploratory in nature, and hopefully future studies can be conducted that utilize larger sample sizes and examine the impact that these and other factors may have on CADS support.

Table 5

Binary Logistic Regression Results (Y = 1 indicates reporting support for the CADS and Y = 0 indicates everyone else) (n = 112)

Variable	**Definition**	**B**	**Exp (B)**
Positivity score	Level of positivity towards CADS outcomes	0.283***	1.327
CADS Familiarity	1 = Did not report being familiar with CADS and 0 otherwise	0.108	1.114
Distance from the CADS**			
	1 = 0 – 2 miles and 0 = otherwise	-0.131	0.878
	1 = 2.01 – 5 miles and 0 = otherwise	1.595**	4.929
Income	1 = under $50,000 and 0 = otherwise	-1.319**	0.267
Constant		-12.045***	0.000

**The difference between the two groups is significant at the 0.95 significance level.
***The difference between the two groups is significant at the 0.99 significance level.
Note. Variable “Distance from the CADS” has “**” after it because, even though there is not an overall *B* for this variable, the variable as a whole was still significant at the 0.95 significance level.

4.4.3. Communication

The Diffusion of Innovation Theory details the importance communication plays in influencing people's adoption (which equates roughly to CADS support here) of an innovation. To explore this, questions were asked on how people received information on the CADS, on what areas they would like to receive more information on the CADS, and in what forms they would like to receive this additional information. Summary statistics are provided for these questions in Table 6 and Figure 8, and Chi-square analysis and an independent samples t-test were used to explore the relationship between support for the CADS and communication.

Table 6 details the forms of communication respondents had received on the CADS, if any, and what forms of communication they would like to receive on the CADS in the future, if any. Respondents could check all answer choices that applied. Some response choices were unique to each question, and if they did not apply to the other question, a "NA" was reported in the table for that response choice. As can be seen, a majority of respondents reported that they both had previously received information on the CADS via the newspaper (70.1%) and that this was the (or a) form of communication in which they would like to receive more information on the CADS (60.4%). This high preference for communication via the newspaper is not unexpected, given that those filling out the survey were most likely newspaper readers to begin with and therefore accustomed to getting information this way. The second most common way people received information was through word-of-mouth, with 34.7% of respondents indicating that they had received information this way. Also, the relationship between the number of ways a respondent had received information on the CADS and their level of support for it was found to be statistically significant, $t(137) = 2.34$, $p = 0.05$, with those who reported support for the CADS receiving, on average, more types of communication (1.52) than those who did not report support for the CADS (1.07).

In terms of receiving additional information on the CADS, the second most preferred way to receive information was via a mailout of some kind. Only some respondents had not received any information or did not want to receive additional information, with 16.0% indicating that they had not received any information and 12.5% indicating that they did not want to receive more information on the CADS.

Table 6

Forms of Communication Have Received and Would Like to Receive on the CADS (n = 144)

	In what forms respondents had previously received information on the CADS	In what forms respondents would like to receive more information on the CADS
Newspaper articles	70.1%	60.4%
Radio segment	8.3%	13.9%
Mailout (flier, pamphlet, etc.)	6.9%	36.8%
Word-of-mouth	34.7%	5.6%
The digester website	4.9%	NA
A TV segment	5.6%	11.8%
CADS Open House	4.2%	NA
CADS Community Meeting	4.9%	9.7%
Have not received any information	16.0%	NA
Would not like to receive more information	NA	12.5%
Not sure	5.6%	4.9%

Figure 8 details the areas on which respondents wanted to receive more information. The highest proportion of respondents, at 43.8%, said that they would like to receive more information on the CADS' "community benefits," followed by on "how they operate" (34.7%), "how they affect property values" (34.0%), and "how safe they are" (28.5%). Additionally, 28.5% of respondents said that they "would not like to receive more information" on the CADS, and 12.5% of respondents said that they were "not sure."

Again, Rogers' (2003) Diffusion of Innovation Theory informed this part of the analysis by providing the idea that there are two distinct communication types (mass media and interpersonal) and that these may have different effects on the adoption of an innovation. In order to assess whether there was a relationship between the type of communication received (mass media, interpersonal, both, or none) and support for the CADS, a Chi-square analysis was run. The relationship was found to be statistically significant $\chi^2(3, n = 129) = 8.80$, $p = 0.05$. Those who reported support for the CADS were more likely to report having received both forms of communication (37.6%) than those who did not indicate support for the CADS (19.4%). Also, those who did not report support for the CADS were more than two times as likely to have reported that they received no communication (25.0%) as compared to those who did report support for the CADS (10.8%). Those who did not report support for the CADS were also more likely to report that they had received interpersonal communication alone (11.1%) than those who did report support for the CADS (4.3%). Similar percentages of respondents within each group reported having received mass media alone: 47.3% of those who indicated support for the CADS and 44.4% of those who did not indicate support for the CADS.

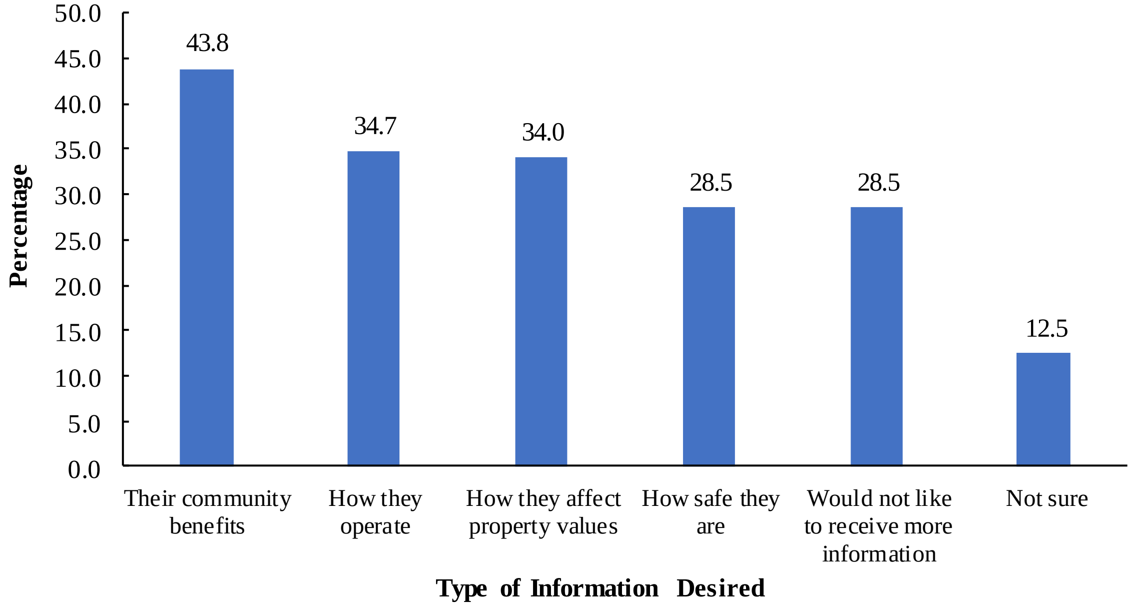

Figure 8. Type of additional information wanted on the CADS (n = 144).

4.4.4. Attitude Change Towards the CADS Over Time

The motivation for asking the two questions on attitude change towards the CADS over time came from wanting to understand whether the passage of time, in addition to the community partner's efforts that took place during this time, were able to mitigate some of the initial skepticism around or critique of the CADS. As Figure 9 shows, nearly half of the respondents (48.2%) reported that their attitudes had "stayed about the same." Only 12.0% reported becoming more negative to some extent over time, and over three times as many as that, at 39.8%, reported becoming more positive to some extent over time.

A linear regression analysis was also run on the Likert-type scale question (featured in Figure 9), wherein the dependent variable was treated as a continuous variable on a scale of 1-5. All iterations of the model had very low R-squared values, however, and so the results of this analysis are not presented here in full (the adjusted R-squared value of the best-fitting model was 11.0%). The major finding of interest from this analysis was that the sole variable that was found to be statistically significant (p = 0.01), and across all variations of the model too, was that of distance from the CADS. A positive relationship was seen between reporting becoming more positive towards the CADS over time and living further away from it. To expand upon these results, the next section will detail the results from the qualitative analysis of the open-ended question.

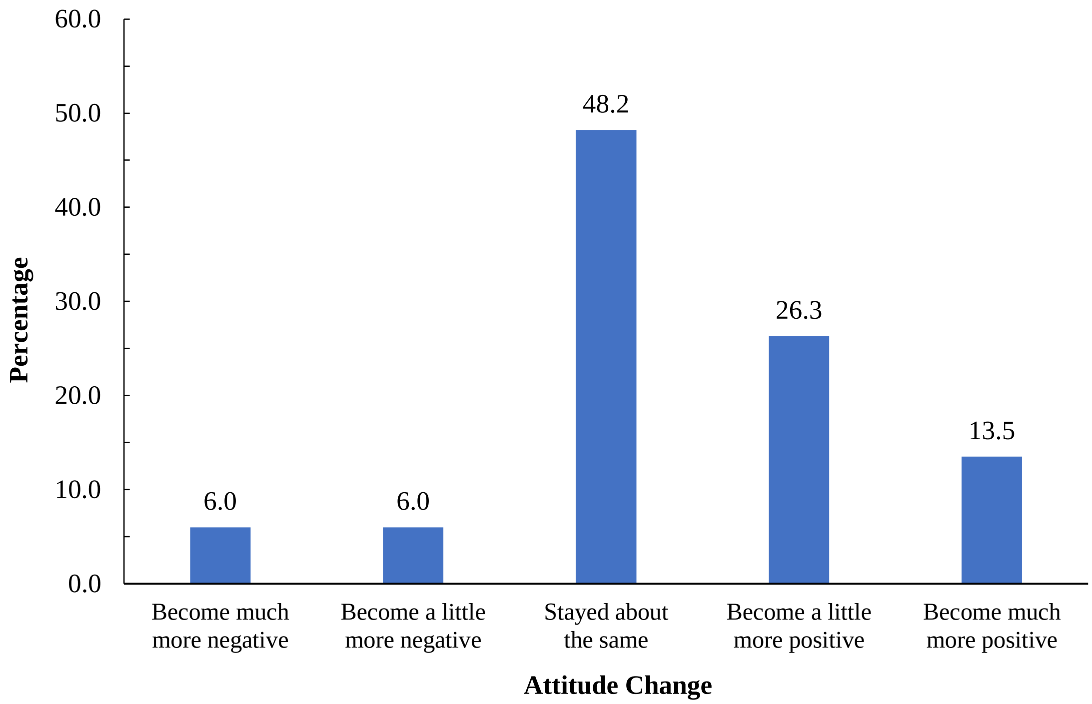

Figure 9. Respondents' attitude change towards the CADS over time (n = 133).

4.4.4.1. Coding Scheme

As has been mentioned, the responses to the open-ended question were analyzed through a qualitative coding process. Table 7 shows the final coding scheme that was used. Results were first analyzed within the context of each attitudinal group. That is, results from everyone who responded that they had "become much more negative" about the CADS were examined together, followed by the results from those who reported that they had "become more negative," and so on and so forth. This was done to preserve the context in which these results were occurring and to contribute to a more granular understanding of why attitudes changed as they had. Afterwards, the number of codes that occurred in each attitudinal group and across all attitudinal groups could be seen, thus contributing to an overall idea of which factors were most prevalent when it came to attitude change towards the CADS. Table 8 details these results.

Table 7

Final Coding Scheme

Code Number	Name	Code Description
1	Odor	Odor mentioned as being a problem
2	Operational challenges	Complaints about operating the CADS; such as its acceptance of off-site wastes, traffic and noise from trucks, management problems, and the CADS not being functional
3	Location	Not liking where the CADS was sited
4	Neighbors/others	Mentioned receiving information from neighbors or others
5	Skeptical of benefits	Not thinking the CADS was necessary, that the electricity produced would benefit people, or that intentions about its construction were honest
6	Unfamiliar/uncertain	Not knowing much about the CADS or not being aware of how it impacted them
7	Lack of communication	Mentioned not receiving additional or recent communication
8	Environmental Benefits	Discussed environmental benefits of the CADS, such as renewable energy production; includes agricultural benefits
9	Always been favor of	Mentioned that had always been in support of CADS
10	Utilization	Expressed positivity that community is now able to use the CADS for food scraps
11	College addressed/working on	Initial problems overcome, or, college working on addressing the problems
12	Education	Learned about the CADS and became more positive
13	No odor	No odor mentioned as a positive

Table 8

Number of Each Code by Attitudinal Group

Code Name	**Codes in Each Attitudinal Group**					
	Become much more negative (n = 8)	Become a little more negative) (n = 8)	Stayed about the same) (n = 22)	Become a little more positive) (n = 16)	Become much more positive) (n = 8)	Total
Odor	6	6	2	1		15
Operational challenges	3			2		5
Location	2		1			3
Neighbors/others	1	2	1	1		5
Skeptical of benefits	4	1		1		6
Unfamiliar/uncertain			14	4		18
Lack of communication			5			5
Environmental Benefits			2	6	4	12
Always been favor of			3	1		4
Utilization					3	3
College addressed/working on				3		3
Education				1	2	3
No odor				1		1

4.4.4.2. Analysis of Codes

Overall, the most prevalent codes were unfamiliar/uncertain (18), odor (15), and environmental benefits (12). What follows is a more in-depth description of the codes that were found in each category and some of the most prevalent patterns or variations that emerged within each group.

Of those who reported that they had "become much more negative" about the CADS, six out of eight of them cited odor as the reason, or one of the reasons, why. For example, one of these individuals wrote, "smells most every day." Several people disliked the CADS' on-campus location and proximity to residents, in part due to the manure trucks that needed to drive through the community in order to get to the CADS. Another theme that emerged was that there was some skepticism about the benefits of the CADS and the intentions behind its construction. Four people spoke to this. For example, one person said, "We do not benefit from the electricity it produces."

For those who had "become a little more negative" towards the CADS, the most mentioned complaint was that of odor. For five of the eight respondents, this was the only complaint they noted. Two people mentioned "neighbors" in their responses, one in conjunction with mentioning odor, stating, "Neighbors in [the community] say odor is still a major issue they have to deal with." The person who was skeptical of the CADS' benefits wrote, "Electricity generation from biodigester…is incredibly inefficient. Renewable energy does not equal green energy."

Of the twenty-two respondents who reported that their attitudes towards the CADS had "stayed about the same," a majority of them (14) mentioned that the reason for this was due to them being unfamiliar with the CADS. A common response was, "Don't know enough about it," or something along these lines. This theme was slightly different from another that emerged, which was lack of communication, where respondents specifically noted that they had not received recent or additional communication about the CADS. This was the second most-cited reason, with five people mentioning it. For example, one respondent wrote, “I was favorable from the start, and I haven’t read or heard anything to shift my view since.” Three people, like the respondent just described, mentioned that they’ve always been in favor of the CADS.

Overall, those who reported that they “had become a little more positive” showed the greatest thematic diversity in responses. At times, some of what was stated seemed in tension with the fact that the respondent was explaining why she or he had become more positive about the CADS. He or she may have been confused by the question, although it is hard to say for sure. For example, one respondent wrote, “The biodigester is surprisingly noisy…I wouldn’t want to live near that noise.” Six out of the sixteen respondents cited environmental benefits as the (or a) reason for becoming more positive about the CADS. For example, one respondent wrote, “Any steps toward protecting our environment are welcome.” Four people mentioned that they were unfamiliar with the CADS. For example, one said, “I don’t know much about it. Seems like a good idea.” Three people mentioned that the reason for their attitude change was because the community college has been working to address community concerns about the CADS. One respondent wrote, “[E]ngineers involved acknowledge some problems – odor and noise – and are trying to fix them.”

There were three themes that came up for the eight respondents who reported that they had “become much more positive” about the CADS. Four respondents said that the reason was due to the CADS’ environmental benefits. For example, one respondent wrote, “Anything renewable is good for all living beings on the planet.” Three of the respondents expressed enthusiasm for the CADS due to being able to use it for food scraps. Those who commented about utilization were some of the most passionate about the CADS. Another person wrote, “Once we read an article in [the newspaper] about the biodigester [around] early 2016 or late 2015, we have been putting ALL FOOD WASTE in the biodigester.” This respondent also speaks to the positive impact education has had on attitudes towards the CADS, and another respondent noted this as well, saying, “I supported the concept when it was first built, and as I learned more about its positive impacts, I support it even more.”

4.5. Discussion and Implications

Although CADS have the potential to bring about many benefits, including environmental and financial, their deployment in America has been constrained, especially when compared to an international context. Community support may be one factor that influences the viability of CADS projects, though this topic does not appear to be well-studied. The purpose of this study was to better understand community support (which was conceptualized in a variety of ways) for a local CADS and what factors may influence this. Though the sample utilized here was not statistically representative and the results do need to be interpreted with caution, hopefully the methods employed here and the results that were found can help shape future CADS-related work and outreach efforts.

The results from this study show that 52.1% of the respondents reported being familiar with the CADS. This may speak to the fact that the technical college did a good job with its initial community outreach in regard to the CADS. An even higher percentage of respondents, at 69.8%, reported that they support the project. While those reporting support for the CADS more likely to be familiar with the project than those who did not, 41.2% of those who reported support for the CADS did not report being familiar with the project. Overall, the technical college will likely want to continue work on raising awareness about the CADS, as this may encourage greater support of the technology.

While respondents' relatively high level of support reported for the CADS is encouraging, it also invites consideration of a key challenge around the concept of support, which is whether this support is translated into any tangible behaviors that could benefit the CADS. In this study, it was found that, in comparison to the high percentage of respondents who reported support for the CADS, lower percentages of respondents reported participating in behaviors that would help support the CADS, such as being WTP for Cow Power, being WTP for the collection of compost, or wanting to use the CADS' drop-off container.

Only 27.5% of respondents indicated that they would be WTP some amount to support the Cow Power program. These findings help illustrate feedback from those who work on the Cow Power program in Vermont and report that demand for the program has eclipsed the supply, which presents challenges for biodigester viability (Babcock et al., 2016). They are also in line with other work that describes how participation in green pricing programs remains relatively low in America, with average participation rates reported at 1.5% in 2005 (Bird & Brown, 2005) and 2.1% in 2012 (Institute for Energy Research, 2013). Furthermore, according to the Institute for Energy Research (2013), just under 2% of Vermont's utility customers participated in green pricing programs in 2012.

Luckily, a higher percentage of respondents reported that they would engage in certain composting behaviors, with 44.6% of respondents reporting that they would like to use the CADS' drop-off container and 40.6% reporting that they would be WTP some amount to have their food scraps collected. However, 48.4% of respondents who reported support for the CADS did not report that they would use the drop-off container. Perhaps they were unaware that contributing their food scraps to the CADS is a way to support it, or perhaps this is a case of people supporting "green" efforts more in name than practice.

There may be potential for the community partner to increase inputs of food scraps from the community. The community partner may want to publicize the drop-off container and how residents' contributions to it may benefit the CADS. However, this may not be the most effective strategy, given that traveling to the drop-off container may not be convenient for many residents, and they may not be motivated to do so, especially if their trash haulers already provide organics collection services. Under Vermont's Universal Recycling Law (Act 148), all trash haulers will be mandated to do this by 2020 (Agency of Natural Resources, 2018). Therefore, as opposed to solely relying on community members' contributions to help meet the need for local organic inputs, VTC may find it more efficacious to also try to partner with trash collection services to see if they are interested in using them as a repository for food scraps.

Additionally, though respondents' stated willingness to engage in certain behaviors that would support the CADS is certainly an element of support, it must be kept in mind that self-reported willingness to engage in pro-environmental behaviors may actually overstate what will happen in reality (e.g., Roe et al., 2011). Those who are working to implement CADS and other renewable energy technologies should take the tension between expressed support and actual behavior into consideration when seeking to garner public favor for these technologies. While attaining support for these technologies on a conceptual level is important, furthering discussions with the public about additional forms support could take may be an important component of promoting the viability of these technologies.

When working to garner support for the CADS, there should be a focus not only on disseminating communication, but on strategically considering the content it covers and the ways in which it is delivered. The results from this survey also showed that there was a positive relationship between the positivity score and CADS support, meaning the more positive the respondent felt about the CADS' outcomes, the greater his or her odds of reporting CADS support were. Therefore, communication on the CADS may want to focus on describing specifics about how the CADS benefits the community and bolstering belief in these, for example, by providing statistics about the CADS' accomplishments (which probably is already a focus of a lot of related outreach). The results from this study also show that there were statistically significant differences between those who reported support for the CADS and those who did not in regard to how many different types of communication were received and in what forms. In particular, those who reported support for the CADS received, on average, more types of communication and in the forms of mass media alone or mass media and interpersonal together. Those who did not report support were more likely to have received no communication or interpersonal alone. Additionally, the potential importance of interpersonal communication was highlighted by the qualitative analysis: Some respondents cited hearing from their neighbors about issues with the CADS, such as odors, as one reason for becoming more negative about it over time. The Diffusion of Innovation Theory (Rogers, 2003) describes the importance of interpersonal communication when it comes to persuading someone whether to adopt an innovation, and the power of this type of communication should not be underestimated, whether it be in the form of people hearing from their neighbors or learning more about the CADS from in-person events, such as an open house or community meeting.

When considering what specifically to communicate on, a more granular look at the outcome statements and qualitative analysis may be helpful. The most prevalent codes from the qualitative analysis (unfamiliar/uncertain, odor, and environmental benefits) may provide insights for additional education. Reducing uncertainty about and increasing knowledge of the CADS' positive benefits, especially environmental, may encourage people to move from feeling about the same as they have towards the CADS to feeling a little more positive about it (although it should be noted that some people who reported feeling the same towards the CADS did so because they had always been in favor of it). In terms of concerns about the CADS, odor and aesthetics were two of the most prevalent, and the community partner may want to let the community know what it is doing to address such concerns. Overall, respondents were more uncertain about potential negative outcomes of the CADS than they were about its positive outcomes, and the community partner may want to work to proactively address some of this uncertainty and let the community know what it is doing to mitigate potentially negative impacts.

Hopefully this would let community members know that VTC is taking these issues seriously and would help them feel more positively about the CADS.

The technical college and others working to increase support for renewable energy may also want to consider how they engage different segments of the community around the technology of interest. The results from this study show that there were statistically significant differences between those who reported support for the CADS and those who did not in regard to many different demographic (and other) factors. This was found in this study via independent samples t-tests and Chi-square and regression analysis. Again, the Diffusion of Innovation Theory predicts that, among other things, early adopters of an innovation will be more highly educated, wealthier, have greater exposure to mass media and interpersonal forms of communication, and be more positive towards science and change as compared to later or non-adopters. Evidence supporting much of this prediction was found in this study. Earlier in the paper, it was noted that the idea of "adoption" has been extended in this paper to include support and that "adopters" (supporters) of the CADS could be considered, if nothing else, earlier, as opposed to later, adopters.

The Chi-square analysis revealed the following: Those who supported the CADS were more likely to support Vermont's goal of producing 25% of its energy from renewable sources by 2025 and Vermont's Universal Recycling Law than those who did not report such support. Support for such measures could be interpreted as being related to having a positive attitude toward change, as the passage of such legislation represents a changing policy landscape with the potential for day-to-day impacts, especially the

Universal Recycling Law. Also, those who supported the CADS were more likely to have received both mass media and interpersonal forms of communication than those who did not report support for the CADS. The Chi-square analysis, did not, however, show that there was a statistically significant difference between those who indicated support for the CADS and those who did not in regard to income and education. The regression analysis did, however, reveal that income had a statistically significant impact on support for the CADS, with the odds of those who made $50,000 or more reporting support for the CADS being greater than the odds of those who made under $50,000 reporting support for the CADS. Although CADS support here did not require a financial commitment, these findings are still in line with other work that has found higher incomes to be associated with higher WTP for electricity produced by ADS (Sanders et al., 2010) and, more generally, work that has found a positive correlation between those who have higher salaries and WTP for energy with less adverse environmental impacts (Rowlands et al., 2003; Zarnikau, 2003). Unfortunately, only a limited number of independent variables could be included in the regression analysis, which further limited the ability to test whether what the Diffusion of Innovation Theory predicted in terms of early adopters held true.

Overall though, the technical college and others wishing to increase support for various renewable energy technologies may want to consider communicating with supporters and non-supporters of these technologies in different ways. For those working to build community support for CADS, they may want to try different communication strategies tailored to the demographics of those who reported support for the CADS and for those who did not. For example, since those who supported the CADS tended to be higher income and live in a mid-range away from it, perhaps communication to these groups could focus on encouraging greater behavioral support of the CADS, such as through supporting the Cow Power program and using the drop-off container. For those who are lower income, on the other hand, or lived either within two miles of the CADS or over five miles away from it, perhaps communication could first focus on building support for the CADS in general. Of course, the sample in this study was not representative, so these demographic trends in regard to CADS support may not hold true for the entire community, and a more representative sample could help further inform communication strategies.

Overall, this study helps provide a base upon which further investigation of community support of CADS can be built. Although this study did not utilize a representative sample, it still highlights some factors researchers may want to explore in the future in regard to what influences support for CADS or other renewable energy technologies. Future work may benefit from utilizing a statistically representative sample and also from including, among other things, the following types of questions:

(1) An open-ended question on why respondents indicated their WTP for the Cow Power program as they did. This program is an important part of CADS viability, and understanding why respondents do or do not support it as they do could help shed light on why demand for this program has diminished. (2) A question that begins with a statement introducing the concept that the CADS benefits from receiving more local food scraps, followed by questions on respondents' WTP to have their food scraps collected and

dropped off to the CADS and their interest in using the drop-off container. One interesting variation of this question would be to first ask respondents about their WTP to have their food scraps collected and their interest in using the drop-off without letting them know this would benefit the CADS. Then, there could be a follow-up statement that describes how these things benefit the CADS, and then these two questions could be repeated in order to assess how these behaviors might change (or at least the intention to perform them might change) in light of information about how these behaviors might benefit the CADS. (3) The question on WTP for the Cow Power program could also be asked in a more straightforward manner. Instead of asking respondents how much they would be WTP for the program as a percentage of their electricity bill, they could perhaps just be asked how many additional dollars per month they would be willing to pay to support Cow Power. This also helps mitigate the problem that arises when respondents who do not pay for their electricity or pay very little for it due to using renewables are asked this question. (4) Questions that cover more community-level factors that could influence support for CADS and renewable energy technologies more generally. This premise is described in further detail below.

4.6. Study Limitations

This study focused especially on individual-level characteristics that influenced CADS support. In reality, community members find themselves in complex sociocultural contexts, where many factors beyond individual characteristics and experiences influence individuals' attitudes and behaviors towards a technology. The limitation of this study can also be extended as a critique of the Diffusion of Innovation Theory, which especially focuses on individual characteristics of adopters and their access to information and how these influence adoption. For example, Brown (1981) extends Rogers' work to include, among other things, an examination of how infrastructure influences the diffusion of an innovation. In the context of examining the adoption of local food (considered to be an innovation here), Inwood, Sharp, Moore, and Stinner (2009) found factors such as price, convenience, and distribution logistics to also influence the diffusion of an innovation. While these factors may or may not apply to CADS adoption, depending upon which element of CADS adoption is being considered, they do represent socio-structural characteristics beyond those initially discussed by Rogers that may influence the adoption of an innovation. Another community-level factor that may be important to consider is subjective norms, the importance of which is further detailed in the Theory of Planned Behavior (Ajzen, 1991).

Additionally, the type of individual-level characteristics that were included in the study could also be expanded upon. When comparing the impact of demographic factors on energy consumers to that of socialpsychological/attitudinal factors on energy consumers, some have found socialpsychological/attitudinal factors to be better predictors of WTP for green energy than demographics (Rowlands et al., 2003). Examples of socialpsychological/attitudinal characteristics that have been found to be positively correlated with willingness to pay a premium for green energy include the following: awareness of environmental consequences (Hansla et al., 2008), environmental concern, altruism (Hansla et al., 2008; Rowlands et al., 2003), and liberalism (Rowlands et al., 2003). These findings may speak to the importance of including similar variables in future work on CADS support.

In addition to including more, or different, variables in future work, the limitations of the methods employed here also need to be kept in mind. First, the sample size was relatively low. One potential reason for this could be the newspaper dissemination of the survey. The research team was unsure of how active the town's newspaper readers were, so there is a possibility that many people did not see the survey. As has been stated, this survey did not utilize a representative sample, which introduces selection bias. One facet of this bias is that the respondents self-selected themselves into the study once the initial newspaper survey went out. This is also known as voluntary response bias. This means that those who felt especially strong about the CADS, either positively or negatively, or had at least some familiarity with the topic, may have been more inclined to respond, as compared to those who were less opinionated towards or knowledgeable about the CADS. Also, some people were likely motivated to participate largely due to the gift card incentive. This could have had a bit of a moderating impact and helped attract respondents beyond just those who had a strong opinion on and/or knowledge of the CADS.

However, this selection bias is not just a limitation, but rather, may also reveal additional insights about the community dynamics surrounding the CADS. The lower sample size and the fact that more respondents felt positively or neutral towards the CADS may indicate that there are not that many members of the community vehemently opposed to the CADS. If this was the case, one might suspect to see a higher response rate and/or more negative responses expressed in the survey. For example, in Smith, Parsons, Van Dis, and Matiru's (2008) study on community attitudes towards a proposed dairy farm expansion in Charlotte, VT, which utilized a similar method of survey dissemination via the newspaper, 20.3% of the surveys were returned (as compared to 7.6% of surveys returned in this study). There may be several reasons for this higher response rate, one of them possibly being that the proposed expanded dairy operation was more of a controversial topic than was the CADS to each of these respective communities.

In addition to selection bias, there was also likely some response bias in this survey. The most pertinent type likely being social desirability bias, wherein respondents feel pressure to give responses that seem socially preferred. For example, this type of bias is often present in WTP questions about environmental goods, with consumers tending to overstate their WTP for such goods when compared to actual marketplace behavior (e.g., Roe et al., 2001). Similarly, in this survey, there were various questions where respondents may have felt compelled to respond more positively due to perceiving those answers to be more socially desired, such as when reporting support for the CADS, WTP for Cow Power, and WTP to have their compost collected. Also, as has been mentioned in this study, there may be a discrepancy between supporting something in word alone and then in action, so positively expressed views, no matter how genuine, may not always translate into action.

In all, the biases mentioned here are important to keep in mind when constructing future surveys. For those interested in doing newspaper surveys, gaining a sense of how active the readership is (as in, are they likely to see a press release or mailout) may be useful when determining whether this technique will garner the desired sample size. Selection bias could be ameliorated by using a random sampling technique and working to garner a representative sample. However, there are insights to be gained in allowing people to self-select into the survey as they did here, one of which is being able to see how much of a "hot button" issue the topic at hand is as indicated by the response rate. Social desirability bias is difficult to eradicate, but paying careful attention to question wording, in addition to asking several different questions around the same concept, can help. In this survey, several questions were asked around the CADS support, extending beyond just a question that explicitly asked respondents whether they supported the CADS. In this manner, a clearer picture emerged of how the respondents may or may not have been supporting the CADS and of a potential discrepancy between supporting the CADS in theory and in practice. Each research method has strengths and limitations, and hopefully those that have been discussed here can be used to inform later work and improve understanding of the topic at hand.

4.7. Conclusions and Recommendations

CADS can play an important role in making ADS technology more viable for SMDFs. The implementation of this technology has many benefits, such as reducing greenhouse gas emissions, mitigating air and water quality problems associated with manure management, and diversifying farms' revenue streams. However, CADS technology is not widespread in America, and one potential barrier to its deployment may be community support, which was relayed to the researchers in this study by the community partner. This study sought to explore what factors influence community members' support of a CADS that was located in their community specifically.

The results here show that while almost 70% of respondents indicated some level of support for the CADS, additional self-reported behaviors that could help the CADS (such as being WTP for the Cow Power program and engaging in composting behaviors) were not as prevalent. There are many reasons why these discrepancies may be the case, and the previous section details some additional areas that could be studied to help further explore these. Those working to expand CADS implementation should consider the different forms they may need public support to take. While it is important to garner support in name, there may be additional actions needed from community members to ensure CADS viability, and additional strategies may need to be deployed in order to increase the prevalence of such actions.

This study also helps highlight the importance communication may play in influencing CADS support, and communication strategies may be enhanced by taking one or more of the following steps: (1) Tailoring content based on certain demographics (such as working to attain CADS support from demographics who are less likely to support it, and working to increase willingness to engage in behaviors that would help the CADS from demographics who are already more likely to support it), (2) Building belief in the positive outcomes of the CADS, (3) Being specific about the ways in which the public can support the CADS and being sure to explain why these actions would benefit the CADS, and (4) Disseminating communication in a variety of forms and working to ensure that both mass media and interpersonal forms are available to community members.

In summary, the results from this study showed that there were certain factors that had a statistically significant relationship to or influence on respondents' support of the CADS, including the number of forms of communication the respondent received on the CADS, the type of communication received (mass media, interpersonal, none, or both), their level of agreement that the CADS brought about positive outcomes and did not bring about negative outcomes (positivity score), level of support for statewide pro-environmental policy measures, political orientation, income, and distance from the CADS. Of these variables mentioned, only income, distance, and positivity score were able to be included in the regression analysis (thus allowing the influence of other independent variables to be controlled for, which the other forms of analysis could not do). The limited number of independent variables that could be included in the regression analysis, along with the non-statistically representative sample that was used, mean that the results here should be interpreted with caution. However, one of this study's major strengths is that it is one of only a few of its kind. There are very few studies devoted to examining public support of ADS, and this research team was not aware of any prior studies examining community members' support of CADS specifically at the time of the study. Hopefully the results found here can provide a starting point for future work and help give researchers and practitioners an idea of some variables that may be important to consider when working to understand and expand community support of CADS and renewable energy technology more generally.

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CHAPTER 5. DISCUSSION

The use of smart meters and CADS could help the United States mitigate some of the adverse impacts associated with residential electricity consumption, such as greenhouse gas emissions, dependence on fossil fuels, and costs. One important component of seeing these benefits realized is consumer engagement with these technologies. Consumer engagement with smart meter and CADS, however, seems to be limited. The purpose of this thesis was to better understand the extent to which smart meters and CADS are being engaged with and what factors may influence such engagement (or lack thereof) through case studies on each smart meters and a CADS in Vermont. The results are expected to be insightful not only for those looking to increase engagement with smart meters and CADS, but also for those who are working to increase engagement with efficient and renewable energy technology more generally. Since the smart meter study used a sample that was statistically representative for Vermont and the CADS study did not, the results from each of these studies cannot be compared as if they were each detailing trends for VT as a whole – only the smart meter study did this. However, the CADS study's major strength was in the more granular look it allowed at a specific community's engagement with a renewable energy technology. The rest of this chapter provides a discussion of the major findings from each of the smart meter and CADS studies.

5.1. The Smart Meter Study

As suspected, consumer engagement with smart meters in Vermont does appear to be limited. Less than 50% of the surveyed respondents reported having a smart meter and, for those who did report having a smart meter, less than 20% of them thought that the smart meter had reduced their electricity use. Concerns about smart meters' impacts on health and privacy were not as prevalent as perhaps an examination of its most outspoken critics might have made it seem though (Hess, 2014). This study helped elucidate that by using a statistically representative sample to assess the prevalence of such concerns. Additionally, respondents did report some interest in receiving additional information, with the highest percentage of respondents, at 31.3%, reporting that they would like to receive more information on how smart meters help to reduce the electricity price. Furthermore, there were statistically significant differences between those who reported awareness of having a smart meter and those who did not. More specifically, the Chi-square analysis showed that those who reported having a smart meter, as compared to those who did not, were more likely to be male than female, live in a single-family dwelling, be home-owners, be 41 or over, and not be concerned about smart meters' potential impacts on health or privacy. The results from the regression analysis showed that those reporting having a smart meter had (1) higher odds of being male than female, (2) of not reporting health concerns, (3) of reporting privacy concerns, (4) of reporting owning a home instead of renting, and (5) of not reporting having a diploma as compared to those reporting having a higher level of education. Results (2) and (5) were not expected, and more research is needed to explore why these might be the case.

These demographic differences between those who reported having a smart meter and those who did not contrast a bit with the profile of those who are WTP for less impactful energy consumption. Of course, WTP for less impactful energy and awareness of smart meters are different forms of engagement, but one may consider awareness of smart meters and being WTP for less impactful energy consumption both to be traits of those who are more environmentally engaged.

Specifically, those who are more WTP for less impactful energy have been found to have higher levels of education (Roe et al., 2001; Rowlands et al., 2003; Zarnikau, 2003) and to be younger and have higher salaries (Rowlands et al., 2003; Zarnikau, 2003). The one study that was found to be even more closely related to the smart meter study done here focused on consumers' willingness to accept a smart meter being installed, both for free and for a fee. The results here showed that, among other things, that those who were more willing to accept a smart meter tended to have more education, and for those willing to accept a smart meter for free, they tended to be younger (Groothuis & Mohr, 2014). These results contrast with the Chi-square finding that those who reported having a smart meter were more likely to be 41 or over. It should be noted, however, that age was not found to be statistically significant in regard to awareness of having a smart meter in the regression analysis, and income was also not found to be statistically significant in regard to smart meter awareness in either the Chi-square or regression analysis. These findings are also in contrast with the regression result that the odds of reporting having a smart meter were higher for those who were less educated as compared to being more educated.

These results also contrast with some of the insights from the Diffusion of Innovation Theory on who might be on the earlier end of the spectrum for adopting an innovation. While the Diffusion of Innovation Theory involves looking at how an innovation is adopted over time, it is still helpful in informing what adopters might look like in a “snapshot” of time. It could be argued that those who report being aware of having a smart meter are more like early adopters than those who did not report being aware of having a smart meter, as early adopters tend to know more about innovations and more actively seek out information. While awareness does not necessarily equal adoption, it was reasoned that the insights from this theory could still be helpful for informing analysis. The Diffusion of Innovation Theory predicts that earlier adopters of an innovation, among other things, will be wealthier and have more education. As has already been discussed, income was not found to have a statistically significant impact on whether one reported having a smart meter, and the opposite trend in education was found.

Overall, the variables examined in these studies as compared to this study necessarily have a different focus, and variables were included in the smart meter analysis that are not often included in studies that seek to profile “green consumers” and that are not discussed in the Diffusion of Innovation Theory, such as concerns about potential health and privacy impacts. Additionally, since smart meters could potentially help save consumers money, they may be motivated to engage with them beyond a desire to support the environment, thus perhaps giving them a different profile than a “green” consumer. Also, perhaps those who actively monitor the information their smart meters provide are more likely to fit the profile of an earlier adopter, but this study did not inquire specifically about that kind of behavior. In order to get a better sense of what smart meter users look like, more quantitative studies are needed. One variable that tends to be consistently included in these kinds of analysis is that of electricity cost and income (Groothuis & Mohr, 2014; Hansla et al., 2008; Rowlands et al., 2003; Zarnikau, 2003). Income was included in the initial analysis for this study, but it was not found to have a statistically significant impact on smart meter awareness. Information on electricity cost was not collected in this study, but would be helpful to collect in future studies, and was collected in the CADS study. More information could also be collected on whether having smart meters encouraged respondents to shift their electricity consumption (either in addition to or instead of reducing electricity consumption), the impact of information on smart meter engagement (especially type and source, including the way electricity consumption information from smart meters is relayed to consumers), how different electricity pricing structures affect the use of smart meters and electricity consumption, and on additional community-level factors that may affect smart meter engagement, such as ease of shifting electricity consumption due to work schedules, among other things (which was something Groothuis and Mohr (2014) did include in their study on willingness to accept a smart meter being installed).

Overall, the results of this study indicate a need for improved outreach on and interventions around smart meters to bolster the benefits they can provide to utilities and electricity customers. Education on smart meters should first raise electricity customers' awareness of the presence of smart meters, and educators may find benefit in tailoring their outreach to those who were found less likely to report having a smart meter, such as renters. Next it is necessary to educate customers on how to access and use the information that smart meters can provide. However, education alone may not be effective if customers do not trust the source of information, which, in the case of smart meters, would tend to be utility companies. Effective education, in this regard, is not just about disseminating information, but also about building trust (Lineweber, 2011; Wynne, 2006).

Additionally, customers not only need to know how to access information from smart meters, but also need to be motivated to act upon this information. To assist with this, additional work on behalf of utilities is likely needed. Utility companies could provide homes with IHDs, which would likely provide a more compelling visual cue to change electricity consumption practices than a monthly bill alone. Also, the absence of dynamic pricing structures, which many of the discussions of smart meter benefits seem predicated upon, is likely to reduce customers' motivation to change electricity consumption behavior. Utility companies may also be well-served to increase the transparency with which they discuss smart meter benefits and pricing structures. That is, in the absence of dynamic pricing, they still need to be able to make a compelling case about the benefits customers can attain from their smart meters. Ultimately though, it seems that greater financial incentives need to be put in place by utilities to further motivate customers to act on the information provided by smart meters. Hopefully, such changes could help the anticipated benefits of smart meters to be more fully realized.

5.2. The CADS Study

The aspect of engagement that was examined most in-depth in the CADS study was that of support, which also included WTP for Cow Power and composting behaviors. While 52.1% of respondents indicated that they were familiar with the local CADS project, a higher percentage, at 69.8%, reported supporting the project. While the prevalence of reported support for the CADS is encouraging in regard to its potential to promote CADS viability, it also invites consideration of a key challenge around the concept of support, which is whether this support is translated into any tangible behaviors that could benefit the CADS. In this study, it was found that, in comparison to the high percentage of respondents who reported support for the CADS, lower percentages of respondents reported participating in behaviors that would help support the CADS, such as being WTP for Cow Power, being WTP for the collection of compost, or wanting to use the CADS' drop-off container. Only 27.5% of respondents indicated that they would be WTP some amount to support the Cow Power program. Luckily, a higher percentage of respondents reported that they would engage in certain composting behaviors, with 44.6% of respondents reporting that they would like to use the CADS' drop-off container and 40.6% reporting that they would be WTP some amount to have their food scraps collected.

Though respondents' stated willingness to engage in certain behaviors that would support the CADS is important, it must be kept in mind that self-reported willingness to engage in pro-environmental behaviors may actually overstate what will happen in reality (e.g., Roe et al., 2011). Those who are working to implement CADS and other renewable energy technologies should take the tension between expressed support and actual behavior into consideration when seeking to garner public favor for these technologies. While attaining support for these technologies on a conceptual level is important, furthering discussions with the public about additional forms support could take may be an important component of promoting the viability of these technologies.

Interestingly, respondents did not only support the CADS if they were familiar with it. Of those who said they supported the CADS, 41.2% of them did not report being familiar with it, although those who supported the CADS were more likely to be familiar with it than those who were not. The technical college will likely want to continue work on raising awareness about the CADS, as this may encourage greater support of the technology. Additionally, only 37.3% of respondents had known that the drop-off container for food scraps existed. Since the technical college would really like to receive more food scraps, the community partner may want to publicize the drop-off container and how residents' contributions to it may benefit the CADS. However, this may not be the most effective strategy, given that traveling to the drop-off container may not be convenient for many residents, and they may not be motivated to do so, especially if their trash haulers already provide organics collection services. Under Vermont's Universal Recycling Law (Act 148), all trash haulers will be mandated to do this by 2020 (Agency of Natural Resources, 2018). Therefore, as opposed to solely relying on community members' contributions to help meet the need for local organic inputs, VTC may find it more efficacious to also try to partner with trash collection services to see if they are interested in using them as a repository for food scraps.

When working to garner support for the CADS, there should be a focus not only on disseminating communication, but also on strategically considering the content it covers and the ways in which it is delivered. The results from this survey also showed that there was a positive relationship between the positivity score and CADS support, with those who had a higher positivity score (indicating how positive they felt towards the CADS' outcomes) having greater odds of reporting CADS support. Therefore, communication on the CADS may want to focus on describing specifics about how the CADS benefits the community and building belief in these outcomes. The results from this study also show that there were statistically significant differences between those who reported support for the CADS and those who did not in regard to how many different types of communication were received and in what forms. In particular, those who reported support for the CADS received, on average, more types of communication and in the forms of mass media alone or mass media and interpersonal together. Those who did not report support were more likely to have received no communication or interpersonal alone. Additionally, the potential importance of interpersonal communication was highlighted by the qualitative analysis: Some respondents cited hearing from their neighbors about issues with the CADS, such as odors, as one reason for becoming more negative about it over time. DOI describes the importance of interpersonal communication when it comes to persuading someone whether to adopt an innovation, and the power of this type of communication should not be underestimated, whether it be in the form of people hearing from their neighbors or learning more about the CADS from in-person events, such as an open house or community meeting.

The technical college and others working to increase support for CADS or renewable energy more generally may also want to consider how they engage different segments of the community around the technology of interest. The results from this study show that there were statistically significant differences between those who reported support for the CADS and those who did not in regard to many different demographic (and other) factors. This was found in this study via independent samples t-tests and Chi-square and regression analysis. The Diffusion of Innovation Theory predicts that, among other things, early adopters of an innovation will be more highly educated, wealthier, have greater exposure to mass media and interpersonal forms of communication, and be more positive towards science and change as compared to later or non-adopters. Evidence supporting much of this prediction was found in this study. Earlier in the paper, it was noted that the idea of "adoption" has been extended in this paper to include support. Additionally, though this study did not have a time element (other than change in attitude towards the CADS over time) and did not focus on categorizing which type of adopter respondents were (innovators, early adopters, early majority, late majority, laggards, or non-adopters), the idea was put forth here that "adopters" (supporters) of the CADS could be considered, if nothing else, earlier, as opposed to later, adopters. This analytical framing was informed by the facts that the CADS had only started operation three years prior to the study (making it relatively new to the community) and that nearly half of the respondents did not report being familiar with the CADS (further showing its relative newness to the community).

The Chi-square analysis revealed the following: Those who supported the CADS were more likely to support Vermont's goal of producing 25% of its energy from renewable sources by 2025 and Vermont's Universal Recycling Law than those who did not report such support. Support for such measures could be interpreted as being related to having a positive attitude toward change, as the passage of such legislation represents a changing policy landscape with the potential for day-to-day impacts, especially the Universal Recycling Law. Also, those who supported the CADS were more likely to have received both mass media and interpersonal forms of communication than those who did not report support for the CADS. The Chi-square analysis, did not, however, show that there was a statistically significant difference between those who indicated support for the CADS and those who did not in regard to income and education. The regression analysis did, however, reveal that income had a statistically significant impact on support for the CADS, with the odds of those who made $50,000 or more reporting support for the CADS being greater than the odds of those who made under $50,000 reporting support for the CADS.

These findings are also in line with other work that sought to profile "green" consumers and found that they tend to be wealthier than their counterparts. This work has also shown, however, that these consumers tend to be younger, have higher levels of education (Roe et al., 2001; Rowlands et al., 2003; Zarnikau, 2003), and lower electricity costs (Hansla et al., 2008; Zarnikau, 2003), which were not found in this study. Unfortunately, only a limited number of independent variables could be included in the regression analysis, which further limited the ability to test whether what the Diffusion of Innovation Theory predicted in terms of early adopters held true. In all, the technical college and others wishing to increase support for various renewable energy technologies may want to consider communicating with supporters and non-supporters of these technologies in different ways.

For those working to build community support for CADS, they may want to try different communication strategies tailored to the demographics of those who reported support for the CADS and for those who did not. For example, since those who supported the CADS tended to be higher incomes and live in a mid-range away from it, perhaps communication to these groups could focus on encouraging greater behavioral support of the CADS, such as through supporting the Cow Power program and using the drop-off container. For those who were lower income, on the other hand, or lived either within two miles of the CADS or over five miles away from it, perhaps communication could first focus on building support for the CADS in general. Of course, the sample in this study was not statistically representative, so these demographic trends in regard to CADS support may not hold true for the entire community, and a more representative sample could help further inform communication strategies.

Overall, this study helps provide a base upon which further investigation of community support of CADS can be built. Although this study did not utilize a representative sample, it still highlights some factors researchers may want to explore in the future in regard to what influences support for CADS or other renewable energy technologies. Future work may benefit from utilizing a statistically representative sample and also from including questions on why people do or do not participate in the Cow Power program (or similar green energy programs), whether respondents' knowing that dropping off food scraps to the CADS will benefit it increases their likelihood of doing so, and more questions that assess how community-level factors, such as social norms, influence CADS support.

CHAPTER 6. CONCLUSIONS & RECOMMENDATIONS

This chapter provides conclusions and recommendations based off of the major findings from each of the smart meter and CADS studies.

Electricity customer engagement with smart meters and CADS is an important component to realizing the benefits these efficient and renewable energy technologies, respectively, can provide. The smart meter study allowed a look at statewide engagement with smart meters, which, as far as the researcher was aware, has not been done before. The CADS study, on the other hand, was the only one that the researcher is aware of that involves looking at public engagement with (with a special focus on support for) a CADS (as opposed to an ADS more generally). These studies each offer important insights on the extent to which these technologies have been engaged with and what factors influence such engagement. The difference in the populations of interest in these studies and the sampling techniques used mean that care should be taken when considering comparisons between these results. Still, it is interesting to compare the conclusions that were arrived at in each study in the context of informing future work on engagement with these technologies and renewable and efficient energy technology more generally.

In each of these studies, there was a degree of engagement with the technologies reported among the respondents, though there were significant limitations to this engagement, especially in regard to reported behaviors that would increase the benefits realized from these technologies. In the smart meter study, only 45.0% of survey respondents in 2015 and 48.6% in 2016 reported having a smart meter. When looking as those who reported that the smart meter had reduced their electricity consumption, only

11.8% in 2015 and 17.2% in 2016 reported that the smart meter had reduced their electricity consumption some amount. In the CADS study, only 52.1% of respondents indicated that they were familiar with the local CADS project, while 69.8% of respondents reported supporting the project. However, lower percentages of respondents reported being willing to engage in behaviors that would further help support the CADS, including reporting being WTP for the Cow Power program (27.5% reported being WTP some amount for this program), reporting an interest in using the CADS' drop-off container (44.6% of respondents), and reporting that they would be WTP some amount to have their food scraps collected (40.6%). These findings may highlight a tension between supporting something in name and also in practice. Overall, perhaps these results can be viewed promisingly, as there is an initial level of engagement with these technologies that can be built upon.

One thing each of these studies invites consideration of is the different forms in which engagement can take and how these can relate, and need to relate, to one another in order to maximize the benefits these technologies can deliver. This is important because certain forms of engagement, such as awareness, and even self-reported support of a technology, are a necessary, but not sufficient component of seeing the benefits from these technologies realized. Furthermore, there would seem to be a logical order in which the public could be engaged with these technologies. First, they need to be aware that they exist, and from there, they need to know how to support and/or utilize the technologies, and last, they need to follow through on said support and utilization.

One strategy to assist in realizing each of the steps in this process is additional outreach. The results from this study have shown that, as a base level, some respondents did report interest in receiving additional communication on these technologies, with the highest percentage of respondents, at 31.3%, reporting that they would like to receive more information on how smart meters help to reduce the electricity price. In the CADS study, the highest percentage of respondents, at 43.8%, reported wanting to receive more information on the CADS' benefits. This is a good place to start from, and perhaps outreach strategies could be tailored according to two groups of people: those who seem less engaged with the technologies and those who already seem to have some level of engagement, including an interest in and willingness to learn more about these technologies. For example, for those who are aware of these technologies, the next steps would involve encouraging further support and utilization of them. For those who are not aware of the technologies, an initial effort would need to be made first to raise such awareness, and then further outreach could be provided that would encourage greater forms of engagement.

As has been reviewed extensively in the discussion section, significant demographic differences were found between respondents who showed some level of engagement with these technologies and those who did not. The smart meter paper detailed the differences between those who reported awareness of smart meters and those who did not, and the CADS paper detailed the differences between those who reported support for the CADS and those who did not. These findings, and findings like them from additional studies, could inform the kind of targeted outreach that has been discussed by giving educators an idea of what the characteristics of more or less engaged groups might be. Content, therefore, could be tailored to and delivered to certain demographics that tend to be associated with different levels of engagement.

Additionally, those doing outreach will need to keep in mind the importance of incentivizing greater engagement with each of these technologies. Education alone will likely not be sufficient. Community members may also need interventions that help address potential structural barriers and a lack of motivation around engaging with these technologies. Such considerations, of course, could be woven into educational outreach, but would also likely need to extend beyond this to additional work done by those looking to improve engagement with these technologies.

There is a degree of engagement with smart meters and CADS in Vermont. It is an important start, but not sufficient to see the benefits maximized from these technologies. This study helps elucidate the extent to which these technologies have been engaged with and what factors might influence such engagement. There has been limited information on these topics in regard to smart meters and CADS, and hopefully these results contribute to a baseline understanding of engagement with these technologies, as well as provide insight on how to further engage consumers with them. Overall, these results are hoped to help inform future work on these topics, including research and outreach that seeks to bolster engagement with these technologies and the benefits they can provide.

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APPENDIX A

Smart Meter Survey Questionnaire

This appendix details the questions that were asked on smart meters in the 2015 and 2016 Vermonter Polls (only questions related to the smart meter analysis are included here).

2015 Survey

The following questions are about smart electricity meters installed by electricity companies:

1. The electricity companies in Vermont have replaced the traditional electricity meters for many of their customers at no cost to the customers. Is your electricity meter a smart meter now?

   Please choose only one of the following:
   - ☐ Yes
   - ☐ No
   - ☐ Don’t know [DO NOT READ]
   - ☐ Refused [DO NOT READ]

2. How has the smart meter affected your electricity use?

   Please choose only one of the following:
   - ☐ The smart meter has significantly reduced my electricity use
   - ☐ The smart meter has reduced my electricity use a little bit
   - ☐ The smart meter has not changed my electricity use
   - ☐ I do not know
   - ☐ Refused [DO NOT READ]

3. Are you concerned about any potential impact to your health due to the smart meter? Would you say that you are
   - ☐ Not concerned at all
   - ☐ Not concerned
   - ☐ Concerned
   - ☐ Very Concerned
   - ☐ Not sure
   - ☐ Don’t know [DO NOT READ]
   - ☐ Refused [DO NOT READ]

4. Are you concerned about any potential impact to your privacy due to the smart meter? Would you say that you are
   - ☐ Not concerned at all
   - ☐ Not concerned
   - ☐ Concerned
   - ☐ Very concerned
   - ☐ Not sure
   - ☐ Don't know [DO NOT READ]
   - ☐ Refused [DO NOT READ]

5. And what is the highest level of education that you have completed? Please choose only one of the following:
   - ○ Less than High School (no diploma)
   - ○ High School graduate (incl. GED)
   - ○ Some college (no degree)
   - ○ Associates/technical
   - ○ Bachelor
   - ○ Post graduate/professional
   - ○ Don't Know [DO NOT READ]
   - ○ Refused [DO NOT READ]

6. How many people are there in your household?

7. How many people in your household are under the age of 18?

8. How many years have you lived in Vermont, including any earlier periods?

9. In what year were you born?

10. Do you live in a rural, suburban, or urban area?

11. Now, I'm going to read you a list of housing-types. Please tell me which one best describes your current home.
    - ○ Mobile home in a mobile home park
    - ○ Mobile home NOT in a mobile home park
    - ○ Unit in a multi-family dwelling (e.g. townhouse, condo, apartment)
    - ○ Single-family dwelling (stick-built or modular)
    - ○ Other (Please specify)
    - ○ Don't know [DO NOT READ]
    - ○ Refused [DO NOT READ]

12. Do you rent or own this home?

13. Was your household's TOTAL income in 2015 more or less than $50,000 before taxes?
    Was it more or less than $25,000 before taxes?
    Was it more or less than $75,000 before taxes?
    Was it more or less than $100,000 before taxes?

14. Now, I have two quick questions regarding your ethnicity and race. First, are you one of the following: Hispanic, Latino, or of Spanish origin?

15. Next, listen to the following list and indicate the race category with which you identify:
    - ○ White
    - ○ Black or African American
    - ○ American Indian or Eskimo
    - ○ Asian or Pacific Islander
    - ○ Something else (specify)
    - ○ Don't know [DO NOT READ]

16. What do you consider yourself to be politically - an independent, a Democrat ,a Republican, a Progressive, a member of a another political party, or of no political affiliation?
    - ○ Independent
    - ○ Democratic party
    - ○ Republican party
    - ○ Progressive party
    - ○ OTHER
    - ○ No political affiliation
    - ○ Don’t know [DO NOT READ]
    - ○ Refused [DO NOT READ]

17. And finally, with what gender do you identify the most?

2016 Survey

I am now going to ask you a few questions about smart meters installed by electric companies:

1. Electric companies in Vermont have replaced the traditional electricity meters with smart meters for many of their customers at no cost to the customers. Is your current meter a smart meter?

2. Would you say that your smart meter has: significantly reduced your electricity use, reduced your electricity use a little bit, or not changed your electricity use?

3. Would you say that you are Not concerned at all, A little concerned, Concerned, Very unconcerned or are not sure about any potential impact to your health due to smart meters?

4. Would you say that you are not concerned at all, a little concerned, concerned, very concerned or are not sure about any potential impact to your privacy due to smart meters?

5. Would you like to obtain any of the following information about smart meters? Please choose all that apply:
   ☐ Information on how smart meters work
   ☐ Information on how smart meters may help me save electricity
   ☐ Information on how smart meters may help to reduce power outages
   ☐ Information on how smart meters may help to reduce the electricity price
   ☐ Information on smart meters' potential impacts on the environment
   ☐ Information on smart meters' potential impacts on health
   ☐ Information on smart meters' potential impacts on customer privacy

6. And what is the highest level of education that you have completed? Please choose only one of the following:
   ○ Less than High School (no diploma)
   ○ High School graduate (incl. GED)
   ○ Some college (no degree)
   ○ Associates/technical
   ○ Bachelor
   ○ Post graduate/professional
   ○ Don't Know [DO NOT READ]
   ○ Refused [DO NOT READ]

7. How many people are there in your household?

8. How many people in your household are under the age of 18?

9. How many years have you lived in Vermont, including any earlier periods?

10. Do you live in a rural, suburban, or urban area?

11. In what year were you born?

12. Do you rent or own your home?

13. Was your household's TOTAL income in 2015 more or less than $50,000 before taxes?
    Was it more or less than $25,000 before taxes?
    Was it more or less than $75,000 before taxes?
    Was it more or less than $100,000 before taxes?

14. Now, I have two quick questions regarding your ethnicity and race. First, do you identify as one of the following: Hispanic, Latino, or of Spanish origin?

15. Next, listen to the following list and indicate the race category with which you most identify:
    ○ White or Caucasian
    ○ Black or African American
    ○ American Indian or Eskimo
    ○ Asian or Pacific Islander
    ○ Don't know [DO NOT READ]
    ○ Refused [DO NOT READ]
    ○ Some other race

16. Please choose only one of the following:
    ○ A Republican
    ○ A Democrat
    ○ An Independent
    ○ A Progressive
    ○ Not Politically Affiliated
    ○ Don't know [DO NOT READ]
    ○ Refused [DO NOT READ]
    ○ Some other affiliation

17. And finally, with what gender do you most identify?

APPENDIX B

CADS Survey Questionnaire

This appendix details the questions that were asked in the 2017 CADS study.

Randolph Resident Survey on Renewable Energy, Composting, and the VTC Community Biodigester

Dear Randolph residents:
Greetings from the University of Vermont (UVM) and Vermont Technical College (VTC)!
We would like to ask you to participate in this short survey of Randolph residents. The purpose of this study is to better understand Randolph residents' thoughts and opinions on different issues related to renewable energy, composting, and the VTC community biodigester located in Randolph. Results and findings from this study will be shared with the community through *The Herald* and other channels. Data collected from this survey will be used for statistical analysis and will be kept strictly confidential. The survey will take about 15 minutes. Once complete, please place your survey in the prepaid envelope attached to this questionnaire, and put it in the mail by Thursday, May 4th. Alternatively, you can complete this survey online at https://tinyurl.com/mvnq4en (please only complete the survey once, either via this hardcopy or online).
If you are interested in being entered in a drawing to win one of five $50 Amazon gift cards, please provide your contact information at the end of the survey.
If you have any questions, please e-mail Samantha at slewando@uvm.edu.

Thank you very much for your time and help.

Renewable Energy Issues:

1. Vermont has a state goal of producing 25% of its energy from renewable sources by 2025. Please indicate your level of support for this goal by circling a choice:

Strongly oppose	**Oppose**	**Neutral**	**Support**	**Strongly support**	**Not sure**

2. Please indicate how realistic you think this goal is by circling a choice:

Very unrealistic	**Unrealistic**	**Neutral**	**Realistic**	**Very realistic**	**Not sure**

3. If Vermont was to increase its public investment in generating more electricity from solar panels, wind turbines, and biodigesters, how strongly would you support public investment in each of these choices?

	Strongly oppose	Oppose	Neutral	Support	Strongly support	Not sure
Biodigesters	1	2	3	4	5	6
Solar panels	1	2	3	4	5	6
Wind turbines	1	2	3	4	5	6

4. Is your electricity meter a smart meter?

   □ Yes □ No □ Not sure

   If you responded yes to the question above, how has the smart meter changed your electricity use?

   □ Reduced significantly □ Reduced a little bit □ No change
   □ Not sure

5. Are you familiar with the Green Mountain Power (GMP) **Cow Power Program**? Please choose **only one** of the following:
   - □ I have participated in the Cow Power program.
   - □ I have heard about the Cow Power program, but have not participated in it yet.
   - □ I have never heard of the Cow Power program.

6. Approximately, what is your average per month electricity cost? $____________

7. The GMP Cow Power program provides GMP electricity customers the option of paying a premium of $0.04 per kWh on top of the regular rate on a portion of their electricity use to support electricity generated from cow manure by Vermont dairy farms. If you are interested in participating in the Cow Power program, what is the maximum premium you would like to pay as a percent of your electricity bill to support Cow Power farms (e.g., 10% means you pay 10% more of your electricity bill each month to support the program)?

Not interested	5%	10%	15%	20%	25%	30%	40%	50%	More than 50%	Not sure

Knowledge and Opinions on the VTC Community Biodigester and Need for Information:

8. The VTC community biodigester was constructed in 2013 and has been operating since 2014. The biodigester has turned an average of 400,000 gallons of manure and food scraps into 185,900 kWh of energy and 400,000 gallons of nutrient-rich fertilizer and cow bedding every month. Please indicate how familiar you are with the VTC community biodigester project by circling a choice:

Very unfamiliar	Unfamiliar	Not sure	Familiar	Very familiar

9. Please indicate your level of support for the VTC community biodigester by circling a choice:

Strongly oppose	Oppose	Neutral	Support	Strongly support	Not sure

10. Please indicate to what extent you believe the VTC biodigester has brought about the following outcomes:

	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
Produces renewable energy from wastes					
Decreases dependence on fossil fuels					
Reduces methane emissions from agriculture					
Reduces odors produced by manure					
Helps with manure management					
Reduces nutrient runoff into waterways					
Reduces food wastes going into landfills					
Serves as teaching tool on sustainable agriculture					
Reduces community aesthetics					
Lowers water quality					
Lowers air quality					
Raises noise levels					
Lowers property values					

11. Since you first learned about the VTC community biodigester, have you become more positive or more negative about it (please circle your answer choice below)?

Become much more negative	Become a little more negative	Stayed about the same	Become a little more positive	Become much more positive

Why? Please explain in the margin below (if you need more space, please write in the top margin of this page):

12. How have you previously received information on the VTC biodigester (please check all that apply)?

□ Newspaper articles
□ Radio segment
□ Mailout (flier, pamphlet, etc.)
□ Word-of-mouth
□ The digester website
□ A TV segment
□ VTC Digester Open House
□ VTC Community Meeting
□ I have not received any information.
□ Not sure

13. On what areas would you like to receive more information on biodigesters (please check all that apply)?

□ How they operate
□ How safe they are
□ How they affect property values
□ Their community benefits
□ I would not like to receive more information
□ Not sure

14. If you could receive more information on the VTC biodigester, what would be the best way(s) for you to receive it (please check all that apply)?

□ Newspaper articles
□ Radio segment
□ Mailout (flier, pamphlet, etc.)
□ Word-of-mouth
□ The digester website
□ A TV segment
□ VTC Community Meeting
□ I would not like to receive more information.
□ Not sure

Composting of Food Scraps:

15. According to Vermont's Universal Recycling Law (Act 148), by 2020, food scraps will be banned from landfills, and Vermonters will be required to separate their food scraps from other trash for proper disposal. How familiar are you with this law (please circle one choice)?

Very unfamiliar	Unfamiliar	Not sure	Familiar	Very familiar

16. To what extent do you support this law (please circle one choice)?

Strongly oppose	Oppose	Neutral	Support	Strongly support	Not sure

Clean stream collection is where food items are kept separate from non-food items during trash collection. The next four questions will be on clean stream collection:

17. If your household was asked by a waste collection service to keep compostable materials (food scraps) separate from other trash, how often do you think your household would do this?

Always	Very often	Sometimes	Rarely	Never	Not sure

18. How much would you be willing to pay per month to have your food scraps collected and dropped off to the biodigester?

    Write in the dollar amount: $____________

19. Prior to this survey, were you aware that there is a drop-off container at the VTC biodigester for Randolph community members to drop off clean stream household food waste?

    □ Yes □ No

20. How often would you like to use this drop-off container to dispose of your household food waste?

    □ Not at all □ 1-2 times per month □ 3-4 times per month □ 5 or more times per month □ Not Sure

Demographics:

21. Are you currently a resident of Randolph?

    □ Yes □ No

22. How far away from Vermont Technical College do you live?

    □ Less than 1 mile □ 1 – 2 miles □ 2.01 – 3 miles □ 3.01 – 5 miles
    □ More than 5 miles

23. What is the highest level of education that you have completed?

    □ Less than High School (no diploma)
    □ Associate/technical
    □ High School graduate (incl. GED)
    □ Bachelor
    □ Some college (no degree)
    □ Post graduate/professional

24. How many people are in your household including yourself ? □ 1 □ 2 □ 3 □ 4 □ 5 □ 6 □ More than 6

25. How many people in your household are under 18? □ 1 □ 2 □ 3 □ 4 □ 5 □ More than 5

26. How many years have you lived in Randolph? ________________

27. Which best describes your current home?
    ◻ Single-family home ◻ Townhouse, condo, or apartment
    ◻ Mobile home ◻ Other

28. Do you rent or own your home?
    ◻ Own ◻ Rent ◻ Other

29. What was your household's TOTAL income before taxes in 2016?
    ◻ Less than $25,000 ◻ $75,000-$99,999
    ◻ $25,000-$49,999 ◻ $100,000 or more
    ◻ $50,000-$74,999

30. What do you consider yourself to be politically?
    ◻ Independent ◻ Democrat ◻ Republican ◻ Progressive
    ◻ No Political Affiliation
    ◻ Other (please specify): ____________________

31. With which gender do you identify?
    ◻ Female ◻ Male ◻ Other

32. In what year were you born? 19________________

33. Please use the space below for any additional comments, questions, or ideas you'd like to share:

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Thank you for taking the time to complete the survey! If you would like to be entered in a drawing to win 1 of 5 $50 Amazon gift cards, please provide your first name AND your preferred contact method (e-mail or phone number) on the line below:

First name:_____________________________

Phone or email:________________________________