# The Home of the Future is the One You Already Live In: Residential Energy-Efficiency in Saratoga County

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#### Abstract

The adoption of energy efficiency technology is a critical component in getting New York's grid ready for the transition to renewables. The goal of this project was to measure Saratoga County's transition to a more efficient grid through residential energy efficiency. We presented the research question; 'How are Saratoga County residents engaging with energy efficiency in their homes, and how does engagement vary by income and location?' Qualitative data of Saratoga County's state funded, and non-profit home energy efficiency programs was collected through interviews with NYSERDA representatives, local community-based organizations, and energy installers. Quantitative data was collected through participant responses to surveys. Survey data was analyzed to see trends between participants income and location using QGIS software. We found disparities in home energy efficiency engagement between income groups and locations in Saratoga County based on, upgrades and weatherization's of homes, monthly cost of heating in the winter, trust in informational sources, audits, and adoption of renewables. From our findings, we propose state programs and initiatives focus on outreach and face-to-face engagement with homeowners and installers through community-based education programs that prioritize lowincome areas who experience environmental injustice through disproportionately higher percentages of energy costs and home energy inefficiencies. We propose future energy efficiency studies in Saratoga County research the outcomes of energy audits and the county's ability to get more homes audited, especially those in hard-to-reach areas.

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#### Introduction

The goal of this project was to measure Saratoga County's transition to a more efficient grid through residential energy efficiency. Energy efficiency can act as a transition in our energy economy that connects residents to the grid through electrification of homes and lowers overall electrical demand. The American Council for an Energy-Efficient Economy found the use of energy efficiency technology and sustainable practices could reduce half of U.S energy use and carbon emissions by 2050 (Nadel, 2019). A growing number of states have introduced public policy programs, mandating that utilities set long-term targets which are required to procure a certain percentage of savings through energy efficiency programs (Cho, 2019).

New York currently ranks eighth highest in national energy usage (EIA, 2020). In 2016, New York consumed 2,708 trillion Btu and generated 167 million metric tons of CO<sup>2</sup> (EIA, 2020). In 2019, New York rolled out an ambitious climate bill to become a carbon-free economy by 2050 (McKinley and Plumer, 2019).

To reach its efficiency goals, New York must reduce its environmental footprint in several sectors. Residential net energy use accounts for 27% of total energy demand, compared to 16.5% nationally (EIA, 2020). New York will have to find ways to become more energy efficient in its residential sector, since there is tremendous room for improvement. Outdated technology in current infrastructure presents an opportunity to make the built environment both healthier and more sustainable. To reach a carbon free economy, individual households could make a difference.

To reduce emissions from residential home energy use, homes can be retrofitted for energy efficiency through weatherization (e.g., insulation, efficient windows, etc.) or through the installation of newer, more efficient home energy appliances. Besides the environmental benefits, retrofitting homes for energy efficiency can lower utility bills and increase indoor air quality and comfort (EPA, 2020). However, if a building is not properly retrofitted for its unique nature and characteristics, it cannot reap all the benefits of the retrofits. Retrofit changes have been most successful when catered to each individual home. Beyond that, catering to different demographics is important because of the differences consumers show in their perceptions of energy efficiency.

#### Background

Consumer perceptions of energy efficiency depend on a variety of factors. While some past research suggests that residential energy demand is dependent on household practices; Romanach et al found the notion of residential energy efficiency held by homeowners was ponderously based on technological aspects (i.e., energy efficient appliances, renewable energy sources). Residential behavior focuses on aspects such as features or new technology that is disconnected from everyday behavior. Another common association with energy efficiency is the environmental and economic benefits. Previous literature found income level to be a determining factor for inciting action towards home energy efficiency, although there was some inconsistency through different income levels.

Boucher et al found that more affluent homeowners collectively show less concern for energy efficiency due to their lack of financial burden, but at the same time, their behaviors tend to 'cluster' when it comes to pro-environmental behavior (Boucher, 2018). This suggests environmental concerns may trigger more efficiency engagement for some high-income residents when compared to financial savings. In contrast, there is also data to suggest that lower-income end users are less motivated to purchase efficiency technology because of environmental concerns and are more motivated by the economic feasibility (Romanach, 2017). Due to the expense of retrofitting homes with new energy efficient appliances, there are environmental justice issues surrounding energy efficiency and overall comfort of low-income homes.

Studies show that low-income families spend the highest percentage of their income on heating and electricity yet receive less energy per dollar because of energy deficient housing (Hernandez, 2013). To combat this environmental injustice issue, the New York State funded organization, NYSERDA, has created incentive programs that help to alleviate costs of retrofitting homes based on income level. The reason for slow adoption of retrofitting is that homeowners must be elect for the process which requires time, knowledge and money. To get to home owners, New York State funds NOGs, NYSERDA programs and contracting companies. Ultimately, the most impactful action for residential energy consumption is the homeowner's decision to undertake home energy efficiency retrofits/upgrades (Boucher, 2018). Although New York homeowners can reap the benefits (e.g., decreasing energy bills, reducing environmental impacts, increasing indoor health and safety) of statewide incentivebased programs; our study plans to address the many fall backs and challenges of encouraging homeowners to implement these programs in their homes. The process one goes through to retrofit their home using available incentives, is a frustrating, time-consuming, and confusing one. It can discourage people from taking advantage of existing incentives just because the process is one that almost no one wants to deal with.

Saratoga County is the area of focus in our study. Our research details the current state of energy efficiency in Saratoga County by examining public perceptions and engagement across different income demographics. How are incentives reaching residents in the county? How are residents engaging with energy efficiency in their homes? Do energy audits work? How does this vary by income and town?

#### **Literature Review**

To understand the current state of energy efficiency programs, incentives, and sustainability in Saratoga County, we did an extensive literature review of; the New York State Energy Research and Development Authority (NYSERDA), National Grid, non-profit organizations focused on energy efficiency in Saratoga County, Studies on energy efficiency, and previous studies of energy efficiency conducted in Saratoga County.

# NYSERDA

NYSERDA is a state-run organization with the mission to "advance innovative energy solutions in ways that improve New York's economy and environment" (NYSERDA 2020). NYSERDA represents public intent to lower energy consumption in numerous ways, one is by funding programs to bring energy efficiency to all New Yorkers. NYSERDA funds over 20 programs to incentivize efficient energy use by lowering home or business's energy bills, reducing a community's environmental impact, and supporting clean energy and transportation in New York State. NYSERDA's ultimate objective is to curb state emissions, promote economic growth, and protect end users. Current NYSERDA programs act as a public resource to conjoin the public's future interests with businesses and their consumers. Although NYSERDA provides

resources to promote, encourage and educate about energy efficiency, there is a long road ahead to achieving statewide adoption.

#### **Residential Incentive Based Programs**

<u>Assisted Home Performance</u> with Energy Star offers income-qualified homeowners in New York State a comprehensive, whole-house approach to improving energy efficiency and home comfort while saving money. It provides those who qualify with a discount covering 50% of the cost of eligible energy efficiency improvements up to \$5,000 per project for single-family homes. Two-to four-unit residential homes with income-eligible residents may qualify for a discount of up to \$10,000.

<u>The Comfort Home program</u>, available in select markets, helps homeowners save money and improve a home's comfort year-round with "seal and insulate" packages. These packages are available through approved contractors and help to fix common problems like drafts and ice dams. Incentives range from \$1,000 to \$4,000 depending on the type of improvements being made.

<u>EmPower New York</u> offers no-cost energy efficiency services such as insulation, air sealing, energy efficient light bulbs, and replacement of an inefficient refrigerator and freezer to income eligible homeowners and renters. The Empower program can fund up renovations up to \$10,000 for low income households. Participating contractors are assigned to homeowners to give free audits to determine how residents can upgrade their home and how the state can help them to become heat pump ready.

Despite NYSERDA's efforts to provide efficiency programs that incentivize residents in New York to upgrade their homes, the organization struggles to develop and implement strategies that draw widespread community engagement. Another problem is how accessible these programs are to homeowners because of information gaps and information overload on the NYSERDA website. Programs and incentives can become hidden to home-owners due to the sheer amount of information one needs to comb through to find out what programs they can take advantage. NYSERDA is trying to address this problem through the implementation of a new Energy Advisor website.

#### **Energy** Advisor Website

During the Spring of 2021, NYSERDA began to implement its Energy Advisor website. The concept of Energy Advisor is to pool all existing efficiency incentives into one online portal. Within one portal, New York residents will only need to fill out one application to see if they qualify for programs sponsored by NYSERDA and their local utilities. In accordance with the Climate Leadership and Community Protection Act of 2019, at least 35% of efficiency funding will be targeted at improving energy infrastructure in disadvantaged communities. From 2020-2025, the Energy Advisor plan adds just over \$880 million in new funding allocations across the state and is estimated to save over 7,559,707 MHw of electricity, 151,063,530 MMtus of natural gas and reduce GHG emissions by 11,654,391 metric tons of CO<sup>2</sup>.

The enormous scale of this project is attributed to its collaborative nature. NYSERDA has partnered with the State's seven major utility companies (excluding Long Island) to fund and execute the Energy Advisor Program. The project's objectives are to increase awareness of efficiency incentives, adopt new efficiency projects, advance energy affordability, increase efficiencies of portfolio investments and ultimately increase end-user satisfaction. In Saratoga County, the sole utility provider is National Grid. (NYS Energy Advisor case).

# National Grid

National Grid is one of the biggest multinational investor-owned electricity and gas providers. Based in the United Kingdom, National Grid has strategized growing its international presence by acquiring utility companies in the Northeastern United States. Some of National Grid's acquired utility companies include Massachusetts Electric Company, Boston Gas Company, New England Power Company, Narragansett Electric company and, in 2000, National Grid merged with Niagara Mohawk Power Corporation.

For upstate New York (including Saratoga County), National Grid promotes energy efficiency for its end users by providing incentives and programs available through its website. National Grid offers 13 incentives that range from curbing electricity usage to upgrading natural gas appliances (National Grid, 2020). The incentives offered by National Grid are separate from those offered both statewide and nationally, this means that those seeking to take advantage of every incentive need to be well versed in what is available to them.

National Grid's participation in the new Energy Advisor program means that incentives that used to be only viewable on their platform will now be consolidated to NYSERDA's new portal. Participants who qualify for any incentives will be able to know on the Energy Advisor website, even if certain incentives meet different needs (*i.e. incentives that promote more efficient natural gas boilers vs. incentives that subsidize upgrades to eclectic boilers will be viewable in one location*). Across the state (*excluding Long Island*) National Grid is budgeted to spend roughly \$32.7 million on the Energy Advisor program between 2020-2025 and in that time is expected to save 15,438 MWh of electricity and 220,414 MMBtu of Natural Gas.

# Local non-profit organizations

# HeatSmart Capital Region

HeatSmart Capital Region is a regional-based branch of a statewide 'HeatSmart' campaign. Their initiative seeks to promote the use of efficiency technology in residential and commercial buildings. Managed by the Capital District Regional Planning Commission, HeatSmart Capital Region provides an educational toolkit to potential customers interested in lowering their utility bills and their carbon footprint. Todd Fabozzi, head of the Capital District's HeatSmart campaign, is a subject of this report, and his interview is used to discuss work in the efficiency industry.

Mr. Fabozzi's insight on clean power primarily focuses on heating and cooling technology, with a specific focus on the promotion of heat pumps. This technology presents an enormous savings opportunity for a broad swath of residents in Saratoga County but there is a barrier. Heat pump technology is one of the more expensive types of energy efficiency upgrades a resident can make to improve their home and for many, the costs associated are too high for county wide adoption. Unpacking the cost/benefit analysis of heat pumps with Mr. Fabozzi provided insight to how some incentive programs can only impact a small proportion of any given community; this will be examined later in our discussion to determine how a campaign like HeatSmart add to Saratoga County's efficiency engagement.

#### Sustainable Saratoga

Sustainable Saratoga is a nonprofit organization that seeks to promote environmentally conscious practices in the city of Saratoga Springs. The organization has many initiatives that extend beyond energy efficiency, but since conception conservation of resources has been one of its key underlying goals. This report details interviews conducted with the organization's Executive Director, Wendy Mahaney. Mrs. Mahaney provided context on the county's current efficiency goals as well as past projects and studies that have sought to curb the region's energy demand. Mrs. Mahaney also provided analysis on other local (and nearby) initiatives that seek to promote energy efficiency for residents who fall into varying and low-income brackets, such as the Affordable Housing Partnership (AHP).

# The Affordable Housing Partnership

AHP is an organization based in Albany, New York that seeks to provide assistance and education to homeowners, home sellers and homebuyers. A specific part of the education services the AHP provides is energy efficiency consultation. For most residents in the region, a Comprehensive Home Energy Assessment is free and is used to highlight areas of a home that can be improved to lower utility bills and overall consumption. The AHP also has a list of approved Home Performance Contractors that can be dispatched to measure a home's energy performance. Kathleen Langton is AHP's Energy Program Manager and provides aid to hundreds of New Yorkers seeking to increase their home's efficiency.

#### Past studies in Saratoga County

# *Retrofitting Homes for Energy Efficiency for Low Income People: A Case Study of Saratoga County*

A previous capstone looked at weatherization and retrofitting of low-income homes in Saratoga county. The Capstone did a literature review of retrofitting and weatherization of residential homes and found five main hypotheses on why retrofitting has not been done to its full potential, these were: costs/benefits, awareness, workforce capacity, split incentive, and funding. The Capstone looked at three different organizations in Saratoga County to analyze their data tracking, services, and constraints. They did semi-structured interviews with directors from the weatherization organizations Weatherization Assistance Program (WAP), EmPower NY, and Low-Income Energy Assistance Program (LIHEAP). They also interviewed a Private contractor from EmPower, the head of the Saratoga Springs Public Housing Authority, and two homeowners who had just received energy audits. The Capstone group was able to use data from WAP and EOC to create a cluster map of homes that had been weatherized by home type.

The study found that although these programs were effective in giving home energyaudits and incentives for home retrofitting, there were multiple constraints in overall home energy retrofitting potential. The main limiting factor was found to be funding in organizations that help to incentivize lower-income homeowners to make switches. The other limiting factors were data tracking from retrofitting projects that organizations did not keep. The capstone team argued that increased data tracking would help inform energy and saving estimates in different regions. The Capstone group also found immense potential for energy saving and retrofitting in mobile homes in Saratoga county because of the lack of insulation and efficient heating technology. Additionally, families in mobile homes could benefit from income-based program incentives. They argued more could be done with the weatherization of public housing and mobile homes because of the existing incentives and benefits associated with weatherization programs.

In 2015, the capstone team identified that Saratoga Springs Housing Authority (SSHA) public housing units were looking into weatherizing. The authors argue that programs and organizations should do more outreach in these areas instead of sticking with their conventional "first come first serve" strategy.

# Studies of Residential Energy Efficiency Retrofits

A study published in *Building and Environment* reviews data from over 45 studies and reviews analyzing energy efficiency retrofits in residential homes. The study locations varied from Europe to the United states, focusing on low-income occupants in lower income communities. The primary goal of the study was to highlight how homes contribute to around one third of global greenhouse gas (GHG) emissions and how retrofitting homes with more energy efficient technologies could greatly reduce GHG emissions.

Data measurements based on three major parameters, indoor environmental quality (IEQ) conditions, thermal comfort, and self-reported health. These parameters align similarly with

information we collected in our Qualtrics survey by not only identifying energy efficiency improvement potential, but also examining health and well-being benefits.

In a study published in *Renewable and Sustainable Energy Reviews*, four clusters of barriers to the adoption of energy efficiency by households were identified: structural, economic, behavioral, and social barriers. The use of empirical data to determine specific properties of households, technologies, and policies is important for learning about energy efficiency adoption and policy success. Empirical data is the only concrete way to provide suggestions for policy intervention. Decision making theories can be used to shape the new structure of the model from intermediary to consumer.

#### 2014-15 NYS Energy Efficiency Potential Study

In a 2014 study conducted by Optimal Energy inc. and paid for by NYSERDA sought to determine the State's energy long term (20 year) efficiency potential across different sectors of the economy (residential, commercial and industrial). This study was a precursor to the 2021 Energy Advisor initiative to highlight areas of focus for developing that program. Economic savings were estimated based on the assumption that there are no market barriers to adoption of efficiency measures and that efficiency potential includes all systems that prove to be cost effective. Barriers that were recognized by this study were itemized as resource-constrained economic potential, this accounts for the inability to immediately implement upgrades (such as retrofitting residential properties, due to factors further detailed in the discussion section of this report) (figure 101)

Of the three economic sectors analyzed, it was found that the residential sector stood to benefit the most from increasing efficiency of natural gas and petroleum technology (Figure 102). To aggregate residential efficiency potential, the study aggregated technological improvements that could be made within four categories: Lighting, Hot Water, Thermal Comfort and Appliances & Plug Loads. Implementing achievable residential efficiency upgrades for the entire state of New York was estimated to cost about \$16 billion from 2013-2032 and in return generated over \$24 billion in gross returns, a projected return of roughly 1.5% (figure 103). Single family homes were determined to account for 2/3 of total savings and multi-family homes accounted for the other 1/3 (figure 104).

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#### **Research Design**

Based on our literature review, there is a lack of information and strategies to gauge consumer perceptions of home retrofits and energy efficiency appliances. Specifically in Saratoga County, there is a gap in knowledge of the geographic and socioeconomic distribution of homes that have already been retrofitted using incentives, and homes with the potential for incentive-based retrofitting. Both knowledge and information gaps make it difficult to assess the success of energy efficiency programs and incentives in Saratoga County, thus limiting the county's energy efficiency potential.

Our Capstone's goal is to conduct an energy efficiency study of Saratoga County by identifying factors that motivate or deter different community members, varying in socioeconomic class and location, in engaging with current energy efficiency programs and incentives. This Capstone will gather a holistic data set from surveys, interviews, and past studies that will ultimately be used to make informed recommendations to state and local organizations to increase energy efficiency potential in Saratoga County. Our research team drafted three hypotheses based on our literature review. First, we hypothesize that there is an income-based disparity of people who are participating in energy efficiency programs and retrofitting their homes. Second, there is a lack of knowledge and education of existing energy efficiency incentives and programs in Saratoga County. Third, geospatial and socioeconomic trends from surveys can be utilized to increase energy efficiency in Saratoga County.

#### **Study location**



Figure 1: Map of Saratoga County

Figure 2: Map of Median Household Income

This Capstone's area of focus is Saratoga County. Saratoga County has a population of just over 229,000 with a population density of approximately 277.7 people per square mile (Section 4: Saratoga County Profile). Of the 94,400 households in the county, the average household has between 2-3 occupants and a medium income of about \$84,000. The poverty rate of 6.17% falls below the national average of 10.5% (Census, 2020). In the county, 71.8% of residents are reported to own their own home (Data USA, 2020). The most densely populated areas of Saratoga County are in the city of Saratoga Springs and the town of Milton with a population of 27,447 and 18,985 respectively. The least densely populated areas of Saratoga County are the village of Victory and the village of Round Lake with a population of 517 and 585 respectively.

#### **Qualitative Methods**

#### Interviews

Eleven semi-structured phone interviews were done with local contractors, NYSERDA employees, and CBOs, resulting in over 8 hours of audio recordings. Audio recordings were transcribed online through Otter.ai. Interviews were used to fill in the informational gap and perceptions between different stakeholders in Saratoga County.

#### NYSERDA Employees

*NYSERDA Project Manager-* David Friello, Energy Affordability and Equity. NYSERDA's Energy Affordability and Equity department works to spread home energy equality to residents in New York through community outreach and income based incentives.

*NYSERDA Energy Consultant*- Mary Thompson Grassi. NYSERDA Energy Consultants work with New York residents looking to upgrade their homes EE by bridging the gap between a homeowner's knowledge and information of state funded incentive based programs, and connecting them with NYSERDA approved contractors.

# Local Contractors

Five semi-structured phone interviews were conducted with contracting companies; Global Dwelling, True Performance, Stalmer and Sun, Highland Home Heating and Cooling, B&B Plumbing and Heating. Contractors were chosen based on location, recommendations, and work with known organizations in Saratoga County.

#### Approved Contractors

*Global Dwelling* interviewee: Terry, representative. Global Dwelling is one of just nine NYSERDA approved contracting companies that conducts audits for the Empower and Assisted Home Performance programs in Saratoga County. Terry was able to explain how much work his company receives to do audit work. The requests for work piles up and Terry even said that they do not need to advertise their services to keep calls coming in. Terry was under the impression that there is a lack of NYSERDA approved contractors for two reasons. Fist, NYSERDA has a lot of red tape and so to adequately report work, a company pretty much needs a back office, which means paying for employees whose only job is to account for the work being done. The second reason is that energy audits are not easy to conduct and do not pay especially well. The audits required for the Assisted Home Performance and Empower programs are intensive and the NYSERDA payout has only decreased over time.

*Stallmer and Sun* interviewee: Tod Stallmer, Owner and Founder. Tod's company is another one of the nine NYSERDA contractors who is approved to do work for the Assisted Home Performance and Empower programs. Todd explained some of the intricacies that companies working with NYSERDA are forced to deal with and spoke to how he sees those added complexities as holding back other companies from seeking accreditation for state-sponsored incentive work. Todd also explained how many times, Empower work is focused on getting the customer the best savings possible, rather than making infrastructure changes like upgrading heating systems. The best retrofit, in terms of payback time, is to upgrade lights to LEDS. While this does save the end user money over time, the real goal of Empower is to get more homes heat pump ready.

*True Building Performance* interviewee: Paul Mendel. We were unable to record our phone call with Paul, however he is an important contractor to discuss. Other stakeholders referenced us to Paul because he is a contractor who cares tremendously about home efficiency in the Capital region. Paul has been involved with the Building Performance Institute and is a member of the

City of Albany's Sustainability Energy Sub Committee. True Building Performance focuses on audit work to drive its pipeline and Paul himself states that he started his business with the intention to educate, not sell. For future research on this topic, Paul Mendel is an important person to speak with.

# Unapproved Contractors

*B&B Plumbing and Heating* interview: We were able to record a phone call with their receptionist. Laurie was unable to answer many of our questions regarding EE programs. When asked to connect us with someone who might have some insight, we were informed there was no one who could help us.

*Highland Home Heating and Cooling* Interview: Stephanie from Highland Homes was very helpful when asked about potential home upgrades. When asked about home upgrades that fall under the NYSERDA umbrella she was unable and unwilling to assist. She had not heard of programs making it clear it wasn't a point of emphasis within the company.

#### Community Based Organizations

Four semi-structured phone interviews were conducted with interviewees from CBOs; Sustainable Saratoga, Heatsmart Capital Region, and the Affordable Housing Partnership. CBOs were chosen based on applicable work with energy efficiency initiatives, education, and outreach in Saratoga County.

*HeatSmart Capital Region* interview: Todd Fabozzi. We were able to connect and record a thorough conversation with Todd. He is an important stakeholder because he teaches at Skidmore and is an advocate for EE upgrades within the community. HeatSmart is entering a new phase of public marketing utilizing a large database of information. Catenis is a private engineering company providing support for similar campaigns across the country. This 'fair data tool' does a market analysis of households for stakeholders covering everything from income to number of individuals in a house.

*Sustainable Saratoga* Interviewee: Wendy Mahaney; board member. Sustainable Saratoga works on community environmental outreach and education within the city of Saratoga Springs.

*Affordable Housing Partnership* Interviewee: Kathleen Langton, Capital Region Energy Advisor. AHP works to help low-moderate income residents benefit from income qualifying NYSERDA programs.

#### **Quantitative Methods**

We used a survey to gather data on residents in Saratoga County regarding their use and perception of energy efficiency. Qualtrics was pivotal in isolating participant demographics, locational data and itemizing engagement of varying homes efficiency. Demographic data was collected through questions of participants' age, household income, zip-code, home type (homeowner, renter), and number of permanent home occupants. Income groups were identified by asking participants to select their combined household income from four income brackets: less than \$66,800, \$66,800-\$134,000, \$134,000-\$200,000, and greater than \$200,000. Participant's selected median household income were later classified into the income groups; Low Income (LI), Lower-Medium Income (LMI), Upper-Medium Income (UMI), and High Income (HI). Income brackets based on census data and sectioned to show which homes would automatically qualify for the Empower and Assisted Home Performance Programs (LI).

Locational data was retrieved using participant latitude and longitude from stored geotags in Qualtrics response data. QGIS was used to analyze geospatial data. Home EE engagement and perceptions were collected through questions of participants' home weatherization, appliance upgrades, past home energy audits, environmental and economic motivations to upgrade homes EE, and reliability of home EE informational sources. Some of the questions measured engagement based on a points scale, where others used simple 'yes' and 'no' responses to determine what actions have been done. We incentivized participants to take our survey with a chance to win one out of twelve \$25 Stewart's gift cards. The survey was disturbed through a variety of channels including Facebook, Skidmore faculty lists, CBOs, and paper flyers.

#### Results

#### **Qualtrics**

Through the distribution of our Qualtrics survey we collected 533 surveys from participants all over the U.S. Of the 533 participants we found 476 to be from our study location after isolating our data to participants who answered yes to being residents of Saratoga County. We were able to isolate respondents from every town in Saratoga County.

# **Demographic Trends**



Figure 3: Map of Income Groups

Using GIS software, we isolated geographic trends of income make-up in Saratoga County. We found that most of the county surveyed fell into the Lower-medium income bracket. while the town of Saratoga, encompassing the villages of Victory and Schuylerville, and the town of Greenfield had a majority of participants in the upper-middle income bracket. There were no towns with a majority of high-income residents. Our findings are consistent with the data from the 2020 census (Fig. 2,3).



#### Weatherization and Upgrades

Through participant responses to the questions, "*Has your home, or it's appliances been upgraded?*" and "*Has your home been weatherized?*" we found that, among income groups, a higher percentage of respondents upgraded their appliances in comparison to those who had weatherized

Figure 4: Upgrade vs. Weatherization by Income Group

their homes. The low-income group saw the least number of upgrades to their home appliances but one of the highest percentages of weatherization. This trend is due to weatherization being a low cost and quick fix method to increase home energy efficiency. There is clearly a need for State funded home energy programs to incentivize low-income households to upgrade their appliances.



#### How Homes Are Heated





Overall, the most common heating system from our respondents in the county was natural gas forced air (41%). The second most common heating source is natural gas fired boilers. The two lower income brackets had a lower adoption of natural gas forced air than the higher income brackets.

This map shows the most common source of heating by town and cities. We found that more populated and urbanized locations like Saratoga Springs, Clifton Park and Ballston Spa are primarily using natural gas forced air, while more rural locations are using a variety of heating sources that are less cost-effective and produce more GHG (Census, 2020). For example, Wilton had a majority of

respondents burning oil for their heat source, while Providence and Greenfield had a majority of respondents using electric air baseboards. This is likely due to an overall larger number of mobile home units per capita in these municipalities. From this we can see that there needs to be more efforts by state funded programs and CBOs to target these areas where residents are using outdated and inefficient heat sources and switch them to electric heat pumps or more sustainable options.

# Cost for Heat



The majority of participants paid between \$125-\$300 for heat during an average winter month. However, we found geographic disparities of monthly heating bills between town and cities in Saratoga County. What we found most interesting was the fact that Corinth, a town with one of the lowest census reported median incomes, as represented in the map to the left, reported having higher heating costs than

Figure 7: Reported Monthly Winter Expenditure on Heat

more affluent towns. This can be explained by environmental injustice trends where lower income groups pay more for their heat than higher income groups, because their homes are usually older and less energy efficient. To address this CBOs and state funded incentive programs should prioritize these areas to level out heating costs by promoting access to cleaner more cost-effective technology.

#### High Income Group Falling Off EE Trends



As income increased, respondents were more likely to use renewables, until the highest income bracket. The uppermiddle income bracket had the highest adoption of renewable sources for heating (~8%), followed by the lower-middle income bracket (~4.5%). The highest income bracket had the

Figure 8: Respondents who reported their homes to be heated with renewables

lowest adoption of renewable sources (~2%), followed by the low-income bracket (~4%). Overall, as income increases, the use of oil-fired boilers decreases. This is in-line with our prediction that the use of an older, less efficient technology will be higher in lower income brackets. It was particularly interesting that the highest income bracket did not have the highest use of modern, renewable technology for their heating even though they have the most disposable income to spend on EE upgrades.



This trend is present again when you look at how respondents reported their reasons for wanting to engage with energy efficiency. As income increased, fewer respondents reported being motivated to engaged with energy efficiency technology to save money. Respondents were increasingly more likely to

Figure 9: Respondents report their main motivation to become more efficient

engage with efficiency technology in order to lower their own consumption- until the highest income bracket. The highest income backet reported the lowest motivation trend for efficiency,

based on our survey's ranking. When we decided to compare this again to measure which respondents were using energy audits, we saw more similar results.

It is important to note that of our total respondents, only 16% reported to have received an energy audit. Of that 16%, the graph on the left is breaking up those respondents by income bracket and if they paid for their energy audits or received it for free audit. Like other trends of engagement, the highest income group is reporting to be the least involved with energy efficiency. The highest income bracket paid more than the two lowest income brackets (*both* 



hovering just below 1% of respondents paid for audits) but is significantly lower than the upper middle-income bracket before it which sits at 5% of respondents paid for an energy audit. We found that the uppermedium income group was paying for more energy audits than high income group. Both the lowest income groups received roughly the same number of free audits (~17%).



We asked participants to rank the most important informational in terms of reliability for home energy efficiency and then grouped answers by income group. Overall, the most reliable source for home energy heating energy efficiency upgrades was 'my own

research' by a large margin, while energy companies and utilities were seen as the least trustworthy source. Among groups, LI and HI were more likely to trust their own research than

#### **Reliability of Informational Sources**

Figure 10: Income Groups Source of Trusted Information

the middle-income groups. However, LI groups were the least likely to trust any other informational source except for friends, neighbors, and relatives. It was notably interesting that the LI group (<\$66,800) trusted NYSERDA the least as a reliable informational source for home EE. In fact, LI groups were 20% more likely to rank NYSERDA last in terms of reliability. This is extremely counterproductive to the overall EE of Saratoga County because while LI groups stand to benefit the most from NYSERDA home EE incentives, they will not take advantage of those incentives if they do not trust NYSERDA.



Audits Work

We found that the majority of respondents who received an energy audit made upgrades. Respondents who have never received an energy audit were far less likely to have made efficiency improvements to their homes. Another interesting correlation is that between income and knowledge of weatherization. We found that wealthier respondents

**Energy Audits Encouraged Efficiency Upgrades:** 

were more likely to know about what weatherization is but are less likely to have weatherized



Respondents Who Have Received an Energy Audit:

Figure 12 & 13: Pie charts show total respondents' engagement with energy audits (left) and outcomes of the audits (right)

their homes. The lower income bracket had a lower knowledge of what weatherization was but

were more likely to have weatherized their home. This data supports other findings from this experiment that there is a 'tipping-point' in affluence in which residents start caring less overall.

There is a relationship between those who got energy audits, and those who made energy efficiency upgrades. Of the respondents, only 16% had received an energy audit. Of those who had received an energy audit, 87% of those made efficiency upgrades. This leads our quantitative data to conclude that energy audits work at encourage efficiency technology.

# **NYERDA** Contractors

Through interviews with contractors, we found that contractor participation in NYSERDA programs is laborious and costly. Staff must go through intensive and costly certification processes. Most contractors do not want to spend the money certifying their staff, and it is a major investment of resources, every time someone is being certified, they are not keeping up with the demand of work the company is getting. There is some talk of relaxing the standard and inviting more contractors in to keep up with demand versus the supply of contractors.

#### Workforce Capacity

Our results show us that workforce capacity is one of the most detrimental problems with retrofits, being one of the most restricting factors because the number of homes retrofitted depends on the availability of workers. All the contractors interviewed stated that there was too high a demand of work to keep up with, and that there is an overall lack of contractors. In addition, to be qualified for current existing NYSERDA programs, credentialling is cost-intensive, and involves credentialing each individual contractor. Strict program requirements also pose a big issue in certifying more contractors and companies. Currently, companies do not want to pull their workers off the street, since they are already struggling to keep up with work demand. More lenient program requirements would provide more incentive for credentialling contractors and would allow more to get certified to keep up with work demand.

NYSERDA subsidization creates some complications within the industry. Since subsidized programs go through the state, payments are not immediate cash transactions and require back-office employees to bill the State for work. This creates one noticeable barrier to entry; companies must be big enough to afford back-office employees. In addition, to become an eligible NYSERDA contractor, companies must pay annual BPI (Building Performance Institute) dues to certify the employees who conduct Empower and Assisted Home Performance Audits. The certifications and dues are not necessarily priced exorbitantly but the process adds another hurdle that may prevent less established companies from entering NYSERDA's market.

These interviews made it clear that because older and more affordable homes stand to benefit more from efficiency upgrades, the LMI segment makes up most of the demand for audits. It was also made clear that there is no shortage of demand for work. Our contact from Global Dwelling surmised that roughly 80% of the audits they conduct are for the LMI market. This indicates that all the audits Global Dwelling conducts are subsidized by NYSERDA. Our contact noted that there is a surplus of clients who would qualify for NYS incentive programs, but they do not have enough time in the day (or competition) to service them all.

#### **Conclusion and Recommendations**

In reviewing the current state of energy efficiency trends in Saratoga County, we have come up several recommendations for how residents can be more engaged and motivated by home EE. Expanding awareness and education of state funded incentive programs to residents and contractors across a variety of platforms will maximize program effectiveness in Saratoga County. From our interviews we learned that homeowner education and engagement is best conducted through face-to-face interactions between energy advisors and target homeowners. However, there also needs to be a targeted approach to seeking out potential homeowners that stand to benefit the most from home EE programs.

This is crucial because we found a disparity of access and trust of home EE programs and information between income groups and locations in Saratoga County. The northern region of Saratoga County including the towns of Corinth, Greenfield, and Wilton should be prioritized in outreach and educational programs because these areas have the greatest percentage of lowincome residents that would qualify for incentive-based programs (Fig \*). Also, residents in these locations experience the most environmental injustice from disproportionate heating costs and lack of clean heating sources. Face to face interactions with residents would benefit home EE the most in these areas because they are primarily composed of the two lower income groups that have the most distrust towards NYSERDA. This can be done by creating a civic engagement program that will focus on creating energy auditors that are from within the community. These Auditors will participate in a program that focuses on college and high school age kids who have energy efficiency in mind. Young community members are the perfect fit for this role as they have a voice and make up a large group of potential participants. Potential auditors once within their community working will reach out through canvassing, energy fairs, and block parties. The face-to-face interaction will aid in filling the gap that we previously see when only spreading awareness through technological sources. The increase will not only aid in customer knowledge but similarly it will increase contractor's knowledge. On top of effectively spreading awareness, creating energy auditors subsequently creates young environmental stewards who have energy efficiency in mind.

Currently programs like *Heat Smart* have started to use targeted marketing software to increase home EE. Catenis is a marketing tool that provides enhanced data analysis to enhance the understanding of residential market trends for electric heat pumps. This "fare data tool" will be used to analyze the participation and perception community members have of energy efficiency programs. Catenis will allow HeatSmart to focus its resources and time on more residents who are more likely to be valuable customers. The data tool will also point HeatSmart to what aspects of efficiency most motivate a given potential customer. Catenis is one example of a method for organizations to speed up how they interact with residents and find residents who will be more receptive to education about efficiency. Education of end users can be enhanced with better market tools but that is just one piece of the puzzle.

#### **Future Research**

Do energy audits really motivate the adoption of residential energy efficiency? That is the overarching question needed for further research. A new study should focus on looking at the data this report was able to pull together and attempt to get more numbers to prove whether Saratoga County is increasing total energy audits. If audits are increasing, what income group is engaging with audits the most? Are the wealthiest residents in the county continuing to pay less mind to efficiency than other income brackets? We were able to show a correlation between audits and home upgrades, but is there more to this story?

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As stated, 11% of low-income residents in New York State lack access to the internet, so how is NYSERDA effectively reaching this demographic? There was a large section of our survey area that we were unable to reach due to technological barriers such as access to a computer, smartphone or again, internet. One way in which the effectiveness of NYSERDA's Energy Advisor Website should be evaluated is, how well they are reaching 'hard-to-reach' demographics. There were multiple notable towns/cities (i.e., Day, Edinburgh, Hadley, Galway, Halfmoon) that did not have the same representation in our data as the towns/cities that had a higher number of respondents. A future study will need to focus on getting equitable representation from respondents.

Additionally, new NYSERDA-approved contractors should be interviewed to understand how they pitch energy efficiency technology to their customers. Contractors were difficult to contact, and even more difficult to get an interview with. Again, NYSERDA-approved contractors stated that they benefit by being credentialed, but that it was a costly process that required everyone to be credentialed. Now NYSERDA is trying to lower barriers to bring more on. Are more approved contractors working within Saratoga County now, and are they stressing the benefits of efficiency to their clientele? Overall, contractors in Saratoga County can barely keep up with the current work demand, it will be important to track this in the future to see if there are more providers working in the region.

Residential energy audits have shown their ability to be effective, but future research should focus on the collection and analysis of data related to the outcomes of audits. A system where audits and their outcomes are kept track of would help us understand the populations of specific geographies and any general trends. Tracking these trends will also present regions in which more audits are needed and isolate income demographics who could be better communicated with. The use of empirical data is the proper way to provide solutions for policy intervention and will provide evidence to lead engagement with residential home efficiency.

# Bibliography

- Boucher, L., Araujo, K., & Hewitt, E. (2018). Do education and income drive energy audits? A socio-spatial analysis of new york state. *Resources, Conservation, and Recycling, 136*, 355-366. <u>https://www-sciencedirect-com.lib-</u> proxy01.skidmore.edu/science/article/pii/S0921344918301782
- Haley, B., Gaede, J., Winfield, M., & Love, P. (2020). From utility demand side management to low-carbon transitions: Opportunities and challenges for energy efficiency governance in a new era. *Energy Research & Social Science*, 59 <u>https://wwwsciencedirect-com.lib-proxy01.skidmore.edu/science/article/pii/S2214629618312878</u>
- Hess, D. J., & Lee, D. (2020). Energy decentralization in california and new york: Conflicts in the politics of shared solar and community choice. *Renewable and Sustainable Energy Reviews*, *121* <u>https://www-sciencedirect-com.lib-</u> proxy01.skidmore.edu/science/article/pii/S1364032120300149
- Baatz, B., Relf, G., & Nowak, S. (2018). The role of energy efficiency in a distributed energy future. *The Electricity Journal*, 31(10), 13-16. <u>https://www-sciencedirect-com.lib-proxy01.skidmore.edu/science/article/pii/S1040619018302495</u>
- Cho, H., Freyre, A., Bürer, M., & Patel, M. K. (2019). Comparative analysis of customerfunded energy efficiency programs in the united states and Switzerland–Costeffectiveness and discussion of operational practices. *Energy Policy*, 135 <u>https://wwwsciencedirect-com.lib-proxy01.skidmore.edu/science/article/pii/S030142151930597X</u>
- Grillone, B., Danov, S., Sumper, A., Cipriano, J., & Mor, G. (2020). A review of deterministic and data-driven methods to quantify energy efficiency savings and to predict retrofitting scenarios in buildings. *Renewable and Sustainable Energy Reviews*, 131 <u>https://www-sciencedirect-com.lib-</u> proxy01.skidmore.edu/science/article/pii/S136403212030318X
- Nadel, S. (2019). Focusing and improving traditional energy efficiency strategies. *The Electricity Journal*, 32(7) <u>https://www-sciencedirect-com.lib-proxy01.skidmore.edu/science/article/pii/S1040619019302015</u>
- Brown, M. A., Soni, A., Doshi, A. D., & King, C. (2020). The persistence of high energy burdens: A bibliometric analysis of vulnerability, poverty, and exclusion in the united states. *Energy Research & Social Science*, 70 <u>https://www-sciencedirect-com.libproxy01.skidmore.edu/science/article/pii/S2214629620303315</u>
- Ohler, A. M., Loomis, D. G., & Ilves, K. (2020). A study of electricity savings from energy star appliances using household survey data. *Energy Policy*, 144 <u>https://www-sciencedirect-com.lib-proxy01.skidmore.edu/science/article/pii/S0301421520303414</u>
- Romanach, L., Leviston, Z., Jeanneret, T., & Gardner, J. (2017). Low-carbon homes, thermal comfort and household practices: Uplifting the energy-efficiency discourse. *Energy Procedia*, 121, 238-245. <u>https://www-sciencedirect-com.lib-proxy01.skidmore.edu/science/article/pii/S187661021733477X</u>

- Wilson, E. J. H., Harris, C. B., Robertson, J. J., & Agan, J. (2019). Evaluating energy efficiency potential in low-income households: A flexible and granular approach. *Energy Policy*, *129*, 710-737. Retrieved from <a href="https://www-sciencedirect-com.lib-proxy01.skidmore.edu/science/article/pii/S0301421519300527">https://www-sciencedirect-com.lib-proxy01.skidmore.edu/science/article/pii/S0301421519300527</a>
- Zhao, D., McCoy, A. P., Agee, P., Mo, Y., Reichard, G., & Paige, F. (2018). Time effects
  of green buildings on energy use for low-income households: A longitudinal study in the
  united states. *Sustainable Cities and Society*, 40 <u>https://www-sciencedirect-com.libproxy01.skidmore.edu/science/article/pii/S2210670718301094</u>
- Myers, E. (2020). Asymmetric information in residential rental markets: Implications for the energy efficiency gap. *Journal of Public Economics, 190* Retrieved from <u>https://www-sciencedirect-com.lib-</u> proxy01.skidmore.edu/science/article/pii/S0047272720301158
- Guide for conducting energy efficiency potential studies: A resource of the national action plan for energy efficiency. (2007). (). Retrieved from <u>https://www.epa.gov/sites/production/files/2015-08/documents/potential\_guide\_0.pdf</u>
- Local energy efficiency benefits and opportunities. Retrieved from <u>https://www.epa.gov/statelocalenergy/local-energy-efficiency-benefits-and-opportunities</u>
- National action plan for energy efficiency vision for 2025: A framework for change . (2008). (). Retrieved from <a href="https://www.epa.gov/sites/production/files/2015-08/documents/vision.pdf">https://www.epa.gov/sites/production/files/2015-08/documents/vision.pdf</a>
- NYS electric utility service territories. Retrieved from <u>https://data.ny.gov/Energy-Environment/NYS-Electric-Utility-Service-Territories/q5m9-rahr</u>
- New York.Gov.Inside the capitol region. Retrieved from <u>https://esd.ny.gov/regionaloverviews/capital/insideregion.html</u>
- U.S Energy Information Administration.Rankings: Average retail price of electricity to residential sector, january 2021 (cents/kWh). Retrieved from <u>https://www.eia.gov/state/rankings/?sid=NY#series/31</u>