

Residential Energy Efficiency in Moderate- Income Households

A Thesis

Submitted by

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Executive Summary

The passage of the Green Communities Act in 2008 established the state of Massachusetts as one of the leaders of energy policy in the United States. As part of the Act, the state has set strong energy efficiency goals and requires efficiency to be the first form of meeting the state's future energy needs. To help meet this goal, energy efficiency programs in the state have been developed to offer some of the best incentives aimed at helping residential utility customers become more energy efficient. Part of the funding for these programs is derived from the customers themselves through the Systems Benefit Charge (SBC).

Within the residential sector SBC funding helps to provide no cost programs to low-income households that make 60% or less of State Median Income (SMI). For all other households that make more than 60% of SMI the Mass Save program has been established to assist these households in achieving energy efficiency. Preventing greater participation by all income groups have been several widely acknowledged barriers: information/knowledge, lack of certainty of savings, preweatherization repairs, split incentives and financial. In order to accomplish the goals of the Green Communities Act it is imperative that these barriers be removed for all households in Massachusetts enabling them to realize the energy savings potential.

The financial barrier for households in the non-low-income sector is a greater challenge for moderate-income households, those households with incomes between 60 and 120% of SMI. While these moderate-income households do have discretionary income, the amount is limited. While the amount of

discretionary income may be limited, there is an opportunity to reduce the energy use in moderate-income households. Moderate-income households account for almost 25% of residential energy usage in the state (Energy Programs Consortium, 2008).

There are already programs in Massachusetts and around the country that are targeting moderate-income households. Programs like ReNew Boston, Kitsap Green, GETS Energy Services, Together We Save and others are providing additional financial and other assistance to moderate-income households to help remove the barriers to their participation and to help them realize the energy savings imbedded in their homes.

Geographic Information Systems (GIS) can be used to map energy efficiency program participant data with Census data can help explain the relationship between participation and income. Using data supplied by Cape Light Compact (CLC) to test this methodology resulted in general trends showing that as income increases so does participation in building envelope and HVAC energy efficiency measures. However, the correlation is not strong or statistically significant and more research needs to be conducted to further investigate the relationship.

Ultimately, in order for Massachusetts to realize the goals of the Green Communities Act and create an energy efficient housing stock it will have to create programs that enable the participation of all households. This includes the overcoming of the financial barriers that prevent families from undertaking energy efficiency work on their homes, which can be more severe for moderate-

income households. Massachusetts should tailor the energy efficiency programs offered in the state to meet the needs of moderate-income households.

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Chapter 1: Introduction and Background on Energy Efficiency

Over the last several years there has been a renewed interest in energy efficiency in part due to climate change and the infusion of funding by the American Recovery and Reinvestment Act of 2009 (ARRA). While residential energy efficiency is not a new field the increased attention being paid to the industry has brought about intensified efforts to break down the barriers that have prevented wider scale implementation. The state of Massachusetts has been at the forefront of this effort and is seen as one of the most progressive states in this regard. In order to achieve the goals the state has set for achieving an energy efficient society the state will have to ensure that all households are able to participate in the process.

Introduction

On July 2nd, 2008 Governor Deval Patrick signed into law the Green Communities Act. The Act is arguably the most progressive energy bill in the United States. The purpose of the Act is to shift the state's energy usage toward more renewable sources, improve energy efficiency and curb the amount of greenhouse gases emitted in the state, while making Massachusetts the center of a "green" revolution. Among other provisions the law calls for energy efficiency to be pursued before the building of new power plants. Part of the funding for these energy efficiency programs comes from the utility customer generated SBC. The SBC is collected and distributed by customer class (residential, commercial and industrial) and in return energy efficiency programs are also to be distributed

equitably to all customer classes (The 187th General Court of The Commonwealth of Massachusetts, 2008).

The Act makes special provisions for ensuring that energy efficiency programs are designed to target low-income households. The Act, however, makes no further distinctions in the residential customer sector. All residential households that make more than the low-income program threshold of 60% of SMI are grouped into the non-low-income Mass Save program. While it is clear that there are many households in Massachusetts that are financially well off enough to improve the efficiency of their homes through the Mass Save incentives, it is unclear if all households that make more than 60% of SMI are able to do so.

Moderate-income households make too much money to qualify for the fully subsidized low-income weatherization programs and may not have the discretionary income to participate in the market rate efficiency programs. For the purpose of this thesis, the term moderate-income household refers to households that make between 60 and 120% of SMI, unless it related to the discussion of a specific program. The reasoning behind this definition will be discussed in the section Ability to Pay. Table 1 provides a breakdown of the different of households in each income group in the state and what percent of residential energy consumption each group consumes.

Table 1: Massachusetts Energy Usage by Income Group

Income Group	Number of Households	Percentage of the Population	Percentage of Total MA Energy Use
State Wide	2,452,599	100%	100.00%
Low-Income (0 – 60%)	739,096	30.14%	26.01%
Moderate-Income (60 – 120%)	693,046	28.26%	24.78%
High-Income (>120%)	1,020,457	41.21%	49.21%

Source: (Energy Programs Consortium, 2008)

While the number of moderate-income households is the smallest of the three groups and the percentage of energy usage for these households is also the least, this does not mean that there are not energy savings to be gained by performing energy efficiency measures in the households. This information begins to leading to the question, to what extent are the current energy efficiency programs reaching these households? If existing programs are not reaching moderate-income households do these programs need to be modified or do new programs need to be designed to target this segment of the residential population? Making certain that energy efficiency programs are accessible for moderate-income households ensures equity and that the goals established in the Green Communities Act are met.

This is the central question of this thesis; to what extent are moderate-income households in Massachusetts participating in the Mass Save residential energy efficiency programs? The implications of not knowing if moderate-income households are participating in the current Mass Save programs means that the state does not know the effectiveness of its programs. If the Mass Save programs are not adequately reaching moderate-income households, it means that these

households are helping to pay for programs that they are not able to access and are essentially paying for energy efficiency work in the state's wealthiest homes. It also would mean that the state is failing to capture the energy savings from 25% of the residential energy market, making it more difficult for the state to achieve the goals of the Green Communities Act.

To answer the question of moderate-income household participation, additional questions also need to be explored. At what income level do households have the discretionary income to participate in Mass Save? Are there energy efficiency programs that are specifically designed to target moderate-income households? Are moderate-income households significantly different from high-income households in their consumption of energy? To what extent is Mass Save reaching moderate-income households?

Low-Income Programs

Currently low-income weatherization programs in Massachusetts are administered by 20 Community Action Agencies (CAAs)¹ located across the state (Massachusetts Association for Community Action, n.d.). Weatherization activities for these agencies are funded by the federal government and utility collected funds. The federally funded Weatherization Assistance Program (WAP) was established by Title IV of the 1975 Energy Conservation and Production Act to provide low-income households with low-cost weatherization measures (Kaiser & Pulsipher, 2004). Funding is appropriated each year and allocated

¹ CAAs are also known as Community Action Programs (CAPs). CAAs are non-profit organizations established by the federal government over 30 years ago to provide assistance and emergency services to low-income families, including Low Income Home Energy Assistance Program (LIHEAP) and WAP (Massachusetts Association for Community Action, n.d.).

proportionally to each state in the form of block grants. In Massachusetts, as in all states, these funds are then distributed to the local CAAs to serve income eligible households. In order for a household to be eligible for low-income energy efficiency services the total household income must not exceed 60% of SMI. On average WAP spends about \$5,500 on each home weatherized (Commonwealth of Massachusetts, 2011).

In addition to funding from federal block grants, CAAs also receive funding from the utility collected SBC. The SBC was established in 1997 and is collected from all utility customers to fund energy efficiency activities. Initially 20% of the SBC was set aside for Demand Side Management (DSM) in the residential sector with a portion set aside for low-income households to be managed by the CAAs (Department of Public Utilities, 2008). In 1998, with backing from the Massachusetts Association of Community Action Program Directors (MASSCAP), the Massachusetts Energy Directors Association (MEDA) and others, the Low-Income Energy Affordability Network (LEAN) was established to help improve the administrative processes (Oppenheim Esq. & MacGregor, 2004). Prior to this time, each CAA negotiated its own contract with the gas and electric Program Administrator(s) (PA) operating in its service territory. The creation of LEAN allowed all of the contracts for the CAAs to be negotiated as one at the state level (ACEEE, 2004).

With the signing into law of the Green Communities Act in 2008, the rules governing the SBC and LEAN were modified. The SBC was adjusted to a quarter of a cent per kilowatt-hour, with the generated funds allocated proportionally to

each customer sector (residential, commercial and industrial) by how much each sector paid into the SBC fund. The new rules also ensured that the low-income sector would receive a minimum of 10% of the electricity generated funds and 20% of the natural gas generated funds (Department of Public Utilities, 2008).

In addition to the SBC the Green Communities Act also allocated additional funding for the CAA run low-income energy programs from the Forward Capacity Market (FCM), Regional Greenhouse Gas Initiative (RGGI), the Energy Efficiency Reconciliation Factor (EERF) and other sources (Cape Light Compact, Nationalgrid, Nstar, Unitil and Western Massachusetts Electric, 2009). In 2009, roughly \$21 million in funding was used to provide energy efficiency services² to approximately 17,000 low-income households. Also as part of the Green Communities Act the PAs are required to develop three year energy efficiency plans for the both the gas and electricity sectors in the state. According to the budgets in those plans between 2010 and 2012, funding will more than double, and the number of low-income households served will also increase starting in 2010 (U.S. Department of Health and Human Services, 2011).

The Green Communities Act has set Massachusetts up to not only be the leader in energy efficiency policy, but in implementation as well. The state's efforts coupled with the WAP program have helped to ensure that low-income families within the state have and will continue to have access to programs that will assist them with achieving energy efficiency. The next challenge for the state will be to create programs for non-low-income households that are as successful

² These services include all of the low-income energy related services like weatherization, fuel assistance, bill payment assistance, etc.

as their low-income counterparts and to ensure that all households in this sector are able to participate.

Chapter 2: Challenges for Moderate-Income Households

The low-income energy efficiency programs in the United States and Massachusetts have a long and proven track record for producing both financial and energy savings for the families that these programs serve. However, in the broader residential market widespread adoption of energy efficiency measures has not happened. Barriers such as a lack of information about or knowledge about energy efficiency, no guarantee of the cost and energy savings, preweatherization repairs, the split incentives challenge and the upfront cost required have help prevent greater market saturation. All of these barriers are important to overcome, but the financial barrier that faces moderate-income households alone can prevent wide scale adoption in this income sector.

Barriers

Energy efficiency has become widely accepted as the first and most cost-effective way to reduce energy use and reduce utility bills for American families; yet in the 35 year history of the energy efficiency industry, the best programs have only been able to produce 2% reduction in energy use in a single year (MA EEAC, 2009). Preventing greater success have been several widely acknowledged barriers: information/knowledge, lack of certainty of savings, preweatherization repairs, split incentives and financial.

Energy efficiency can be confusing due not only to its technical aspects, but also because of the confusing information about what is cost effective and the

best way to reduce energy waste (Institute for Sustainable Communities, 2009). As with any home renovation the whole process can take time and patience to complete. Making the process less appealing is that while energy efficiency measures typically save money and energy over the long run virtually no one is willing to guarantee an individual household that they will save money by installing efficiency measures (Fuller M. , 2009).

Many homes are old and require preweatherization repairs³ before energy efficiency measures can be installed (Marion Institute, 2011). This is especially true in a state like Massachusetts where most homes are over 50 years old, 56% of homes were built before 1960 and 35% of homes were built before 1940 (U.S. Census Bureau, 2000). Another barrier is the challenge of the split incentive that exists for families that rent their homes. In this case the landlord that owns the unit typically does not pay the utility bills and has little incentive to improve the efficiency of the building; while the tenant who pays the utility bills has little incentive to invest in a unit they do not own, may not live in long enough to see a return on any investment made, and may not even be able to get permission from the owner to make such alterations (Fuller M. , 2009). If a household can get past these barriers they will have to pay for the improvements made to their home. Financing, incentives and rebates may be able to help diffuse the upfront cost, but generally there is still a portion of the project cost due before work can take place (Thorne, 2003). While these barriers affect all income groups they can be greater

³ Preweatherization repairs are repairs that need to take place in the home before weatherization can occur. These repairs can include the removal and replacement of knob and tube wiring, asbestos, mold and other repairs.

challenges for low- and moderate-income households, because they tend to live in older homes, rent instead of own, have less if any discretionary income to invest and can less afford to take a risk without a guarantee.

Using the 2007 American Communities Survey, the National Housing Conference estimates that there were approximately 15.6 million moderate-income homeowners in the U.S. The incomes of these homeowners ranged between \$50,450 and \$75,760 or 80 to 120% of the national median income. The report states that these homeowners make too much to qualify for WAP, but do not have the discretionary income to pay for the upfront costs of energy efficiency (Cohen, Richardson, & Lubell, 2009). In Massachusetts the situation is no different. Households that make less than 60% of SMI have been and continue to be served by the 100% subsidized CAA run energy efficiency programs. For households that make more than 60% of SMI, the Mass Save program offers a one size fits all model. While the Mass Save program offers some of the best energy efficiency incentives in the country, how many of the households that make more than 60% of SMI have the necessary discretionary income to cover the co-payment required to participate in key retrofit measures?

For example, Mass Save is currently offering residential customers rebates on insulation to help improve the efficiency of their homes. Customers must live in a single family home with one to four units and must have a free Home Energy Assessment performed on their home. The rebate is for 75% of the cost of installed insulation up to \$2,000 (The RCS Network, 2011). This incentive is one of the best in the country for residential customers; yet it requires customers to

pay their portion of the cost upfront to access the rebate. Mass Save also offers generous rebates for installing high efficiency heating systems and hot water systems. The customer portion of an insulation project can be more than the 25% or \$666 for jobs that exceed the \$2,000 incentive cap. If a household wants to replace its old inefficient heating or hot water system the costs for projects can quickly climb into the thousands of dollars. Mass Save does offer the HEAT Loan, a seven year 0% loan of up to \$25,000, to customers who want to finance energy efficiency measures in their homes, but it is only available to customers who own their home and who qualify with one of the participating lenders. This means that renters and many homeowners who do not qualify for the HEAT Loan are only able to benefit from the 75% insulation incentive and the other rebates if they have the cash on hand to cover their portion of the project.

The funding for these program and others is generated in part from the SBC that all gas and electric customers have and continue to contribute to. The question then remains: does every non-low-income household in Massachusetts have the required matching funds in discretionary income that it can put toward making their home more energy efficient?

Ability to Pay

In answering this question the definition of discretionary income must first be examined. The simplest and most strict definition is the income a household has left after paying taxes and meeting its basic needs of food, clothing and shelter. This definition, however, does not account for any expenses related to health care, education and transportation, which for most households would be

considered basic needs in today's society (Reference for Business, 2011). Another way to look at discretionary income might be to compare the spending of demographically similar households to determine average expenditures and derive discretionary income that way (Marketing Charts, 2007). And yet another source defines discretionary income as the money that a household has left over to save or spend after taxes and paying for all the costs necessary to live a middle class lifestyle (American Incomes, 2009). This definition is broader and leaves more room for debate on what expenditures could be included as a basic need; however, it includes purchases that for most families would be considered basic needs by many and priorities over energy efficiency measures. No definition of discretionary income will be exact; there will be room for discussion on what should and should not be included as a necessary expenditure, but in the end it is a subjective judgment call on the part of the researcher (American Incomes, 2009).

Even if one definition is agreed upon, actually determining how much discretionary income a household has is difficult. There is no government agency that is responsible for calculating it, and it must be compiled from surveys like the Bureau of Labor Statistics' Consumer Expenditure Survey. Citing a report by The Conference Board, the business-to-business information website Marketing Charts states that 64% of households in the U.S. have discretionary income (2007). According to the publication *American Incomes*, roughly 66% of households in the U.S. have discretionary income (American Incomes, 2009). Using either of these sources it is evident that a majority of households in the U.S.

do have at least some discretionary income, but about 1/3 do not; yet this presents only part of the picture.

Table 2 shows discretionary income estimates for different household income ranges broken out by year, month and week. Over the course of several weeks or months most households could save enough discretionary income to cover the 25% copayment needed to participate in the Mass Save insulation rebate program. What these figures do not account for are factors such as family size, adjustments in salary and cost of living in different regions of the country, or race/ethnicity.

Table 2: Average Discretionary Income by Household Income Range, 2007

Household Income Range	Percent of Households	Discretionary Income Per Household		
		Yearly	Monthly	Weekly
Under \$20,000	20.6%	\$0	\$0.00	\$0.00
\$20,000 to \$39,999	23.2%	\$0	\$0.00	\$0.00
\$40,000 to \$49,999	9.8%	\$4,848	\$404.00	\$93.23
\$50,000 to \$69,999	15.3%	\$8,533	\$711.08	\$164.10
\$70,000 to \$79,999	5.8%	\$14,850	\$1,237.50	\$285.58
\$80,000 to \$99,999	8.1%	\$18,671	\$1,555.92	\$359.06
\$100,000 to \$119,999	5.5%	\$25,274	\$2,106.17	\$486.04
\$120,000 to \$149,999	4.7%	\$36,112	\$3,009.33	\$694.46
\$150,000 or more	6.8%	\$112,766	\$9,397.17	\$2,168.58
All Households	100%	\$13,345	\$1,112.08	\$256.63

Source: (American Incomes, 2009)

By household size, couples without children have the most discretionary income per capita, and single parent households with children under the age of 18 have the lowest (American Incomes, 2009). Table 3 shows discretionary income by family size compared to SMI and the 60% low-income threshold⁴. By ethnicity

⁴ The SMI was calculated from the LIHEAP Fiscal Year 2009/2010 income requirements table for Massachusetts (U.S. Department of Health and Human Services, 2011)

and race Hispanics then blacks have the lowest per household average discretionary income (American Incomes, 2009). Households with incomes greater than \$100,000 control 78% of discretionary income, and households making more than \$200,000 control 38% of discretionary income; meanwhile, the 60% of households at the other end of the spectrum making less than \$50,000 control just 3% of discretionary income (Marketing Charts, 2007), and households that make less than \$40,000 have virtually no discretionary income. By region, households in the Northeast have the highest amount of discretionary income (American Incomes, 2009). According to these statistics it is likely that moderate-income households in Massachusetts do have some discretionary income; yet the majority of discretionary spending is controlled by households that tend not to have children living at home, are more affluent, have higher levels of education, are white and are older.

Table 3: Estimated Discretionary Income by Family Size and SMI in Massachusetts

Family Size	60% of SMI	Discretionary Income at 60% SMI	100% of SMI	Discretionary Income at 100% SMI
1	\$29,126	\$0	\$48,543	\$4,848
2	\$38,087	\$0	\$63,478	\$8,533
3	\$47,049	\$4,848	\$78,415	\$14,850
4	\$56,011	\$8,533	\$93,352	\$18,671
5	\$64,973	\$8,533	\$108,287	\$25,274
6	\$73,935	\$14,850	\$123,223	\$36,112
7	\$75,615	\$14,850	\$126,024	\$36,112
8	\$77,295	\$14,850	\$128,826	\$36,112

Sources: (American Incomes, 2009) (U.S. Department of Health and Human Services, 2011)

Moderate-income households may have enough discretionary income over the course of a year to cover the 25% or more co-payment, but this will require them to save. If moderate-income households have discretionary incomes, they

then should be able to build up unrestricted savings⁵ that they could then use for the Mass Save co-payment. However, for most families the process of saving, especially moderate-income ones, will have to compete with other discretionary expenditures. According to the publication *American Incomes*, in 2007 the top discretionary expenditures were:

1. Entertainment
2. Dinner at full service restaurant
3. Cash contributions to a religious organization
4. Non-payroll deposits to retirement plans
5. Alcoholic beverages
6. Cash gifts to people in other households
7. Airline fares
8. Lodging on trips
9. Tobacco and smoking products
10. Lunch at a full service restaurant

(2009)

Reviewing Table 2 and Table 3 again, one could reasonably conclude that if a moderate-income family with children goes out to dinner and a movie once per week or takes a trip that includes air fare once a year, discretionary income and savings can be reduced very quickly, leaving little if any money for energy efficiency measures.

Determining unrestricted savings, like discretionary income is difficult. This is especially true for low- and moderate-income households, because these households often do not have formal savings accounts. For households with incomes between \$35,000 and \$50,000, less than half of them have at least \$500 in savings for emergencies (Lopez-Fernandini, 2010). The personal savings rate in

⁵ Unrestricted savings are savings that accessible for discretionary use such as a savings account. Restricted savings on the other hand are savings that are not readily accessible, those savings that have restrictions on withdraw like a 401k, 529 college savings fund, an IRA, etc. (Lopez-Fernandini, 2010).

the U.S. had been declining steadily from the 1970s when it was around 10% until 2008 when it was around 2.5% (Federal Reserve Bank of St. Louis, 2011). This holds true even when it comes to more affluent households. Less than 30% of households making more than \$100,000 have enough saved to cover three months of their expenses. In addition, the number of low- and moderate-income households with no savings safety net is growing (Lopez-Fernandini, 2010).

The implication of these studies on discretionary income and savings is that moderate-income households likely have some discretionary income, and some of them even have some unrestricted savings. However, the question still remains at what income level households above 60% of SMI have enough income or savings to participate in the energy efficiency services offered by Mass Save. It is also clear that family size, race and ethnicity, and where a family lives also affect household discretionary income levels.

An analysis of the Crittenton Women's Union's Massachusetts Economic Independence Index (Mass. Index) can provide further insight in helping to answer this question. The Mass. Index does not provide calculations of actual household incomes, but rather an index of what a specific household needs to earn without subsidies in order to be healthy, safe and meet their most basic needs (Crittenton Women's Union, 2011). The Mass Index, in contrast to indexes like the Federal Poverty Level (FPL) and the calculations of discretionary income used in Table 2, provides for variations in expenditures by location and family composition. The index is available for the entire state of Massachusetts, each county and for the city of Boston. The index calculates the income 410 different

family sizes/types need to be economically independent. For these calculations the index assumes that all adults work full time and that all adult workers are part of employer-sponsored health insurance (Crittenton Women's Union, 2010)⁶. The calculations in the Mass. Index do not include any unrestricted savings or discretionary income, or in other words the index does not include funding that households could put toward the Mass Save co-payment.

By using incomes listed in the Mass Index and adding \$666, the amount a household needs to contribute to receive the full \$2,000 incentive offered by Mass Save's insulation rebate program, to each family type's annual income, the lowest income necessary for each family type can be determined. The annual income needed by each family type can then be compared to the corresponding SMI⁷ and it can be determined at what percentage of SMI each household type can afford to cover the co-payment needed to participate in the Mass Save insulation rebate program. Table 4 provides a few examples of different three and four member family types. This does mean that households will have to save \$55.50 each month and that saving that amount would have to take precedence over all other discretionary expenditures.

⁶ Full details of the methodology behind the Mass. Index analysis please see Appendix I.

⁷ The SMI was calculated from the LIHEAP Fiscal Year 2009/2010 income requirements table for Massachusetts (U.S. Department of Health and Human Services, 2011)

Table 4: Example of Mass Index Analysis

Family Type Makeup	Adult Preschooler Schoolage	Adult Infant Preschooler Schoolage	2 Adults Schoolage	2 Adults Infant Preschooler	2 Adults Preschooler Schoolage
Annual Wage Needed	\$61,618	\$83,844	\$52,700	\$72,728	\$68,751
Annual Wage Plus Mass Save Co-Pay	\$62,284	\$84,510	\$53,366	\$73,394	\$69,417
SMI for Family Size	\$78,415	\$93,352	\$78,415	\$93,352	\$93,352
Annual Wage as % of SMI	79.43%	90.53%	68.06%	78.62%	74.36%

Sources: (Crittenton Women's Union, 2010) (U.S. Department of Health and Human Services, 2011)

Some households are able to cover the co-payment at 47% of SMI, while other households would not be able to do so until they reach 128% of SMI. The average point at which households become able to participate is 86.65%. This means somewhere between 60% and 128% of SMI households in Massachusetts become financially able to participate in the Mass Save insulation rebate program.

As stated before this means that these moderate-income households would be putting the investment in energy efficiency before all other discretionary expenditures, while households that make less than 60% of SMI do not have to pay anything for similar energy efficiency measures and households that make greater than 128% of SMI can more readily participate in Mass Save.

The lower threshold for moderate-income households has already been determined by WAP's upper cutoff point of 60% of SMI. The upper threshold, on the other hand, remains undefined. A 2002 report conducted for the Maine State Planning Office by Hart Energy Consulting defines moderate-income households as households that have limited incomes, yet have enough income to cover their living expenses (Hart, 2002). As noted before, the National Housing Conference

defines moderate-income homeowners as those with incomes between 80 and 120% of the national median income⁸ (Cohen, Richardson, & Lubell, 2009). The report *Income, Energy Efficiency and Emissions* by the Energy Programs Consortium uses the term middle-income households, which the report defines as those households that have incomes between 80 and 120% of SMI. The report also notes that these cut-off points are already being used to determine eligibility for some government programs, in the Census and in statistical analysis (2008).

According to a 2010 issue brief⁹ by the Green Justice Coalition, many households in Massachusetts do not reach an income level that provides the discretionary income until they reach 120% of SMI (Green Justice Coalition, 2010). There are currently several programs in the state and around the country that are already targeting this moderate-income demographic or segments of this group. With all of these factors combined and the Mass Index analysis, 120% of SMI is a reasonable upper bound for defining moderate-income households. By setting the income range of 60 to 120% of SMI for moderate-income households it captures most of the households in Massachusetts that while able to afford their monthly expenses have little to no discretionary income.

Barriers like a lack of information/knowledge, unguaranteed savings, preweatherization repairs, split incentives and financial discussed earlier in this chapter have helped to inhibit the more wide scale adoption of energy efficiency

⁸ The report defines moderate-income households as those with between 80 and 120% of SMI, because their household incomes are too high to qualify for WAP, yet too low to cover the upfront costs of energy efficiency measures in their homes (Cohen, Richardson, & Lubell, 2009).

⁹ This issue brief is based in part on research that I participated in during an internship in the summer of 2010 and the preliminary basis for some of the research in this thesis.

measures in homes across all incomes. The financial barrier, however, presents a greater challenge for moderate-income than it does for high-income households. The income of these households is too high to qualify for low-income programs that offer free weatherization services and allows little opportunity for them to save the upfront co-payment often required for many energy efficiency programs.

Chapter 3: Targeting Moderate-Income Households

It is well documented how the barriers laid out in the last chapter have in part prevented greater participation in energy efficiency and how the financial barrier is more difficult for moderate-income households to overcome. What is less well documented is the potential for energy savings in moderate-income households compared to high-income households. There are, however, programs around the country that are targeting their efforts at reaching moderate-income households.

Market Need and Potential

What is the potential for energy savings in the moderate-income household segment of the market? According to a 2002 report produced for the Maine State Planning Office by Hart Energy Consulting, moderate-income households are less likely to take proactive steps to reduce their energy consumption, because they have little disposable income to spend on energy efficiency measures. Yet like in the low-income sector there are energy savings to be gained by investing in energy efficiency measures in the moderate-income sector (Reducing Household Energy Consumption in Maine).

Obviously there are energy savings to be gained from improving the energy efficiency of the homes of every income sector. In the low-income sector the CAAs provide fully subsidized weatherization assists to households whose incomes fall below 60% of SMI and helps these households become more energy efficient and hopefully more economically stable. The report *Income, Energy Efficiency and Emissions* by the Energy Programs Consortium states that actual energy savings potential in the low-income housing sector are higher than perceived by policy makers (2008). Is the same true for moderate-income households?

The Energy Programs Consortium report goes on to compare low-income households, which they classify as up to 80% of SMI, to high-income households, those with incomes over 120% of SMI. The report concludes that while low-income households use less energy overall they use more per square foot, mainly because they live in older less efficient homes, have fewer appliances and the appliances they do have tend to be older and less efficient. Because of these factors low-income households have a great potential for energy savings; however, unlike high-income households low-income households need assistance to achieve the potential (2008). McKinsey & Company makes the same point in their report *Unlocking Energy Efficiency in the U.S. Economy*, stating that low-income households have a higher rate of consumption and potential for savings when compared to non-low-income households. The reason that low-income households use less energy on a per house basis is that on average they live in smaller homes (2009). The Hart report makes a similar case in Maine, stating that

much of the energy efficiency work in Maine will be done by those households that can afford to upgrade their homes and appliances without intervention or assistance, but low- and moderate-income households will need to be assisted and targeted (Reducing Household Energy Consumption in Maine, 2002). While the Energy Programs Consortium report mentions moderate-income households and includes data for this income segment throughout the report, the focus is comparing the low-income and high-income sectors and advocating for greater attention to be paid to low-income households.

Data shows that in a typical household up to 80% of energy use comes from space and water heating. The biggest potential for energy savings in most homes comes from improving the efficiency of the building's envelope and its heating and water heating systems. Because low- and moderate-income households tend to have fewer energy using appliances and devices than high-income homes, the percentage of energy use from heating and hot water could be even greater (Hart, 2002). Using the data from the Energy Programs Consortium, Table 5 compares total energy usage for each income group by the average square footage of each group's home. The results show that households that have incomes over 120% of SMI do use more total energy, but by square footage they use 8.75% less energy than the average household, 23.54% less than the average low-income household and 22.61% less than the average moderate-income household. These results speak further to the point that low- and moderate-income households live in homes that are less efficient than high-income households.

Table 5: Estimated Massachusetts Household Energy Usage

SMI Group	Number of Households	Total Usage in Billions of BTUs	Percentage of Total MA Energy Use	Usage Per Household in BTUs	Average Household SqFt¹⁰	BTUs Per SqFt
State Wide	2,452,599	282,716	100.00%	115,272,003	2,236	51,553
0 – 60%	739,096	73,532	26.01%	99,489,106	1,617	61,527
60 – 120%	693,046	70,063	24.78%	101,094,300	1,663	60,790
>120%	1,020,457	139,121	49.21%	136,332,055	2,898	47,043

Source: (Energy Programs Consortium, 2008)

If the energy usage per square foot and the potential for energy savings per square foot are higher in moderate-income households than in the high-income households, then it would be appropriate to target or at least ensure these households are participating in energy efficiency programs at a rate commensurate to other income groups. If the Hart report is correct that higher income households are undertaking energy efficiency measures on their own without assistance, then the efforts of the non-low-income program need to be concentrated on reaching moderate-income households.

The NMR Group, Inc. recently published a report for the Gas Networks evaluating the process and impact of the Gas Networks’ Residential High Efficiency Heating and Water Heating Equipment Program (HEHE). The program operated in Massachusetts, Maine, New Hampshire and Rhode Island and provided residential customers with rebates for installing high-efficiency gas water heating and heating equipment, as well as provided training and education to contractors (HEHE Process and Impact Evaluation, 2010). The report surveyed

¹⁰ The average household size for the Northeast region was used, because this information was not supplies at the state level in this report.

participants of the program to find out why they were participating and compared them to the general population to find out demographically who was participating. The surveys revealed that the high up-front cost of more efficient equipment was a barrier preventing them from purchasing the high-efficiency equipment; yet most participants responded that they would have installed the high-efficiency equipment even without the rebates (NMR Group, Inc., 2010). These participants are free riders,¹¹ and the free ridership rates for the various measures in this program ranged from 50 to 73% (NMR Group, Inc., 2010).

While the HEHE evaluation focuses on a narrow set of measures, the report notes that the free ridership findings are consistent with findings from other reports conducted in other states (NMR Group, Inc., 2010). The HEHE evaluation also reports on the demographics of participants, which help to inform who is participating.

The report found that program participants tend to be older and wealthier than the population as a whole, and more often they do not rent and reside in a standalone single-family home. Table 6 shows the comparison between the population as a whole and program participants.

¹¹ In an earlier report the NMR Group, Inc. defines free ridership as the percentage of energy efficiency measures that would have been installed by participants without the program's incentives (NMR Group, Inc., 2005).

Table 6: HEHE Participant Demographics

Statistic	Population as a Whole	Program Participants
Incomes Less Than \$50,000	29%	11%
Incomes Greater Than \$150,000	5%	11%
Rent Their Home	18%	1%
Live in a Single Family Detached Home	65%	84%
Have a College Degree	24%	32%
Under 45 Years of Age	27%	19%

Source: (NMR Group, Inc., 2010)

There is evidence that there are free riders, especially for some program measures and that they are more likely to higher-income households. This demographic data also seems to imply that moderate-income households may not be as heavily represented among participants in the current programs.

With 80% of household energy use coming from space and water heating, it is logical to design programs like HEHE to target improving the efficiency of the equipment used to heat both water and living space in homes. There, however, is a flaw in the design of programs if not all of the households in the non-low-income program are able to participate in the program. Designing programs that target moderate-income households that use more energy per square foot than high-income households and tend to live in older homes with older heating equipment would also seem logical.

Targeting Moderate-Income Households

Though the data on discretionary income and energy savings potential in moderate-income homes is not complete nor conclusive, there are energy efficiency programs across the country that have been designed to target these households. A review of some of these programs will show that the programs

presume some of the financial barriers described above for this income group and may provide lessons for future programs in Massachusetts.

In Massachusetts, ReNew Boston was the first program to use funding secured through the city of Boston's Energy Efficiency and Conservation Block Grant (EECBG)¹² in conjunction with the Mass Save insulation rebates (City of Boston, 2011). ReNew Boston offers residents in Boston whose incomes fall between 60 and 120% of SMI \$2,600 toward insulation and air sealing (City of Boston, n.d.). The Green Homes Brookline program has been set up by the city of Brookline to mimic the ReNew Boston program (Climate Change Action Brookline, n.d.).

The Oil Heat Efficiency Program (OHEP) is a program administered by Conservation Services Group (CSG), LEAN and the Massachusetts Oilheat Council (MOC). The program is a \$1.7 million rebate program funded by ARRA to replace old (>20 years) oil heating systems with new more efficient oil heating systems. Rebates of up to \$4,000 are provided to homeowners in one to four family residences whose incomes are between 60 to 120% of SMI (Conservation Services Group, n.d.).

Outside of Massachusetts there are also programs that have or are targeting moderate-income households in Wisconsin, New York, Maryland, Illinois, Berkeley and Richmond, CA, and in Kitsap County, WA.

¹² EECBG is a competitive/formula grant based on the Department of Housing and Urban Development's Community Development Block Grant. The ARRA allocated \$3.2 billion toward EECBGs for energy efficiency and conservation programs (U.S. Department of Energy, 2010).

In Illinois the Energy Efficiency Trust Fund (EETF) was established by the Renewable Energy, Energy Efficiency, and Coal Resources Development Law of 1997, to promote residential energy efficiency. In 2009, the EETF allocated funding for the Illinois Energy Efficient Affordable Housing Construction Program that helps local governments and non-profits that develop housing cover the additional costs associated with undertaking energy efficiency measures (Illinois Department of Commerce and Economic Opportunity). The program provides \$4,500 per unit for retrofits and \$4,000 per unit for new construction, and is designed to target low- and moderate-income households in affordable housing projects where income does not exceed 80% of AMI (Illinois Department of Commerce and Economic Opportunity, 2009).

In Milwaukee, the Wisconsin Energy Conservation Corporation (WECC) ran a pilot program called Together We Save that targeted low- to moderate-income homeowners. For the pilot two neighborhoods were selected because they were known to have low- to moderate-income households and a homeownership rate of at least 50% (Kraft & Schauer, 2010). Once a homeowner's application was approved they were assigned a locally hired Energy Advocate who conducted an initial walk-through audit of the home. The Energy Advocate's job was to help walk the homeowner through the process, provide information about energy efficiency and provide language translation if necessary. After the initial walk-through a more in-depth energy audit was conducted, which could include a blower door test. The consultant that performed the audit also submitted a report to both the homeowner and the administrator of the program with

recommendations and estimated costs to perform the work (Kraft & Schauer, Together We Save, 2010).

The Energy Advocate was again there to help the homeowner understand the report and the process moving forward. The homeowner’s cost to perform the work was determined by a sliding scale based on their household income (Kraft & Schauer, 2010).

Table 7: provides a breakdown of the sliding scale and compares them to the SMI for Massachusetts. This comparison shows that the Together We Save program covered at least 75% of the project cost up to 70% of SMI and 50% of the project cost above that.

Table 7: Comparison of Together We Save Sliding Scale and Massachusetts Incomes

Income Ranges as a % of the FPL	% of Cost Paid by Program	2009 FPL Income Ranges for MA	% of MA SMI¹³
<200%	100%	<\$36,624	<46.71%
201% - 250%	90%	\$36,625 – 45,780	46.72 – 58.38%
251% - 300%	75%	\$45,781 – 54,936	58.39 – 70.06%
>300%	50%	>\$54,937	>70.07%

Sources: (Kraft & Schauer, Focus on Energy Evaluation, 2010) (U.S. Department of Health and Human Services, 2011) (2009 MassHealth Income Standards and Federal Poverty Guidelines, 2009)

If the homeowner decided to move forward with the recommendations in the report a pre-selected contractor was assigned to the job once the homeowner had contributed 75% of their cost. Financing was also provided as an option for those homeowners who did not have the upfront capital to pay their portion of the work. If for some reason the homeowner decided not to move forward they were

¹³ The income level for a household of three was chosen for comparison because the average household size in Massachusetts is 2.54 and the average family size is 3.17 (U.S. Census Bureau, 2005 - 2009).

charged a \$150 fee to help cover the cost of the audit (Kraft & Schauer, Together We Save, 2010).

Table 8: Together We Save Participant Households by Income Groups

Income Range % of FPL	% of Coast Paid	Number of Households	Average Program Contribution	Average Participant Contribution
<200%	100%	24	\$8,679	\$0
201% - 250%	90%	13	\$4,721	\$525
251% - 300%	75%	1	\$3,596	\$1,199
>300%	50%	13	\$2,310	\$2,310

Source: (Kraft & Schauer, Focus on Energy Evaluation, 2010)

Table 8 shows the number of households participating in each income group and the average retrofit cost to both the program and to the participant. Only the one household in the 251 – 300% of FPL group most likely falls in to the moderate-income household range, and it remains unclear how many of the 13 households in the >300% of FPL group, if any, are moderate-income households. Regardless of how many of the households in these upper two income groups are moderate-income households, on average they had to contribute more than the co-payment required by Mass Save, and on average they received a greater financial contribution. It is also interesting to note that the two lower income groups had more participants than the two higher income groups.

In New York State, the Home Performance with Energy Star program offers additional assistance to households who make up to 80% of Area Median Income (AMI)¹⁴. Income is verified by pay stubs and other documents. Incentives

¹⁴ It is possible that AMI could be different from SMI, especially in places like New York City where the cost of living and wages are higher than in other parts of the state.

are up to 50% of the cost of energy efficiency improvements, with a maximum of \$5,000 for single family homes and \$10,000 for some multi-family buildings.

Renters are also eligible for assistance (New York State, n.d.).

The EmPOWER Clean Energy Communities Grant Program in Maryland, run by Maryland Energy Administration (MEA), uses Strategic Energy Investment Funds (SEIF) to target moderate-income households for energy efficiency measures. Each county in the state is allocated a percentage of these funds based on that county's percentage of low- to moderate-income households (Maryland Energy Administration, 2007). For this program moderate-income households are defined as households with incomes between 60 and 85% of SMI (Fisher, 2011). Grants are awarded local governments and non-profits on a competitive basis in each county. The program has a maximum allowable expenditure per home of \$8,000 with HVAC replacement or \$5,000 for measures that do not include replacement of the HVAC (Maryland Energy Administration, 2007).

Each grantee decides how they want to verify the incomes of its participants, whether that is by pre-selection through partner organizations like Habitat for Humanity, a signed statement by the household that the income of the household falls within the allowable range, or by document verified earnings such as pay stubs and tax returns. Each grantee program is also reviewed by a MEA hired Evaluation Measurement and Verification (EM&V) contractor to ensure that the program is in compliance with the income qualifications (Fisher, 2011).

The EmPower program was developed in part because the targeting of low- and moderate-income households is required by the state's Regional Greenhouse Gas Initiative (RGGI) regulations. To comply with the regulations some of the proceeds from RGGI are being allocated to the SEIF grants (RGGI, Inc., 2011). State law requires that 8.75% of the proceeds from CO₂ auctions are set aside for low- and moderate-income households for auctions conducted between March 1, 2009 and June 30, 2012 and 23% for auctions that were conducted before those dates and any auctions after those dates (RGGI, Inc., 2011).

Officials in the state also recognized that many low- and moderate-income families are renters, who have traditionally been excluded from past weatherization programs. Through the creation of the Multi-Family Energy Efficiency Housing Affordability (MEEHA) Program the state is targeting the retrofitting of apartment units of low- and moderate-income families (RGGI, Inc., 2011).

Similar to Maryland's laws regarding RGGI proceeds, New Jersey law requires that 20% of the Global Warming Solutions Fund is used for bill payment assistance for low- and moderate-income households. The program is also using marketing materials to target these income groups to educate them about current energy efficiency programs and ways these households can reduce their utility bills. This program considers 400% of the FPL is the upper bound for low- and moderate-income households. (RGGI, Inc., 2011). Comparing 400% of the FPL to the previous sources for Massachusetts the result for a household of three

people would be \$73,248 in annual income (2009 MassHealth Income Standards and Federal Poverty Guidelines, 2009) or 93.4% of the SMI (U.S. Department of Health and Human Services, 2011).

On the other side of the country in Kitsap County, Washington, Kitsap Green has established a revolving loan fund program. The program is run by the Kitsap County Energy Conservation Committee and is targeted at moderate-income households (Salamack, Kitsap Green Jobs Weekly Update, 2010). According to Autumn Salamack, the Resource Conservation Manager, the county's low-income program has been very successful over the last 30 years and the Committee wanted to take the next step and target moderate-income homeowners by building off of that success. In addition, the design of Kitsap Green was influenced by the 2009 *Recovery Through Retrofit Report* released by the White House's Middle Class Task Force Council on Environmental Quality. Ms. Salamack referenced the report findings that many of the same barriers mentioned before in this thesis are preventing middle-class households from making energy efficient improvements on their homes and that these barriers need to be addressed at the state and local levels (Salamack, Resource Conservation Manager, 2011).

Kitsap Green's revolving loan program was established with a local credit union through EECBG funds from the Kitsap County and the city of Bainbridge. The program has also established a loan loss fund and is set up to continue without further funding. To qualify for a subsidized loan the household income of applicants must fall between the upper WAP threshold (60% of AMI) and 120%

of AMI (Salamack, Kitsap Green Jobs Weekly Update, 2010). The upper threshold was set at 120% of AMI because the incomes in the northern end of Kitsap County are influenced by the city of Seattle and the program wanted to find a range that would serve all areas of the county (Salamack, Resource Conservation Manager, 2011).

In Berkeley and Richmond, California the GETS Energy Services is a partnership between the two cities and the Rising Sun Energy Center. The GETS program is also targeting moderate-income households (Rising Sun Energy Center, n.d.). The program is funded in part by ARRA funds (Office of Energy and Sustainable Development, n.d.). Rising Sun Energy Center is a non-profit green workforce training organization that is in charge of the program delivery. Households located in prequalified Census Tracts in the south and west of Berkeley are automatically qualified for the program, and households outside these neighborhoods must meet the program’s income requirements (Rising Sun Energy Center, n.d.).

Table 9: Berkeley Income Requirements

# of Persons per Household	Low End of Threshold	High End of Threshold	High End % of SMI
1	\$29,791.32	\$75,960	153%
2	\$29,791.32	\$86,760	134%
3	\$48,124.44	\$97,560	122%
4	\$57,291.00	\$108,360	113%
5	\$65,077.16	\$117,120	106%

Source: (Rising Sun Energy Center, n.d.)

Table 10: Richmond Income Requirements

# of Persons per Household	Low End of Threshold	High End of Threshold	High End % of SMI
1	\$38,148.68	\$71,450	144%
2	\$38,148.68	\$71,450	110%
3	\$47,124.84	\$80,350	100%
4	\$56,101.00	\$89,300	94%
5	\$65,077.16	\$96,450	87%
6	\$74,053.32	\$103,600	82%

Source: (Rising Sun Energy Center, n.d.)

Table 11: California LIHEAP Income Requirements

# of Persons per Household	LIHEAP Income Thresholds (60% of SMI)	100% of SMI
1	\$29,791.32	\$49,652.20
2	\$38,957.88	\$64,929.80
3	\$48,124.44	\$80,207.40
4	\$57,291.00	\$95,485.00
5	\$66,457.56	\$110,762.60
6	\$75,624.12	\$126,040.20

Source: (State of California, 2007)

The lower bound of the requirement is 60% of SMI in Berkeley and slightly lower in Richmond, while slightly lower in Richmond, while the upper threshold reaches as high as 153% of California's SMI for California's SMI for some household types (see

Table 9

Table 10 and Source:

Table 11). In Berkeley, the incentives range from \$250 to \$7,000 with participant co-payments ranging from \$300 up to \$5,000. In Richmond, the program requires a \$200 deposit, but covers the first \$5,000 of the project cost

with any additional costs above that being the responsibility of the participant (Office of Energy and Sustainable Development, n.d.).

Table 12: Review of Programs

Program	Income Target as Percentage of SMI	Incentive
ReNew Boston	60 - 120%	Covers the customer's 25% of the Weatherization Incentive
Green Homes Brookline	60 - 120%	Covers the customer's 25% of the Weatherization Incentive
OHEP	60 - 120%	\$4,000 rebate for oil heating system replacement
EETF	≤80% of AMI	\$4,500 for retrofits and \$4,000 for new construction
Together We Save	≤70%	Up to 75% and 50% above this point (tiered incentives)
Assisted Home Performance with Energy Star	≤80% of AMI	Up to 50% with a max of \$5,000 for single family and \$10,000 for multi-family
EmPOWER	60 - 85%	Up to \$8,000 with HVAC replacement or \$5,000 with out
New Jersey	≤93.40%	Marketing and outreach
Kitsap Green	60 - 120%	Low interest revolving loan fund
GETS Energy Services – Berkeley, CA	60 up to 153%	\$250 to \$7,000 incentive with \$300 to \$5,000 co-payment
GETS Energy Services – Richmond, CA	60 up to 144%	\$200 deposit with up to \$5,000 covered by program

While it is evident that there is a range of programs with different income scales and design, all of these programs have been specifically tailored to target moderate-income households. The attempt here was not to evaluate the different programs, their funding sources, design or efficacy in reaching the targeted households, but to establish that there are in fact programs across the country that are attempting to address the energy efficiency needs of moderate-income households. It is clear that there are at least some organizations and states that

have felt the need to design specific programs and the allocate funding to target moderate-income households.

The perceived need by the energy efficiency industry to target moderate-income households speaks further to the fact that all households not be treated the same with regard to energy efficiency programs. Moderate-income households will have a greater challenge overcoming the upfront cost of performing energy efficiency work in their homes. Providing additional assistance is important if Massachusetts want to create savings from the ¼ of the residential energy market that moderate-income households represent.

Chapter 4: Analysis of Participation on Cape Cod

The evidence laid out in the previous chapters suggests that moderate-income households do have some discretionary income, although the amount is limited. There are programs around the country and in Massachusetts that are targeting moderate-income households. Moderate-income households use more energy per square foot and tend to live in less efficient homes than high-income households. There is also evidence to suggest that higher income households are more likely to participate in energy efficiency programs. Yet what is still unknown is the rate at which moderate-income households are participating in Mass Save.

GIS Analysis

Mass Save does not collect income data on households that participate in its programs, making answering the question of moderate-income household participation difficult. There may be other ways to answer this question using data

that is available with tools like Geographic Information Systems (GIS). The following is a demonstration of the type of analysis that can be conducted to determine if there is discernable difference in participation levels between neighborhoods with different median incomes.

Existing income data from the U.S. Census Bureau and participant data from Mass Save programs can be used to conduct the analysis. Mass Save does have the addresses of the customers that have participated in their programs and a record of what measures were performed on each of these homes. This data can be imported into GIS and geocoded, a process by which each address is located on a street map. Census¹⁵ data like household income, race, educational attainment, number of housing units, housing unit occupancy, nativity and language spoken can also be imported into GIS at the block group level¹⁶. After both of these data sets have been imported into GIS they can be joined¹⁷ together spatially by block group. This allows the comparison of the joined data by block groups for a geographic area. While this methodology does not provide a household to household comparison, it has the potential to offer insight into trends and an overall picture of participation rates and participant demographics of the Mass Save program.

¹⁵ 2000 Census data was used, because the most recent 2010 Census is not fully available and the American Community Survey 5-year estimate includes income data only down to the tract level.

¹⁶ Block groups offer the finest grain view of the data, because the Census wants to protect the privacy of individual households. Block groups are drawn to encompass 600 to 3,000 people.

¹⁷ Joining is a process in GIS where by two sets of data are joined together either by matching fields in the data sets or by their matching locations geographically.

CLC has provided the addresses for the participants of the Mass Save program in the company's service territory from 2007 through July of 2010¹⁸. It is important to note that because CLC is only an electric utility serving Cape Cod and the Islands; the data provided does not include any information on natural gas energy efficiency measures that households in their service territory might have pursued through Mass Save. It is also important to note that for the purposes of this analysis that only HVAC and building envelope measures were included. These measures were included, because they often require a participant copayment. Other measures performed in participant households such as CFL light bulbs, audits, energy star appliance program and solar hot water program were excluded from the data set, because there was either no participant contribution required or the measures required very large customer contributions.

¹⁸ The original data set provided by CLC was filtered to include only building envelope and HVAC measures, which resulted in 2,722 households.

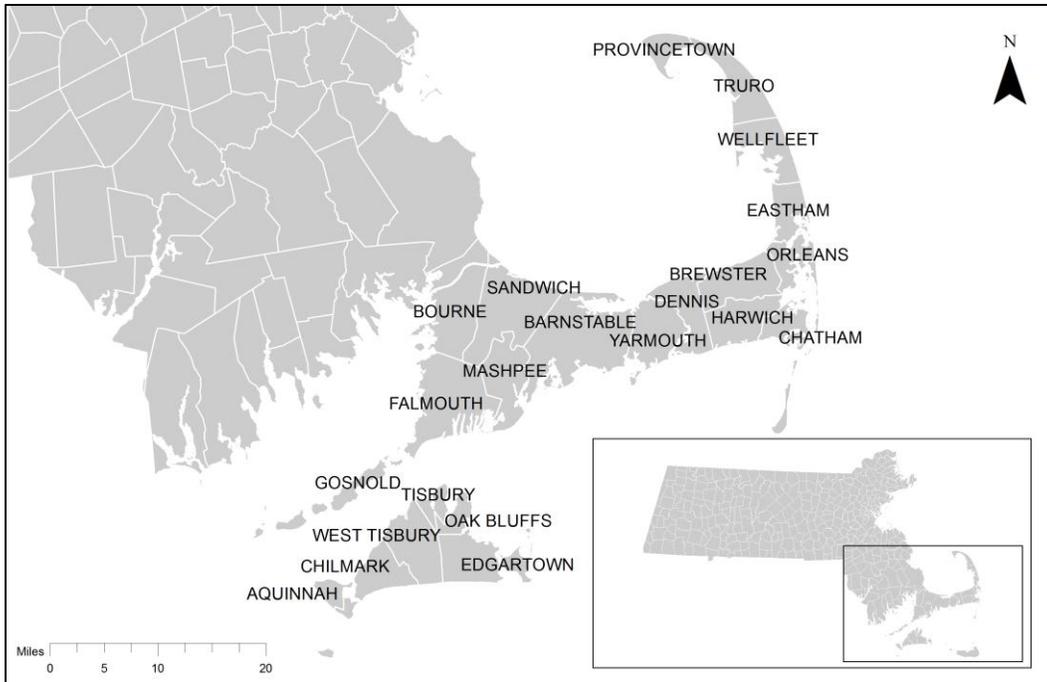


Figure 1: Area of Analysis

The locator map in Figure 1: shows the towns and area mapped in the analysis. Figure 2 show a few of the different maps that provide most interesting data as it relates to the question of income and participation¹⁹. For each of the maps the variables are shown by block group and are broken into quintiles. While these maps provide an interesting view of the CLC service territory individually, they provide little direct insight into the level at which moderate-income households are participating.

¹⁹ Additional maps and tables are located in Appendix II: Additional GIS Maps and Graphs.

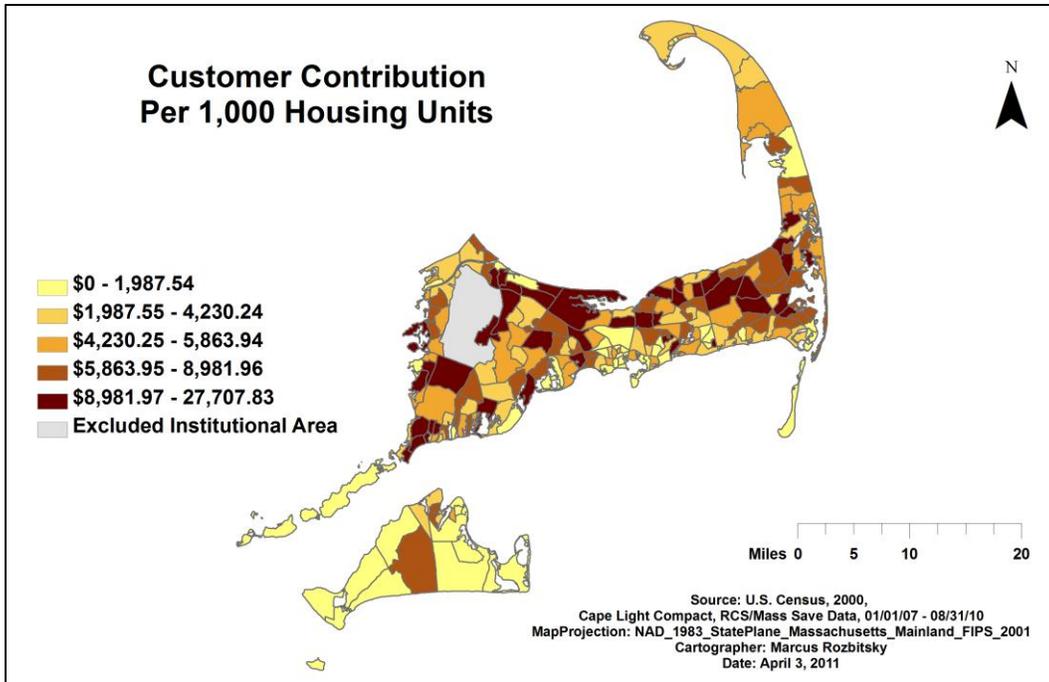


Figure 2: Customer Contribution per 1,000 Housing Units

The map in Figure 2 shows the amount of total customer contributions in each block group. The contributions of each block group has been normalized by 1,000 households for the map in Figure 2, to provide a more equal comparison across the block groups. In Figure 3 the map shows the total number of measures undertaken in each block group and has been normalized by 1,000 households for each block group. Figure 4 provides a map of the breakdown of the median income of each block group.

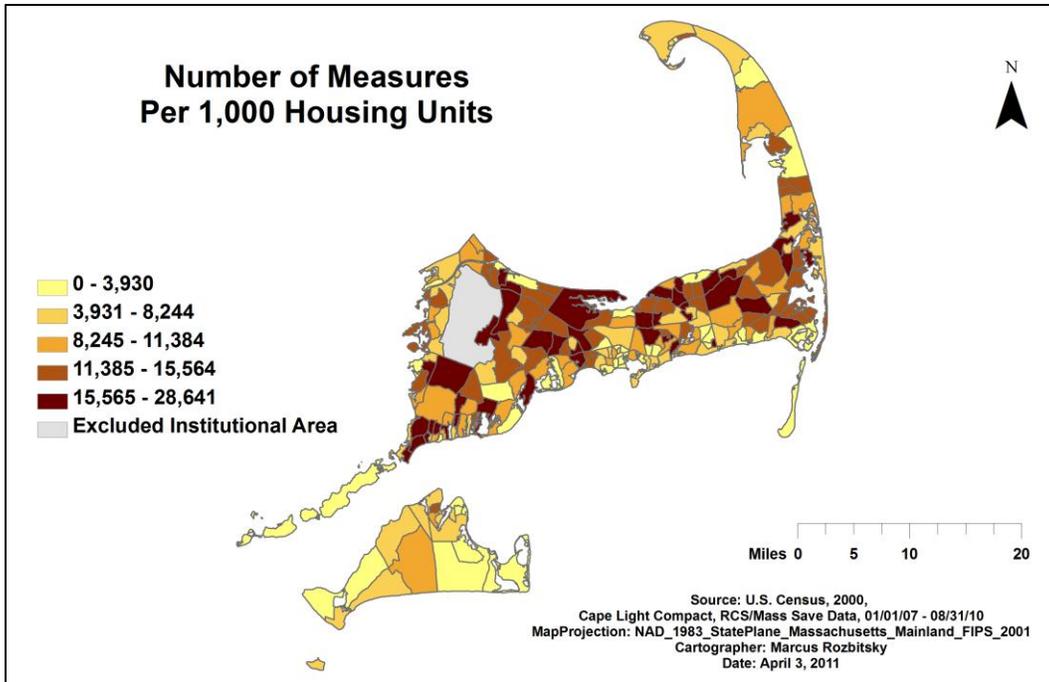


Figure 3: Number of Measures per 1,000 Housing Units

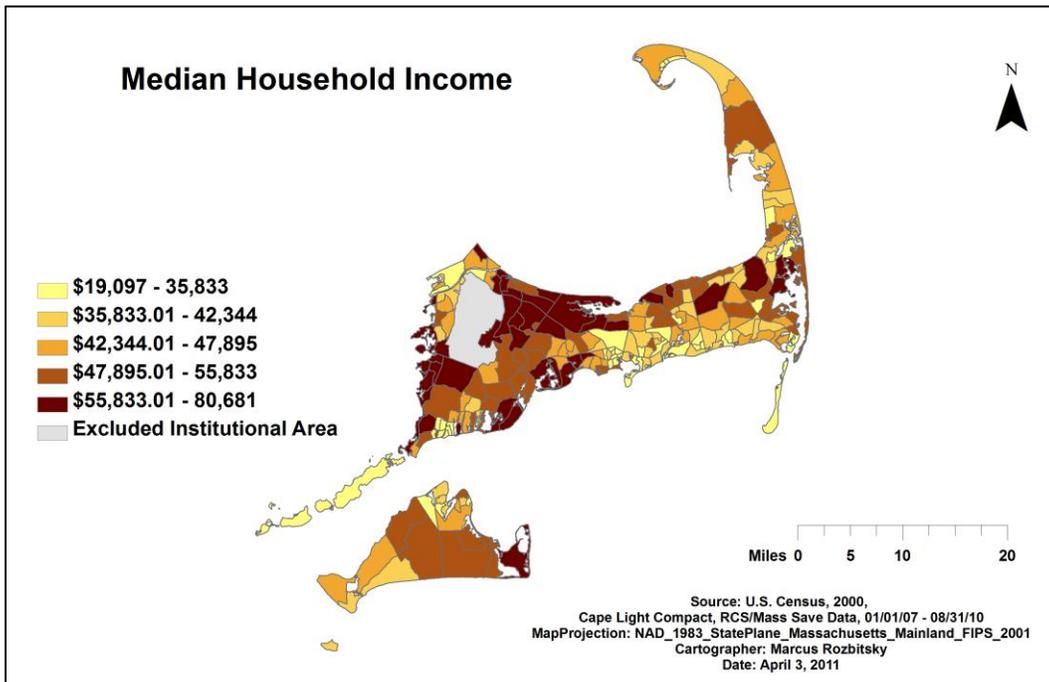


Figure 4: Median Household Income

The map in Figure 5 shows the percentage of owner occupied housing units. This map was produced, because the split incentives issues is a barrier to

participation, and because moderate-income families tend to rent their homes more often than they own them. Cape Cod, in addition, has a high rate of vacation/seasonal housing units which may or may not affect the participation rates of the units' owners.

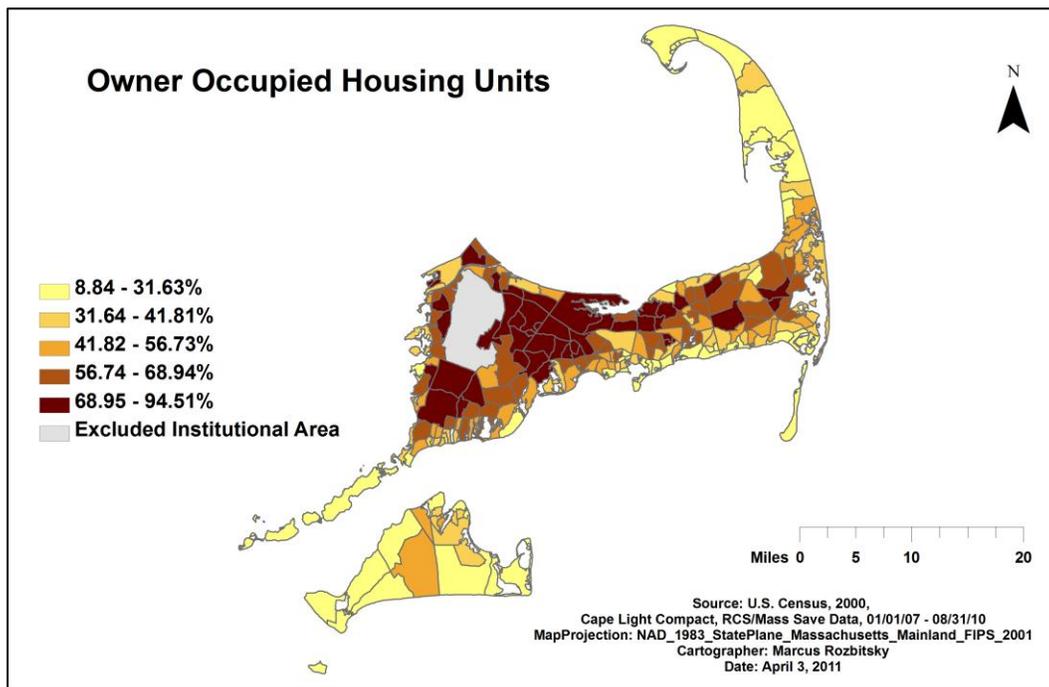


Figure 5: Owner Occupied Housing Units

Again, trying to gather useful information on the participation rates of moderate-income households by looking at these maps as well as those in Appendix II: Additional GIS Maps and Graphs is difficult. However, in the process of joining together the CLC participant data with Census block groups, a spreadsheet of the aggregated data is created. From this spreadsheet graphs comparing the different mapped variables can be created. Figure 6 through Figure 11 show the resulting scatter plot graphs. The trend lines in each of these graphs do show a correlation between the various attributes in a way that is consistent

with the premise that as income increases so does participation in energy efficiency.

In the block groups, as the median household income increases the number of kWh saved increase, as well does the number of measures and the customer contribution. The higher percentage of renters and vacation/seasonal housing units in a block group the fewer measures undertaken. Likewise the reverse is true; as the percentage of owner occupied units increases so does the number of measures. In each of these cases, however, the correlations between the two attributes is weak. Table 13 provides a list of the compared attributes and the R² values for each of the graphs' trend lines, in order of lowest correlation to highest. The strongest correlation among these graphs is the relationship between owner occupied units and the number of measures per 1,000 housing units, which has a R² value of just 0.2385, so even the strongest correlation is still weak.

Table 13: R² Values for Scatter Plot Graphs

Attribute Comparison	R² Value
kWh Saved Per 1,000 Housing Units by Median Household Income	0.0061
Number of Measures Per 1,000 Housing Units by the Percentage of Renter Occupied Units	0.0266
Number of Measures Per 1,000 Housing Units by Median Household Income	0.0730
Customer Contribution Per 1,000 Housing Units by Median Household Income	0.1220
Number of Measures Per 1,000 Housing Units by the Percentage of Vacation/Seasonal Units	0.1430
Number of Measures Per 1,000 Housing Units by the Percentage of Owner Occupied Units	0.2385

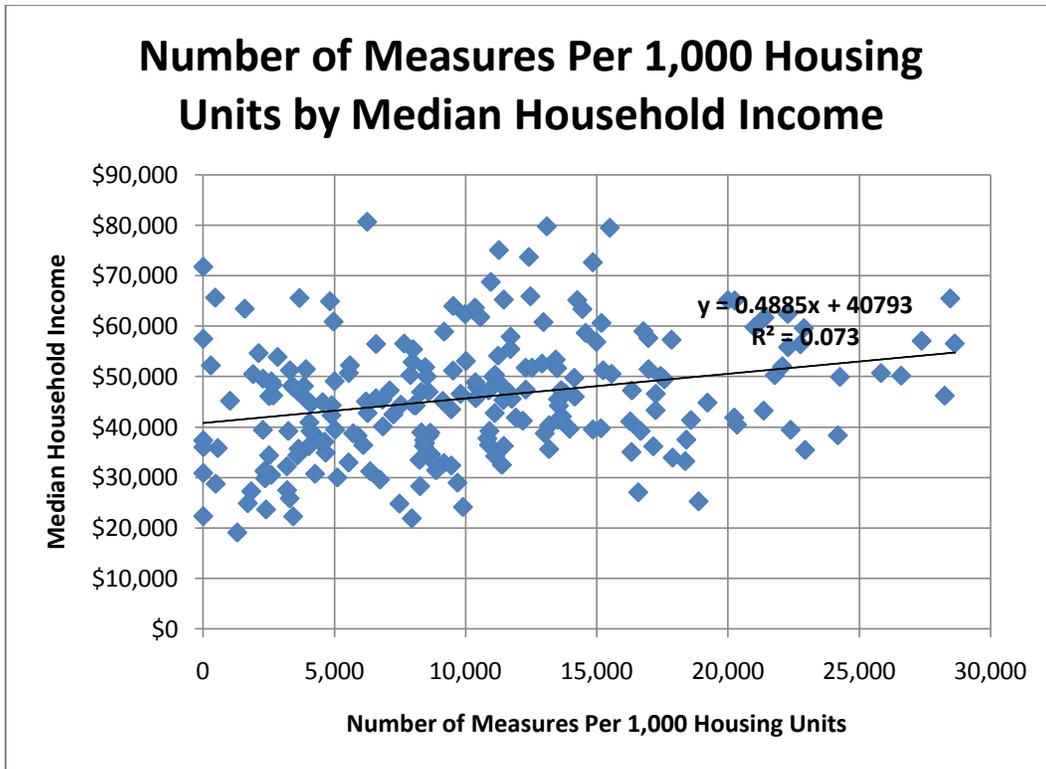


Figure 6: Number of Measures per 1,000 Housing Units by Median Household Income

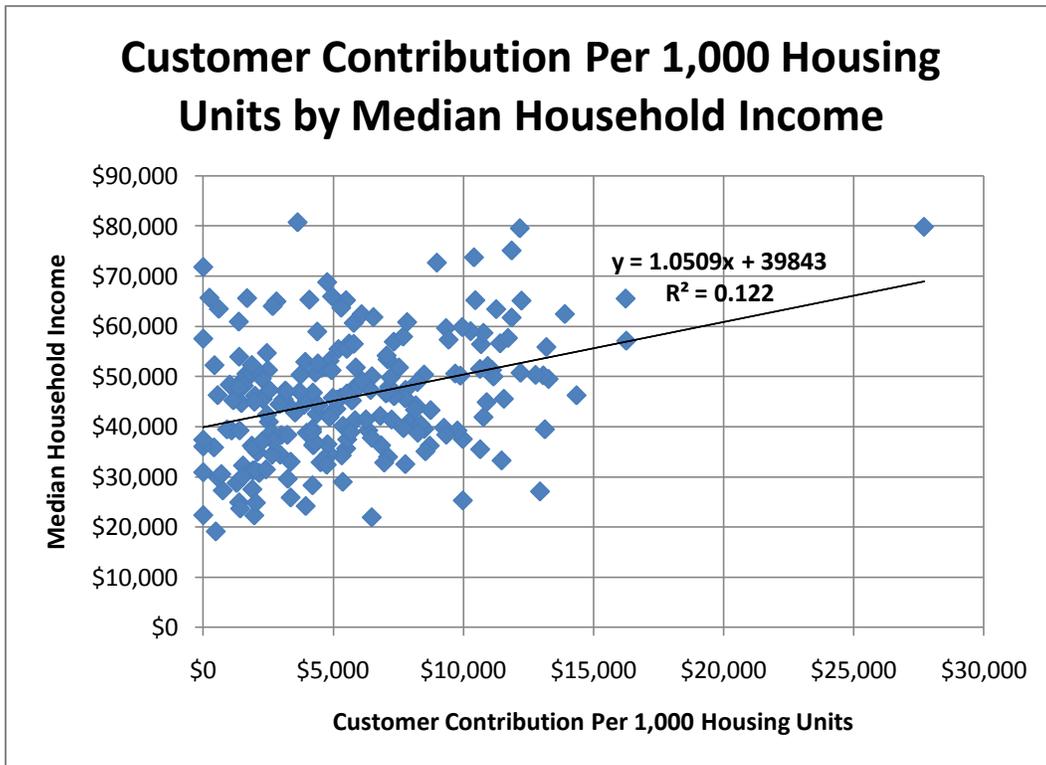


Figure 7: Customer Contribution per 1,000 Housing Units by Median Household Income

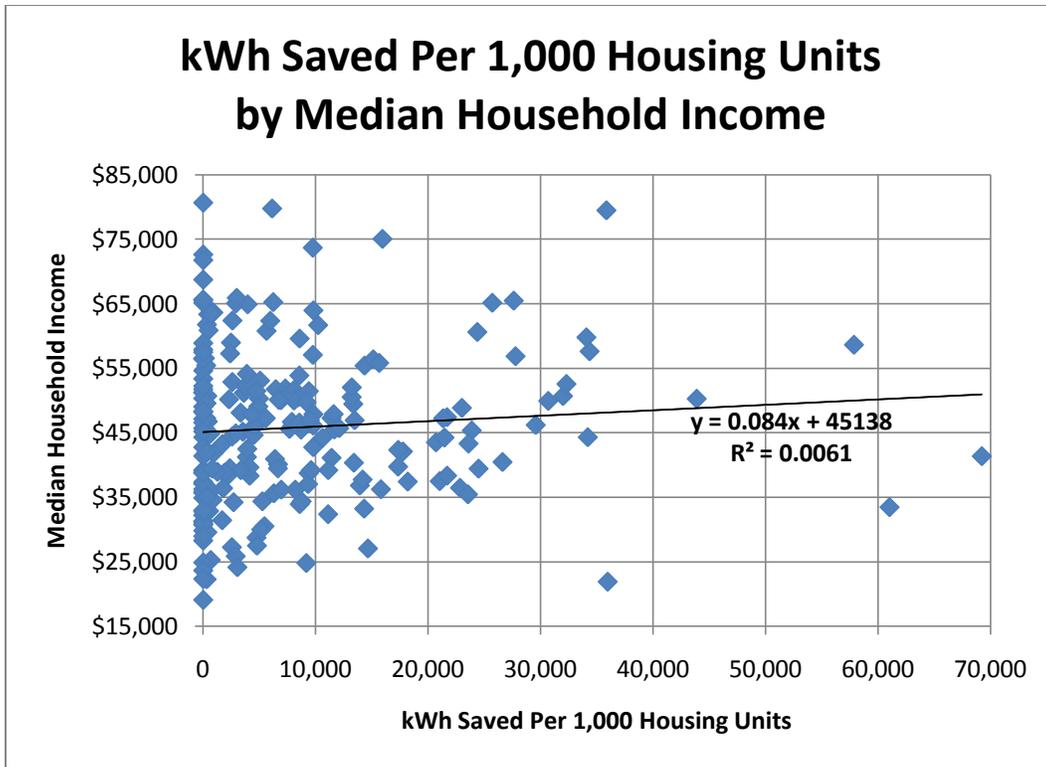


Figure 8: kWh Saved per 1,000 Housing Units by Median Household Income

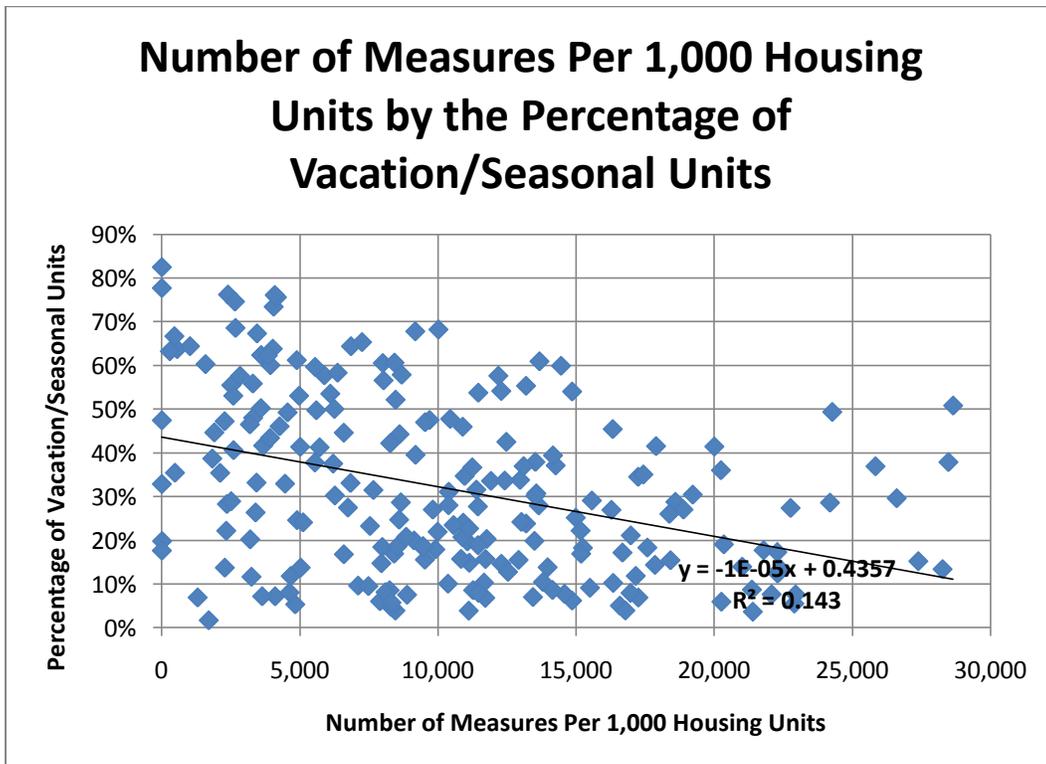


Figure 9: Number of Measures per 1,000 Housing Units by the Percentage of Vacation/Seasonal Units

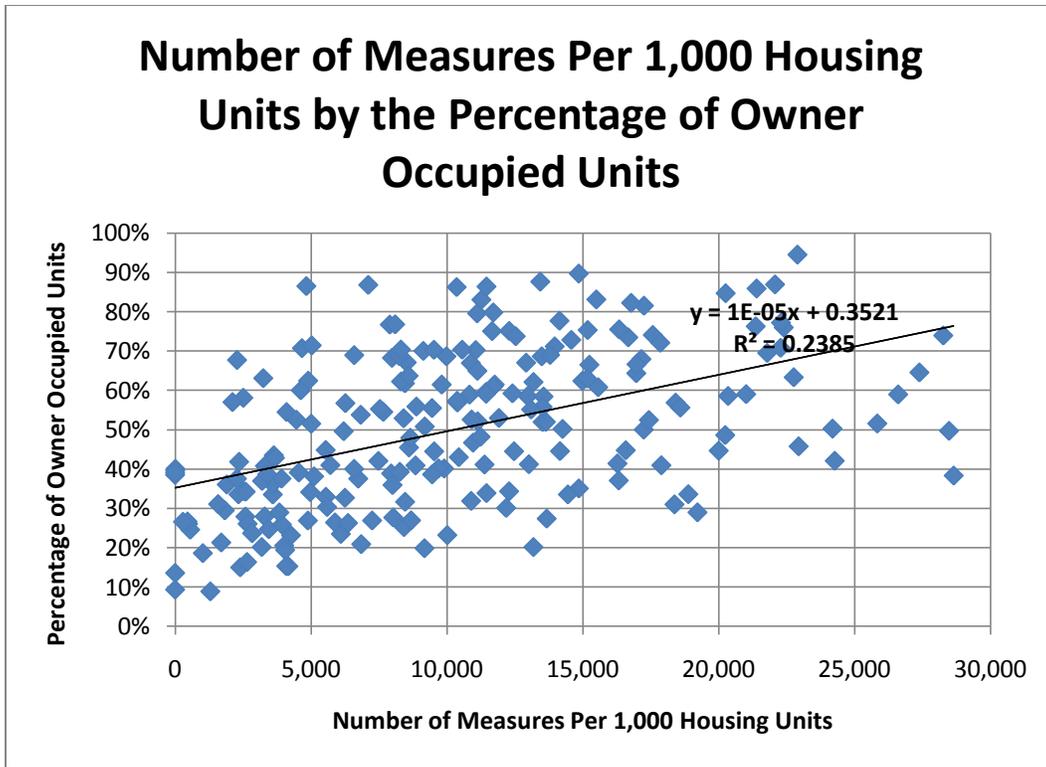


Figure 10: Number of Measures per 1,000 Housing Units by the Percentage of Owner Occupied Units

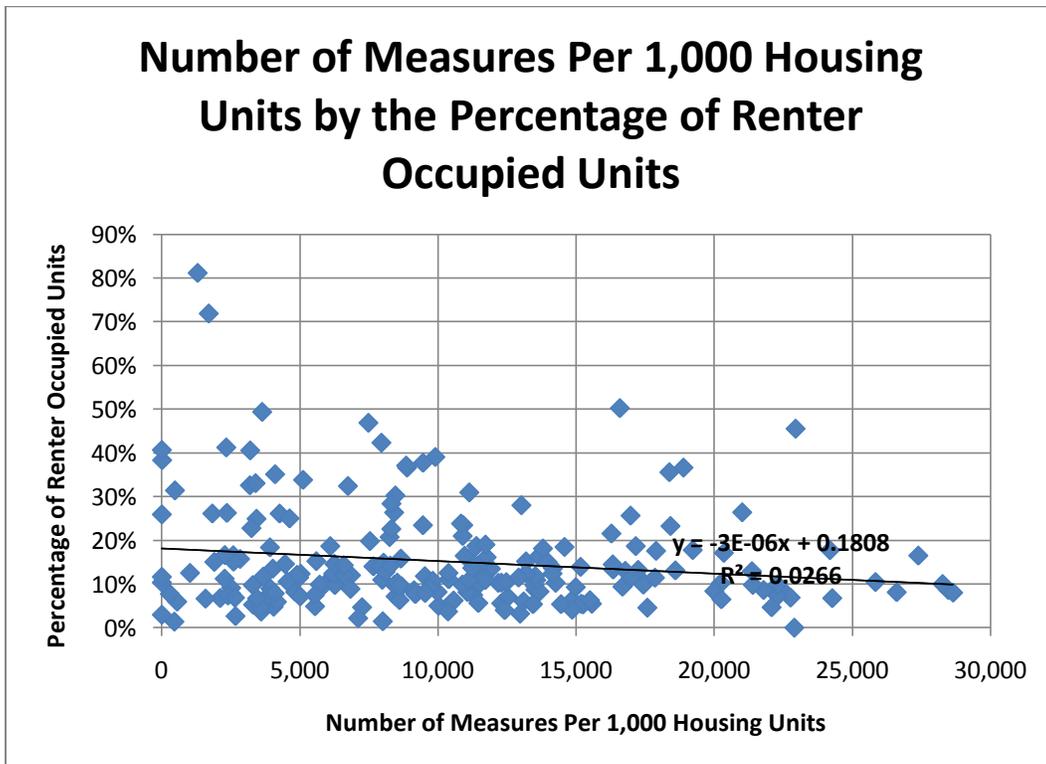


Figure 11: Number of Measures per 1,000 Housing Units by the Percentage of Renter Occupied Units

Using these methods of analysis, it cannot be stated with any certainty that income and home ownership has an effect on the participation rates in energy efficiency programs. It is important to reiterate a few details at this point. This analysis only looked at one portion of the state of Massachusetts and only the electricity utility participant data from the area. Cape Cod and the islands, because of the seasonal nature of residency in the area also present an atypical area for the demonstration. The Census data being used is from 2000 and is being aggregated up to the block group level. Block groups while created to be similar in population density do vary in both their population and in the number of housing units within them. Additionally, while the median household income was used for each block group the actual incomes for households within a block group can vary quite drastically. Probably most importantly there is no way to determine the actual income of participant households. All of this is to say that the original challenge of assessing the participation rate of moderate-income households remains.

While to what extent moderate-income households are participating in the Mass Save program has been left unanswered, the methodology of the GIS analysis demonstrated here still offers potential. This methodology might prove more informative if conducted with a data set that includes both natural gas and electricity customers and is for a larger portion or all of the state. The analysis conducted using this method, however, will always be limited in what it can reveal about participation rates. Using the median income from block groups and aggregated participant data to the block group level instead of the actual incomes

of participants will never provide the granular detail needed to be absolutely sure if moderate-income households are participating.

Chapter 5: Conclusions and Recommendations

The purpose of this thesis was to evaluate to what extent moderate-income households are participating in the Mass Save programs. While it may not have directly answered the question, the hope is that it has provided further insight into the participation ability of moderate-income households by looking at each of the sub-questions. The following conclusions and recommendations are intended to help inform policy makers and program designers on how to improve Mass Save, ensure all households are able to participate and help achieve the goals of the Green Communities Act.

Conclusions

This thesis was designed to address the question of the extents to which moderate-income households in Massachusetts are participating in the Mass Save residential energy efficiency programs. To answer this question there were four sub-questions that were asked as well. At what income level do households have the discretionary income to participate in Mass Save? Are there energy efficiency programs that are specifically designed to target moderate-income households? Are moderate-income households significantly different from high-income households in their consumption of energy? To what extent is Mass Save reaching moderate-income households?

In attempting to answer each of these questions a few key points have come forth. Yes, moderate-income households do have discretionary income;

however, for many of them the amount of discretionary income is limited. In order for these households to spend their discretionary income on energy efficiency measures, they would have to prioritize energy efficiency over other discretionary spending, such as a vacation, seeing movies and eating meals out.

There is a perceived need in the industry for providing moderate-income households additional assistance to help them take advantage of energy efficiency opportunities in their homes. Across the country there are programs that have been designed to target moderate-income households. Interviews and literature both point to the need for these moderate-income programs, yet neither has made a strong case based on data.

Moderate-income households also present a large potential for energy usage reductions through efficiency measures. Like the low-income sector, moderate-income households tend to live in smaller homes and use more energy per square foot than high-income households. It is also likely they have older less efficient energy using appliances and devices, and fewer of them. This means that most of the energy saving potential in their homes is likely to come from building envelope improvements or the replacement of major appliances like the heating system and refrigerator.

The results of GIS analysis of the service territory of CLC did indicate correlations in that data that would suggest that income may play a role in the participation rates of households in CLC's service territory, although those correlations are weak. It cannot be stated with any confidence that income plays a

role in CLC's service territory or that moderate-income electricity customers are not participating in the Mass Save program.

In the end, the question of the ability of moderate-income households to participate cannot be answered by any of the sub-questions with certainty. However, evaluating these questions not as separate pieces, but in their entirety, the financial constraints are likely to play an important role in the ability of moderate-income households to achieve the potential energy savings imbedded in this income sector of the residential market. This means that moderate-income households are paying into the Mass Save program through the SBC and may be unable to fully participate because they cannot afford the co-payment required. In other words, the households that cannot participate are subsidizing energy efficiency work in the state's wealthiest homes (Green Justice Coalition, 2010).

Recommendations

The energy efficiency programs that the state of Massachusetts has and continues to develop in order to achieve the goals laid out in the Green Communities Act will have to confront the barriers laid out previously: lack information/knowledge, lack of certainty of savings, preweatherization repairs, split incentives and financial. Participation rates in Massachusetts and around the country have been low across all income groups due to these barriers. Success will only be achieved if all of these groups are able to and do participate at greater rates. This thesis makes a case that all of the households in the non-low-income segment should not be treated the same. Special consideration needs to be made when designing energy efficiency programs to take into account households with

different incomes and means of participating. Like the report by Hart Energy Consulting recommends for the state of Maine, Massachusetts will have to tailor programs, incentives and subsidies for moderate-income households. Doing so will be the only way the state can reach its full energy savings potential and the only way it can ensure the equitable distribution of the customer generated SBC funding.

The GIS analysis demonstrated in this thesis offers potential if a data set includes larger service territories, preferably the entire state, as well as participants of gas energy efficiency programs. Using GIS and Census data; however, will never give a complete picture of who is participating and who is not, it will instead provide generalizations and conjectures. Evaluations conducted on the efficacy of energy efficiency programs should gather income and other demographic information on participants whether that is at the time of the installation of the measures or in follow-up surveys. To lessen privacy concerns participants could be allowed to opt out.

Further Research

GIS and Statistical Analysis

In the continued absence of actual income data on participants, a more detailed GIS and statistical analysis could be conducted using data from the entire state as well as more recent Census data. If Mass Save and the PAs would agree to provide all participant data, including natural gas and electricity customers, such an analysis with a larger data set might provide a better picture of which households are participating. Also, as shown in the methodology used in this

thesis, all fears about customer privacy should be diminished because of the way data is joined to Census block groups and identifying addresses are removed.

In addition, GIS might be most beneficial for Mass Save and the PAs as a tool used to determine which block groups/neighborhoods and populations have had low number of participants, and where it can target its marketing and outreach efforts.

RECS Data

At the outset of my research it was my intention to analyze 2009 RECS Household Energy usage data to compare the energy usage of the three different income sectors (low-income 0 - 60%, moderate-income 60.1 - 120% and high-income >120% of SMI) similar to the analysis done in the report *Income, Energy Efficiency and Emissions*. This report concludes that while low-income households use less energy overall, they use more per square foot, mainly because they live in older less efficient homes, have fewer appliances and the appliances they do have tend to be older and less efficient. Because of these factors low-income households have a great potential for energy savings; however, unlike high-income households, low-income households need assistance to achieve the potential (2008).

While the report mentions moderate-income households and includes data for this income segment in its graphs the focus of the report is comparing the low-income and high-income sectors. The RECS data was not released in time for me to perform a similar analysis using newer data; however, it may be beneficial to

pursue this research once the data is fully available to compare energy usage across the different income groups.

Appendix I: Methodology

Crittenton's Mass Index Methodology

When calculating at what percent households begin to have discretionary income, I used the Crittenton Women's Union's *Massachusetts Economic Independence Index 2010*. I chose the Mass Index, because it is tailored to Massachusetts and provides accurate costs associated with living in the state. The Mass Index also includes all of the necessary expenses that a household must pay in order to live independently, without assistance from federal, state or other aid sources. While it could be debated whether or not all of the expenses covered by the Mass Index are non-discretionary expenses by the strictest definition of discretionary income, the expenses covered in the Mass Index are expenses that would likely be met before spending money on energy efficiency measures by most households and therefore relevant to count as necessary expenses for the purposes of this thesis. It is important to note exactly what the Mass Index does and does not include in its calculations.

The Mass Index does not include expenses for restaurant meals, gifts, electronics, recreation, vacations, emergency savings, retirement savings, education savings or an owned home. The Mass Index only accounts for household expenses that meet the most basic needs such as housing, utilities, food, basic transportation, child care, health care, clothing, personal items, household items and taxes (Crittenton Women's Union, 2010). A more detailed breakdown of how each expense was calculated can be found in the *Methodology*

for the Massachusetts Economic Independence Index 2010 (Crittenton Women's Union, 2011).

To determine at what income level each household type in the Mass Index becomes economically independent, I used the Mass Index's annual income needed by each family type plus the \$666 required to participate in the Mass Save insulation rebate program, assuming a customer is eligible to receive the full \$2,000 incentive. I then compared these income figures to the 2009/2010 fiscal year income requirements from LIHEAP to calculate the SMI for each family type (U.S. Department of Health and Human Services, 2011). I calculated what percent the Mass Index's wages were of SMI. This resulted in the finding that households in Massachusetts begin to become able to afford the Mass Save program at 46.66% of SMI, but it is not until 127.86% of SMI that all of the family types in the Mass Index become able to do so. The average point at which these family types become able to participate is 86.65%.

Program Review

I conducted an internet search for the programs across the country that are or have targeted moderate-income households. Once I found programs I reviewed the program websites to gather information about the programs. I also reviewed the websites as well as conducted a literature search for reports and program evaluations on the programs. These searches yielded almost no information on why moderate-income households were being targeted by the programs. I then tried to contact staff members with each of the programs outside of Massachusetts to see if they would be willing to discuss with me why their programs were

developed. The results of these phone interviews or email correspondences helped to inform the section on outside programs.

GIS

Data Sets

- Participant data from CLC for 2007 through July of 2010 for the non-low-income program. The data only includes CLC customers for electricity service and does not include any gas customers.
- Removed all measures except HVAC and Building Envelope measures, labeled BHVAC and IEnvl respectively in the CLC data set.
- Went through both data sets and corrected abbreviations that are not valid in ArcGIS.

Other Layers

- Added the counties for the state of MA
- Added layers from MassGIS of the towns and for the locator map
 - <http://www.mass.gov/mgis/towns.htm>

Tiger Line Data

- Downloaded 2009 Tiger Line Data from the U.S. Census Bureau for the 3 counties in CLC's service territory.
 - <http://www.census.gov/geo/www/tiger/tgrshp2009/tgrshp2009.htm>
- Appended the three layers into one layer
- Created an address locator
- Geocoded the participant data to the address locator

- Went through the unmatched and tied address to manual locate each address using the online map services provided by the search engines Google and Bing. The unmatched records were caused by several issues:
 - Alternate street names for the same street in the Tiger data vs. the CLC data
 - The Tiger data was missing zip codes, street names and address ranges for many of the streets.
 - In most cases I was able to verify the location of the record and map it, which resulted in the matching of almost 98% of the address records.

Census Data

- Downloaded Census demographic data from the 2000 Census through the American Fact Finder in Excel format.
 - http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=DEC&_submenuId=datasets_1&lang=en
 - Housing:
 - Total housing units
 - Occupied, vacant and seasonal housing units
 - Owner and renter occupied housing units
 - Income:
 - Number of households
 - Median household income
 - Breakdown of households in each Census income group

- Language:
 - Over 5 population
 - Over 5 population that speaks English only
 - Over 5 population that does not speak English
- Nativity:
 - Total population
 - Native born population
 - Foreign born population
- Race:
 - Total population
 - White
 - Non-white population (Created by subtracting the white population from the total population.)
- Created one Excel file using all of the Census data files downloaded
- Added Census Block Group for the state of Massachusetts and then created a new layer of just the selected Block Groups on Cape Cod

Coordinate System

- All of the data layers were converted into the coordinate system:
NAD_1983_StatePlane_Massachusetts_Mainland_FIPS_2001

Joins

- Used both Spatial and Table joins to join the participant data and Census data to the Block Group layers. This process helps to eliminate any participant information that could be used to locate individuals.

Creation of New Fields

- Created the new to help normalize the data for Block Group comparison.
 - Number of Measures per 1,000 Housing Units
 - kWh Saved per 1,000 Housing Units
 - Customer Expenditures per 1,000 Housing Units
 - Formula Example:
 - $\text{Number of Measures} \div (\# \text{ of Housing Units} \div 1,000)$

Data Layer Creation

- Created a series of data layers using the joined data layers

Participant Data Layers

- Customer Contribution per 1,000 Housing Units
- kWh Saved per 1,000 Housing Units
- Number of Measures per 1,000 Housing Units
- Quantity of Measures
- Total Customer Contribution
- Total kWh Saved

Demographic Data Layers

- Median Household Income
- Percentage of the 25+ Population who completed 0-12th grade
- Percentage of the 25+ Population who completed >12th grade
- Percentage of the foreign born population
- Percentage of the +5 Population that does not speak English
- Percentage of the +5 Population that does speak English

- Percentage of the Non-White Population
- Percentage of the Owner Occupied Housing Units
- Percentage of the Renter Occupied Housing Units
- Percentage of the Seasonal/Vacation Housing Units

Matrix Layers

- Block Groups by Income Levels (0-60%, 60-120% and >120%)
- Participant Contributions in 5 Groups

Graphs

- Exported the attribute table used to created the data layers to Excel
- Used the attribute table to create scatter plot graphs of the participant data and demographic information

Scatter Plot Graphs

- Number of Measures Per 1,000 Housing Units by Percentage of Over 5 Population that Does Not Speak English
- Number of Measures Per 1,000 Housing Units by Educational Attainment
- Number of Measures Per 1,000 Housing Units by the Percentage of Foreign Born Population
- Number of Measures Per 1,000 Housing Units by the Percentage of Non-White Population
- kWh Saved Per 1,000 Housing Units by Median Household Income

- Customer Contribution Per 1,000 Housing Units by Median Household Income
- Number of Measures Per 1,000 Housing Units by Median Household Income
- Number of Measures Per 1,000 Housing Units by the Percentage of Renter Occupied Units
- Number of Measures Per 1,000 Housing Units by the Percentage of Owner Occupied Units
- Number of Measures Per 1,000 Housing Units by the Percentage of Vacation/Seasonal Units
- The R^2 value is calculated for each attribute comparison by Excel

Appendix II: Additional GIS Maps and Graphs

Table 14 lists the R^2 values for all of the attribute comparisons in the graphs created from the GIS analysis attribute table. While all of the comparisons show some correlation between the variables that show moderate-income and other hard to reach households have lower participation rates none of them are significant. The strongest correlation among these graphs is the relationship between owner occupied units and the number of measures per 1,000 housing units, which has a R^2 value of just 0.2385, so even the strongest correlation is still weak.

Table 14: R^2 Values for Scatter Plot Graphs

Attribute Comparison	R^2 Value
kWh Saved Per 1,000 Housing Units by Median Household Income	0.0061
Number of Measures Per 1,000 Housing Units by the Percentage of Foreign Born Population	0.0126
Number of Measures Per 1,000 Housing Units by the Percentage of Renter Occupied Units	0.0266
Number of Measures Per 1,000 Housing Units by Educational Attainment	0.0338
Number of Measures Per 1,000 Housing Units by Percentage of Over 5 Population that Does Not Speak English	0.0351
Number of Measures Per 1,000 Housing Units by Median Household Income	0.073
Number of Measures Per 1,000 Housing Units by the Percentage of Non-White Population	0.1025
Customer Contribution Per 1,000 Housing Units by Median Household Income	0.122
Number of Measures Per 1,000 Housing Units by the Percentage of Vacation/Seasonal Units	0.143
Number of Measures Per 1,000 Housing Units by the Percentage of Owner Occupied Units	0.2385

The following maps and graphs were excluded from the GIS analysis chapter because they did not speak directly to the driving questions of the thesis, but are included to show the other comparisons evaluated during the GIS analysis process.

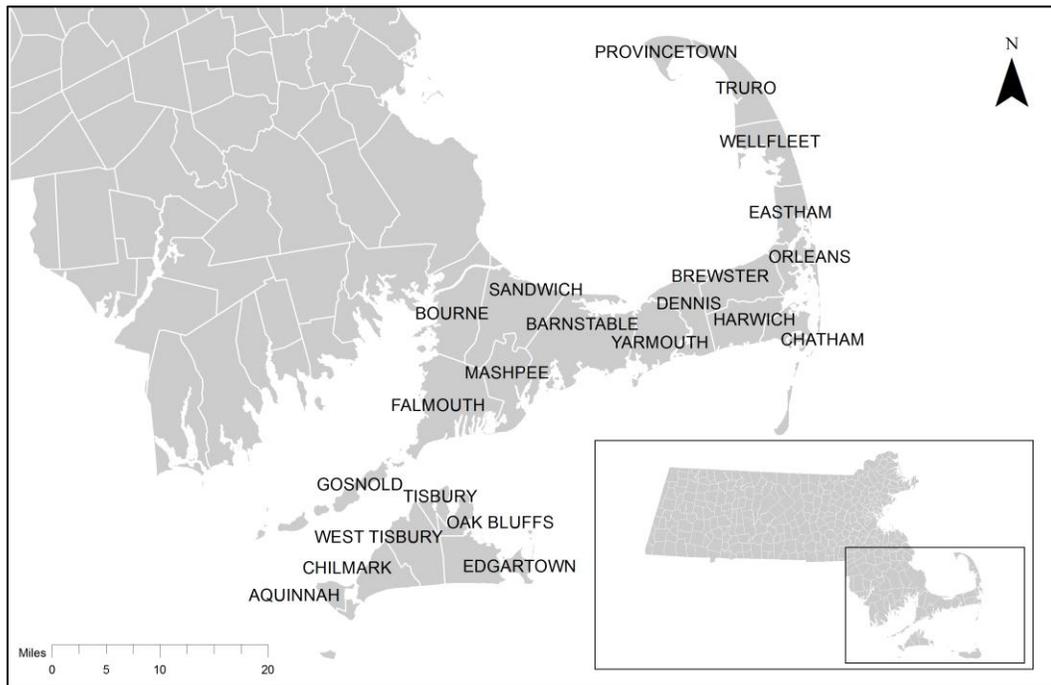


Figure 12: Area of Analysis

The locator map in Figure 1: shows the towns and area mapped in the analysis. The maps in Figure 2 through Figure 27 show some of the different demographic information and participant data mapped by block group. In each of the maps the different variables represented are broken into quintiles. While these maps provide an interesting view of the CLC service territory individually, they provide little direct insight into the level at which moderate-income households are participating.

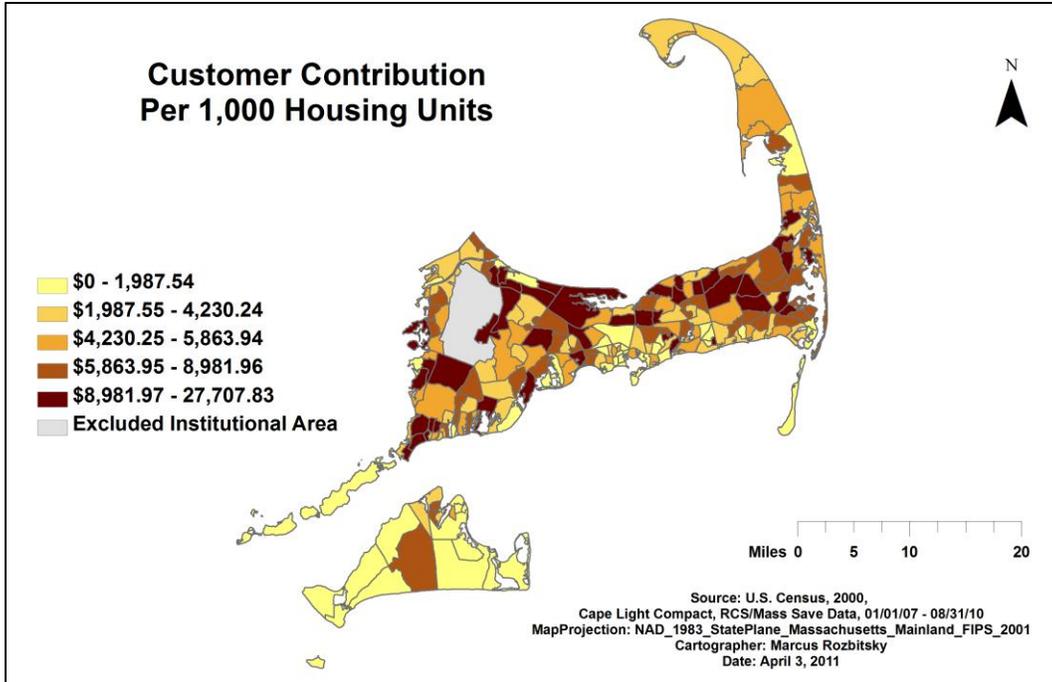


Figure 13: Customer Contribution per 1,000 Housing Units

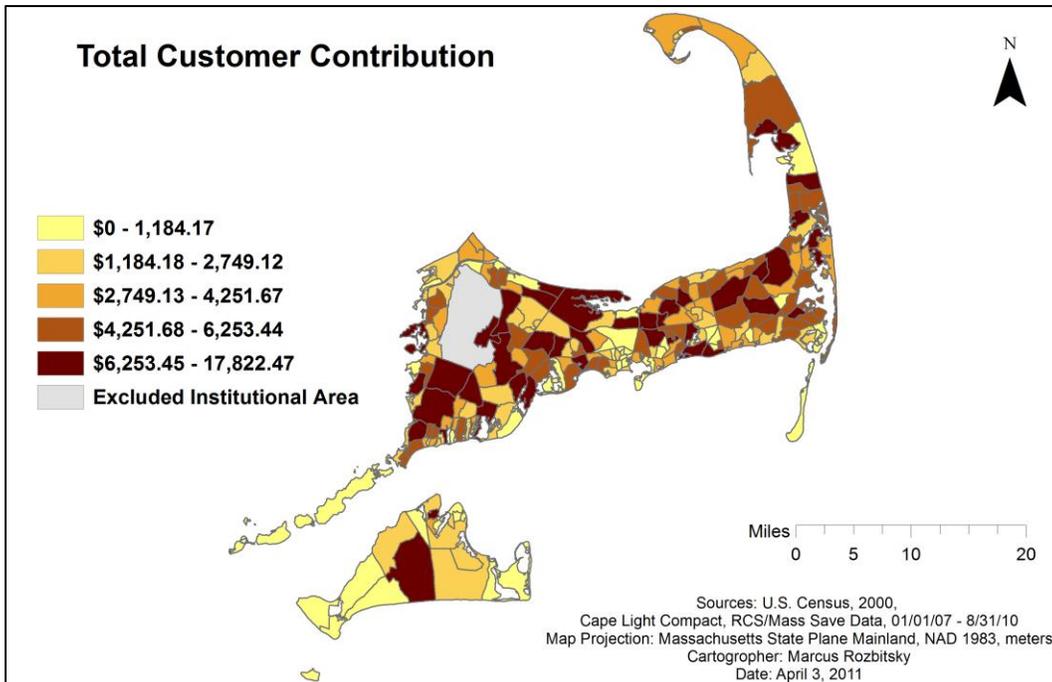


Figure 14: Total Customer Contribution

The maps in Figure 13 and Figure 14 show the amount of total customer contributions in each block group. The contributions of each block group has been normalized by 1,000 households for the map in Figure 13, to provide a more equal comparison across the block groups.

In Figure 3 and Figure 16 the maps show the total number of individual measures undertaken in each block group. Like in Figure 13, the measures in Figure 15 have been normalized by 1,000 households for each block group.

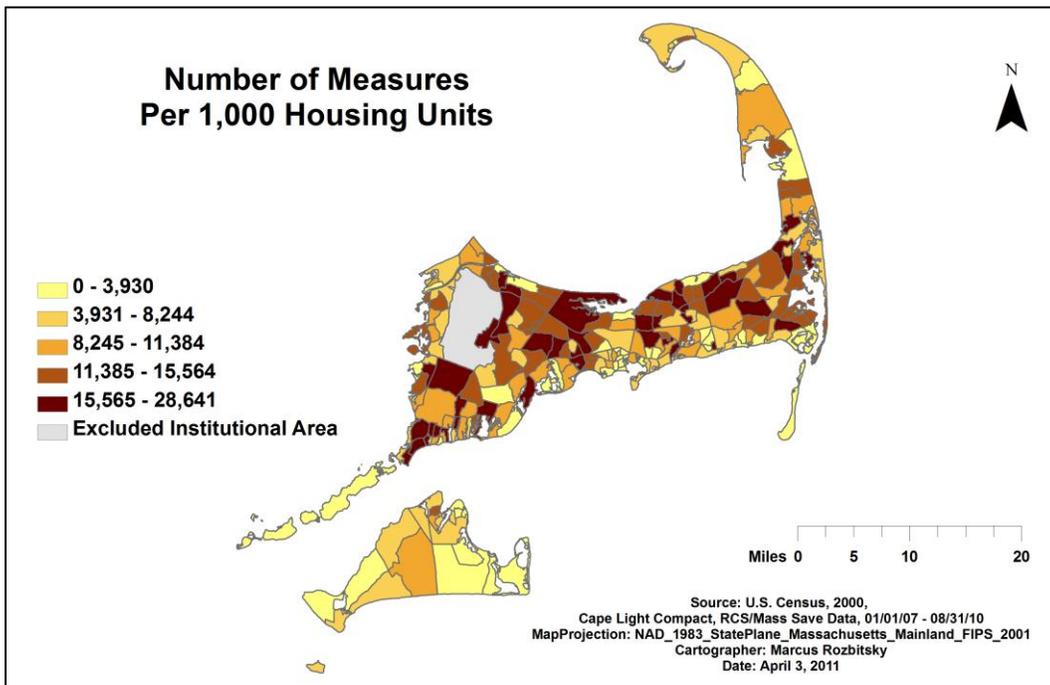


Figure 15: Number of Measures per 1,000 Housing Units

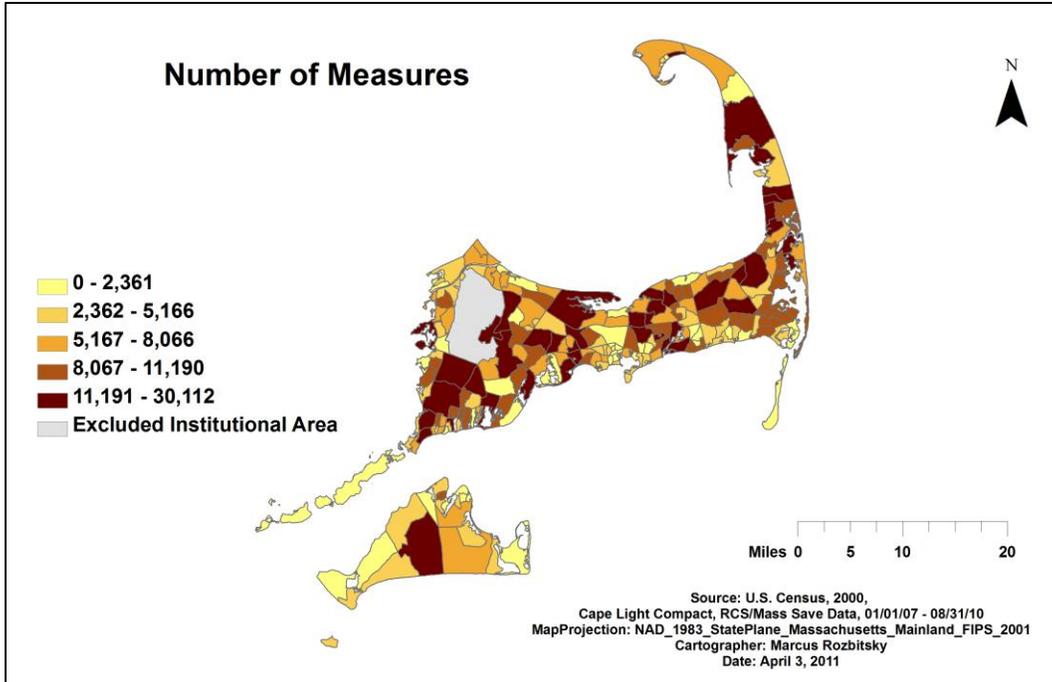


Figure 16: Number of Measures

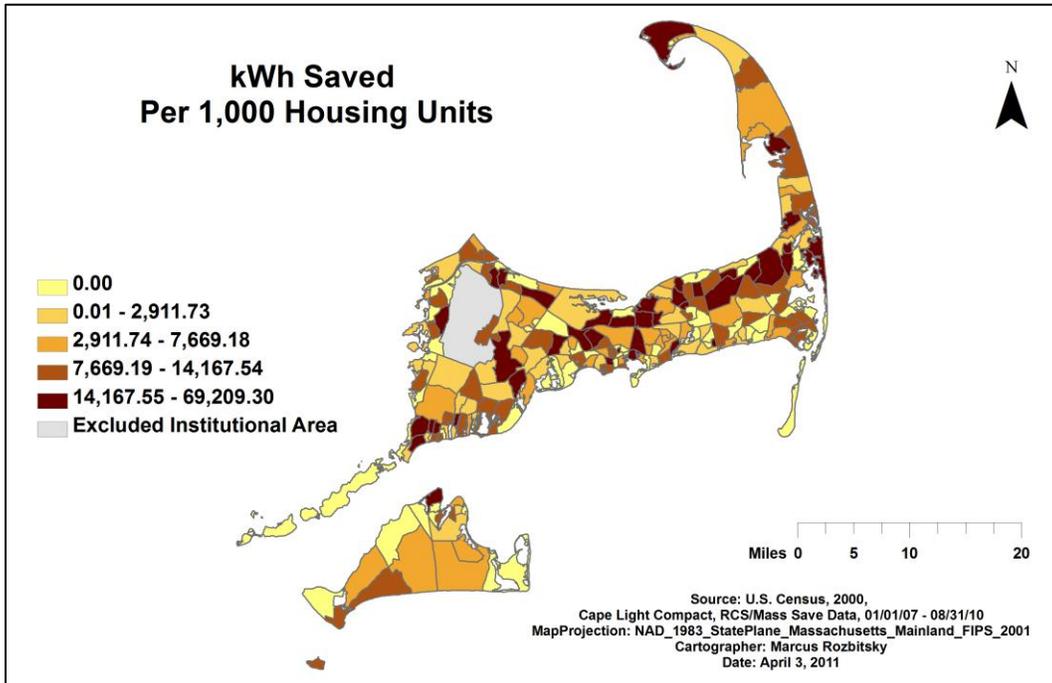


Figure 17: kWh Saved per 1,000 Housing Units

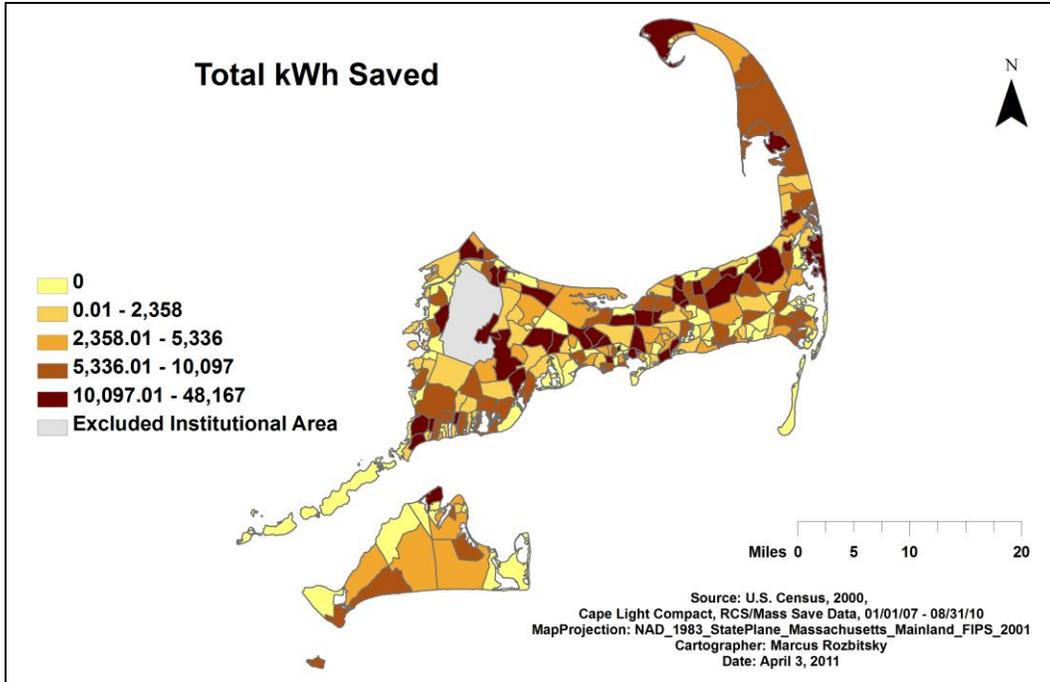


Figure 18: Total kWh Saved

Again the same approach was taken for Figure 17 and Figure 18, but in this case the maps represent the total kilo-watt hours that were saved due to the measures installed in each block group. Figure 19 provides a map of the breakdown of the median income of each block group.

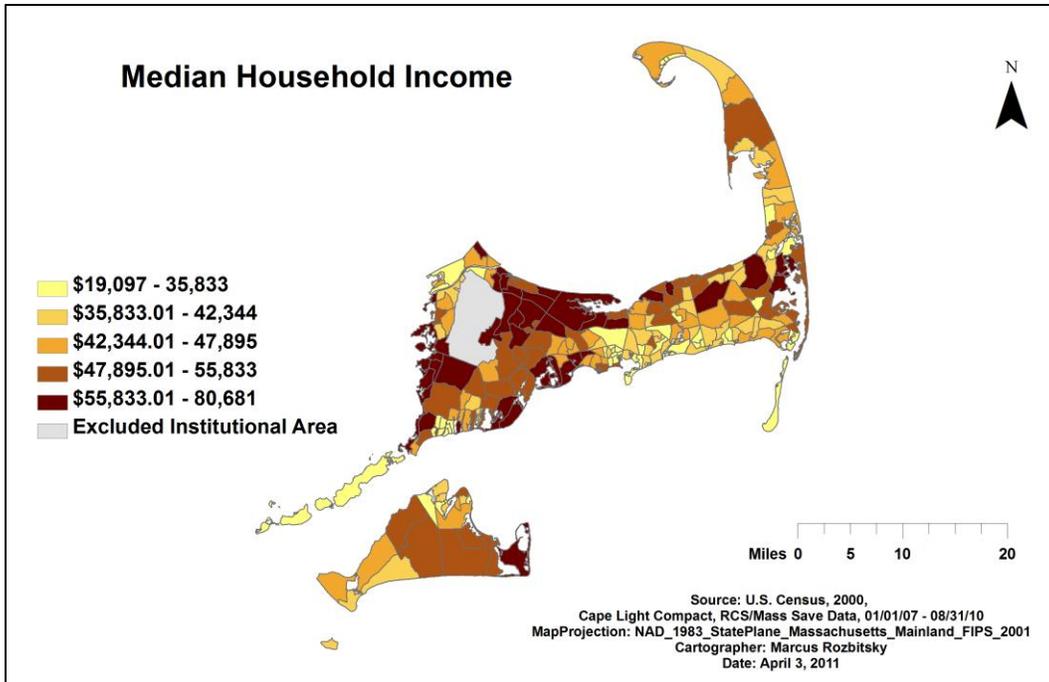


Figure 19: Median Household Income

The maps in Figures 20, 21 and 22 show housing unit occupancy by the percentage of owner occupied and renter occupied units, as well as the percentage of vacation or seasonal housing units. These maps were produced, because the split incentives issues is a barrier to participation, and moderate-income families tend to rent their homes more often than own them. Cape Cod, in addition, has a high rate of vacation/seasonal housing units which may or may not affect the participation rates of the unit’s owners.

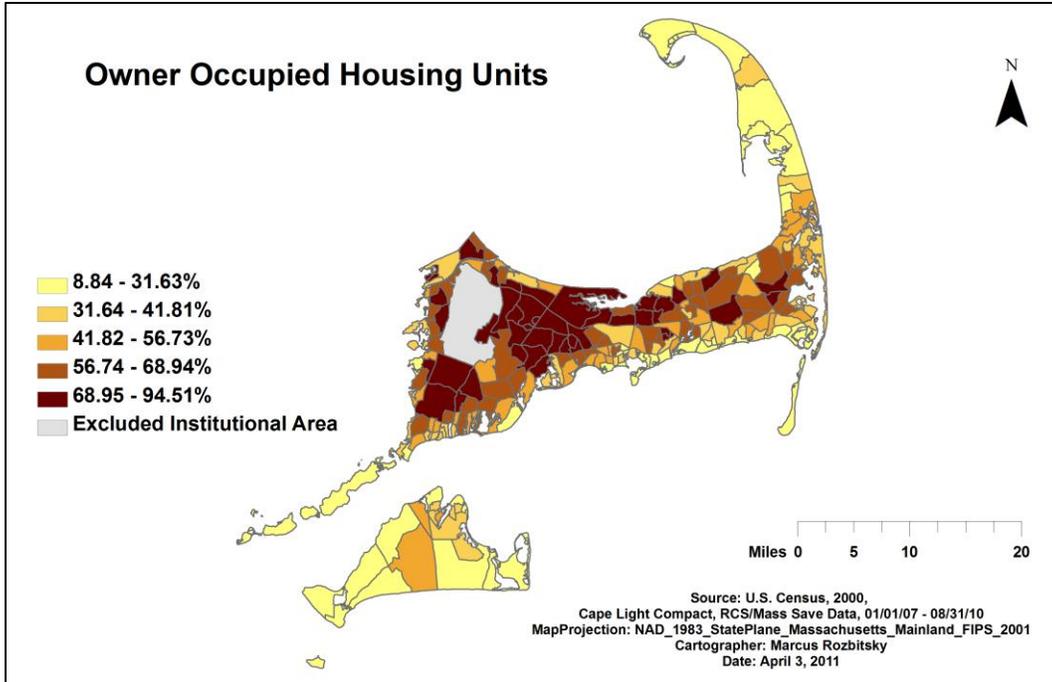


Figure 20: Owner Occupied Housing Units

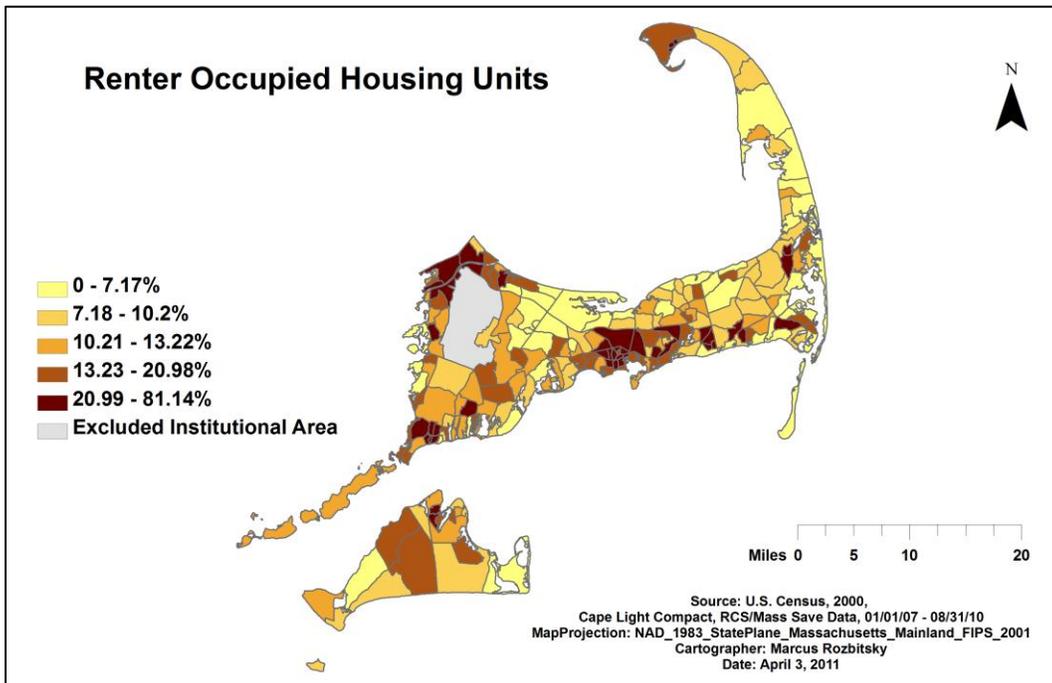


Figure 21: Renter Occupied Housing Units

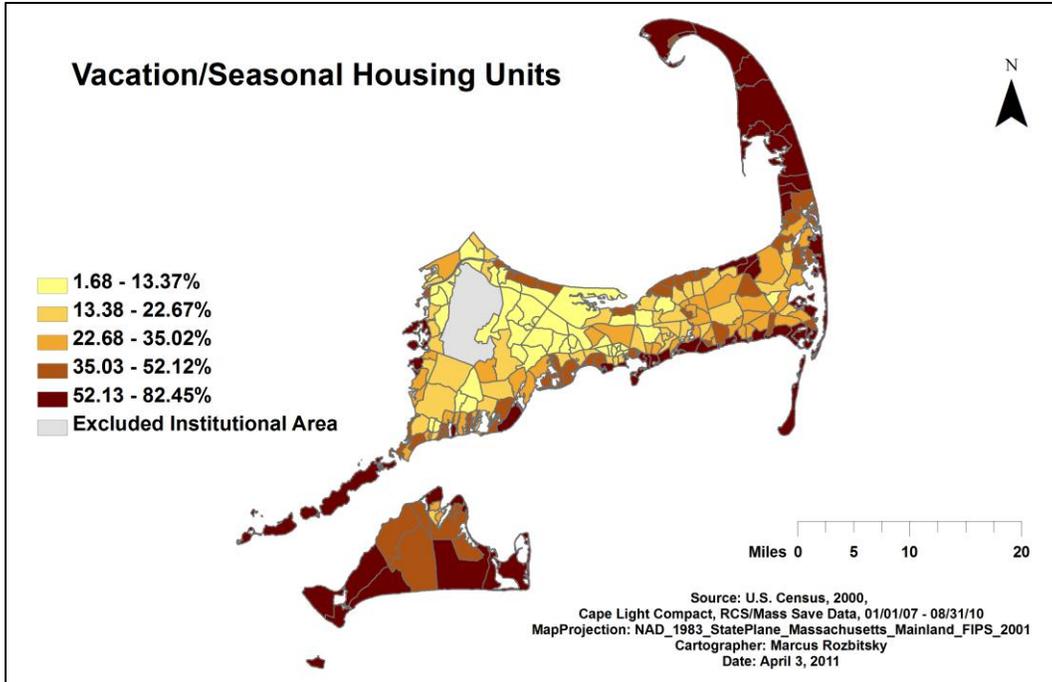


Figure 22: Vacation/Seasonal Housing Units

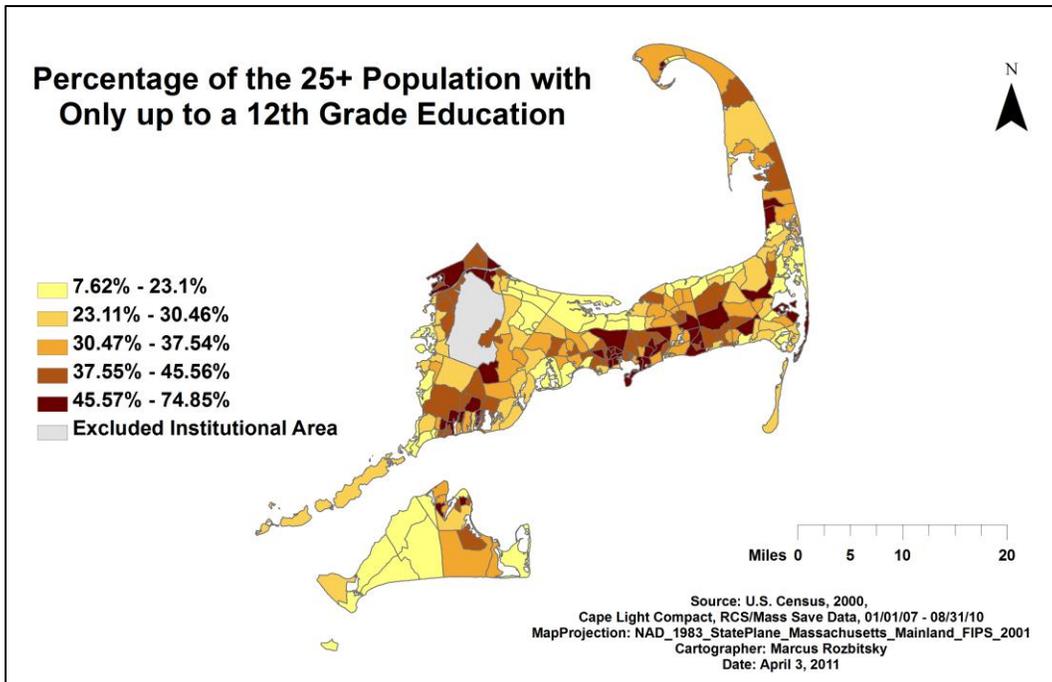


Figure 23: Percentage of the 25+ Population with Only up to a 12th Grade Education

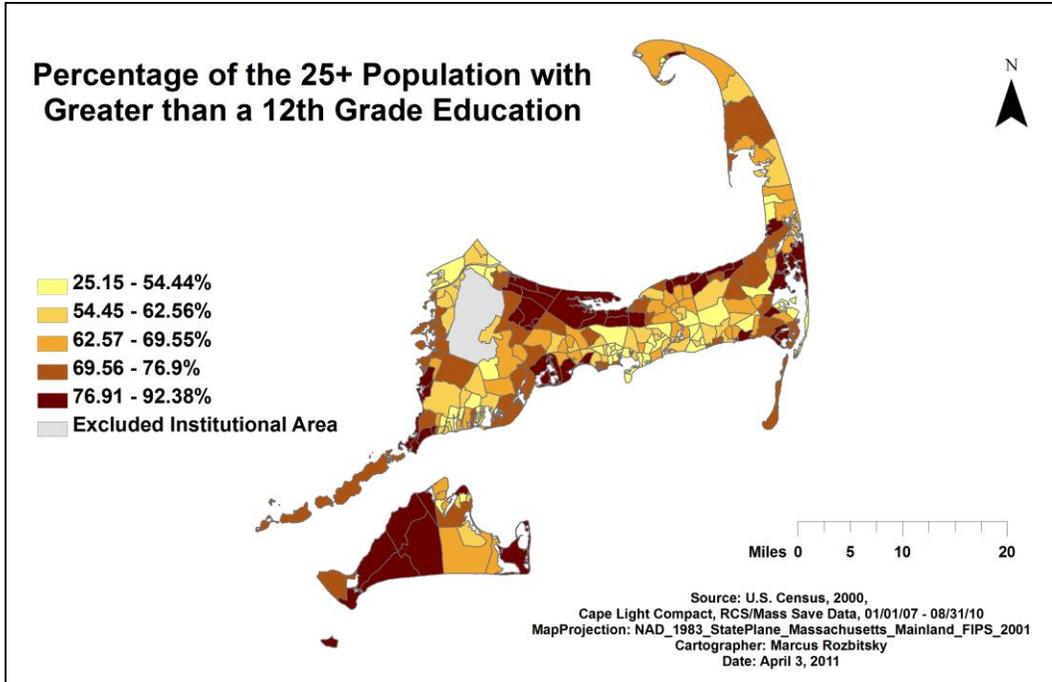


Figure 24: Percentage of the 25+ Population with Greater than a 12th Grade Education

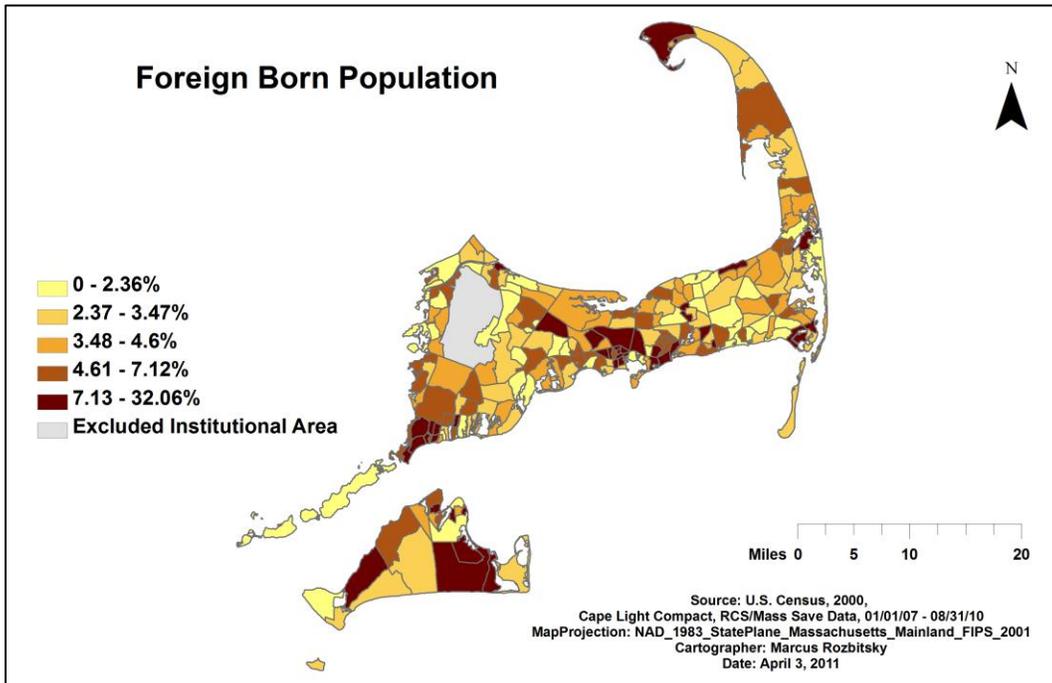


Figure 25: Foreign Born Population

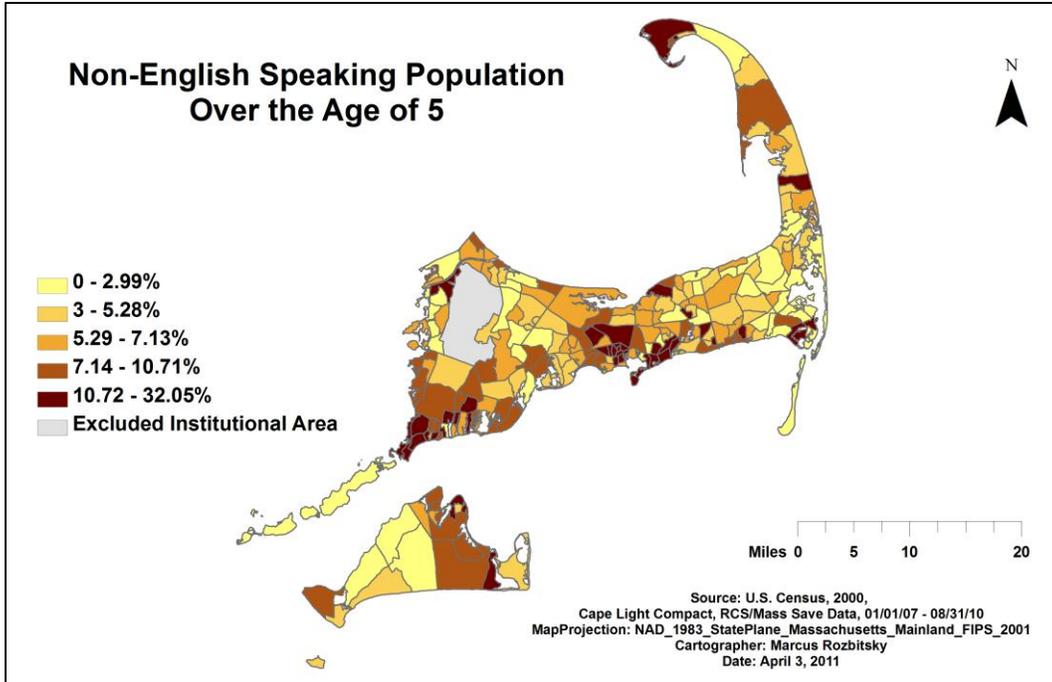


Figure 26: Non-English Speaking Population Over the Age of 5

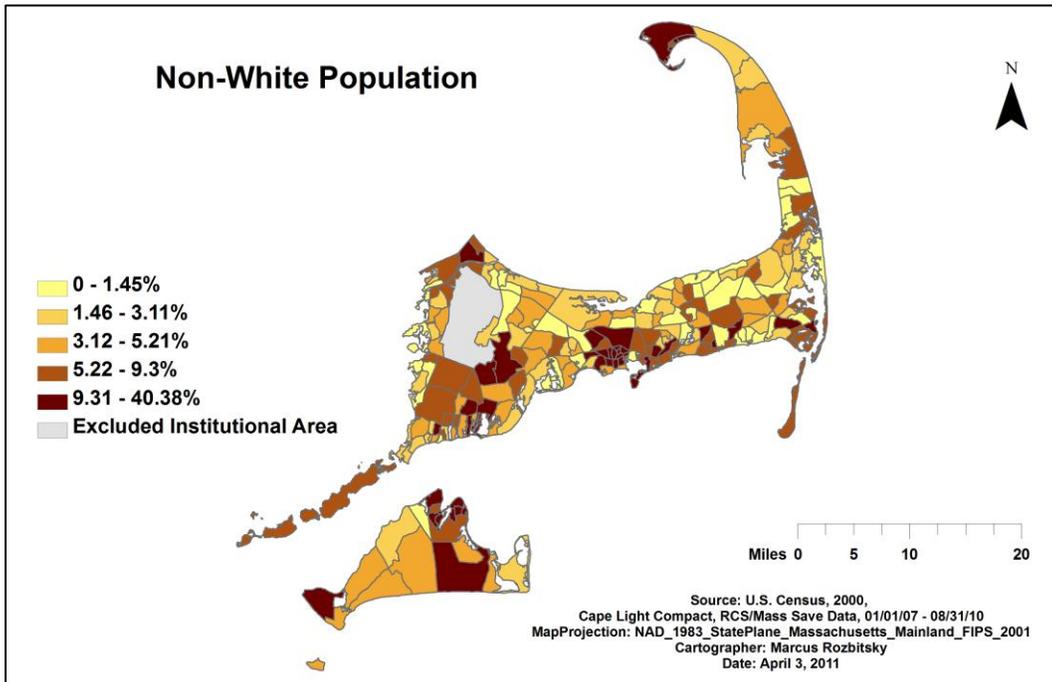


Figure 27: Non-White Population

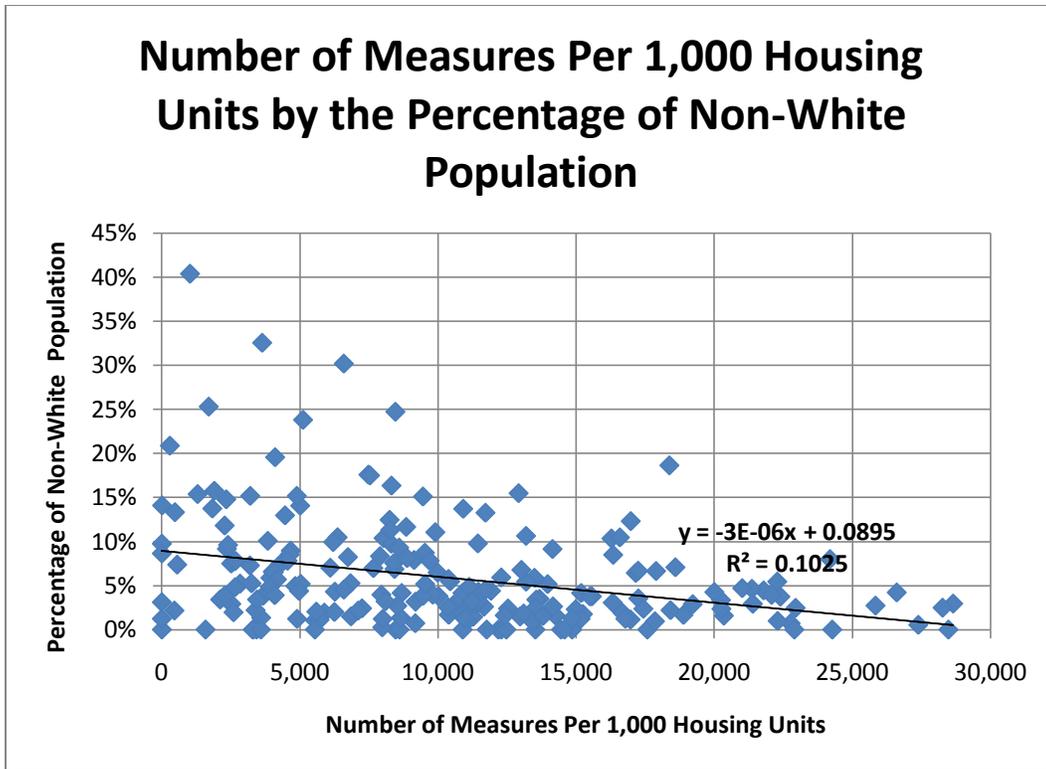


Figure 28: Number of Measures per 1,000 Housing Units by the Percentage of Non-White Population

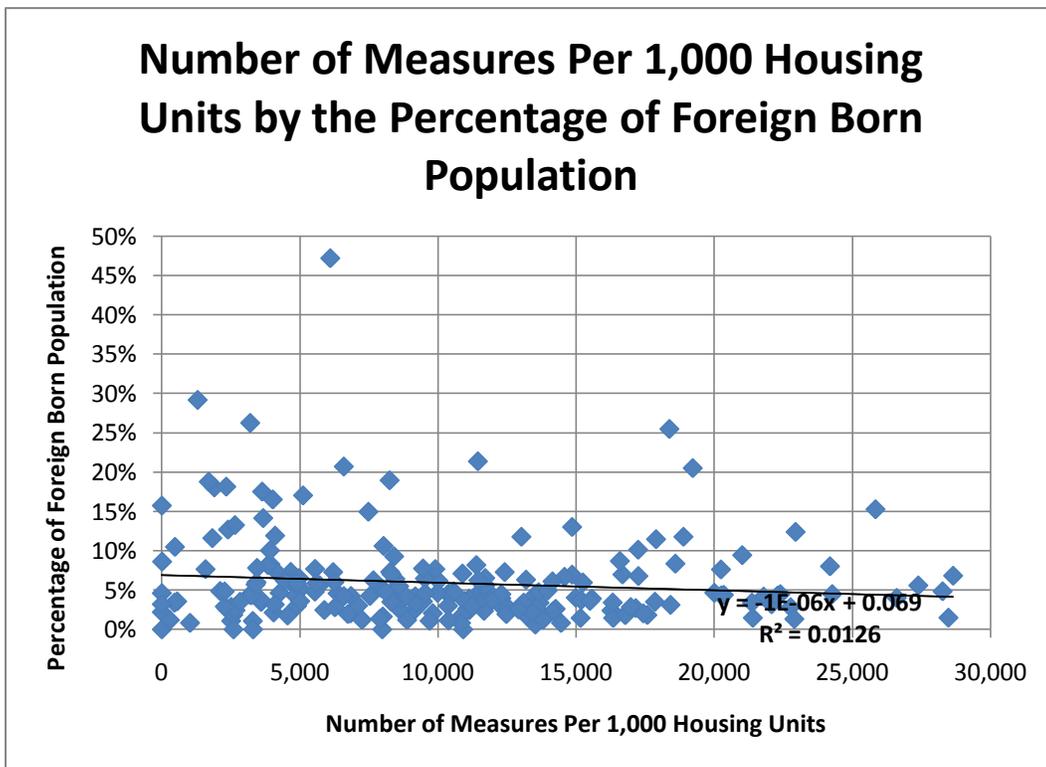


Figure 29: Number of Measures per 1,000 Housing Units by the Percentage of Foreign Born Population

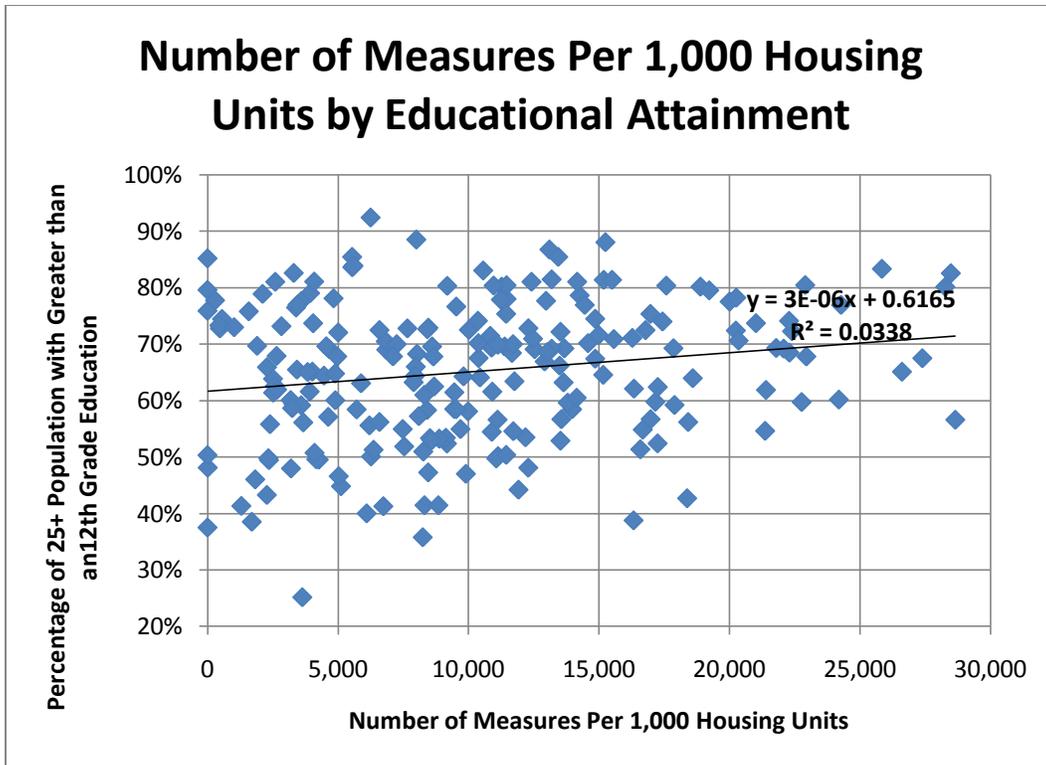


Figure 30: Number of Measures per 1,000 Housing Units by Educational Attainment

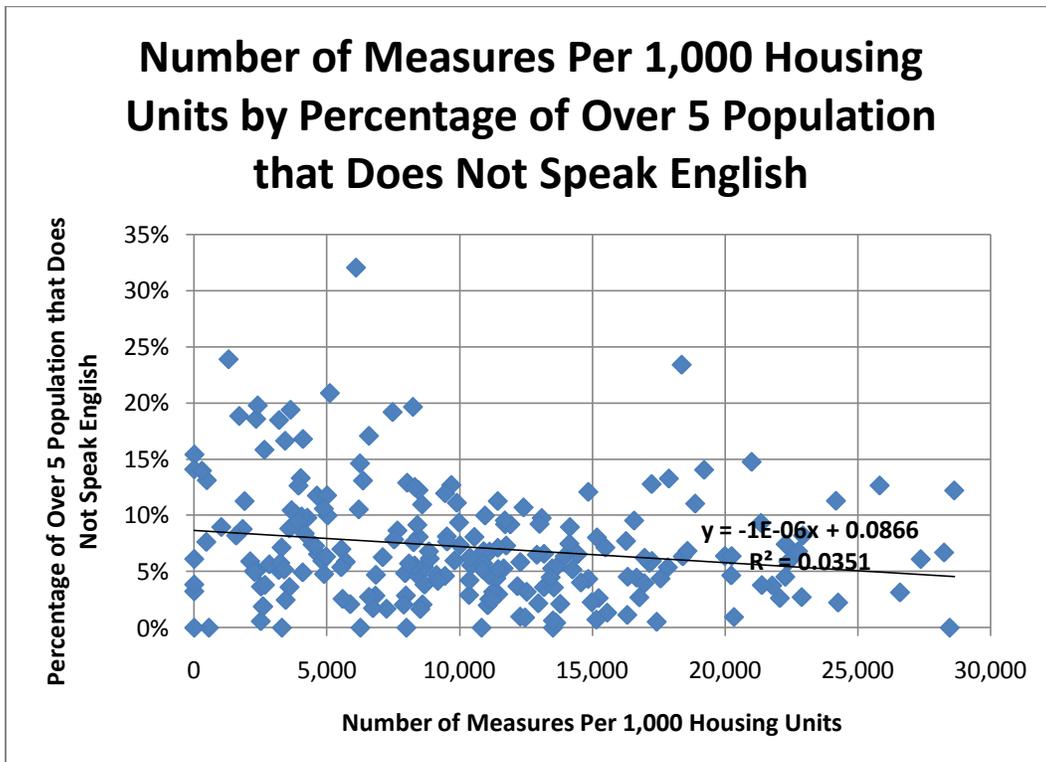


Figure 31: Number of Measures per 1,000 Housing Units by the Percentage of Over 5 Population that Does Not Speak English

Appendix III: IRB Approval



OFFICE OF THE VICE PROVOST
Social, Behavioral, and Educational Research
Institutional Review Board
333 JEDD0016

Re: IRB Study # 1102048
Title: *Moderate-Income Programs*
PI: Marcus Rozbitsky
Department: Urban and Environmental Policy and Planning
IRB Review Date: 2/26/2011

February 28, 2011

Dear Marcus,

This is the official notification that your project, *Moderate-Income Programs*, protocol # 1102048 does not meet the definition of human subject research under the Code of Federal Regulations Title 45 Part 46.102(f); therefore is not subject to review by the Institutional Review Board.

Please be sure to file this notification.

Sincerely,

A handwritten signature in black ink, appearing to read "Yvonne Wakeford".

Yvonne Wakeford, Ph.D.
IRB Administrator

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