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Energy Efficiency Programs at All Utilities: An Analysis of the Factors that Lead Electric Utilities to Invest in Energy Efficiency

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Energy Efficiency Programs at All Utilities: An Analysis of the Factors that Lead Electric Utilities to Invest in Energy Efficiency

A Thesis Presented

by

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And to my two little ones, Nela and Lucy, for all their good cheer and assistance in smoothing out some of the rougher parts.

ABSTRACT

ENERGY EFFICIENCY PROGRAMS AT ALL UTILITIES: AN ANALYSIS OF THE FACTORS THAT LEAD ELECTRIC UTILITIES TO INVEST IN ENERGY EFFICIENCY

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While the utilization of energy efficiency has grown in recent years, it has not been distributed evenly across the country. In some states, over 2% of a utility's budget is spent on energy efficiency; in other states that number is 0. Much of the growth in energy efficiency has been due to state policies and the development utility-level energy efficiency programs. Yet, all utility programs are not created equal. Because they are often exempt from state regulation (and therefore state energy efficiency policy), publicly-owned utilities have traditionally lagged behind IOUs when it comes to EE programs.

This research quantifies energy efficiency programs in four Midwestern states: Iowa, Indiana, Michigan and Wisconsin. The first part of the thesis evaluates 474 electric utilities as to whether they had an energy efficiency program in 2010. The second part of the thesis evaluates each utility's EE program spending in terms of energy and utility specific factors, as well as socio-economic, housing stock and political variables. Through descriptive statistical analysis and the creation of a predictable linear regression model, this thesis identifies relationships between the dependent variable (EE program spending as a % of a utility's total revenue) and commonly cited barriers to EE program development.

Through the analysis, this study finds widespread EE program coverage in Iowa, Michigan and Wisconsin. Also, it finds states are the greatest predictor of utility energy efficiency program spending. A utility's ownership type and the share of homes that heat with electricity are also significant predictors of program spending.

Key Words: "Energy Efficiency Programs" "Energy Policy" "Rural Electric Cooperative" "Municipal Utility" "Investor-owned Utility" "Energy Efficiency Resource Standard"

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

GLOSSARY

Common Program (branded-program) – In some states, a commonly branded energy efficiency program exists that utilities can take part in. Utilities benefit from greater scale and shared administration costs. Often these programs are run by a third-party administrator.

Decoupling – Decoupling is a rate adjustment mechanism that breaks the connection between how much energy a utility sells and the revenue it collects. It helps minimize the conflict between selling energy for a profit and promoting energy efficiency.

Demand-Side Management (DSM) - Demand-side management is the management of energy demand, either through incentivizing end-user energy efficiency or through peak-load management: getting end-users to lower the peak energy usage–programs that run dishwaters and hot water heaters at night when energy use is low versus the evening when energy use is high. While increased energy efficiency reduces overall energy use, better load management can often reduce the need for additional electrical generation capacity. While both types of demand-side management programs are important this research focuses on solely energy efficiency.

Energizing Indiana – Common program in Indiana that began in 2011. IOUs must participate and non-jurisdictional POUs are allowed to join (and most have).

Energy Efficiency Resource Standard (EERS) – An EERS is "a mechanism established by law that encourages more efficient use of electricity and natural gas by requiring utilities to save a certain amount of energy either on an annual basis, on a cumulative basis, or both. Utilities achieve these savings by implementing energy efficiency programs to help their customers save energy in their homes and businesses." (Furrey, 2009)

Focus on Energy – Common program in Wisconsin that has been around since 2005. IOUs must contribute and participate. POUs either may either participate or retain their contribution and operate an independent program.

Generation & Transmission Cooperative – Made-up of rural electric cooperatives. G&Ts generate and/or purchase the electricity distributed and sold by RECs. In some areas (Hoosier Energy in Indiana is a good example) a G&T cooperative has operated a common energy efficiency program for its REC members.

Integrated-Resource Planning (IRP) – IRP is "a planning and selection process for new energy resources that evaluates the full range of alternatives, including new generating capacity, power purchases, energy conservation and efficiency, cogeneration and district heating and cooling applications, and renewable energy resources, in order to provide adequate and reliable service to its electric customers at the lowest system cost." (Energy Policy Act of 1992) IRP has helped utilities see energy efficiency (or demand-side management) as a resource and a useful alternative to increasing generation capacity in response to growing demand.

Investor-Owned Utility (IOU) – IOUs are one of the three types of utilities that distribute electricity or natural gas to customers. IOUs are for profit companies regulated by state public utility commissions. They are often very large, serving customers across many states.

Load Management – Often a key component of demand-side management programs, load management refers to managing the way customers use energy. Often this involves programs that get customers to switch some of their energy use from peak periods to times when energy demand is low. Successful load management programs can reduce the need for increasing generation capacity (i.e. new power plants).

Municipal Utility (MU)- MUs are a publicly-owned utility operated by a municipality. MUs can be large and serve cities with hundreds of thousands of customers or can serve small towns with hundreds of customers.

Public Benefit Funds – Public benefit funds are a mechanism that utilities can use to recoup costs for energy efficiency programs.

Public Utility Commission (PUC) – The PUC is the state body that regulates utilities. They are usually responsible for monitoring EERS.

Publicly-Owned Utility (POU) – POUs include MUs and RECs. Because POUs are answerable to their customers via boards, committees and elections, they are often not regulated by state PUCs.

Rural Electric (Member) Cooperative (REC or REMC) – RECs are utilities that serve a mainly rural customer base. They were created by the federal government to serve areas of the country that IOUs found uneconomical to serve. While some RECs are still heavily made up of farms and other rural customers, some have seen suburbs grow in their service areas.

CHAPTER 1

INTRODUCTION

As energy prices rise and climate change is recognized as a more pressing and legitimate threat, the interest in energy efficiency has grown ever more in recent years. Appliances and automobiles have become more efficient. Energy efficient building practices are becoming more commonplace in design and construction. There are even net-zero energy buildings being constructed, structures that produce as much energy as they use. Yet, one of the biggest energy drains in this country is our existing building stock. For the year 2010, the U.S. Energy Information Administration estimated that 41% of total energy consumption was used in buildings.

Thankfully there are a myriad of ways to make this consumption more efficient. Technological advances in lighting, appliances and heating systems, more efficient and green building practices (including the retrofitting of older buildings to perform more efficiently), and changing the way we use our buildings are just a few. Yet many of these solutions are not taken advantage of due to a number of market failures. While they may be more cost-effective over the course of their use, efficient appliances, lighting and building products usually have higher up-front costs and are not always adopted. Customers knowingly choose less efficient products because of lower initial costs. When it comes to buildings, even more barriers exist that prevent sizable investments in energy efficiency. Builders have traditionally not incorporated energy efficiency measures into construction. Homeowners can be reluctant to make an investment when they might sell the home before they reap the benefits. This can be even more so with businesses where short-term results usually outweigh long-term ones. In the case of rental units (residential, commercial or industrial), there's the issue of the split incentive where the landlord owns the building, but the tenant pays the energy bill. Landlords do not have an incentive to lower an energy bill they don't pay and tenants do not have an incentive to invest in a property they don't own.

Because these barriers have prevented the free market from readily utilizing energy efficiency, leaders at the national, state and local levels have instituted an assortment of policies to increase energy efficiency. Federal efficiency standards for automobiles have been created. Local and state building codes have incorporated energy efficiency to varying degrees. Public education campaigns dedicated to conservation come from the public, private and non-profit sphere. In many areas of the country the policy toolbox now includes an array of incentives, rebates, loans and other services packaged together in utility-sponsored energy efficiency programs.

Beginning in the late 1970s with rising oil costs, the breadth of energy efficiency programs expanded rapidly with the passage of the Public Utility Regulatory Policies Act which required large utilities to institute energy efficiency and conservation programs (EIA 2000). As energy prices decreased in the 1980s interest in energy efficiency waned and many programs were allowed to retire (Walker 1985). In the last decade though, existing programs have grown exponentially and new programs are being created each year. Currently there are robust programs of all shades and sizes being run throughout United States.

Yet it is difficult to quantify the extent of energy efficiency program adaption, as well as compare the relative strength and size of various programs. The National Rural Electric Cooperative Association claims that 96% of co-ops have efficiency programs, 70% offer financial incentives to promote greater efficiency, and 73% of co-ops plan to expand their programs in the coming years. Yet what constitutes an energy efficiency program is not defined. Twenty-six percent of co-ops offer a program, but no financial benefits. Do they offer financing, market-rate services, or do they simply send a *How to Save Energy* educational booklet with the annual report each year? The literature that has reviewed energy efficiency programs suggests a dearth of programs at rural electric cooperatives. Is the 96% in program coverage cited by the NRECA a very recent phenomenon? Or is a trade association like NRECA more generous in its definition of an energy efficiency program than the academic community?

Usually, the impetus for utilities to conduct an energy efficiency program is a state mandate. Of the three types of utilities, often only investor-owned utilities (IOUs) can be regulated by state officials. Rural electric cooperatives (RECs) and municipal utilities (MUs), collectively known as publicly-owned utilities (POUs), are usually beyond the grasp of regulation since they are already answerable to the communities they serve via committees, boards and elections. A review of the literature on energy efficiency programs suggests that generally POUs, have not adopted energy efficiency programs to the same degree that IOUs have. Many attribute this to the exception given to POUs in many states' energy efficiency mandates.

Yet, some of the oldest and best programs in the country are at POUs. Considering the relationship that POUs have to their customers (be they members of the REC or citizens of the city operating the MU), it makes sense that a POU should be able to design and operate a program that better fits the specific needs of its customers. The localized nature of RECs and MUs stands in stark contrast to many IOUs, which tend to be larger, with service areas that span multiple states and regions of the country. If a POU is able to overcome their distinct barriers to energy efficiency program adoption, their potential for operating a successful program should be greater because of the special relationship they have with their customers.

This thesis is an attempt to better understand the extent of energy efficiency program coverage across four Midwestern states with a rich variety of utility size and ownership structure. Beyond simply answering the question: What percent of utilities have an energy efficiency program, this thesis includes an examination of how utility-level factors such as energy consumption rates, utility size, electric rates, type of customer base, and ownership structure predict how much a utility is willing to invest in energy efficiency. Socio-demographic and economic factors in utilities' service areas may also predict a utility's rate of energy efficiency investment, and those relationships are also explored in this thesis.

Because of the influence of state-level policies on utility programs, studies have often compared energy efficiency adaptation and funding at the state-level. Those few studies that have explored utility-level programs and how factors like ownership structure and size influence them, have rarely done so quantitatively. This research assesses energy efficiency program adaption at all electric utilities in Iowa, Indiana, Michigan and Wisconsin. Utilities are compared based on total program spending as a percentage of total revenue for the year 2010. Factors such as state policy and history, ownership structure, energy use, and housing stock are evaluated in order to see how they might predict spending on energy efficiency. As part of this analysis, a regression model is built to explore relationships between these factors and energy efficiency spending.

In its broadest sense, the goal of this research is to increase the utilization of energy efficiency. While utility programs have been essential in driving the growth of energy efficiency, it is imperative that all utilities, regardless of size, ownership type, geography, or regulation, strongly pursue energy efficiency. It has been regularly claimed (Wilson, 2008; Fischlein, 2009; Frieschlag, 2011, Smith, 2010) that publicly-owned utilities lag behind IOUs when it comes to investing in energy efficiency. I plan to more definitively address that claim, as well as identify which factors are significant barriers to energy efficiency program development. By doing so, I will show what type of utilities are lagging behind and what are the factors most significantly driving that deficit. These findings will be helpful to policymakers, program managers, and others interested in energy policy.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

> Most of the DSM [demand-side management, aka energy efficiency] literature dates to the late 1980s and early 1990s… Much of the literature has focused on implementing DSM in investor-owned utilities or large municipal utilities. However, analyses of DSM programs have often ignored the unique plight of consumer-owned utilities. These organizations…have different institutional structures, and face different challenges and opportunities in implementing DSM programs than IOUs. (Wilson, 2008)

Academic literature on the energy efficiency programs and policies of rural electric cooperatives (REC) and municipal utilities (MU) is not extensive. An initial search turned up only a handful of articles that specifically looked at energy efficiency within RECs and Mus. Many articles deal more generally with energy efficiency, not differentiating between investor-owned utilities and publicly-owned utilities. Articles that deal more generally with demand-side management (DSM), specifically load management, are more prevalent.

Although energy efficiency programs are usually managed at the utility level, many studies (Doris, 2011; Furrey, 2009; Nadal, 2010; Sciortino, 2011; York, 2005; Foster, 2012; Eldridge, 2007 & 2008) evaluate energy efficiency utilization on a state by state basis. These studies emphasize the often controlling factor of state policy and rarely evaluate programs at the utility level. Yet they are a helpful resource in assessing state policy.

In addition to articles generally about DSM programs, there is also a growing literature that explores energy use more broadly. Some articles (Tierney, 2011) explore renewable energy and the growth of its use by both utilities in general, and RECs and MUs in particular. While renewable energy programs may be similar to energy efficiency programs in some respects, differences in utilization and cost-effectiveness make comparisons across the programs problematic. More useful are articles (Greer, 2003, 2008) that explore the organization and structure of different utility types and how they have changed over the years. As much of the literature suggests, it is often these factors that bolster or limit particular programs.

2.2 Energy Efficiency at Publicly-owned Utilities

As stated above, research into how RECs and MUs have pursued energy efficiency is limited. One of the stronger studies (Wilson, 2008) analyzes all the RECs and small MUs across Minnesota. It provides a, "background on rural co-operatives and municipal utilities in the context of the US electric sector and highlights[s] the challenges and opportunities of implementing DSM programs at these institutions." It is a break from much of the energy efficiency program literature because it looks at the question of ownership model in each utility and how that influences program adaption. The study takes a mixed research approach in examining program adaption at POUs across Minnesota.

Through direct surveying of POUs, the researchers came to a few key findings:

- DSM programs improve customer relations and the utility's public image
- Developing strong local partnerships are a key ingredient to success
- Organizational capacity to create and manage programs was a strong limiting factor (especially within very small utilities)
- Common market barriers to energy efficiency were identified in rural areas and small towns (lower incomes, access to energy efficiency products and specialty contractors, heavy residential electrical load)
- MUs tend to be smaller, have a smaller residential load, and have less experience than RECs in delivering DSM programs
- RECs have tended to focus more on load management programs than MUs.

Another article by the same research team, (Fischlein, 2009) approaches the lack of energy efficiency at POUs through the prism of climate change and emission reductions. While the paper doesn't evaluate a set of utilities for program adaption it does address POUs specifically. It notes the lack of research and data on POUs, that the, "majority of research either implicitly or explicitly focuses on IOUs." It cites a 2005 study that found program adaption at MUs and RECs at 11% and 21% respectively. Yet, it also acknowledges that industry sources at the time suggest program adaption levels over 50%. The researchers attribute much of lack of program adaption at POUs to a lack of regulatory authority, claiming that POUs largely govern themselves outside of state purview.

Meyer (1983, explores the history of utility regulation and comes to a similar, though more general, conclusion regarding the lack of regulation at POUs. He challenges the claim that MUs can better serve their customers when free from state or federal regulation, arguing that self-regulation encourages inefficient operation of services.

Surveys and case studies of existing programs are also important. One good case study, which explicitly explores successful energy efficiency programs instituted by RECs, begins with a short history of DSM programs at RECs beginning in the 1970s and continuing into today (Frieschlag 2011). Frieschlag finds that RECs do not invest in energy efficiency to the scale that IOUs do, "many of these nonprofit organizations simply lack the member and management commitment necessary to deliver high performance energy saving programs." More specifically the study identifies a number of barriers experienced by RECs: lack of integrated resource planning, the demographics of RECs' rural service areas which demand specifically tailored programs and the lack of contractor infrastructure need to deliver energy efficiency effectively. Frieschlag (2011) also attributes a lack of member interest in energy efficiency as a contributing factor.

While one of the consensuses of the literature seems to be that RECs with the strongest programs tend to those that are subject to state energy efficiency mandates, Frieschlag (2011) does provide a case study of an exception: Hoosier Energy. Hoosier Energy is a generating and transmission cooperative serving 18 RECs in southern Indiana which began operating DSM programs for its RECs in 2009. While an EERS had already been passed by the Indiana legislature, it was not set to begin until 2010 and only applied to jurisdictional utilities (of which Hooiser Energy's co-ops are not). So in many ways Hoosier Energy's energy efficiency program was voluntary. In fact Frieschlag (2011) attributes the program's creation to expected electricity demand growth through 2028 and never mentions the state's EERS.

2.3 State-level Policy and Energy Efficiency

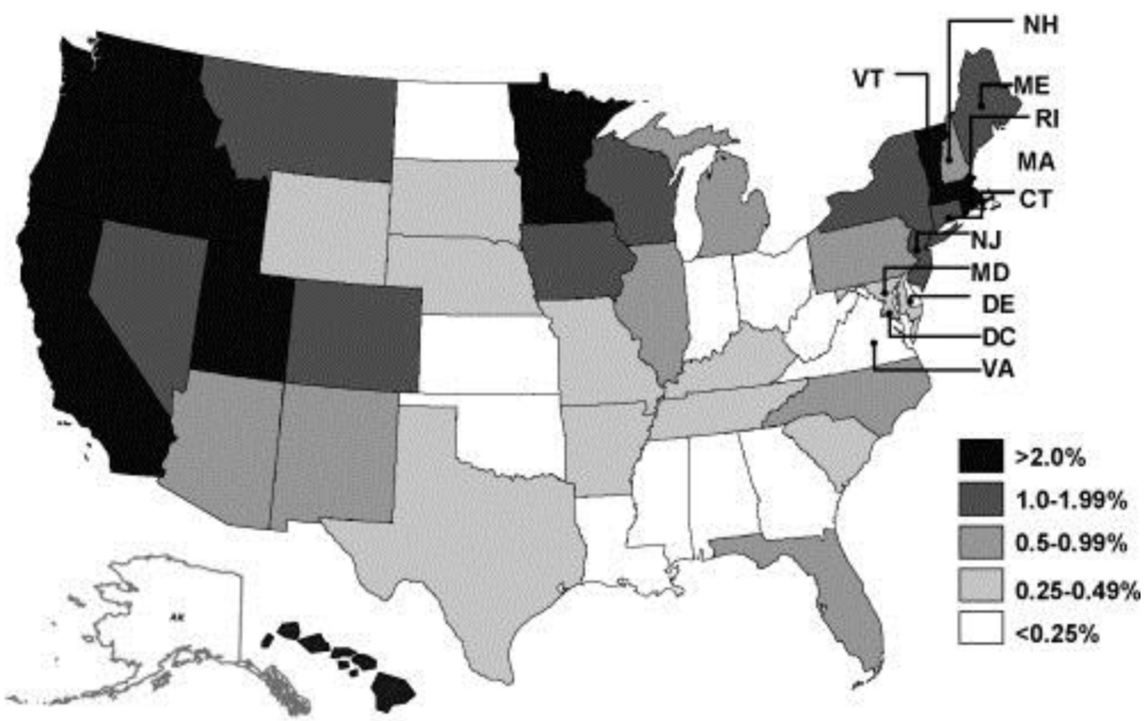
Because of the market failures that have hampered the energy efficiency industry throughout the decades, federal, state and local policies have been extremely important in increasing the use of energy efficiency. While in the past building codes, land-use regulations and state incentives and/or rebates have proliferated, the recent development of state Energy Efficiency Resource Standards (EERS) has greatly expanded energy efficiency.

A good introduction to policy options is (Nadal, 2010). It outlines three major policy strategies that states currently use to advance utility DSM. These include: integrated resource planning, public benefit funds, and energy efficiency resource standards. The paper also defines two complimentary policies that have assisted the spread of DSM: decoupling and regulatory incentives.

Furrey (2009) defines EERS as, "a mechanism established by law that encourages more efficient use of electricity and natural gas by requiring utilities to save a certain amount of energy either on an annual basis, on a cumulative basis, or both. Utilities achieve these savings by implementing energy efficiency programs to help their customers save energy in their homes and businesses."

Because of the accessibility of data at the state-level and the strong influence of state policy, comparisons are often done at the state-level. In an evaluation of energy efficiency program spending, (Nadal 2010) separates all states into 5 different levels. It finds higher spending levels in the Northeast, Upper Midwest, and the West (Figure 2.1). The article also identifies states with a longer history of energy efficiency programs. Those states with significant energy efficiency programs before 2007 tend to match those with higher spending levels and are concentrated in the same areas of the country.

Figure 2.1: Spending on Electric Utility Energy Efficiency Programs as a Percent of Utility Revenues (2009)



Source: ACEEE analysis using data from CEE and EIA[2] (Nadal 2010)

Another state-level analysis, (Sciortino 2011), shows an increasing adoption of EERS. While there were only seven states with an EERS before 2008, twenty-six states now have them in place. This report looks at the twenty states that have had an

EERS in place for at least two years and sees how energy savings results match up to goals. It finds that generally states are finding success with EERS: over half of the states have exceeded their energy savings goals and only three states are short of their goals by more than 20%. It also finds that states are finding success irrespective of geography or the state's experience with energy efficiency programs in the past. The issues that do influence program success are, "the clarity and appropriateness of the regulatory framework, the length of time allowed for program administrators to ramp-up programs, and the overall commitment of all parties to invest the proper resources to meet targets." (Sciortino 14)

A broad look at state-level energy efficiency policy is the annual ACEEE State Energy Efficiency Scorecard. Begun in 2007, this report ranks all 50 states and the District of Columbia based on six energy efficiency policy areas: 1) utility and public benefits programs and policies; 2) transportation policies; 3) building energy codes; 4) combined heat and power; 5) state government initiatives; and 6) appliance efficiency standards. With six annual reports released, the scorecard has become a reliable way to measure the relative strength of state energy efficiency policy over the years.

A recent report from the National Renewable Energy Laboratory, (Doris 2011), presents a regression analysis that explores how state-level policy might influence energy use. With per capita residential energy use as the dependent variable, their analysis found EERS, high efficiency building codes and electricity rates to be significant and have negative relationships with energy use. Incentives and rebates were not found significant. In their commercial energy use analysis: rates, EERS, efficient building codes, and personal tax incentives were all found to be significant and have a negative relationship.

CHAPTER 3

RESEARCH SCOPE, METHODOLOGY AND DATASET

3.1 Research Questions

This research was driven by a desire to figure out why POUs haven't established energy efficiency programs to a similar extent as IOUs and to figure out how best to correct that. Yet, because utility-level research has been sparse (especially quantitative research), it became necessary to evaluate a population of utilities in order to see where IOUs and POUs actually stood in terms of program adaption and operation. Therefore, this study first addresses the question:

1. Compared to investor-owned utilities, do publicly-owned utilities operate energy efficiency programs, and how does their program spending levels compare to IOUs?

With that questioned addressed, the second part of my thesis goes into more depth, utilizing descriptive statistics and regression analysis to find relationships between energy efficiency program spending and factors distinct to each utility. The second question this study addresses is:

2. What are the factors that influence energy efficiency program adaption and operation? What is the relative influence of state policy, utility ownership type, energy use, housing stock and other factors specific to a utility and its service area?

3.2 Hypothesis

After reviewing the literature on energy efficiency programs, especially those focusing on POUs, I hypothesize that POUs have not pursued energy efficiency in great numbers because they are usually exempt from state energy efficiency mandates. Once excluded from state minimum standards I expect POUs are less driven internally to pursue energy efficiency because of common barriers cited throughout the literature:

- Tend to be smaller
- Tend to be poorer
- Are usually more rural and isolated
- Customer base are usually heavily residential
- Often have little or no demand growth
- Have relatively low rates
- Lack the political and popular will within the POU for energy efficiency
- Independent culture of management and customer base

While I expect there to be an assortment of programs at RECs and MUs, I expect that most POUs have not operated an energy efficiency program. I also expect to find relationships between many of the common barriers listed above and the total program spending.

3.3 Methodology

The analysis of the data takes a two-step process. First, the data is explored through descriptive statistics: comparison of means, medians, quartiles, standard deviations. I divide up the data by state and analyze program spending as a percent of total revenue, the dependent variable. Then the same process is done to the data based on ownership type. Lastly descriptive statistics for the dependent variable are evaluated in terms of both ownership types and states.

Data for the dependent variable, energy efficiency program spending as a percentage of total revenue, is then divided into four groups: no programs and three tiers: the upper third of program spending, the middle third and the lower third. Means are taken for each tier for every independent variable evaluated and cross-tabulated. This is done for the overall dataset as well as for a data-subset of only POUs and then data-subsets of each state's POUs. This is done to uncover potential relationships between independent variables and the dependent variables overall and those specific to POUs in certain states.

The second step of the process is a linear regression analysis. Based on a literature review and preliminary data analysis, I create a model (Model 1) with five independent variables, plus three state dummy variables. I evaluate a second model (Model 2), which has the same variables as Model 1 plus ownership type dummy variables. These two models are regressed within the overall dataset and the POU data-subset. Then I subtract the state dummy variables from Models 1 and 2 to create Models 3 and 4 which are applied to the state/POU data-subsets. Changes in variable significance, coefficient strength and sign throughout the regressions were observed and interpreted.

3.4 Data Selection

The sheer number of utilities in the United States (over 3,200) and the lack of consistent reporting precludes this paper from a quantitative exploration of energy efficiency programs at all utilities in all 50 states. While all utilities are required to submit data to the federal Energy Information Administration, most do not include energy efficiency data in their submission. Using energy efficiency program data from the EIA-861 dataset would result in a sample that probably skews toward large utilities and those which are already required by regulation to operate a program and report on the results. Since this study seeks to gain a better understanding of program activity at small and unregulated utilities, this sample would not suffice.

Instead, this research evaluates all utilities in four states. Providing an in-depth analysis of a relatively small number of states allows me to capture utilities that do not operate programs and those that operate very small programs. The four states chosen: Iowa, Indiana, Wisconsin and Michigan, were selected because of the variety they represent in regulation, program management structure, history and program funding (see Figure 2.1). Within each state, their variety in utility ownership model and size, demographics, and political persuasion was valued. As roughly proximate, the four states should be similar in climate, culture and history, important controls. While other nearby states were considered for the research as well (Minnesota and Illinois especially), actual energy efficiency program spending data for the calendar year 2010 proved most accessible in the four states chosen.

3.5 State Background Energy Information

While all four states are similar in size, population, geography, climate and culture, it is helpful to note the differences in energy use.

3.5.1 Electrical Generation and Use

This is especially true when it comes to analyzing energy efficiency programs operated by electric utilities. The type of fuel a state uses to power its grid and whether that fuel is resourced locally or imported both help set the landscape on which energy efficiency thrives or is under-utilized. All state background data comes from the EIA state profiles.

Iowa – Iowa ranks 5th in the nation for highest per capita energy use. This is probably most due to the state's large rural and agricultural population and large industrial base. In 2010, about 72% of electrical generation in Iowa came from coal, 14% from renewables, 9% nuclear, and 5% natural gas. Different than most states, nearly all of Iowa's renewable energy does not come from hydro-electric facilities; with almost 20% of Iowa's total electricity coming from wind in 2011. It also has a relatively high consumption of liquefied petroleum gases (LPG, also known as propane) and is the nation's largest producer of ethanol (which also might help explain the state's high per capita energy use).

Indiana – Indiana ranks 10th in the nation in terms of highest per capita energy use. While Indiana also has a sizable rural population, it has more urban and suburban areas than Iowa (20% of electricity goes to residential use compared to 16% for Iowa). Its high energy use might better reflect the state's lack of investment in energy efficiency rather than other geographic or economic factors. Considering the state is one of the nation's leaders in coal production, Indiana generates most of their electricity from coal, upwards of 87% in 2010. Twelve percent was from natural gas and only 1% came from non-hydro renewables, although the largest geothermal heating and cooling system in the United States is being built in Muncie. Indiana is also a major producer of ethanol.

Michigan – Michigan is ranked 35th in highest per capita energy use. This is probably due both to the large urban areas in Michigan and to the state's relatively lower industrial share of energy use (only 25% compared to 49% in Iowa and 45% in Indiana). The state also has a high utilization of natural gas resources, both because of the large reserves and storage capacity in the state. Still, in 2010, Michigan generated 57% of its electricity from coal, 23% from nuclear, 18% from natural gas, and 3% from non-hydroelectric renewables (primarily biomass).

Wisconsin – Wisconsin is ranked 26th in highest per capita energy use. The state is very similar to Michigan; its larger share of industrial use (32% to 25%) help account for the higher per capita energy use. Also similar to Michigan, Wisconsin generated 57% of its electricity from coal, 19% from nuclear, 17% from natural gas, 4% from non-hydro renewables and 3% from hydro-electric facilities. Wisconsin is also a major producer of ethanol.

3.5.2 Home Heating Fuels

The variety of home heating fuels that a state's households use is also important to a state's energy use portfolio. Generally in the United States, natural gas is the most common heating fuel, supplying 50% to 60% of the population for the past

50 years. Since it is delivered by a pipeline infrastructure, generally the more rural an area is, the less likely it has access to natural gas. Because of the price, efficiency and ease of delivery, natural gas is usually the first option when available. Wherever natural gas isn't available, consumers must choose between electricity, LPG, oil or wood. Electricity tends to have higher shares of use where heating loads are lighter (the Southeast, Southwest, and Pacific Northwest). Historically, electricity use for heating has been a severely inefficient way to heat a home (especially in cold climates) and early energy efficiency programs often targeted those homes for efficiency measures. It should be noted though that recent advances in heat pump technology and greater adoption of weatherization strategies have allowed for more efficient electric heating.

In the Mountain West, Plain States, and Midwest, propane is used when natural gas isn't available and electricity hasn't been used. In the Northeast, oil is the fuel of choice when natural gas isn't available. In some Northeastern states over half the homes are heated with oil. Not only does this lead to volatile heating costs as the price of oil changes, but as the price has gone up, the Northeast's reliance on oil heat has become a liability. Wood is the other fuel that is used substantially across the United States. While many use wood as a supplemental fuel source, there are many states where a sizable population uses it as its main heat source. Those states (ID, ME, MT, NH, NM, OR, VT – all over 6%) tend to have a sizable rural population, extensive forests and lack major metropolitan areas.

Table 3.1: Home Heating Fuel Shares - 2010

Home Heating Fuel	Iowa	Indiana	Michigan	Wisconsin
Natural Gas	65.8%	63.0%	78.0%	66.1%
LPG (Propane)	13.8%	7.9%	9.2%	11.0%
Electricity	16.2%	24.9%	7.0%	13.0%
Oil	1.1%	1.4%	2.0%	4.4%
Wood	1.6%	1.9%	2.8%	4.3%

Source: U.S. Census 2010 5-year ACS data

The four states in this research are similar in heating fuel variety and are good examples of the variety in the Midwest (Table 3.1). There are some peculiarities to note though. Probably because of its more southern position geographically, Indiana has a higher proportion of electricity use for heat. All show similar natural gas use except for Michigan which is much higher. This is maybe due to a substantial gas reserve in Michigan and one of largest natural gas storage capacities of any state in the country. Wisconsin, with more acres of forest than either Indiana or Iowa, shows a higher wood use, while Iowa has slightly more LPG use.

3.5.3 State Energy Efficiency Policies

A state's energy efficiency policy often has the greatest influence on energy efficiency program spending. Both past and present energy policy can have an effect. While all four states examined currently have energy efficiency resource standards, their timelines of implementation, savings target levels, and jurisdiction varies (Table 3.2).

Table 3.2: Energy Efficiency Resource Standards

State	Savings Target	Standard applies to…	Status of POUs in 2010
Ind. – EERS Enacted 2009	*Entire Industry* – 0.3% annual savings in 2010, increasing to 1.1% in 2014, and leveling at 2% in 2019	All jurisdictional utilities submit 3-year DSM plans – which includes all IOUs and any POUs who have not opted out of jurisdiction	All EE programs voluntary
Iowa - EERS Enacted 2009	*Individual Utilities* – Varies by utility from 1% to 1.5% annually by 2013	IOUs, who must submit 3-year plans; MUs and RECs are required to implement energy efficiency programs, set energy savings goals, create plans to achieve those goals, and report to the IUB on progress, although saving target standards do not apply.	POUs must implement EE programs, but POUs are free to set their own targets
Mich. – EERS Enacted 2008	*Entire Industry* – 0.3% annual savings in 2009, ramping up to 1% in 2012 and thereafter	All utilities, saving targets are split between IOUs and POUs based on their respective shares of sales; for all utilities a spending cap exists.	Energy saving standards and spending cap applies to all POUs
Wisc. – EERS Enacted 2010	*Entire Industry* – 0.75% in 2011, 2012 and 2013	All utilities who participate in Focus on Energy (FOE) – only IOUs are required to participate, contributing at least 1.2% of their gross revenue; POUs must either contribute about 0.4% or retain their contribution and operate a Commitment to Community (CTC) program.	EERS was not in effect until 2011, all POU programs voluntary or in preparation for 2011 standard

Source: ACEEE State Energy Efficiency Policy Database, State PUC Reports

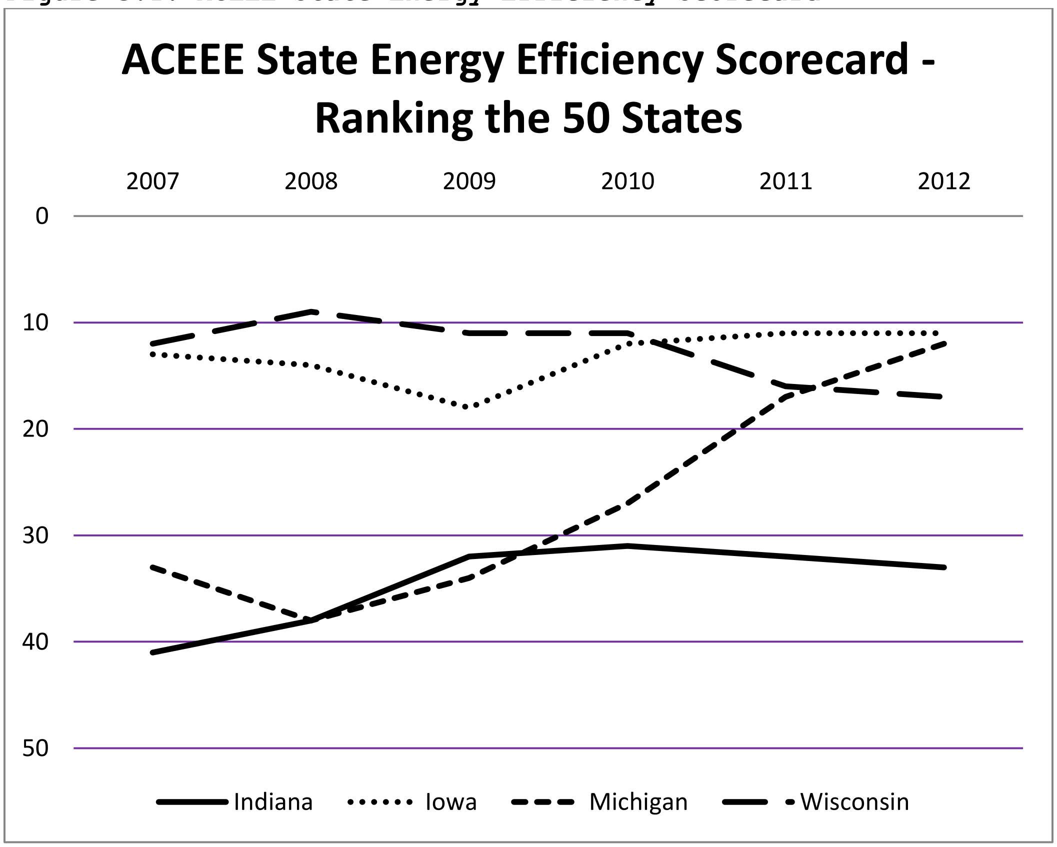
Of the four states, only Michigan's EERS does not make a distinction between POUs and IOUs. Indiana's EERS applies to all POUs that have not opted out of jurisdiction (which means POUs are only regulated in Indiana as long as they'd like to be). Iowa's EERS requires POUs to implement programs, set energy saving goals, create plans to achieve those goals, and report to the Iowa Utilities Board on their progress. Yet the minimum energy savings targets set out in the EERS do not apply to POUs. Iowa's POUs are allowed to set their own goals, however minimal they'd like them to be. Wisconsin's EERS applies to the state-branded program Focus on Energy (FOE) of which only IOUs are required to contribute and participate. POUs in Wisconsin either can contribute to FOE (about 1/3 of what IOUs contribute) or retain their contribution and operate an independent Commitment to Community program in their own service area – which they are then required to report on.

The historical legacy of energy policy in these states is also important. During the 1980s, Iowa, Michigan and Wisconsin all had energy efficiency programs operating in their states. Yet much of that changed in the 1990s. According to ACEEE's State Energy Efficiency Policy Database, "Michigan had a history of fairly aggressive energy efficiency programs until 1995, when demand-side management and integrated resource planning were discontinued during the move toward electric restructuring. Michigan had essentially no utility-sector energy efficiency programs from 1996 until 2008." While Wisconsin's and Iowa's programs did not disappear, they did not see increasing utilization until the last decade culminating in the passage of EERS. Indiana historically has not had any significant energy efficiency programs.

This historical legacy is evident in the first annual ACEEE State Energy Efficiency Scorecard created in 2007 (Figure 3.1). In it both Wisconsin and Iowa rank in the low teens, while Michigan and Indiana rank 33 and 41 respectively. By the 2012 Scorecard, after the reimplementation of energy efficiency programs in Michigan, the state had jumped up to 12th right behind Iowa. Indiana still lags quite far behind. While Michigan's and Indiana's EERS were passed within one year of each other and have similar energy saving goals, Michigan has had much better results. While Indiana was still designing their system, Michigan's was in full swing.

Considering it takes acts of legislature to enact EERS, it's curious how politics have influenced the operation of EERS. While their EERS sets an energy saving minimum, the Michigan legislature decided to also cap the amount of money that utilities can spend on their energy efficiency programs. "Spending for each utility is limited to 0.75% of total sales revenues in 2009, 1.0% in 2010, 1.5% in 2011, and 2.0% in 2012 and each year thereafter." (ACEEE State Policy Database) In Wisconsin following the 2010 conservative victories in state elections, the legislature capped energy efficiency spending so severely that the minimum savings standards in the EERS had to be lowered. Spending caps are a somewhat odd addition to energy efficiency programs considering that the programs tend to only fund cost-effective measures in the first place.

Figure 3.1: ACEEE State Energy Efficiency Scorecard



Source: ACEEE State Energy Efficiency Scorecards 2006-2012

3.6 Dataset

The dataset represents all the 474 electric utilities operating in the states of Iowa, Indiana, Michigan, and Wisconsin. When appropriate, utilities headquartered outside of these states that serve customers in these four states were included. Utilities that serve customers in more than one of the states examined are separated by their state designation and considered separate utilities (which is how they operate in respect to state regulatory bodies).

One of the reasons that Midwestern states were chosen for this research is the rich variety of utility ownership structure, geography, and size. They are either an investor-owned utility (IOU) or a publicly-owned utility (POU). Within POUs they are either a rural electric cooperative (REC) or a municipal utility (MU).

Table 3.3: Shares of Utilities, Sales and Customers by Ownership Type

All N=474	# of Utilities	Share of Sales (mWhs)	Share of Customers	Average # of Customers
IOUs	**28**	**82%**	**81%**	**356,538**
REC	**116**	**9%**	**11%**	**11,478**
MU	**330**	**9%**	**8%**	**3,179**
Small MU	292	41%	45%	1,614
Large MU	38	59%	55%	15,204

Source: EIA-861 (2010)

While IOUs only account for 6% of the 474 utilities, they are responsible for 82% of electric sales and serve 81% of the customers (Table 3.3). Both RECs and MUs (especially small MUs) are much smaller in size and tend to serve more rural areas. IOUs serve all types of customers: urban, suburban, and rural; in more populated areas their service areas tend to be contiguous, occasionally broken up by a MU. In suburban areas there tends to be some overlap between RECs and IOUs, with more MUs mixed in. In the heavily rural areas, IOU territory snakes along major roads with RECs serving the customers along smaller roads. Small towns and villages are served by a mix of IOUs, MUs, and RECs.

The utility mix in each state varies as well. Iowa is characterized by a large number of small MUs (28% of the entire dataset consists of small MUs in Iowa). MUs and RECs in Iowa have a larger market share than POUs in the other states, about 28%, split evenly between RECs and MUs. RECs in Iowa are concentrated in the most rural pockets of the state, generally not serving even small towns or villages. They appear to not have experienced much suburban encroachment.

Indiana's RECs however have found themselves serving many suburban customers. While RECs do not serve traditional town and village centers in Indiana, many subdivisions have popped up in their territory. Of the four states Indiana has the largest share of customers served by RECs (17%).

Like Indiana, Michigan's RECs appear to have a more suburban look than other states. Michigan is also characterized by having many fewer utilities than other states, only 58 (Table 3.4). This is especially true with small MUs and RECs. While they do have many fewer small MUs, Michigan is tied with Indiana for having the most amount of large MUs including 3 of the top 8.

Wisconsin has the most IOUs of any of the states, including a number of small regional IOUs. RECs tend to be concentrated in the central, northern and western parts of the state. While RECs in Wisconsin don't seem to have experienced the suburban encroachment that Indiana's or Michigan's RECs have, they tend to include more towns and village centers than the other states.

Table 3.4: Ownership Type by State

	IOUs	RECs	Small MUs	Large MUs	Total
Iowa	3	41	133	3	180
Indiana	5	41	60	12	118
Michigan	8	10	28	12	58
Wisconsin	12	24	71	11	118
Total	28	116	292	38	474

Source: EIA-861 (2010)

3.6.1 Dependent Variable

Through this research, I explore factors that help predict the volume of community investment in energy efficiency through programs operated at their electric utility. Energy Efficiency Resource Standards are either set as minimum energy saving as a percent of total sales or as minimum program expenditures as a percent of total revenue. Because I am interested in utilities and their commitment to energy efficiency, I choose to focus on program funding rather than energy savings, which are more a measure of program design and efficiency. The dependent variable in this research is a utility's energy efficiency program spending as a percentage of their total revenue.

Total energy efficiency program expenditures for the calendar year 2010 were collected from a combination of each state's public utility commission and/or the utilities themselves. These data include residential, commercial, industrial, and agricultural programs. Although efforts were made to gather as uniform data as possible, each state has different minimum standards and reporting procedures. What a utility in Wisconsin might report as part of their energy efficiency program, a utility in Iowa might consider as part of their general service and not energy efficiency. As a rule, load management and general education programs were excluded. On some occasions utilities submitted their energy efficiency program spending combined with their load management or renewable energy program spending. On those occasions the utility was contacted and an energy efficiency program spending total was clarified.

3.6.2 Independent Variables

My independent variables fall into four categories: energy/utility, socio-economic, housing stock, and political. Energy and utility data come from the Energy Information Agency (EIA-861). Two of the most critical energy/utility variables that may explain variations in energy efficiency program investment are electric rates and electric energy use. Because rates often vary within a utility based on customer class and volume, the rate variable is calculated by dividing a utility's total revenue ($) by their total sales (kWh). I believe that rates will have a positive relationship with the dependent variable. It's logical to think that where the price of electricity is higher, the demand for energy efficiency will be greater.

Electric energy use is calculated by dividing residential sales (kWh) by residential customers. Residential sales and customers are used to generate a proxy for normalized energy use rather than total sales and customers because when commercial and industrial customers are included, the energy use data is heavily influenced by the customer class mix (per customer industrial use is much higher than per customer residential use) and communities with energy-intensive industries will have high averages for energy use. This variable is difficult to predict. On one hand, communities that use more energy should have more of an incentive to invest in energy efficiency and therefore energy use should have a positive relationship with the dependent variable. On the other hand, a community that has had an energy efficiency program for many years might already exhibit low energy use.

Wilson (2008) cites size as one of the key barriers to EE program development at POUs. I evaluate a utility's size by examining both total customers and total sales (kWh) data. I expect size to have a positive relationship with the dependent variable, EE spending as a % of total revenue.

The other two energy/utility variables I examine are percent of customers that are residential and percent of sales that are residential. Both variables attempt to test the assertion that a heavy residential customer base is a common barrier to energy efficiency program development (Wilson, 2008 and others). I expect to find a positive relationship between residential customers or load and the dependent variable.

Table 3.5: Independent Variables

	Variable	**Source**
Energy / Utility	-State (Dummy) -Ownership Type (Dummy) -Total Customers -Total Sales -Electric Rate -Residential Electric Energy Use -% of Customers are Residential -% of Sales are Residential	EIA-861
Socio-economic	-Mean Household Income -% of population 25 or older w/ Bachelor's Degree or higher	2010 5-year ACS – township-level data aggregated based on utility electric service area
Housing Stock	*% of Housing units which are:* -Owner-occupied -Single Family Houses -Mobile Homes -Built before 1940 -Built after 1979 -*% of Housing units heated with*: -Gas -LPG (Propane) -Electricity -Wood	2010 5-year ACS – township-level data aggregated based on utility electric service area
Political	-% of residents who voted for President Obama in 2008	State election websites – county-level data aggregated based on utility electric service area

I include a number of variables to represent socio-economic factors and characteristics of the housing stock that may impact the demand for energy efficiency. All are taken from the 2010 5-

year American Community Survey (ACS). Data are collected at the municipal and township level, weighted, and combined according the service areas of utilities.

Because of the non-contiguous nature of electric utility service areas, it is difficult to assign ACS data to individual utilities. The data in this research are a reasonable attempt to assign township-level data to utilities. Indiana and Wisconsin were done in near identical ways. In each a detailed statewide map with both utility service territories and township boundaries was used to assign each township an electric utility. If a municipal utility was in the township, then the utility was assigned to the township. If a township had a mix of providers, it was generally assigned to the provider who serviced the most territory in the township. Exceptions were made when a large town or small city appeared to be the bulk of the township's households in which case whichever provider served the populated area was assigned to the township.

Iowa was done in a similar way to Wisconsin and Indiana, except a service territory map could not be found that had township boundaries, only county lines. So townships could not be assigned based on which provider served the bulk of the township. Except for townships served entirely by IOUs or containing a MU, nearly every township in Iowa is served by both a REC and IOU with the IOU serving the more populated area of the township. Since the goal is to get a good picture of a utility's customers, if a township was serviced by a REC in any significant way, it was assigned to that REC unless the township had more than 1,000 households. Then it was assumed that a substantial majority of the township's households were concentrated in the populated areas and thus served by the IOU. In Michigan there was not a detailed service territory map available. But the state's public utility commission's website does provide a list of electric provider by city, town, and township. That was used to assign a list of cities, towns, and townships to each utility.

Once each of the states' utilities had a list of cities, towns, and townships assigned, then township-level data was aggregated and averaged on a weighted basis (per number of households, adults over 25, or housing units depending on the variable). This left a clear estimate for each independent variable.

Socio-economic data includes mean household income and educational attainment. In a study of Minnesota POUs, Wilson (2008) cites low incomes as a common barrier to program development. By estimating mean household income for each utilities service area, I am able to test this assumption. I expect income to have a positive relationship with the dependent variable. To evaluate whether the education level of a utility's customers helps predict EE program spending, I look at the percent of population over 25 with at least a Bachelor's degree. Considering that a lack of information has traditionally been a barrier to energy efficiency, I expect that a more educated population (and presumably more informed) would be more likely to lobby their utility and support energy efficiency programs.

The type of housing an area has certainly influences its energy use and could potentially influence demand for energy efficiency. While some variables like the age or how many housing units are in the building affect energy usage, other variables like percentage of rental units relate to the issue of a split-incentive and the problems it creates for energy efficiency. Overall, I consider the following types of housing stock date (the percentage of households that are): single family residences, mobile homes, built after 1979, built before 1940 and owner-occupied.

It’s difficult to hypothesize relationships for many of these variables. For instance, because older homes tend to use more energy than newer homes, a community with a high percentage of the older variety should logically have a greater demand for energy efficiency. Yet older homes also present many structural roadblocks to energy efficiency like older wiring, moisture issues and potential access problems. So it’s possible that an area with older housing would be less likely to invest in energy efficiency because of these barriers. Likewise, high percentages of mobile homes and rental units could suggest an area greatly in need of creative energy efficiency programs, but the barriers that mobile homes and the split-incentive create would actually prohibit programs from being developed.

Additionally I include data on how people heat their homes, the percent of households that heat with: natural gas, LPG (propane), electricity and wood. Of these four types, the use of electricity to heat is the variable most likely to have a relationship with how an area's utility invests in energy efficiency. Traditionally, electric heat has been the most energy-intensive way to heat a space and therefore has been targeted by energy efficiency programs for decades. While higher shares of electric heat would be an argument for more energy efficiency spending, it's also likely that lower shares could indicate an area that has already aggressively targeted electric heat in past programs and therefore indicates an area that strongly favors energy efficiency. The preponderance of electric heat is also geographic, the more south one goes the more likely that the heat is electrically provided. In this research Indiana has higher rates of electric heat than the other states and it is also more south than the others.

I also explore a political variable in this research. When state-level energy efficiency investments are compared nationally (see Figure 2.1), states on the Pacific Coast and in the Northeast tend to lead the nation, followed closely by states in the Upper Midwest. States in the South, Lower Midwest, Southwest, Mountain West and Plains states tend to lag behind.

Is it a coincidence that the more energy efficient states also tend to vote for Democrats in Presidential elections while those that lag behind support Republicans? This variable explores that connection at the county and utility-level.

The percent each county voted for President Barack Obama in 2008 was collected from state election websites. These percentages were then attached to the township and city data and aggregated by weighted average the same way ACS data was combined.

CHAPTER 4

RESEARCH ANALYSIS AND RESULTS

4.1 Descriptive Statistics

4.1.1 Energy Efficiency Programs? Yes or No?

Much of the literature on energy efficiency programs suggests that IOUs are more likely to operate programs than RECs or MUs (Wilson, 2008; Fischlein, 2009; Frieschlag, 2011, Smith, 2010). This is traditionally attributed to a state regulatory framework that sets energy efficiency standards for IOUs while exempting POUs. The four states in this thesis regulate utilities differently when it comes to energy efficiency. This variety in regulation helps explain the different levels of program coverage in each of the states.

Of the 474 utilities examined 78% operated energy efficiency programs in 2010 (Table 4.1). Michigan, with its clear policy that requires IOUs and POUs to offer a program had 100% coverage. Wisconsin also found every utility in the state spending part of their budget on energy efficiency, either through the state-branded program Focus on Energy or operating an independent program. Although Wisconsin had complete coverage in 2010, their EERS was not to take effect until 2011. Since Wisconsin has had energy efficiency programs for decades now, it's likely that most utilities have chosen to pursue energy efficiency voluntarily over the past few years.

Table 4.1: Percentage of Utilities with Energy Efficiency Programs by State and Ownership Type (2010)

State	IOU	Large MU	Small MU	REC	All	Number of Utilities
Iowa	67%*	100%	95%	98%	96%	180
Ind.	100%	0%	0%	41%	19%	118
Mich.	100%	100%	100%	100%	100%	58
Wisc.	100%	100%	100%	100%	100%	118
All	96%	68%	77%	76%	78%	474

Note: *Only the two large IOUs operate programs in Iowa. The third IOU is the Amana Colony, a Mennonite like religious community. They are very small and likely exempted from the state regulations.

While Iowa requires a certain energy saving standard of its IOUs, it instructs its POUs to operate an energy efficiency program, set goals and report on the results. Yet it does not set minimum standards for the programs or goals. Still though, 170 of the 177 POUs in Iowa operated programs in 2010. Considering there's still a voluntary nature to programs at POUs in Iowa, it's good to see such high numbers of program coverage. Fully 96% of Iowan utilities operate programs. In 2010, utilities in Indiana had not fully adopted the recently passed EERS and therefore there were no energy efficiency program requirements in the state. All five of the IOUs and almost half of the RECs operated programs. Overall less than 20% of utilities spent on energy efficiency in Indiana.

4.1.2 Energy Efficiency Program Spending as a % of Total Revenue

Once levels of program coverage have been established, I move on to analyzing levels of spending for those programs. First, I evaluate the dependent variable, program spending normalized by a utility's total revenue, in terms of the state variable. Second, I look at the dependent variable solely in terms of ownership type. Next, state and ownership variables are combined and I look for trends. Finally, I split up the utilities into four segments based on the strength of their dependent variable value and look for potential relationships with the independent variables.

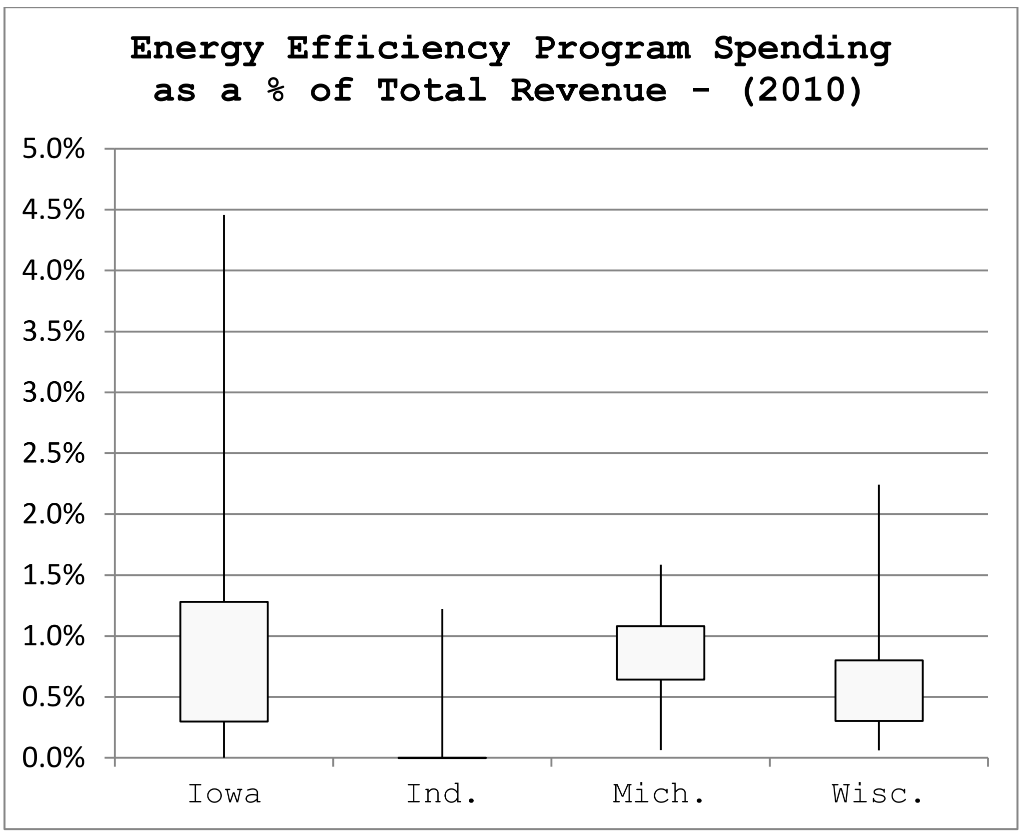
Based on a review of state medians and means for utility program spending, the "average utility" in Iowa and Michigan has greater levels of EE spending than the "average utility" in Wisconsin or Indiana (Table 4.2). Aside from having the highest mean *spending/revenue*, Iowa also has the greatest dispersion among its utilities. Its standard deviation is more than twice those of the other states. Considering that Iowa only requires minimum program standards of two of its utilities, that leaves the vast majority of utilities free to set their own standards. While that does result it low levels of funding at some utilities it also results in some high spending at others (Figure 4.1).

In contrast Michigan has the most specific instructions to its utilities in terms of program spending and energy saving goals. It requires the same minimum energy saving standard for all utilities, as well as imposing a spending cap. This might help explain Michigan's low standard deviation and smaller dispersion than Iowa's or Wisconsin.

Table 4.2: Descriptive Statistics of *Spending/revenue*, Specific to State Data-subsets

State	N	Mean	Median	Standard Deviation
Iowa	180	0.95%	0.75%	0.91%
Indiana	118	0.08%	0.00%	0.20%
Michigan	58	0.85%	0.85%	0.35%
Wisconsin	118	0.60%	0.47%	0.40%
All	474	0.63%	0.47%	0.71%

Figure 4.1: Energy Efficiency Program Spending as a % of Total Revenue, State Factor

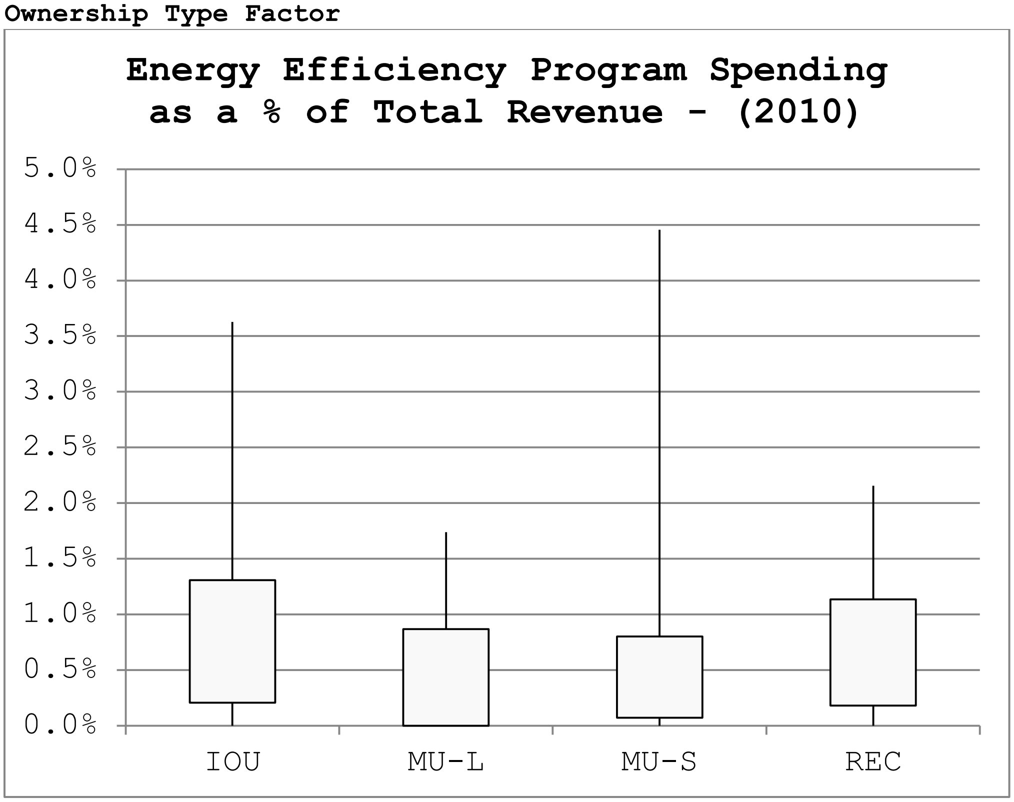


Note: This box plot shows both the range: the solid black lines, and the 1st and 3rd quartiles: the boxes. So many of Indiana's utilities have 0% program spending that the 3rd quartile for the state is at 0.

Wisconsin is similar to both Iowa and Michigan. In 2010 Wisconsin did not have an EERS in effect and therefore did not impose clear standards upon all utilities. Like Iowa, Wisconsin has a greater dispersion than Michigan with higher spending outliers. However, as can be seen in Figure 4.1, Wisconsin's box plot, the heart of its data, is below Michigan's.

Program spending at Indianan utilities hardly even shows up on the box plot in Figure 4.1. The 3rd quartile of the data is at 0 and only the few IOUs and RECs with programs show up in the range.

Figure 4.2: Energy Efficiency Program Spending as a % of Total Revenue, Ownership Type Factor



Note: This box plot shows both the range: the solid black lines, and the 1st and 3rd quartiles: the boxes.

From a comparison of box plots (Figures 4.1 and 4.2), ownership type appears to have less of an influence over the dependent variable. All four types are concentrated between 0 and 1%. While the dispersions for small MUs and IOUs rise up above 3% and 4%, the bulk of each type's *spending/revenue* is similar.

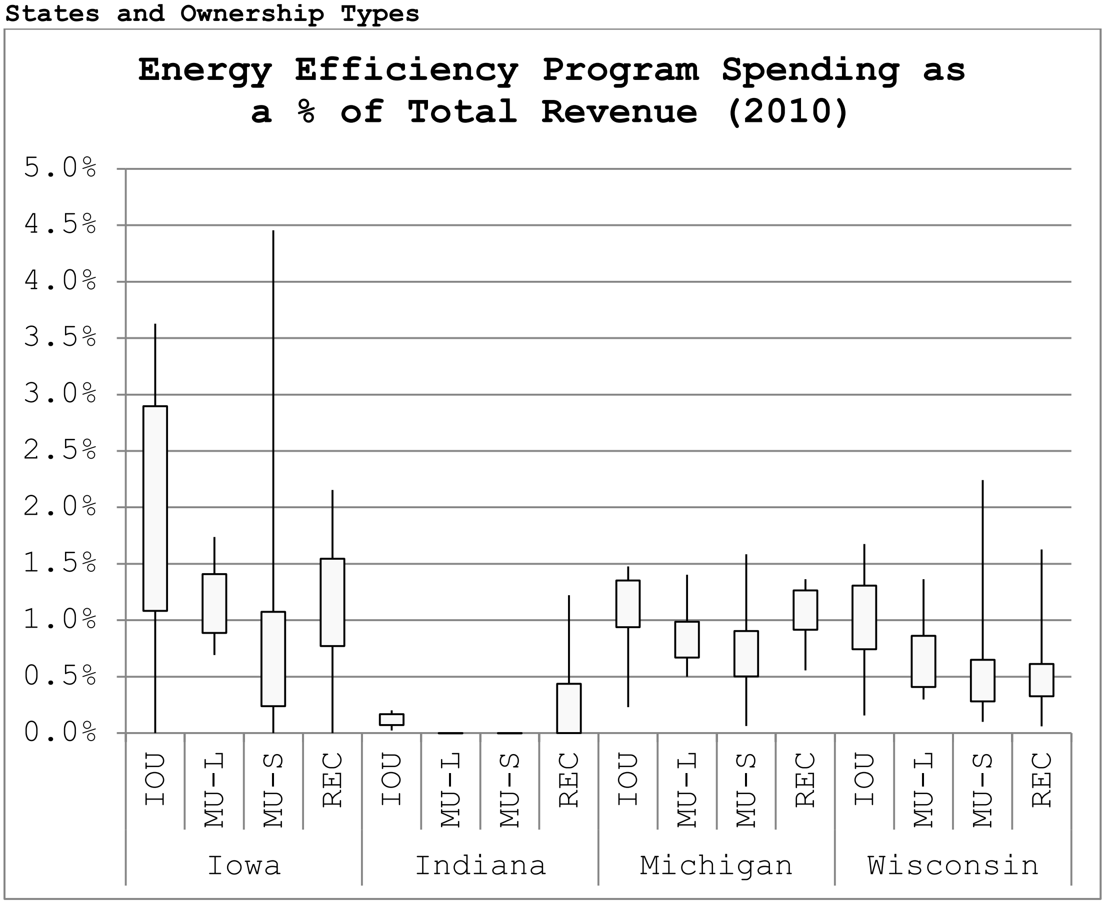
Table 4.3: Descriptive Statistics of *Spending/revenue*, Specific to Ownership Type Data-subsets

Ownership	N	Mean	Median	Stand. Dev.
IOU	28	0.97%	0.94%	0.77%
Large MU	38	0.55%	0.58%	0.48%
Small MU	292	0.59%	0.38%	0.77%
REC	116	0.68%	0.55%	0.57%
All	474	0.63%	0.47%	0.71%

Looking at means and medians, a difference emerges (Table 4.3). IOUs exhibit the highest spending levels, almost 1%. RECs appear to have the next highest average with a mean of 0.68% and a median of 0.55%. MUs have the lowest funding levels with small MUs' mean slightly higher than large MUs, but their median much lower at 0.38%. Unlike the state comparisons, there is not as much variance in standard deviation within the ownership data-subsets. IOUs and small MUs have the highest, with RECs not far behind. Only large MUs have a relatively concentrated dataset. Based on my belief that states control more for *program/spending* variance than ownership type, it makes sense that the former's dispersions would be smaller. The greater dispersions (standard deviations) in the ownership types suggest that the data is being dispersed by more controlling factors (i.e. states).

When a box plot of states and ownerships types is create (Figure 4.3) more trends begin to emerge. I am able to see how ownership types rank in certain states, whether a pattern follows in each state or just one. Also, I am able to see where trends run opposite each other within individual states.

Figure 4.3: Energy Efficiency Program Spending as a % of Total Revenue, States and Ownership Types



Note: This box plot shows both the range: the solid black lines, and the 1st and 3rd quartiles: the boxes. Much of Indiana's data are 0, including all of MU-L and MU-S and over half of REC.

Figure 4.3 again emphasizes the wide dispersion of *spending/revenue* that Iowa utilities have. Both IOUs have high numbers (the third IOU, Amana Society Services, serves the Amana Colonies, a Mennonite-like community and must be excluded from regulation as they do not offer a program). Thirteen of the top 14 utilities in the overall dataset are small MUs and RECs in Iowa. And the averages for large MUs and RECs in Iowa are higher than any other ownership category in any other state. The relative high numbers for all types of utilities in Iowa is a strong argument for the controlling factor of the state variable.

With Indiana's data-subset dominated by utilities without EE programs, only the IOUs and RECs show data above zero. Even with over half of Indiana's RECs not operating programs (and therefore with 0% for *spending/revenue*) RECs still have greater mean *spending/revenue* (0.21%) than IOUs (0.12%). For just the 17 RECs that have EE programs the mean average in 2010 was 0.51%, which is not that much below the overall average for RECs across all four states.

After Iowa, Michigan performs the best of the three remaining states. Like Iowa, IOUs and RECs have the best results followed by large MUs and then small MUs. Unlike the other states, RECs in Michigan have spending levels on par with IOUs. Average *spending/revenue* numbers in Wisconsin tend to better represent what some studies have suggested: that IOUs invest more, followed by large MUs and then small MUs and RECs.

4.1.3 Cross-tabulation Analysis

As part of the analysis process, the dependent variable, program spending as % of revenue, is divided into four segments. First, utilities without programs are grouped together and then the remaining 360 utilities are divided into three groups of 123, 123 and 124. Then mean averages are taken for each group within each independent variable. (Median averages were used for *total customers* and *total sales* because of the extreme variation in utility size.) This process is not only done for all the utilities, but also within each state and ownership model. This helps identify where possible relationships exist between the independent and dependent variables, controlling for both the state and ownership factors.

Table 4.4: States and Shares of Spending/revenue Tiers

States	IA	IN	MI	WI
Upper Third	42%	1%	43%	18%
Middle Third	22%	8%	48%	39%
Lower Third	31%	10%	9%	43%
No Program	4%	82%	0%	0%
All	100%	100%	100%	100%

Table 4.4 shows the four states broken down into shares for each *spending/revenue* tier. Iowa shows sizable shares of the data. Considering that 38% of the total utilities are in Iowa this makes sense. Iowa has many utilities dispersed throughout the dataset (upper – 42%, middle - 22% and lower - 31% of Iowa's

utilities), while nearly all of Indiana's utilities (82%) did not operate a program in 2010. Michigan's utilities are concentrated in the upper and middle thirds of the data, 43% and 48% respectively. On the other hand, Wisconsin' utilities are concentrated in the middle and lower thirds, 39% and 43% respectively.

Table 4.5 is similar to Table 4.4, but it shows ownership type shares. Over half of IOUs (54%) are in the upper third of spending. Small MUs are concentrated more on the lower spectrum of spending, while RECs tend to be more on the upper end. Similar to the analysis of Table 4.3 and Figure 4.2, the evaluation of ownership type independent of the state variable is limited.

Table 4.5: Ownership Types and Shares Spending/revenue Tiers

Ownership	IOU	MU-L	MU-S	REC
Upper Third	54%	19%	21%	35%
Middle Third	19%	40%	25%	25%
Lower Third	25%	10%	31%	18%
No Program	3%	31%	23%	22%
All	100%	100%	100%	100%

After examining the tiers of *spending/revenue* data in terms of states and ownership types, I look at the independent variables for potential relationships. Tables 4.6-4.8 show the mean averages for each of the potential 18 independent variables at each of the four tiers of *spending/revenue*. I do this calculation in the six datasets and data-subsets that are included in the regression analysis. These include overall dataset, the POU data-subset and then each of the four state/POU data-subsets. Using these six allow me to see potential trends overall, within only POUs and then within POUs in particular states.

Looking at the overall dataset, a few variables show signs of a potential relationship (bolded and italicized). Size, both *total customers* and *total sales*, suggests a positive relationship. Because of the wide dispersion of utility size (extremely large utilities in the upper and lower thirds), medians are presented in Table 4.6. *Total sales* appears to be positive in POUs, IA and MI, while *total customers* suggests positive relationships in just IA and MI. Only the Indiana data-subset suggests a negative relationship with size. The data in Indiana does show that utilities that do not operate programs are much smaller than those that do.

Both percentage of customers that are residential (*% res cust*) and percentage of sales that are residential (*% res load*) suggest positive relationships–that the higher percent of residential customers and sales, the greater relative investment in energy efficiency. Either one or both of these variables appears to have a positive relationship in every data-subset except for Indiana. This is curious because a large residential load or customer base has been seen as a barrier to energy efficiency programs.

Two other variables that suggest a potential relationship overall are *% Obama voters* and *% mobile homes*, both negative. When the relationship between political leanings and program spending is considered at the state-level (Figure 2-1), it appears there's a positive relationship between spending and Democratic support. Yet, within the overall dataset, as well as the POU data-subset, the data is suggesting that the relationship is negative. In Michigan however, *% Obama voters* appears to have a positive relationship. The other, *% mobile homes*, suggests a negative relationship. When broken down, relationships appear to be a mix of positive (IA and IN) and negative (POUs and WI).

The heating fuel variable data also hint at potential relationships. People that heat their homes with electricity have traditionally been one of the low-hanging fruit that utility energy efficiency programs have targeted first. Overall, there appears to be a positive relationship between *% elect heat* and *spending/revenue*. This also looks to be the case within POUs and Iowa. The *% wood heat* variable suggests a negative overall relationship. Within subsets it looks both positive (IA) and negative (POUs and WI). These breakdowns are similar to the subset splits for *% mobile homes*. Since both variables are potential proxies for how rural an area is, these relationships help hint at the overall relationship between program spending and how rural an area is.

At this level of analysis, I didn't find much potential for relationships between the dependent variable and income, electricity rates, energy use, educational attainment or many of the housing stock variables. For some of the variables like rate, energy use and educational attainment, the problem is likely how the variable was calculated. Unlike the variable *total sales*, a variable like rate has little variability in its numbers and therefore little room to indicate relationships. My calculation for rate (total sales / total revenue) might be too simple to create a dataset with enough variability to show relationships. In future studies it would be preferable to find a calculation for these variables that creates more variability in the data.

Table 4.6: Cross-tabulation of Dependent Variable with State and Ownership Variables I

Data set	Tiers	N	Spending/revenue	Total Cust. Median	Total Sales (mWh) Median	Rate (¢/kWh)	Res Energy Use (MWh/cust.)	% Res. Cust.	% Res. Load
Overall	Up.	123	1.540%	***3,185***	***80,159***	9.9	10.98	***86.8%***	***50.4%***
	Mid.	123	.654%	***2,586***	***45,584***	10.2	9.87	***86.0%***	***49.0%***
	Low.	124	.245%	***1,395***	***28,000***	9.8	10.33	***84.5%***	***44.6%***
	None	104	.000%	2,027	60,749	9.1	11.78	86.8%	51.4%
	All	474	.639%	2,065	48,982	9.8	10.70	86.0%	48.7%
POUs	Up.	108	1.550%	2,221	***51,908***	10.2	11.37	***86.7%***	***52.4%***
	Mid.	118	.648%	2,554	***44,607***	10.3	10.01	***86.0%***	***49.3%***
	Low.	117	.251%	1,371	***25,627***	10.0	10.29	***84.3%***	***45.9%***
	None	103	.000%	2,113	60,552	10.0	11.79	86.9%	51.8%
	All	446	.613%	1,896	40,915	10.1	10.83	85.9%	49.7%
IA/ POUs	Up.	74	1.703%	***1,488***	***28,383***	10.0	***12.78***	***86.4%***	54.0%
	Mid.	40	.693%	***999***	***21,590***	10.0	***11.92***	***83.8%***	49.3%
	Low.	56	.215%	***798***	***12,800***	10.0	***10.84***	***83.2%***	53.5%
	None	7	.000%	***486***	***6,180***	10.0	***9.78***	86.8%	50.2%
	All	177	.967%	965	16,872	10.0	11.85	84.9%	52.6%
IN/ POUs	Up.	1	1.221%	13,108	***279,494***	10.0	***13.64***	92.7%	59.3%
	Mid.	9	.574%	19,180	***374,586***	10.0	***15.54***	96.2%	71.9%
	Low.	7	.317%	14,412	***439,328***	10.0	***15.62***	93.2%	52.6%
	None	96	.000%	2,470	66,627	10.0	11.94	86.9%	51.5%
	All	113	.076%	3,560	94,786	10.0	12.47	88.0%	52.3%
MI/ POUs	Up.	18	1.163%	***8,627***	***148,810***	***11.1***	***7.42***	87.7%	***47.9%***
	Mid.	28	.682%	***4,001***	***66,307***	***10.7***	***7.23***	84.4%	***39.6%***
	Low.	4	.158%	***1,325***	***20,479***	***10.0***	***5.96***	85.5%	***28.2%***
	None	0							
	All	50	.813%	4,478	77,545	10.8	7.20	85.7%	41.7%
WI/ POUs	Up.	15	1.279%	4,255	96,479	10.0	9.02	***86.7%***	45.9%
	Mid.	41	.597%	2,401	43,630	10.5	8.83	***86.0%***	51.0%
	Low.	50	.290%	2,634	72,906	10.0	9.27	***84.3%***	37.8%
	None	0							
	All	106	.549%	2,739	63,735	10.2	9.06	86.0%	44.1%

Table 4.7: Cross-tabulation of Dependent Variable with State and Ownership Variables II

Data set	Tiers	N	Spending/revenue	% Obama Voters	Mean HH Inc.	% Bach or Higher	% Owner Occupied	% Single Family	% Mobile Home
Overall	**Up.**	123	1.560%	***49.5%***	$58,325	22.9%	77.7%	80.9%	***5.0%***
	Mid.	123	.654%	***51.7%***	$56,452	21.3%	76.5%	77.5%	***5.5%***
	Low.	124	.245%	***53.2%***	$58,271	22.6%	77.4%	79.9%	***5.6%***
	None	104	.000%	43.6%	$59,290	19.9%	78.6%	80.9%	8.0%
	All	474	.639%	49.8%	$58,037	21.7%	77.5%	79.7%	5.9%
POUs	**Up.**	108	1.550%	***48.9%***	$60,271	21.4%	***83.3%***	***87.5%***	***6.7%***
	Mid.	118	.648%	***50.4%***	$58,933	18.7%	***84.0%***	***85.7%***	***9.2%***
	Low.	117	.251%	***51.8%***	$63,713	21.6%	***84.5%***	***85.7%***	***10.0%***
	None	103	.000%	42.8%	$67,525	19.5%	85.3%	86.7%	9.0%
	All	446	.613%	48.5%	$62,123	20.4%	84.1%	86.5%	8.4%
IA/ POUs	**Up.**	74	1.703%	47.8%	$58,617	22.3%	79.0%	85.9%	***4.0%***
	Mid.	40	.693%	47.4%	$57,238	20.4%	79.1%	83.8%	***3.9%***
	Low.	56	.215%	51.7%	$57,405	24.2%	78.6%	85.3%	***3.5%***
	None	7	.000%	48.3%	$67,261	23.2%	80.8%	84.3%	4.1%
	All	177	.967%	48.9%	$58,264	22.5%	79.0%	85.1%	3.8%
IN/ POUs	**Up.**	1	1.221%	47.3%	***$61,999***	22.9%	90.1%	***84.1%***	***14.6%***
	Mid.	9	.574%	42.0%	***$62,703***	20.7%	85.7%	***83.8%***	***12.9%***
	Low.	7	.317%	43.0%	***$65,797***	20.8%	86.7%	***78.2%***	***11.3%***
	None	96	.000%	43.2%	$58,645	19.7%	78.3%	80.6%	***8.3%***
	All	113	.076%	43.1%	$59,441	19.9%	79.5%	81.1%	8.8%
MI/ POUs	**Up.**	18	1.163%	***52.3%***	$52,334	***22.1%***	76.7%	74.6%	7.9%
	Mid.	28	.682%	***49.8%***	$50,825	***21.7%***	67.8%	68.8%	3.9%
	Low.	4	.158%	***49.8%***	$51,789	***13.5%***	74.4%	77.6%	9.2%
	None	0							
	All	50	.813%	50.7%	$51,445	21.2%	71.6%	71.6%	5.7%
WI/ POUs	**Up.**	15	1.279%	50.5%	$64,504	***25.5%***	73.6%	70.7%	***4.4%***
	Mid.	41	.597%	58.1%	$58,212	***21.6%***	78.3%	76.8%	***6.3%***
	Low.	50	.290%	56.6%	$58,683	***21.4%***	75.8%	74.3%	***7.1%***
	None	0							
	All	106	.549%	56.3%	$59,324	22.1%	76.4%	74.8%	6.4%

Table 4.8: Cross-tabulation of Dependent Variable with State and Ownership Variables III

Dataset	Tiers	N	Spending/revenue	% Houses 1939	% Houses 1980	% Gas Heat	% LPG (Propane)	% Electric Heat	% Wood Heat
Overall	**Up.**	123	1.560%	31.7%	27.1%	51.2%	24.7%	***14.8%***	***4.5%***
	Mid.	123	.654%	30.7%	28.2%	57.2%	18.2%	***13.9%***	***5.4%***
	Low.	124	.245%	31.5%	27.5%	53.3%	21.5%	***13.3%***	***6.0%***
	None	104	.000%	28.4%	31.5%	54.2%	19.0%	19.2%	3.4%
	All	474	.639%	30.7%	28.4%	54.0%	20.9%	15.1%	4.9%
POUs	**Up.**	108	1.550%	33.0%	26.3%	49.9%	25.8%	***15.5%***	***4.2%***
	Mid.	118	.648%	31.1%	27.9%	57.8%	17.7%	***13.9%***	***5.1%***
	Low.	117	.251%	32.3%	27.1%	52.6%	22.3%	***13.0%***	***6.1%***
	None	103	.000%	28.3%	31.4%	53.9%	19.0%	19.4%	3.4%
	All	446	.613%	31.2%	28.1%	53.6%	21.2%	15.3%	4.8%
IA/ POUs	**Up.**	74	1.703%	***37.6%***	***21.8%***	45.8%	29.7%	***17.8%***	***2.9%***
	Mid.	40	.693%	***37.8%***	***20.4%***	57.7%	21.2%	***15.3%***	***2.6%***
	Low.	56	.215%	***38.4%***	***19.2%***	56.4%	24.2%	***12.8%***	***2.5%***
	None	7	.000%	32.6%	27.8%	54.1%	30.9%	***11.1%***	***0.6%***
	All	177	.967%	37.7%	21.1%	52.2%	26.1%	15.4%	2.6%
IN/ POUs	**Up.**	1	1.221%	***13.6%***	***49.1%***	26.5%	35.9%	24.8%	11.5%
	Mid.	9	.574%	***19.7%***	***41.9%***	21.3%	27.7%	37.3%	8.0%
	Low.	7	.317%	***20.1%***	***41.1%***	28.0%	27.8%	28.9%	8.3%
	None	96	.000%	***28.0%***	***31.7%***	53.9%	18.2%	19.9%	3.6%
	All	113	.076%	26.4%	33.3%	50.3%	19.0%	22.0%	4.2%
MI/ POUs	**Up.**	18	1.163%	25.2%	***30.2%***	61.2%	17.2%	7.6%	7.8%
	Mid.	28	.682%	32.4%	***23.7%***	79.5%	4.9%	9.1%	2.3%
	Low.	4	.158%	27.5%	***23.2%***	72.3%	12.2%	4.9%	7.1%
	None	0							
	All	50	.813%	29.4%	26.0%	72.5%	9.9%	8.2%	4.6%
WI/ POUs	**Up.**	15	1.279%	***21.0%***	***40.7%***	58.0%	16.3%	12.8%	***6.0%***
	Mid.	41	.597%	***26.1%***	***34.9%***	51.2%	20.8%	10.8%	***8.9%***
	Low.	50	.290%	***27.5%***	***34.4%***	50.1%	20.1%	11.6%	***9.8%***
	None	0							
	All	106	.549%	26.1%	35.5%	51.6%	19.8%	11.5%	8.9%

4.2 Regression Analysis

4.2.1 Regression Methodology and Model Creation

Through a preliminary data analysis of 18 potential independent variables, I chose five to combine with state dummy variables to construct a predictive model for energy efficiency program funding as a percentage of total revenue. This is Model 1. I then add ownership dummy variables to Model 1 in order to create Model 2. Table 4.9 shows what variables are in each model.

Table 4.9: Regression Models and their Independent Variables

		Applied to all states (entire dataset and POU data-subset)		Applied to individual state/POU data-subsets	
Variable	**Type**	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Total Sales	**Utility**	X	X	X	X
% Res Load	**Utility**	X	X	X	X
% Obama	**Political**	X	X	X	X
Income	**Economic**	X	X	X	X
% Elect Heat	**Heat**	X	X	X	X
Iowa	**State**	X	X		
Michigan	**State**	X	X		
Wisconsin	**State**	X	X		
IOU	**Ownership**		X*		
Large MU	**Ownership**		X		X
REC	**Ownership**		X		X

***Note: The IOU dummy variable in Model 2 is only included when model is applied to entire dataset. It is not included when Model 2 is applied to the POU data-subset.**

For the first part of the analysis I apply the two models to the overall dataset and then to just the POU data-subset. Model 1 allows me to look for the effects of the state variables as well any significant relationships between the dependent variable and the five independent variables when controlling for state effects. Model 2 allows me to additionally evaluate for the influence of ownership type across all the states. By applying Model 2 to both the overall dataset and the POU data-subset I am able to get a better understanding of what the effects of ownership type are. I am also able to see cases where independent variables might have come up significant in Model 1, but not in Model 2. This might indicate that the variety of the dependent variables is better explained by ownership type than by the independent variable in question.

The next part of the analysis is applying models to individual state data-subsets. To create Model 3 I took Model 1 and subtracted the state dummy variables leaving only the five independent variables (see Table 4.9). Likewise Model 4 is simply Model 2 without the state dummy variables and without the IOU dummy variable. In these two models, I am looking for relationships between the independent and dependent variables that are distinct to individual states. While *% Obama voters* might be insignificant overall, it might be significant and positive in one state and significant and negative in another state.

Throughout these regressions, I analyze changes in significance, direction of relationship and the weight of coefficients. Both standardized and unstandardized beta coefficients are evaluated. To get an idea of how much change an unstandardized coefficient contributes to the dependent variable, I apply the difference between the first and third quartiles of the independent variable's data to the unstandardized coefficient. This allows me weigh the respective predictive nature of significant independent variables. Finally, I evaluate variables for significance at 90%, 95% and 99% confidence levels and each regression is tested for multi-collinearity through its tolerance value.

The five variables included in all models are: *total sales*, *% res load*, *% Obama voters*, *income* and *% elect heat*. These were chosen based on evaluation of the *spending/revenue* cross-tabulations (Figures 4.6-4.8), preliminary regression analysis and a review of the literature. *Total sales*, *% res load* and *income* have all been cited in a number of studies (Wilson, 2008, etc…) as common barriers to program development at small and publicly-owned utilities. In early data analysis, *total sales* and *% res load* also appeared likely to exhibit a relationship with the dependent variable. Because of the apparent correlation between electoral politics and energy efficiency funding at the state-level, I included *% Obama voters* in order to test the relationship at the county and utility level. Since homes that heat with electricity are often the first target of energy efficiency programs, I thought that the relative use of electric heat would be a strong predictor of program funding.

In early analysis I applied Model 1 without state dummy variables to the overall dataset. This resulted in very few if any significant independent variables and a low R-squared. This helps show the controlling nature of state policy and other state factors and how little can be gained from a regression that doesn't take states into account. For this reason Model 1 is built with state dummy variables included.

Because of Indiana's numerous utilities without programs and little funding for those with programs, I choose to include the other three states, IA, MI and WI, as dummy variables in Model 1. Likewise for the ownership dummies, I choose small MU as the constant to regress against because in early data analysis I found it to be the most different of the four ownership variables.

4.2.2 Regression Results

When Model 1 is applied to the overall dataset (Table 4.10), the regression has an R-squared of 0.27 and all three state dummy variables are significant at 99%. Michigan has a slightly greater coefficient than Iowa with Wisconsin not far behind both of them. Controlling for state factors, *total sales*, *% res load* and *% elect heat* all show significant and positive relationships. State variables by far are the strongest predictors of the dependent variable. Of the remaining independent variables *% elect heat* has the strongest relationship. Not only does it have the highest standardized coefficient, but its unstandardized coefficient has the greatest effect. If a utility's *% elect heat* were to increase from the first to the third quartile of the dataset (from 9% to 20%) their predicted *spending/revenue* would increase by 0.18%. This is substantial considering the median *spending/revenue* for all utilities is 0.47%. While *total sales* and *% res load* are both significant, their effects are not as important, especially *total sales*. Increasing from the first to the third quartiles of their respective data would net increases of 0.004% for *total sales* and .10% for *% res load*.

Model 2 is listed in Table 4.10 as well. Adding the ownership variables increases the R-squared from 0.27 to 0.31. State variables are still the most controlling in the model. Again both Michigan and Iowa have unstandardized coefficients over 1 with Iowa slightly higher now that ownership type is being controlled for. The Wisconsin variable explains the dependent variable just about as well as it did when ownership was not included. Of the three ownership dummies, *IOU* is significant at 99% and *REC* significant at 90%. *Large MU* is not significant. Aside from being more significant *IOU* has a stronger relationship with the dependent variable than *REC*. Like the three state variables included, all three ownership variables have positive relationships.

Table 4.10: Regression Results with Models 1 & 2 within Overall Dataset

Overall dataset	**Model 1 - Basic**			**Model 2 - Basic w/Ownership dummies**		
Variable	**Unstand. Coefficient**	**Stand. Coefficient**	**Tolerance Value**	**Unstand. Coefficient**	**Stand. Coefficient**	**Tolerance Value**
Total Sales	2.302E-08***	0.113***	0.943	7.869E-09	0.039	0.612
% Res Load	0.003*	0.075*	0.909	0.002	0.069	0.699
% Obama	-0.005	-0.064	0.687	-0.006	-0.074	0.682
Income	4.246E-06	0.065	0.927	3.376E-06	0.052	0.890
% Elect Heat	0.016***	0.193***	0.676	0.016***	0.192***	0.673
Iowa	1.026***	0.703***	0.543	1.059***	0.725***	0.527
Michigan	1.074***	0.497***	0.539	1.048***	0.485***	0.536
Wisconsin	0.779***	0.476***	0.429	0.777***	0.474***	0.426
IOU				0.424***	0.141***	0.583
Large MU				0.148	0.057	0.846
REC				0.135*	0.082*	0.751
	Beta Coefficient (Constant):		**-0.46**	**Beta Coefficient (Constant):**		**-0.422**
	Adjusted R-Squared:		**0.27**	**Adjusted R-Squared:**		**0.31**

Note: Levels of significance: ***99%, **95%, *90%

In the Model 2 regression within the overall dataset only % *elect heat* remains significant, still at 99%. Both *total sales* and % *res load* are no longer significant. With the same unstandardized coefficient as Model 1, % *elect heat* in Model 2 predicts *spending/revenue* similarly. The variability that is explained by *total sales* in Model 1 is likely better explained by *IOU* and that is why it drops from significance in Model 2.

Models 1 and 2 are then applied to the POU data-subset (Table 4.11). Since this research attempts to test and quantify barriers to program development at POUs especially, it is helpful to look at how the same models perform with IOUs excluded from the data.

Table 4.11: Regression Results with Models 1 & 2 within POU Data-subset

POU data-subset	**Model 1 – Basic**			**Model 2 - Basic w/Ownership dummies**		
Variable	**Unstand. Coefficient**	**Stand. Coefficient**	**Tolerance Level**	**Unstand. Coefficient**	**Stand. Coefficient**	**Tolerance Level**
Total Sales	2.403E-07	0.070	0.829	6.914E-08	0.020	0.520
% Res Load	0.003**	0.089**	0.880	0.002	0.058	0.639
% Obama	-0.005785	-0.075	0.687	-0.006	-0.072	0.685
Income	3.887E-06	0.062	0.890	3.542E-06	0.056	0.883
% Elect Heat	0.015***	0.186***	0.673	0.015***	0.188***	0.669
Iowa	1.025***	0.717***	0.530	1.030***	0.720***	0.527
Michigan	1.043***	0.471***	0.564	1.041***	0.470***	0.564
Wisconsin	0.751***	0.457***	0.434	0.745***	0.453***	0.433
Large MU				0.1083085	0.043	0.646
REC				0.126	0.079	0.568
	Beta Coefficient (Constant):		-0.44	Beta Coefficient (Constant):		-0.40
	Adjusted R-Squared:		**0.29**	**Adjusted R-Squared:**		**0.30**

Note: Levels of significance: ***99%, **95%, *90%

When I apply Model 1 to the POU data-subset I get an R-squared of 0.29, very similar to the 0.27 when Model 1 is applied to the overall dataset. All three state variables are again significant at 99% and have positive coefficients very close to the entire dataset regression. The independent variable *% elect heat* has a slightly smaller coefficient, still strongly predictive though. While *total sales* is not significant like it is when Model 1 in regressed in the overall dataset, *% res load* has the same coefficient and is now significant at 95% rather than 90%.

When I apply Model 2 to the POU data-subset, the IOU dummy variable is naturally removed from the model. This leaves just Large MU and REC in Model 2 along with the five independent variables and three state variables. While this regression increases the R-squared by a percentage point to 0.30, neither of the ownership variables are significant and *% res load* is no longer significant. Otherwise the three state variables and *% elect heat* all have similar coefficients to their results in the other three regressions in Tables 4.10 and 4.11.

Following the analysis of the independent variables controlling for state factors, I apply models to each state/POU data-subset. For the same reason I created Model 2, (in order to evaluate potential barriers to program development specifically at POUs), I found it necessary to remove IOUs from this level of analysis by creating a POU-only data-subset for each state. IOUs also number quite few in each state which makes their inclusion as a dummy variable difficult.

For each state I apply two models. Model 3 consists of the five basic independent variables: *total sales*, *% res load*, *% Obama voters*, *income*, and *% elect heat*. Model 4 consists of the five independent variables plus two ownership variables: *large MU* and *REC*.

Table 4.12: Regression Results from Models 3 & 4 in Iowa/POU data-subset

Iowa/POU data-subset	Model 3 - State Basic			Model 4 - State Basic w/Ownership dummies		
Variable	**Unstand. Coefficient**	**Stand. Coefficient**	**Tolerance Level**	**Unstand. Coefficient**	**Stand. Coefficient**	**Tolerance Level**
Total Sales	1.005E-06*	0.141*	.823	9.920E-07	.139	.343
% Res Load	.006	.127	.839	.006	.115	.660
% Obama	-0.008	-0.079	.840	-0.008	-0.075	.829
Income	5.080E-06	.055	.932	4.915E-06	.053	.929
% Elect Heat	0.024**	0.207**	.836	0.024**	0.206**	.833
Large MU				-.146	-.021	.510
REC				.058	.028	.560
	Beta Coefficient (Constant):		**0.26**	**Beta Coefficient (Constant):**		**0.27**
	Adjusted R-Squared:		**0.08**	**Adjusted R-Squared:**		**0.09**

Note: Levels of significance: ***99%, **95%, *90%

When Model 3 is applied to the Iowa/POU data-subset (Table 4.12), both *total sales* and *% elect heat* come up significant. Unlike the Model 1 regression in the overall dataset, *total sales* in the Iowa/POU data-subset shows a relationship that is not only significant, but also has a stronger coefficient. A utility that increased in size from the first quartile to the third (a gain of 55,718 kWh worth of sales) would increase *spending/revenue* by 0.06%. Like regressions in Models 1 and 2, *% elect heat* shows a positive relationship with a coefficient of 0.024. A first to third quartile increase in homes heated with electricity would increase program *spending/revenue* in Iowa by 0.24%, a sizable amount considering the median *spending/revenue* for Iowa POUs is only 0.75%.

Model 4 evaluates whether controlling for the type of POU within each state adds variation and clarity to the model. In Iowa, only *% elect heat* is significant in Model 4. Neither *large MU* or *REC* is significant. Not only is *total sales* no longer significant, but its tolerance score is below 0.4. The R-squared for each of Models 3 or 4 is below 0.10.

Table 4.13: Regression Results from Models 3 & 4 in Indiana/POU data-subset

Ind/POU data-subset	Model 3 - State Basic			Model 4 - State Basic w/Ownership dummies		
Variable	**Unstand. Coefficient**	**Stand. Coefficient**	**Tolerance Level**	**Unstand. Coefficient**	**Stand. Coefficient**	**Tolerance Level**
Total Sales	3.011E-07***	0.319***	.758	1.406E-07	.149	.375
% Res Load	.003***	0.278***	.830	.001	.146	.696
% Obama	0.003	0.090	.901	0.003	0.099	.879
Income	-4.851E-07	-.029	.785	-1.298E-06	-.078	.746
% Elect Heat	0.008***	0.373***	.870	0.008***	0.365***	.813
Large MU				-.004	-.007	.535
REC				0.148***	0.350***	.475
	Beta Coefficient (Constant):		**-0.39**	**Beta Coefficient (Constant):**		**-0.30**
	Adjusted R-Squared:		**0.34**	**Adjusted R-Squared:**		**0.42**

Note: Levels of significance: ***99%, **95%, *90%

Within this data, Indiana (Table 4.13) is really defined by a sizable portion of utilities within the state without EE programs. Less than half of the RECs and no MUs operated programs in 2010. When Model 3 is applied to the Indiana/POU data-subset, *total sales*, *% res load* and *% elect heat* are all significant and positive. In Model 4 both *% elect heat* and *REC* are highly significant and positive. Considering that RECs are the only utilities without zeros for the dependent variable this makes sense. The highly significant *% elect heat* could help explain why those RECs voluntarily choose to establish an EE program.

Table 4.14: Regression Results from Models 3 & 4 in Michigan/POU data-subset

Mich/POU data-subset	Model 3 - State Basic			Model 4 - State Basic w/Ownership dummies		
Variable	Unstand. Coefficient	Stand. Coefficient	Tolerance Level	Unstand. Coefficient	Stand. Coefficient	Tolerance Level
Total Sales	1.042E-07	.118	.943	-6.310E-08	-.072	.673
% Res Load	.003	.221	.884	-.001	-.052	.431
% Obama	0.013*	0.262*	.980	0.014**	0.287**	.942
Income	2.020E-06	.056	.933	-9.574E-07	-.027	.868
% Elect Heat	.005	.057	.864	.006	.070	.859
Large MU				.130	.165	.711
REC				0.388**	0.464**	.406
	Beta Coefficient (Constant):		-0.14	Beta Coefficient (Constant):		0.05
	Adjusted R-Squared:		0.14	Adjusted R-Squared:		0.23

Note: Levels of significance: ***99%, **95%, *90%

Michigan's R-squared for Models 3 and 4 are 0.14 and 0.23 respectively (Table 4.14). In Model 3 only *% Obama voters* is significant and it is positive. It has a coefficient of 0.013 which means that if a Michigan POU's electoral support for President Obama grew from the first quartile to the third (47% to 54%), *spending/revenue* would increase by 0.09%. For perspective, the median *spending/revenue* for Michigan POUs is 0.76%. With the inclusion of POU ownership variables in Model 4, both the significance and strength of coefficient of *% Obama voters* increase very slightly. Also *REC* is significant at 95% and positive at 0.388. As the box plot suggests above (Figure 4.1), RECs in Michigan do appear to have greater *spending/revenue* percentages than MUs. Model 4 shows that even when controlling for the independent variables in the model, RECs still spend more.

In preliminary data analysis Wisconsin often seemed to have more independent variables come up significant than any other state. When Models 3 and 4 are applied to the Wisconsin/POU data-subset, three variables come up significant for Model 3 and four come up for Model 4. In Model 3, *% Obama voters* is negative and significant at 99%. Both *% elect heat* and *income* are significant (95% and 99% respectively) and positive. While *% elect heat* has consistently come up significant in a variety of regressions, this is the first time that *income* has come up significant. As the mean income of a utility's service grows from the first to third quartile of data (from $51,531 to $64,451), spending/revenue would rise by 0.11%. This is equivalent to the first to third quartile rise in *% elect heat*. These are significant increases considering the median *spending/revenue* for Wisconsin POUs in 2010 was 0.44%.

Yet more influential in this model than either of those two variables is *% Obama voters*. Unlike what was proposed in the hypothesis (or as is indicated in Michigan), *% Obama voters* shows a negative relationship in Wisconsin POUs when controlling for the independent variables. A first to third quartile increase in *% Obama voters* would increase *spending/revenue* by 0.14%.

Table 4.15: Regression Results from Models 3 & 4 in Wisconsin/POU data-subset

Wisc/POU data-subset	Model 3 - State Basic			Model 4 - State Basic w/Ownership dummies		
Variable	**Unstand. Coefficient**	**Stand. Coefficient**	**Tolerance Level**	**Unstand. Coefficient**	**Stand. Coefficient**	**Tolerance Level**
Total Sales	-2.290E-07	-.078	.931	-2.103E-07	-.071	.356
% Res Load	.003	.151	.840	0.005*	0.308*	.278
% Obama	-0.015***	-0.312***	.971	-0.016***	-0.316***	.969
Income	8.807E-06***	0.278***	.929	8.046E-06***	0.254***	.899
% Elect Heat	0.015**	0.215**	.863	0.014**	0.208**	.860
Large MU				-.156	-.175	.243
REC				.107	.088	.447
	Beta Coefficient (Constant):		**0.63**	**Beta Coefficient (Constant):**		**0.60**
	Adjusted R-Squared:		**0.19**	**Adjusted R-Squared:**		**0.21**

Note: Levels of significance: ***99%, **95%, *90%

Model 4 in the Wisconsin/POU data-subset shows the same significant variables as Model 3 except that *% res load* is also significant. While variable’s coefficient is large, its tolerance value is quite low at 0.278. Likewise *total sales* and *large MU* both have low tolerance values. With such low levels it is best not to trust the results of the Model 4 regression in the Wisconsin/POU data-subset.

4.2.3 Independent Variable Findings

Table 4.16: Found Relationships of Independent Variables to Dependent Variable

Independent Variable	Type	Hypothesized Relationship	Found Relationship
Total Sales	Utility	Positive	Positive
% Res Load	Utility	Negative	Positive
% Obama Voters	Political	Positive	Positive/Negative
Income	Housing	Positive	Positive
% Elect Heat	Heat	Positive	Positive
Michigan	State	Positive	Positive
Iowa	State	Positive	Positive
Wisconsin	State	Positive	Positive
Indiana	State	Negative	Negative
REC	Ownership	Negative	Positive
Small MU	Ownership	Negative	Negative
Large MU	Ownership	Negative	Undetermined
IOU	Ownership	Positive	Positive

State – The state variable was found to be the most predictive of any factor. Regardless of whether ownership variables are included or whether IOUs are excluded from the data being regressed, Iowa, Michigan and Wisconsin hold consistent coefficients. Even the coefficient for Wisconsin, the weakest of the states, is greater than the strongest independent variable, % elect heat, or any of the ownership dummy variables. When ownership variables are not controlled for (and the five independent variables are), Michigan is slightly stronger. When ownership dummy variables are included, Iowa is slightly stronger.

Ownership – When Model 2 is applied to the overall dataset, IOUs come up as the strongest in terms of program funding. While

RECs are found to have a positive effect as well, it is much less than IOUs when controlling for states and the five independent variables. When IOUs are excluded from the data, RECs indicate a positive relationship to EE spending in Michigan and Indiana. However when Model 2 is applied to the POU dataset, RECs do not come up significant. This suggests there's not strong variation between MUs and RECs across all four states. Large MUs never show a significant relationship. It's likely that there's not enough variability between large and small MUs.

Total sales – When Model 1 is applied to the overall dataset, *total sales* has a positive and significant relationship with *spending/revenue*. Yet when ownership type is controlled for, *total sales* is no longer significant. This suggests that the size of the utility does matter in many cases; but size has more to do with IOUs generally being larger than POUs. When IOUs are excluded from data (as when Model is applied to the POU data-subset), *total sales* is not significant. However within Iowa and Indiana POUs *total sales* is significant and positive.

% res load – While % res load is significant and positive in Model 1 regressions it is insignificant in Model 2 when ownership type is controlled for. These are the results both in the overall dataset and within just the POUs. Initially this finding of a positive relationship seems at odds with earlier studies that cited a large residential load as a barrier to energy efficiency program development. Yet, it's likely that the seemingly positive relationship is more a result of much higher residential loads at RECs than small MUs (65% to 46%) than a positive relationship independent of ownership type. RECs have shown to have greater spending/revenue than small MUs and when ownership is controlled for, *% res load* is no longer significant. Within states, *% res load* only came up significant in Indiana and again it's likely due to some RECs spending on programs and no MUs spending on programs.

% Obama voters – Because of the apparent correlation between state-level funding for energy efficiency and how likely states vote for the Democratic candidate in presidential elections, it was presumed that the relationship would continue to be positive at the county and utility-level. Models 3 and 4 suggest this to be the case in Michigan. *% Obama voters* is the only significant variable in both regressions. In Wisconsin however, the variable has a negative sign. Of the three independent variables that are significant, *% Obama voters* is the strongest predictor in Wisconsin. Often in spatial analysis an electoral variable becomes a proxy for a measure of how rural an area is. Liberals live in cities and conservatives live in the country. Yet, Michigan and Wisconsin have more political diversity in rural areas than most states do. In Wisconsin for example, some of the most politically conservative areas of the state are in the wealthy suburbs around Milwaukee. It's possible that the negative sign on % Obama voters in Wisconsin is a proxy for the rural/urban divide, but that the politics are switched.

Income – While low incomes has often been cited as a barrier to energy efficiency at RECs and small MUs, the only relationship I find between an area's income level and program funding is in Wisconsin. Here it has a positive relationship, which means the wealthier an area is, the greater its utility provider invests in energy efficiency. In their study of EE programs at Minnesota POUs, Wilson (2008) found low incomes to be a barrier to program development. This finding of a positive relationship in Wisconsin (the state adjacent to Minnesota) supports that.

% Elect Heat – This variable is another that could be hypothesized in either direction. Logically, it makes the most sense for *% elect heat* to have a positive relationship. Historically, heating with electricity has been terribly inefficient and therefore electrically-heated homes are usually one of the first targets by energy efficiency programs. So a utility with a higher percent of electrically-heated homes in its area should have more reason to fund a program. This variable continually comes up significant and positive. It is significant in the both the overall and POU datasets, regardless whether I am controlling for just states or ownership type as well. It also is positive in the state/POU data-subsets for Iowa, Indiana and Wisconsin. Only in Michigan did it come up insignificant. Also it is often the strongest predictor of the dependent variable for any of the five independent variables.

4.3 Overall Findings

1) *In 2010, energy efficiency programs were nearly universal across Iowa, Wisconsin and Michigan. By 2012, program coverage in Indiana was substantial.*

Of the 336 utilities in those states, only 8 did not operate a program in 2010. Of the 178 utilities in Iowa that are asked to develop programs though not held to minimum standards, only 8 claimed some sort of exception and did not develop a program. All of the programs in Indiana in 2010 were created voluntarily since their EERS didn't go into effect until 2011. Although outside of the state's EERS jurisdiction, the majority POUs in Indiana began operating programs in 2012. Coverage there now is much more widespread, likely between 80% and 90%.

2) *The state a utility is in is by far the most controlling factor.*

This is due to state policy, regulatory authority and whether there's a history and/or culture of energy efficiency and conservation. While all four states had enacted EERS by 2010, Michigan's policies were implemented in 2009, Iowa in 201 and Wisconsin and Indiana in 2011. Iowa has set relatively high standards for IOUs, while instructing POUs to operate programs but excluding them from minimum standards. Michigan's standard is less than Iowa's but applied to all utilities, IOUs and POUs alike. Wisconsin requires IOUs to contribute to a common program; POUs either contribute to the common program, operate independent program, or a mix of the two. Indiana requires all jurisdictional utilities to reach an energy savings standard similar to Michigan's. Jurisdictional utilities include all IOUs and the roughly 10% of POUs which haven't opted out of jurisdiction.

Within these basic frameworks of policy and regulation, the state's history and culture really help drive how much utilities invest in energy efficiency. Utilities in Iowa and Wisconsin have consistently operated energy efficiency programs since the 1980s. Before a lull from 1996 to 2008, Michigan had a strong history of energy efficiency programs in the state. These histories helped drive energy efficiency irrespective of the EERS. While Indiana was one of the first states in this group to pass an EERS, their energy efficiency program didn't start until 2011 with some utilities not starting until 2012. Looking back to Figure 3.1, one can see that Michigan and Indiana were ranked similarly before they each passed an EERS. Even though the standards are not that dissimilar, by 2012 Michigan had become on par with Iowa and Wisconsin, while Indiana still languished far behind. This is likely due to the history Michigan and their utilities had in utilizing energy efficiency, as well as popular support rooted in history of conservation.

While this idea has been studied and presented many times, very few studies have explored a state's influence at the utility level. Through examination of means, medians, standard deviations and regression analysis, it clear that the state a utility is in greatly influences energy efficiency program spending. In 2010, the average utility in Iowa or Michigan spent the most (between 0.95% and 0.75% of total revenue), followed by Wisconsin (between 0.60% and 0.47%) and then Indiana (less the 0.08%).

Reprint of Table 4.2: Descriptive Statistics of *Spending/revenue*, Specific to State Data-subsets

State	N	Mean	Median	Standard Deviation
Iowa	180	0.95%	0.75%	0.91%
Indiana	118	0.08%	0.00%	0.20%
Michigan	58	0.85%	0.85%	0.35%
Wisconsin	118	0.60%	0.47%	0.40%
All	474	0.63%	0.47%	0.71%

Of the three states with widespread program coverage in 2010, only Michigan set a minimum standard for their POUs. Iowa did not and Wisconsin's standard would not begin until 2011. While Iowa had many small utilities with low *spending/revenue* data, they also had many utilities with some of the highest percentages in the dataset. This can be seen in the high standard deviation, almost three times Michigan's. Because Michigan sets clearer standards for its POUs, does that lead to their funding levels being grouped more closely together? Conversely, could Iowa's greater freedom with their POUs in setting program goals lead to a wider dispersion of success?

3) *While investor-owned utilities spend more on their energy efficiency programs as a percent of their total revenue than do municipal utilities or rural electric cooperatives, small municipal utilities spend considerably less on average than large MUs or RECs.*

In 2010, IOUs in these four states invested almost 1% of their total revenue in energy efficiency (Table 4.3). They were followed by RECs, large MUs and finally small MUs. Small MUs, while they spend the least on average are a diverse group when it comes to funding levels with 14 of the top 16 utilities in the overall dataset being small MUs. Their lower levels of funding are also evidenced through the regression model. In Model 2, small MUs are the constant that the other ownership dummy variables are being regressed against. Both RECs and IOUs show significant and positive relationships when controlling for state factors and the five independent variables.

Reprint of Table 4.3: Descriptive Statistics of *Spending/revenue*, Specific to Ownership Type Data-subsets

Ownership	N	Mean	Median	Standard Deviation
IOU	28	0.97%	0.94%	0.77%
Large MU	38	0.55%	0.58%	0.48%
Small MU	292	0.59%	0.38%	0.77%
REC	116	0.68%	0.55%	0.57%
All	474	0.64%	0.47%	0.71%

4) *The bigger a utility is, the more it invests in its energy efficiency program.*

Through descriptive statistics and regression analysis, *total sales* (kWh) continually showed a positive relationship with *spending/revenue*. Yet it is difficult disentangle size from ownership type, especially when there's very large amounts of spending at very large IOUs. Within only POUs, size did show positive relationships in Indiana and Iowa.

5) *The percent of a utility's total electrical load that's residential potentially has a positive relationship with* spending/revenue*.*

Often cited as one of the common barriers to energy efficiency at rural utilities, especially among RECs and MUs, this paper finds that *% res load* and *spending/revenue* potentially have a positive relationship. First, in a comparison of means (Table 4.6) and within regression Model 1, *% res load* suggests a positive relationship. While it's possible this is the case, it more likely that the relationship is better explain by RECs spending more than small MUs. And that RECs have a much greater share of residential load than small MUs. Because when ownership types are controlled for *% res load* is no longer significant.

6) *As a general rule, a liberal political persuasion at the local level does not increase investments in energy efficiency programs.*

While the *% Obama voters* does show a positive relationship when the regression model is applied to Michigan, it also shows a negative relationship when Model 3 is applied to the Wisconsin data-subset. Neither in the overall dataset nor the POU dataset, does *% Obama voters* reach a level of significance. This is the case when controlling for state and ownership effects. Since the state capitol is where much of the energy efficiency policy takes place, the political make-up of the legislature may be a better predictor of energy efficiency than the political make-up of the population.

7) *Areas with larger shares of houses heated with electricity, invest more in energy efficiency programs.*

This finding supports the idea that energy efficiency programs target homes that are electrically-heated. It makes sense that utilities that serve communities with higher shares of electrically-heated homes would be more interested in pursuing energy efficiency and delivering program services. The variable was found to be significant and positive both in the overall and POU datasets, as well as in Iowa, Indiana and Wisconsin.

CHAPTER 5

LIMITATIONS AND FURTHER RESEARCH

One of the goals of this research was to evaluate how ownership type at an electric utility affected the development and operation of an energy efficiency program. I had thought if I created a dataset of all the utilities within a sample of states, I could take the findings and apply them more broadly to MUs, RECs and IOUs all across the country. By selecting four states that controlled for many factors (climate, culture, etc.), it was thought that state policy and regulation would be the main controlling factors; that states could be categorized as: no energy efficiency regulation, only regulation of IOUs, or regulation of all utilities.

But what I found was that even in a sample of four states I found a good deal of variety in state policy and regulation. Likewise I learned that there's more to the state factor than just policy. A state's history of energy efficiency utilization and attitude towards conservation are likely factors as well. The state-level influence appears to not only be the strongest factor in energy efficiency program funding, but also something extremely distinct to each state.

Many of the findings likely would apply to nearby states in the Midwest, but that applicability grows thin as one moves to other regions of the country. For one, the disparity in wealth between rural and metro areas in the Midwest is not as stark as it is in the South. While this study didn't find that income level was a reliable predictor of energy efficiency spending (outside of Wisconsin), in other regions with a poorer rural population that might not be the case.

While I made all reasonable attempts to create a uniform dataset, it is far from perfect. Each state utilizes different systems and templates that utilities use to submit energy efficiency program data. Even within states numerous forms and procedures exist for utilities of different ownership types and size. Sometime spending data is simply one line item in a larger budget, sometimes the entire report is about energy efficiency and I had to add up individual line items. Any future attempts to create a dataset of EE program spending or energy savings should take these cautions into account.

Likewise, the method of attaching socio-demographic and economic variables to utility service areas was far from perfect. In other areas of the country where there's more uniformity in a utility provider across a town or county, attaching variables would be a smoother process. Yet the states in this study have extremely complicated service areas that simply do not match any geographic designation of the census bureau.

As part of the research process, I intentionally set the issue of scale aside in order to focus on small and very small publicly-owned utilities. Yet if the greater goal is to reduce energy use, it makes sense that policymakers focus first on the largest utilities. To help put this thesis in perspective, it's necessary to address the issue of scale.

In Iowa for example, the two large IOUs distribute 37 times as much energy as the smallest 100 utilities combined. From a policy standpoint, does it make sense to spend time and resources on getting small utilities to start programs when the contribution of these utilities to total energy use is comparatively insignificant? A modest program at a large utility can save more energy than many robust programs at small utilities.

In this thesis I have normalized the size of utilities by their total revenue, but can energy efficiency programs at very large and very small utilities even be compared via a monetary normalization? Is an investment of $40,000 by a utility with 1,000 customers as relatively effective as an investment of $40 million by a utility with one million customers? What about $4,000 for 100 customers? At each of these vastly different scales, I briefly address what specific activities constitute an energy efficiency program?

Tables 5.1 and 5.2 shed light on these questions. Table 5.1 presents five different scales of program spending in Iowa. First are the two IOUs who spend in the tens of millions of dollars, then the three highest spending POUs who spend in the hundreds of thousands, then three POUs in the tens of thousands, then four MUs who spend just over 10,000, followed by three of the smallest programs in Iowa. Table 5.1 also shows quick comparisons of program offerings, while Table 5.2 gives more detail about numbers of participants and total funding in specific program categories.

Table 5.1: Scale and Types of Energy Efficiency Programs at Utilities in Iowa

Utility	Ownership Type	EE Spending Rank	Total EE Spending	EE Spending as % of Revenue	Total Customers	Appliance/Heating/ Cooling Rebates	Lighting Incentives	Weatherization	Significant Non-Res. Program(s)
MidAmerican Energy	IOU	1	$42,252,259	3.63%	637,604	X	X	X	X
Interstate P&L	IOU	2	$28,567,395	2.17%	483,196	X	X	X	X
Linn County REC	REC	3	$922,204	2.16%	24,685	X	X	X	X
North West REC	REC	4	$639,909	1.81%	9,477	X	X	X	X
Cedar Falls	MU-L	5	$635,972	1.74%	17,911	X	X	X	X
Franklin REC	REC	41	$78,729	1.50%	1,933	X	X		
Clarke EC	REC	42	$76,289	0.70%	5,229	X	X		
Akron	MU-S	45	$54,460	4.14%	836	X	X		
Farnhamville	MU-S	84	$13,035	3.38%	257	X	X		
Alta	MU-S	86	$12,694	0.93%	965	X	X		
Forest City	MU-S	87	$12,055	0.23%	1,969	X	X		X
Aurelia	MU-S	88	$11,920	1.67%	521	X	X		
Pleasant Hill Community Line	REC	169	$150	0.04%	103		X		
Alta Vista	MU-S	170	$143	0.08%	197				
Marathon	MU-S	172	$100	0.05%	223	X			

Source: Energy efficiency program reports from Iowa PUB website

Generally, the smaller programs tend to just offer lighting incentives (i.e. free CFLs) and rebates for new space heating/cooling systems, appliances and domestic hot water systems. These rebates can be as low as $15 for a ventilation fan or as high as $6,500 for a heat pump. Considering that lack of staff capacity is a common barrier to program development at small utilities, it makes sense that small utilities would focus their resources on less complicated programs like offering rebates.

As programs grow in size the variety grows as well. Both North West REC and Cedar Falls MU offer weatherization programs, as well as commercial/industrial programs. Both of these types of programs, especially when they offer energy audits and/or financing options tend to be more complicated and can take more staff to manage. Weatherization programs not only require knowledgeable staff at the utility, but also local and experienced energy efficiency contractors to carry out the work. Industrial, commercial and agricultural programs can require greater expertise as well. While energy efficient lighting upgrades in a single family house are usually as simple as changing a light bulb, large stores, factories and other facilities can have more complicated systems that require more knowledge and skill in order to upgrade.

Table 5.2: Energy Efficiency Program Specifics and the Scale of Spending at Utilities in Iowa

Utility	Programs/Incentives Offered – Total participants served / type of program (total $ spent) – (RES: Residential, NON-RES: Non-Residential)
MidAmerican Energy	RES: 11,661 HVAC ($2.2 Mil), 1 Mil Lighting ($1.4 Mil), 25,793 Energy Star Appliances ($1.2 Mil), 4,998 Weatherization ($723,429), 6,091 New Construction ($2.1 Mil), 45,276; NON-RES: 62,173 Lighting ($1.2 Mil), 2,038 Custom Program ($1.1 Mil), 22,588 Small Commercial Program ($1.2 Mil), 13,980 Energy Analysis Program ($3.2 Mil), 527 Comm New Const ($5.9 Mil); also appliance recycling, agriculture, & multi-family programs
Intersta te P&L	RES: Heating/cooling, appliance rebates ($8.1 Mil), Energy Audits/Weatherization ($1.3 Mil), Appliance Recycling ($1.6 Mil); NON-RES: Heating/Cooling/Appliance Rebates ($4.5 Mil), Custom Program ($6.3 Mil), Comm New Const ($3.5 Mil) and Multi-family, New Home Const, Agriculture, and Performance Contracting Programs
Linn County REC	RES: 143 Geothermal HP ($299,140), 346 DHW ($79,588), 1,485 Energy Star Appliances ($102,387), other lighting, heating/cooling, DHW
North West REC	RES 58 Geothermal HP ($160,727), 105 Air Source HP ($91,169), 180 DHW ($63,008), 95 Weatherization ($44,081), other appliances, heating/cooling, lighting; NON-RES: 5 custom industrial program ($162,384), other lighting, heating/cooling
Cedar Falls	Offers Energy Audits to houses at least 10 years old where CFLs, low-flow showerheads and other small measures are installed. Aside from various heating/cooling and appliance rebates, the utility offers rebates on weatherization measures following the audit
Franklin REC	RES: 12 Geothermal HP ($18,280), 18 Air Source HP ($11,490), 33 DHW ($13,605), other lighting, appliance, heating/cooling, DHW incentives,
Clarke EC	RES: 21 Geothermal Heat Pump ($30,892), 13 Air Source Heat Pump ($8,423), 3,218 Lighting ($5,471), other heating/cooling, DHW, Energy Star Appliances
Akron	RES: 9 Gas Furnace/Boiler Incentives ($45K), 17 Elect DHW heaters ($3,400), 3 new home construction ($6,000)
Farnhamv ille	RES: 400 Lighting ($0), 2 Res Heat Pumps ($13,035)
Alta	RES: 702 Lighting Incentives ($1,953), 7 Res Heat Pumps ($2,338), 1 Ventilation Fan ($15), 24 Electric DHW ($7,928)
Forest City	RES: 864 Lighting ($1,284), 40 Energy Star Appliances ($2,863), 15 Appliance Recycling ($363), 16 Air Cond ($1,600), 6 Vent. Fans ($60), NON-RES: 112 Lighting ($5,886)
Aurelia	RES: 440 Lighting ($1,320), 20 Energy Star Appliances ($650), 1 Air Cond ($100), 5 Res Heat Pumps ($8,400), 8 Electric DHW ($1,600)
Pleasant Hill	CFL bulbs handed out to members who attended Annual Meeting
Alta Vista	Management costs for Low-Income program likely funded from different source?
Marathon	2 Energy Star Appliances ($100)

Source: Energy efficiency program reports from Iowa PUB website

At the top of Table 5.1 are the two large IOUs in Iowa. While MidAmerican Energy and Interstate P&L distribute about 75% of the energy in the state, they account for 86% of the total spending on energy efficiency programs in the state. Because they proportionally spend more than their smaller counterparts, it's difficult to parse out how much of their increased program options are due to more relative spending or more absolute spending. While the program offerings at the IOUs and large POUs may seem similar in Table 5.1, Table 5.2 shows the breadth and budgets of specific programs. The IOUs do have more spending in common programs like rebates and lighting as would be expected. However these common programs that tend to dominate the portfolio of EE programs at small utilities tend to be a small percentage. Less than 15% of MidAmerican Energy's total spending is on residential rebates and lighting. The two RECs with the largest budgets, Linn County and North West, spend between 60% and 75% on residential rebates and lighting. And aside from Forest City MU (which offered a commercial lighting program), all the other POUs in Table 4.13 spent their entire budget on residential rebates and lighting.

One of the advantages of scale appears to be that EE programs can increase in variety as well as simply offer more of the same. This short survey shows that small EE programs tend to only offer rebates and lighting upgrades. For the small utilities who have larger spending as a % of revenue (Farnhamville and Akron), their relatively large spending is simple due to offering larger incentives and allowing more participants. Farnhamville's entire EE program in 2010 was two residential heating pump rebates, in operation very similar to Marathon's which also offered two rebates (for efficient appliances). The difference was that Marathon's rebate was worth $50 each, while Farnhamville offered over $6,500. Likewise, Akron offered 9 furnace/boiler rebates each worth $5,000. This encompassed 83% of their total budget.

As the program's budget expands the program variety also expands. Once programs reach budgets into the hundreds of thousands, they begin regularly incorporating weatherization and expanding incentives to commercial, industrial and agricultural customers. Looking at the large IOUs and their budgets in the tens of millions, the program variety expands even more. Aside from offering the same package as the large RECs and MUs, the IOUs offer many other specialized programs that can target niches. They can divide up their commercial program to serve large, small and new construction commercial all separately. MidAmerican Energy even has an Energy Analysis program which offers advanced energy audits to large commercial/industrial customers.

Aside from a similarly designed study that created a better dataset through a more defined and exhaustive collection of program data or more sophisticated calculation of the independent variables, the best next steps for future research would be to explore these states in greater detail.

Iowa, with its large number of utilities, robust programs and detailed reporting mechanisms offers a great laboratory to explore energy efficiency programs in more detail. As the short survey above explained, it’s possible to get program spending and energy savings data for very specific efficiency measures. It would be interesting to explore which types of measures help utilities most effectively reach their energy savings goals.

Indiana is interesting because of the relatively strong EE program developed voluntarily by many of the RECs in 2009. Additionally, almost all of the RECs and most of the MUs voluntarily joined Energizing Indiana, the state-branded program in 2012. Since Hoosier Energy (the cooperative of 17 RECs with an EE program in 2009), started their energy efficiency program independent of state policy, it would be interesting to find out how joining the state program, Energizing Indiana, has affected their program.

While Michigan does have savings minimums and spending caps on all its utilities which constrict variability, they do exhibit an interesting mix of program management options. There are three common programs in Michigan and a number of utilities who operate independent programs. Since Michigan’s utilities are split somewhat evenly between the four options, it would be interesting to explore the relative success of each program versus the utilities that operate programs independently.

CHAPTER 6

CONCLUSION

The thing that stands out most in this study is the quickly evolving nature of the energy efficiency industry. This research evaluated the year 2010. If one were to apply the same method to 2012 data *spending/revenue* results would likely be greater; 2008 data on the other hand, the results would likely much less.

Indiana is probably the best example of this. For a long time the state has been in the lower tiers of states when it comes to energy efficiency. While it took a year or two longer than expected to get fully operation, their common program Energizing Indiana now has a substantial membership among POUs. Even though they're exempted from the minimum standards set forth in the state's EERS, nearly every REC and most MUs have joined the state program anyway. These voluntary actions towards energy efficiency by the state's POUs even precede the state's EERS and Energizing Indiana. In 2009, Hoosier Energy, a G&T Cooperative made up of 17 RECs, created an energy efficiency program of their own. While the voluntary programs at the state's IOUs spent an average of 0.12% of their total revenue on energy efficiency programs, the average for the 17 RECs was 0.51%, over four times as much.

This is similar to Iowa where even though POUs are exempted from the minimum standards, over 90% of them developed energy efficiency programs; with some of them investing a higher percentage of their total revenue than the state's large IOUs. Michigan and Wisconsin have found success as well with every utility in each state investing in a consumer energy efficiency program.

These are all positive developments. In Wisconsin and Michigan, where POUs are given minimum energy saving or program spending standards, every utility invests in an energy efficiency program. In Iowa and Indiana, where POUs are excluded from the minimum standards (though encouraged to develop a program), nearly every utility invests in an energy efficiency program. The main thread running through these four states is that a state energy efficiency policy has been established. Even where POUs are exempted from the regulation, they still seem to be investing in energy efficiency.

For policymakers looking to increase the adoption of energy efficiency in their communities one of the lessons in this thesis is that flexibility in policy design can be a good thing. Iowa's EERS is a good example. Although the relatively strong energy saving standard does not apply to POUs the state does not exempt POUs from the EERS entirely. They require POUs to establish energy efficiency programs, but allow each POU to set their own goals, however ambitious or modest they may be. This has led to a wide variety of programs types and spending levels. While there are a number of RECs and MUs in Iowa that have small programs, there are many POUs in Iowa that voluntarily spend more on energy efficiency than any POUs in Michigan, even though the latter are not exempt from their state energy efficiency standards. It's the flexibility in Iowa's policy that allows for some publicly-owned utilities to develop stronger energy efficiency programs than they might have if they were given strict minimum standards.

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