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CAMBRIDGE COMMUNITY ENERGY INNOVATIONS

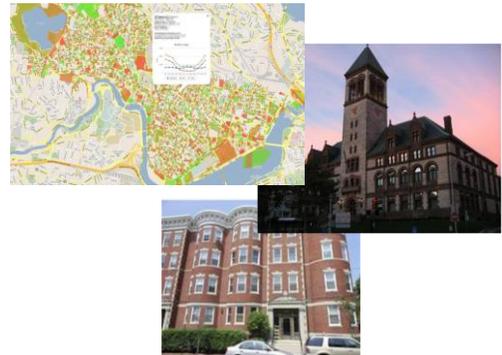
A NEW APPROACH TO MULTIFAMILY EFFICIENCY

Report of the:

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Executive Summary

The semester’s objective was to propose a set of multifamily energy efficiency experiments that can be implemented by NSTAR and the City of Cambridge to unlock all available energy savings in the Cambridge multi-family residential sector. In developing this proposal, we examined the state of energy efficiency programs available in Massachusetts; assessed the unique barriers to multifamily efficiency; assessed the concerns of stakeholders likely to be involved in implementing the pilot; and sought to imagine how local community organizations and “big data” can be leveraged to design the next decade of energy efficiency programs.

The City of Cambridge also has a strong interest in the success of a multifamily energy efficiency program: in addition to the economic benefits that improvements in energy efficiency bring to Cambridge’s multifamily residents and building owners, a successful multifamily efficiency program could help to realize the city’s greenhouse gas emission reduction goal – to 20% below 1990 emission levels.

The Practicum’s proposed plan for a multifamily energy efficiency pilot program for the City of Cambridge, Massachusetts investigates two propositions:

1. A streamlined, community-level energy efficiency program can increase resident participation beyond the level that impersonal marketing and a complex assessment and financing system can yield.
2. More data-driven methods of energy efficiency program implementation can produce measurable increases in the level of resident and owner participation.

The plan is composed of six design ideas:

1. *Process improvement*, built around a program implementer who guides landlords through the entire retrofit process;
2. *Community empowerment*, which leverages local institutions and community organizations to conduct outreach and education on the value of energy efficiency in their communities;
3. *Financing*, which includes streamlining the Mass Save HEAT loan program;
4. *Technology*, which tests new control technologies in selected buildings to improve efficiency while enhancing occupant comfort;
5. *A typology-driven approach* to home energy assessments involving an online tool; and
6. *Energy data transparency*, which tests the benefits of disclosing building energy ratings.

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Our proposal includes two primary components:

- A **Base Citywide Component** that is intended to directly improve the participation and savings impact of multifamily efficiency programs. This component includes a streamlined program process, tools for community and resident empowerment, adequate financial tools to address split incentive, and innovative technologies appropriate for the multifamily sector. We believe that this portion of the pilot is most effective if deployed at the city scale, though we recognize that program constraints may require a smaller geographic scope,
- A **Data Central Component** that develops new tools targeted at improving access to information about building-level energy performance and potential and that are intended to assist with market transformation. This component includes an opt-out data disclosure initiative, a typology-based remote assessment tool, and the possibility of additional data products such as an energy rating system and performance map. We believe that these analytical tools are most appropriate to pilot in a controlled and more manageable neighborhood scale.

We propose that these two components be rolled out simultaneously in Cambridge. We believe that this pilot can be implemented and evaluated in the space of three years.

In this report, we describe both the generic barriers and solutions in multifamily energy efficiency as well as the specific details of our Cambridge pilot proposal. We also include a rough plan for program evaluation that would allow the energy efficiency field as a whole to benefit from the learning that can be extracted from this pilot.

Introduction

This report is the product of a semester of work by students enrolled in a graduate-level course in the Department of Urban Studies and Planning at the Massachusetts Institute of Technology. Our objective has been to propose a set of multifamily energy efficiency experiments that can be implemented by NSTAR and the City of Cambridge. We want to unlock all available energy savings in the Cambridge multi-family residential sector. In developing this proposal, we examined the state of energy efficiency programs available in Massachusetts; assessed the unique barriers to multifamily efficiency; assessed the concerns of stakeholders likely to be involved in implementing the pilot; and sought to imagine how local community organizations and “big data” can be leveraged to design the next decade of energy efficiency programs.

Despite the great success of energy efficiency programs in Massachusetts, there is substantial room for improvement in hard-to-reach segments of the housing market. Multifamily residential housing, in particular, poses a number of challenges that make the multifamily sector one of the most difficult markets for energy efficiency programs to penetrate. They also create an opportunity to invest in new ways of achieving energy efficiency.

Overcoming these barriers would be significant in several ways. For Massachusetts’ utilities, it would make it easier to remain at the forefront of the energy efficiency field. Due largely to the success of the utility-run Mass Save program, the American Council for an Energy-Efficient Economy recently ranked Massachusetts as the best state for energy efficiency for the second year running (ACEEE 2012). Developing a breakthrough model for multifamily efficiency programs would cement the status of the state’s utilities as national leaders and make it easier to meet mandatory savings goals.

The City of Cambridge also has a strong interest in the success of a multifamily energy efficiency program. The Green Communities Act of 2008 empowered cities and towns to direct the pace and direction of energy efficiency implementation and Cambridge was an early adopter. In addition to the economic benefits that improvements in energy efficiency bring to Cambridge’s multifamily residents and building owners, a successful multifamily efficiency program could help to realize the city’s greenhouse gas emission reduction goal -- a 20% reduction below 1990 emission levels. The city has also been working with two of its anchor institutions - MIT and Harvard - to increase sustainability. In May 2013 the city signed a Sustainability Compact with both universities, promising to increase sustainable development efforts across the city.

The Purpose of the Pilot: Experimentation and Learning

We see this pilot as an opportunity for bold action. Our intention is to test creative ways of thinking about energy efficiency. We believe that this can create an important learning

opportunity, not just for the city of Cambridge, but also for NSTAR and other Mass Save efficiency program administrators as well. Indeed, communities across the state should be able to draw useful lessons from the pilot.

Generally, we are interested in investigating two propositions. The first is that a streamlined, community-level energy efficiency program can increase resident participation beyond the level that impersonal marketing and a complex assessment and financing system can yield. The second is that more data-driven methods of energy efficiency program implementation can produce measurable increases in the level of resident and owner participation.

We propose to test these propositions by piloting six program design ideas within two distinct program components. In the **Base Citywide Component**, we propose implementing *process improvements, community-based outreach and organizing efforts, new approaches to project finance, and innovations in building technology*. In a **Data Central Component**, we include concepts related to *building typology assessments and data transparency*.

Pilot-Development Process: Research, Community Engagement & Feedback

In designing this pilot, we began by reviewing previous energy efficiency programs implemented both in Cambridge and around the world. Reading these reports definitely shaped our thinking. Class discussions helped us identify solutions that might work in Cambridge. Spokespeople for many energy efficiency groups were generous with their time, meeting us, both inside and outside of class.

Given our one semester time limit, we realized that we would not be able to complete a comprehensive assessment of the views of all relevant stakeholder groups in the city. We were, however, able to meet with representatives of many groups. A list of the people we interviewed over the course of the semester is included in Appendix A. We invited all of these representatives and others to join us for a symposium in late April 2013. This gave us a chance to present our preliminary findings and proposals. A post-symposium online survey gave us still more to work with. The complete list of symposium participants is included in Appendix B.

This report provides both background on the barriers and concepts related to multifamily energy efficiency and our specific proposal for crafting an effective and innovate multifamily pilot in Cambridge, Massachusetts. First, we provide a brief overview of Cambridge's multifamily housing market, describing the city's demographics and building characteristics that shape energy consumption. Next, we describe the barriers that hinder the implementation of multifamily energy efficiency programs. We then provide an overview of the two major aspects of our proposal—the Base Citywide component and the Data Central component—and the provide

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background and discussion on the various element embedded in the proposal. We finish with our recommendations for an evaluation plan and our concluding thoughts.

Cambridge Context

The city of Cambridge is dominated by multifamily housing. 84% of the city's households live in multifamily buildings (U.S. Census Bureau 2011). Multifamily housing accounts for an estimated 31%² (Peregrine Energy Group 2012) of the city's energy use with an estimated (economically feasible) efficiency potential of 21%³ (Cadmus Group 2012). These facts alone indicate that local program designers should pay close attention to the multifamily sector, although, several aspects of Cambridge's demographic and built environment make multifamily energy efficiency particularly difficult to achieve.

Cambridge has high rates of both rental housing and condominium ownership. 65% of the city's population lives in rental housing (U.S. Census Bureau 2011), and condominiums account for 27% (Cambridge CDC 2011). Therefore, any approach to unlocking energy savings in Cambridge's multifamily sector must address these forms of ownership.

Additionally, due largely to the city's strong university presence, Cambridge has a very young and mobile rental market. Students account for 27% of the city's adult population. 53% of the city's rental units have a primary householder under the age of 35. Additionally, 40% of renters have lived in their current residence for less than five years (U.S. Census Bureau 2011). Many residents have lived in Cambridge for only a year or two, moving between Cambridge, Boston and Somerville due to the deep interconnectedness of these neighboring towns. These factors exacerbate what is generally viewed as a split incentive problem. A young and transitory rental population has little incentive to invest in long-term upgrades to their homes.

Cambridge's tight housing market also contributes to the problem. In most cases, landlords can benefit indirectly by using the promise of low energy costs to compete for prospective tenants. In Cambridge, however, the rental vacancy rate is under 3% (compared to a national average of nearly 8%) (U.S. Census Bureau 2011). This suggests that landlords in Cambridge have little difficulty finding tenants to fill empty units. In our view, this means that they tend to feel less pressure to lower energy costs as part of their advertising strategy.

Cambridge's heterogeneous landlord population also raises obstacles to energy efficiency. While data on ownership characteristics are incomplete, interviews with individuals experienced with the market indicate that small-scale property owners, each controlling a few small buildings, own a rather large percentage of the city's rental property (CBSM workshop participant 2013) This makes organizing an energy efficiency program difficult. Scaling up the ideas we have in mind will require working with a large number of property owners. Additionally, many landlords use third-

² Study excludes heating oil.

³ Electricity and gas only.

party property management firms to run their day-to-day operations. This adds an additional layer of complexity to any efficiency improvement efforts. The primary point of contact for a rental property may not have the authority to make improvements.

Nevertheless, despite the added difficulties facing a multifamily energy efficiency improvement program in Cambridge, there are ample opportunities for energy savings. Cambridge has a very old housing stock relative to the rest of the nation, with 52% of its rental units built before 1940 (U.S. Census Bureau 2011). Massachusetts did not enact its first residential energy code until 1975 (Berstein, et al. 2002), so the majority of rental units are poorly insulated and could still benefit from retrofits. Additionally, though it is rare in the rest of the nation, the northeastern United States is highly reliant on inefficient and costly oil heat. Fuel oil is less prevalent in Cambridge's rental housing stock than elsewhere in the state, but 13% of its units are still heated by fuel oil. This presents additional "low-hanging fruit" that can be seized by a successful energy efficiency program.

Cambridge's diverse, but overwhelmingly young, population can be a real asset. While a young, student-dominated population is transitory, they tend to be tied to a very small number of anchor institutions and community groups. Universities, hospitals and medical centers, and large employers like Google and Microsoft, employ or engage a large number of Cambridge's citizens. There are strong and diverse community groups, including more than 75 churches,⁴ more than ten Jewish synagogues or community groups,⁵ a mosque, several arts collectives, a food co-op, dozens of formal and informal sports teams, several environmental non-profits, and many music groups and venues. All can be used as a way to reach the city's diverse population.

Barriers to Multi-Family Energy Efficiency

Despite the investment in energy efficiency programs in the City of Cambridge in recent years, home energy assessments and efficiency upgrades have proceed rather slowly in the multi-family rental sector. Currently, only 6% of the multi-family rental market in Cambridge has completed an energy efficiency assessment in the past three years (Cambridge Energy Alliance 2012). Our proposed pilot will pinpoint barriers to energy efficiency in Cambridge's multi-family rental market, many of which are similar obstacles to multi-family rental markets in other cities across the country. We describe several of these below.

Upgrade Processes Are Complex and Involve Many Players

⁴ Online church directory (Emmanuel Gospel Center Church Directory 2013)

⁵ Online community directory (JewishBoston.com 2013)

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In 2010, the Mass Save program created a Multi-Family Market Integrator (MMI). The Integrator's role is to coordinate efficiency work while guiding customers through the retrofit process. Despite the presence of the Integrator, building owners still have to manage and navigate a complex process.

It is difficult for building owners to understand which efficiency programs they are eligible for. Different utility rate classes (in the commercial and residential sectors) are eligible for different programs. Even different parts of a building may qualify for separate efficiency programs: common areas in multi-family buildings are usually included under commercial programs, while residential units are included under a different heading. Such segmentation gets in the way of a 'whole building approach to energy efficiency.' This, in turn, discourages many building owners from any pursuing efficiency improvements (McKibbin 2013).

Building owners must be able to finance efficiency upgrades. We spoke with one landlord who is who is working with a local energy company to install solar panels on his roof. While the company tries to guide him through the retrofit process, he is still unable to put together a financial package to cover the costs of installing solar panels. He has spent months trying to understand the various rebate and incentive programs. While this particular landlord understands the benefits of energy efficiency and is willing invest the time and energy required to add solar panels, many landlords are either unaware of the value efficiency holds or are unable to make sense of the various programs and funding opportunities. A lack of "handholding" in the upgrade process discourages landlords from completing assessments and upgrades.

The existing, in-person, home energy assessment process involves numerous time-consuming steps that can be expensive. Each requires communicating with several organizations. In a single test home assessment, we were required to speak with no less than 8 *different* representatives of the same company *before* getting a home energy assessment arranged. Anyone seeking to complete an assessment, make retrofits and find financing will probably have to speak to three or more organizations and their representatives, including a contractor to do the retrofit work, one or more banks, and Mass Save to actually get their rebates. One person we interviewed reported waiting six months to secure their rebate to which they were entitled (CBSM workshop participant 2013). All of this discourages landlords and tenants.

Lack of Understanding of the Value of Energy Efficiency

One primary impediment to energy efficiency in multifamily settings is the lack of understanding of the benefits of efficiency. Most residents do not think about efficiency on a daily basis. They do not see evidence of efficiency gains being made. They do not know the options available to them, or how to approach a landlord to discuss energy improvements.

Split Incentives Between Landlords and Tenants

Landlords have split incentives or conflicting incentives. Landlords do not want to pay for efficiency improvements since tenants pay utility bills. All the costs fall on the landlord while the efficiency savings go directly to the tenant.

Lack of Access to Capital

The upfront costs of efficiency improvement work are often too high for many landlords, especially small property owners who struggle to stay afloat or have other maintenance priorities. And, landlords who wish to complete an efficiency upgrade cannot get access to capital since most lenders are unconvinced of energy savings projections and unwilling to underwrite loans for efficiency improvements.

Inability of Tenants to Initiative Upgrades

Tenants in 5+ unit buildings are not able to make deep efficiency improvements without the permission of their landlords. After most assessments, only light bulbs are changed. It is difficult for tenants to get landlords to make these upgrades, often because landlords are absent or indifferent.

Lack of Energy Information in Housing Market

Prospective tenants and buyers must make decisions without knowing exactly what the energy performance of buildings in which they are interested. Owners, tenants, and the Mass Save retrofit program providers may have a hard time estimating efficiency potential. Present approaches to gathering this information are cumbersome and costly. Efforts to streamline acquisition of the relevant data have to be balanced against privacy needs.

A Lack of Tenant Ability to Control Their Indoor Environments

Currently, utility companies in the Boston area do not have access to programs that subsidize building temperature controls. As a result, most buildings do not have heating controls in all the rooms and apartments, creating indoor environments that are usually too hot or too cold. Tenants are forced to moderate room temperatures through highly inefficient means (i.e., opening windows when it is too hot).

Lack of Committed Personal Recruitment

While HEET and the Cambridge Energy Alliance organize a great many community events to speak directly to citizens about energy efficiency, there is little structured support for this type of in-person, community based social marketing. Advertising emphasize subway ads, radio bits, or bus stop panels, when high touch person-to-person communication is much more effective. Most community groups, even those that help their members pay expensive fuel or heating bills in the

winter, do not have the capacity (financial or informational) to be engage their members in meaningful conversations about energy efficiency.

Complexity and Diversity of Built Environment

Like many cities in New England, the Cambridge building stock is quite diverse, constructed at various stages over the past two hundred years and developed in very different styles. This makes rolling out consistent technologies or developing virtual assessment tools extremely challenging.

Privacy Concerns of Citizens and the State

City and state officials, as well as citizens, are concerned about the privacy information. Information disclosure is a sensitive subject, even for something that may be seen as “impersonal” as levels of heating use or energy consumption. While water consumption levels are public, and utilities will disclose energy data to any prospective resident, many landlords and tenants are reluctant to make public their energy consumption levels. The use of thermal imagery to reveal potential for savings has also been a subject of criticism due to privacy concerns (CBSM workshop participant 2013).

PILOT OVERVIEW

We propose the implementation of a multifamily energy efficiency pilot program in the City of Cambridge, Massachusetts, which is intended to last three years, beginning in the Fall of 2013. The program proposes to recruit buildings that range from 2 to 20 units.

We suggest that the program include six elements:

7. a process improvement element, built around a program implementer who guides landlords through the entire retrofit process;
8. a community empowerment element, which leverages local institutions and community organizations to conduct outreach and education on the value of energy efficiency in their communities;
9. a financing element, which includes streamlining the Mass Save HEAT loan program;
10. a technology element, which tests new control technologies in selected buildings to improve efficiency while enhancing occupant comfort;
11. a typology-driven approach to home energy assessments involving an online tool; and
12. an energy data transparency element, which tests the benefits of disclosing building energy ratings.

The program will operate at two scales: a Base Citywide Component and a Data Central Component.

Base Citywide Model

This will incorporate process improvements, community capacity-building, financing elements, and the use of control technologies. It will apply to multi-family buildings in the entire city of Cambridge.

Data Central

This will operate at the neighborhood scale — within Central Square — where a group of about 400 buildings will use the typology-based remote home energy assessment tool, and test building energy performance disclosure.

Addressed Barriers

Below, we summarize the various components of our proposal, and the market barriers that they confront.

Table 1: Proposal summary chart. By authors.

Theoretical Perfect Market	Actual MF EE Market Conditions	Program Elements	
		(Short-term pilot)	(Longer-term policy)
		Process Improvements	

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No transaction costs	Process is complicated, time-consuming & disruptive	<ul style="list-style-type: none"> • Single “turnkey” program provider • “Cohort” approach to program delivery
Perfect information & Rational behavior	<ul style="list-style-type: none"> • Renters/buyers don’t know energy costs • Limited knowledge of EE potential 	<p style="text-align: center;">Data Transparency</p> <ul style="list-style-type: none"> • Energy map • Pilot full data disclosure in 1 neighborhood • Typology-based Remote/low-touch energy assessment tool • Option – Mandate energy & building rating disclosure • Option – Voluntary disclosure framework.
	<ul style="list-style-type: none"> • Limited knowledge programs exist • Behavioral inertia – people need to be inspired & trust the program 	<p style="text-align: center;">Community Based Social Marketing</p> <ul style="list-style-type: none"> • Recruit community leaders • Incentive system for community organization recruitment • Develop success stories • Tenant Tool-Kit
Access to capital & no agency problems	<ul style="list-style-type: none"> • Approval for HEAT Loan time-consuming • Split-incentive – owners & tenants • Difficulty lending to condo associations 	<p style="text-align: center;">Adequate Financing</p> <ul style="list-style-type: none"> • Expedite HEAT Loan approval • Promote green lease terms & “energy saving calculator” tool • Implement on-bill tariff based repayment of energy financing in multi-metered MF • Document loan performance
Appropriate technologies readily available	Innovative technologies not offered as part of standard upgrade package	<p style="text-align: center;">Appropriate Technologies</p> <ul style="list-style-type: none"> Pilot & test innovative control systems Integrate control systems into basic eligible technologies.
Seamless coordination of market	<ul style="list-style-type: none"> • Complicated institutions • Need for collaboration, mutually supportive policy 	<p style="text-align: center;">Collaborative Management</p> <p>Establish a multi-stakeholder steering committee (owners, tenants, contractors) with influence on MF program delivery.</p>

Organization of the Proposal

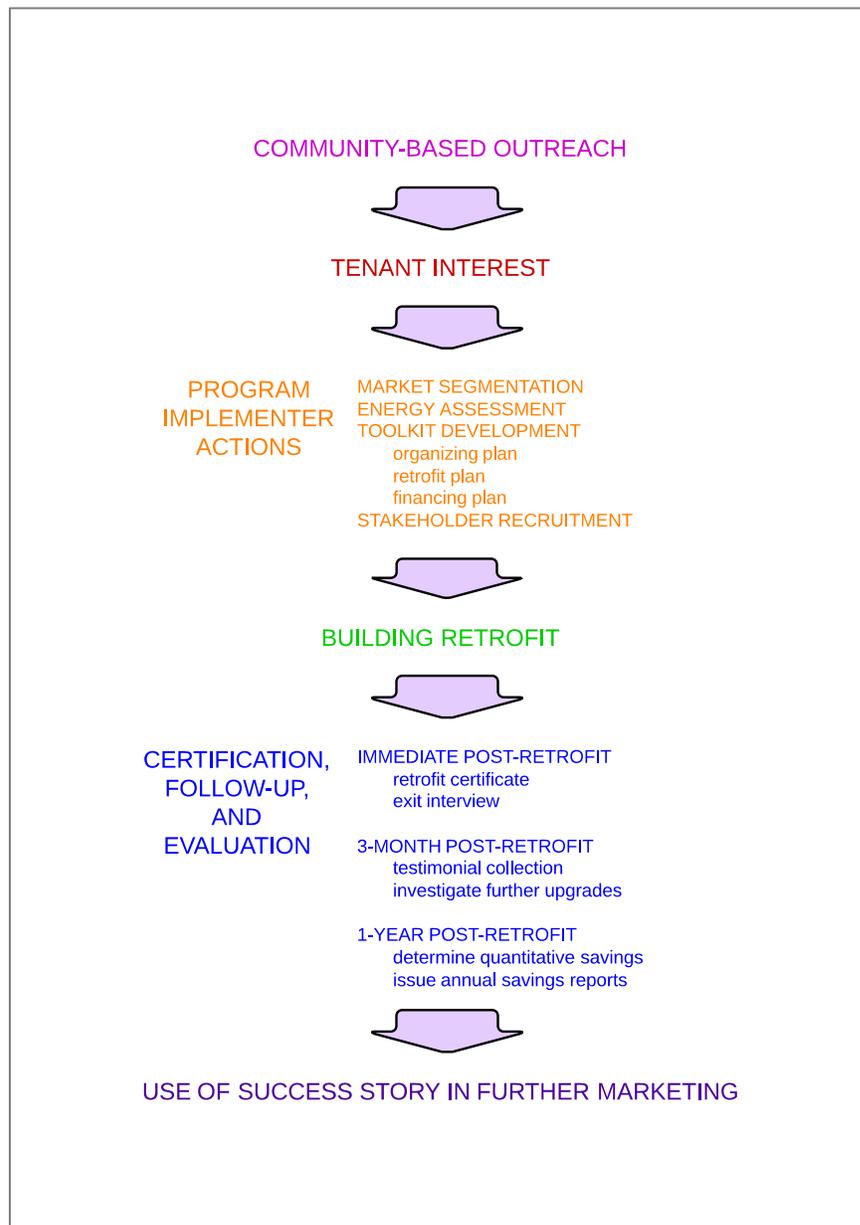
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The following two sections provide detailed descriptions of the background and our recommendations related to the Base Citywide and Data Central components. Each section provides a chronological description of the proposed pilot and in-depth discussion of the various program elements involved. In the appendix, a pilot program Gantt chart describes the specific timing of the various tasks to be completed before and during program implementation.

Base Citywide Component

The Base Citywide component will be managed by a single program implementer in charge of outreach and marketing, energy audit/assessment, financing, retrofit, and post-retrofit follow-up. This component combines concepts related to program process improvements, community-based social marketing, project financing, and new technologies. The structure of this component is based around providing the tools and resources necessary to pique resident interest and keep them moving through the program participation pipeline. The figure below summarizes our proposed program structure from the perspective of a program participant.

Table 2: Participant's perspective. By authors.



In roughly chronological order, this will involve:

1. **Community-Based Social Marketing.** The single program implementer will reach out to residents throughout the city by leveraging *community partnerships* and *success story showcasing*.
2. **Tenant Toolkit.** Once a tenant expresses interest, the program implementer will ask about their living situation and create a home-specific approach based on their location in the *market segmentation*. Criteria used to determine this approach will include building characteristics (determining likely efficiency measures) and occupancy characteristics (determining how best to engage neighbors and landlords). The program implementer will also assign a *community liaison* (probably someone assigned to the community group that the tenant is a member of) to arrange for an *on-site assessment* and prepare a *work proposal, financing plan, and outreach support*.
3. **Financing Plan.** The financing plan will involve a zero-interest loan secured through one or more local banks. These loans will be available to all city residents. A site-specific repayment plan will be worked out.
4. **Liaison Intervention.** The assigned liaison will work with the tenant and interested neighbors to get the building owner involved in the retrofit and to present a retrofit workplan. Building owners will also be able to obtain financing information by approaching the program implementer directly (i.e. the first two steps can be skipped if the building owner already desires a retrofit).
5. **Retrofit.** After securing building owner buy-in, the program implementer will arrange for the installation of efficiency measures. The first 400 units retrofitted through this program will be eligible for the installation of *additional unit-control measures*.
6. **Energy Efficiency Calculator.** Based on building characteristics and the type of work done, the program implementer (potentially in partnership with a third party contractor specializing in savings calculations) will provide a report spelling out projected energy savings at the time of the retrofit.
7. **Retrofit Certification.** Based on actual project savings, the landlord will be presented with a formal certificate from NSTAR (potentially co-signed by the City of Cambridge and the program implementer) indicating the scope of the work performed in the building for display on the exterior of the building and for use in rent negotiations with current and future tenants.
8. **Retrofit Exit Interview.** Immediately post-retrofit (or preferably at the time of retrofit), the community liaison will conduct an interview with the tenant(s) and the landlord, reviewing their experience and documenting the results. These data will be used in evaluation and future success story-showcasing.
9. **Three-Month Follow-Up.** After three months, the community liaison will conduct another round of follow ups with tenants and landlords to gather testimonials about the benefits

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(improved comfort, etc.) resulting from the retrofit that can be used as future success stories, and follow up on any additional efficiency work that might provide still further energy savings that the landlord might not have agreed to at the time of the original retrofit.

10. **Annual Home Energy Reports.** The program implementer (potentially in partnership with a third party evaluator or software provider) will track the subsequent building performance and realized energy savings. Resulting savings reports will be provided annually to the landlord and tenants to demonstrate actual energy savings, as well as used in success story showcasing.
11. **Community Ambassadors.** Tenants and landlords who have had positive experiences will be recruited as community ambassadors by the program implementer. They will play an ongoing role in continuing CBSM efforts.

PROCESS IMPROVEMENTS

Currently, upgrade programs are fragmented between different building types, and the process to achieving an efficiency upgrade is overwhelming to navigate and understand. These factors discourage landlords and tenants from realizing efficiency in their homes. We propose improving the programs process, having all residential upgrades coordinated by one master turnkey contractor and introducing a “cohort” approach, incentivizing groups to participate in assessments and upgrades in batches.

PROGRAM IMPLEMENTER

Background

The MMI was created to coordinate the efficiency upgrade process and guide residents through that process. Even with this help, the number of efficiency upgrades completed, especially deep upgrades, such as installing insulation or a new, efficient HVAC system, remains low in Cambridge. It appears that the MMI has failed to provide a seamless experience for its customers. People living in buildings with 5+ units have raised concerns about the level of commitment the service provider makes to each customer. Also, building owners do not have a person they can talk with who can explain the equipment or the way the upgrade process works. Building owners are given long lists of contractors and equipment, but no sense of who’s dependable or what the quality of the equipment is. They are required to handle all of the coordination with contractors and apply for rebates themselves (Symposium participants 2013). If a building owner has to complete all these steps, and figure out how the process works, they are not likely to do any efficiency work.

To improve the customer experience and personalize the care given to each customer, we recommend selecting a Program Implementer willing to work with a technical advisor and a community liaison to coordinate the upgrade process. The Implementer should manage outreach and marketing, energy assessments, financing, and retrofits. They need to know all about NSTAR’s program offerings as they relate to 2-4 unit and 5+ unit buildings (including gas and electric offerings). The Implementer should work with a community liaison who acts as a primary point-of-contact for the customer during the upgrade process. The liaison should also help customers recruit other tenants as well as their landlord. The Implementer should work with a technical advisor to produce a detailed description of the work that needs to be completed. By introducing a technical advisor and a community liaison, customers will be able to get more individualized attention and assistance.

Proposition to Test

Establishing a Program Implementer who works with a technical advisor and community liaison to guide customers through the retrofit process will result in increased participation in efficiency programs as well as deeper retrofits completed.

Key Assumptions

1. The Program Implementer will be able to tap into local community groups to serve as community liaisons.
2. The coordination between the program implementer, community liaison and technical advisor will be seamless.

Program Design

The Program Implementer will: (1) conduct outreach to residents through community partnerships and success story showcasing; (2) schedule assessments; (3) create short-term and long-term retrofit plans with the assistance of a technical advisor; (4) develop financial plans; (5) select community liaisons to assist with tenant and landlord recruitment, as well as with communication of the process and work to be completed; (6) schedule retrofits; (7) provide a report of projected energy savings to the landlord; (8) coordinate community liaisons to conduct retrofit exit interviews and post-retrofit follow-ups; (9) continuously track each building's energy performance and realized energy savings over the course of two years; and, (10) recruit tenants and landlords who have had positive experiences to be community ambassadors as part of CBSM.

We recommend that the City and NSTAR jointly develop and issue a Request for Proposals (RFP) to select a single individual who will serve as Implementer for the pilot project. The RFP should be issued nine months before the start of the pilot, with an implementer selected at least six months prior to the start of the pilot. The Implementer should have ample time to select, train and coordinate community liaisons and a technical advisor. More specifically, the Implementer will need time to develop relationships with community organizations and select community liaisons; issue an RFP for a technical advisor and select an individual to serve in this role; and work with the technical advisor to develop and issue an RFP to select a pool of 3-5 dependable, vetted contractors from which customers would be required to choose.

Evaluation

Qualitative Interviews

Through interviews, we can determine if the Program Implementer, technical advisor, and community liaison are successful in managing the complexity of the process and providing a seamless experience for customers.

Quantitative Indicators

- Number of assessments completed
- Percent reached that completed assessment
- Number of retrofits completed broken down by type of upgrade (i.e., insulation, air sealing, light fixtures, etc.)

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- Percent reached that completed retrofits broken down by type of upgrade
- Percent interested that convert to whole-building assessment
- The time it takes from start to finish to complete an assessment and implement upgrades

COHORT APPROACH TO HOME ENERGY ASSESSMENT DELIVERY

The Massachusetts Clean Energy Center and the Massachusetts Department of Energy Resources' Solarize Mass Model have been hugely successful in recruiting residents to install solar panels on their roofs while reducing installation costs. The more residents that sign up for the Program, the more the cost per participant decreases, encouraging residents to recruit their neighbors (Massachusetts Clean Energy Center 2013). From 2011 to 2012, the number of communities participating in the program increased from 4 to 17, indicating that residents are excited about efficiency and are eager to recruit their neighbors (Massachusetts Clean Energy Center 2013). We recommend a similar effort to recruit more people in Cambridge to sign up for home energy assessments and reduce the cost per assessment. This strategy could assist in CBSM efforts by helping spread awareness of the value of efficiency and encouraging the completion of assessments.

Propositions to Test

1. Clustering home energy assessments in one-week periods will reduce the cost of performing the assessments
2. Offering discounts to people who assemble at least 10 of their neighbors or friends to complete energy assessments over the same time period will increase the number of assessments conducted.

Key Assumptions

1. People will be motivated by others in their community to sign up for an assessment that is already free and does not result in an immediate decrease in their energy bill.
2. People will be able to easily organize their neighbors or friends to complete an assessment during a same one-week period.

Program Design

Residents will be incentivized to recruit at least ten of their neighbors or friends to complete a home energy assessment during a set one week period. If they can recruit at least ten of their neighbors to sign up for an assessment, each person will receive a 10-15% discount on one efficiency upgrade completed as a result of the assessment. The program implementer will manage this process. While we believe that arranging for assessments and retrofits in waves would be a useful strategy in encouraging program take-up, we also feel strongly that Program Implementers must be flexible in their ability to schedule appointments around the availability of

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building residents and owners. Therefore, the process of arranging cohorts for program participation should be done alongside the normal process of scheduling assessments and retrofits on an as-interested basis.

Evaluation

Quantitative Indicators

- Number of assessments generated through referrals
- Number of community members actively recruiting others
- Percent reached that sign up for assessment
- Percent reached that complete an assessment
- Percent interested that convert to whole-building assessment
- Percent of assessments coming from referrals

EMPOWERING COMMUNITIES AND RESIDENTS

One primary impediment to energy efficiency in multifamily settings is the lack of social engagement that funnels individuals into available efficiency programs. Residents do not think about efficiency on a daily basis, do not see evidence of efficiency gains being made around them, do not know what options are available to them, and do not know how to approach their landlords or fellow tenants to discuss energy improvements. We investigate potential community-based interventions that would motivate residents to pursue energy upgrades and shepherd them through the retrofit process.

Background

Energy efficiency programs face substantial social barriers in their attempts to increase participation rates. Potential participants must be educated about program benefits, convinced to participate, and then shepherded through the participation pipeline. Traditional approaches to energy efficiency program administration largely ignore these challenges. They assume a passive role in program marketing and outreach will be sufficient. Allowing participants to take the initiative in arranging energy upgrades suggest placing this responsibility in the hands of the Program Implementer. We base this suggestion on the results of Community-Based Social Marketing studies, and propose formalizing CBSM strategies to the Cambridge energy efficiency pilot.

Much of the theory behind Community-Based Social Marketing is based on the work of Doug McKenzie-Mohr, whose book *Fostering Sustainable Behavior* (McKenzie-Mohr 2011) lays out a way of promoting behavioral change. CBSM program architects begin by identifying the specific barriers that, if changed, would achieve a desired end. They then construct a marketing and outreach campaign (built around consumer psychology and social network theory) to encourage targeted populations to adopt these behaviors. A CBSM campaign might, for example, provide substantial resources to early adopters and rely on social networks to diffuse their behavior, create a mechanism to advertise local community members who are (and are not) adopting desired behaviors, or solicit token commitments from community members before asking that they engage in deeper behavioral changes.

The power of CBSM is that it integrates social networks and social pressure directly into program marketing efforts. In an energy efficiency context, such an approach is crucial if program administrators hope to move beyond easily-implemented measure and easily-convinced participants and actively penetrate hard-to-reach markets.

By default, efficiency programs do little in the way to community-based outreach and marketing. Typically, programs are marketed through traditional media and distribution channels (such as

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radio advertisements and utility bill inserts) that provide little social impetus to act and force participants to take the initiative in organizing a home energy upgrade. In this traditional model, the approach that the program administrator takes towards potential participants is largely passive.

Fortunately, the energy efficiency is beginning to understand the need to adopt locally-tailored programs that target and encourage the adoption of specific behaviors. A recent white paper by the American Council for an Energy-Efficient Economy summarizes how CBSM principles have been adopted by the field to date (Vigen and Mazur-Stommen 2012).

In Massachusetts, program administrators have already begun to implement changes that indicate a more active stance towards participant outreach. Significantly, both of Mass Save's primary multifamily program implementers--Conservation Services Group and Next Step Living--conduct outreach to community groups to encourage participation in existing programs.

The Home Energy Efficiency Team (HEET), a grassroots community organization operating in Cambridge and the surrounding towns, has taken this approach much further and holds volunteer-driven energy efficiency "barnraisings" in local homes and institutional buildings (such as houses of worship) (Home Energy Efficiency Team 2013). HEET's operations leverage the power of communities to drive energy efficiency forward, by encouraging local residents to come together, learn about energy efficiency potential and method, and help members of their communities lower their utility bills. As the labor is volunteered, typically building owners and residents only pay the cost of materials.

Outside of Massachusetts, a number of program implementers have directly tested elements of community-based social marketing. The US Department of Energy's Better Buildings Neighborhood Program (US Department of Energy 2013) has acted as an incubator for new ideas in energy efficiency program administration and has sponsored over 40 pilots that test various parts of energy efficiency program implementation, including marketing and outreach efforts. One of these programs, Better Buildings for Michigan (BetterBuildings for Michigan 2013), has particular success in conducting outreach through anchor institutions that allow program operators to leverage existing social networks in the community.

Despite this forward progress, there is much work to be done to ensure that the power of social networks is embedded within the structure of energy efficiency programs. In our conversations with local actors in the Cambridge energy efficiency field, we have heard a general dissatisfaction with the cohesion and structure of existing efficiency options, particularly in the multifamily sector. To overcome both the natural inertia of energy efficiency recruitment and the specific

challenge posed by split incentives in multifamily buildings, a concerted and methodological approach to participant relations is needed. A program implementer must have direct access to the existing channels that communities use to interact, and they must be available as trusted advisors who are willing and able to proactively work with multifamily residents and building owners to drive efficiency projects forward.

Below, we propose a process to facilitate this. Our proposal revolves around the role played by a program implementer in building relationships with community organizations, demonstrating the viability of energy efficiency improvements through these channels, and guiding building-level stakeholders towards retrofits. This community-based approach is intended to overcome the social barriers to energy efficiency, which we believe are as imposing in the multifamily sector as financial obstacles. The approach we describe is labor-intensive, and it requires far more of program implementers than traditional approaches to program outreach and participant relations. However, we believe that a commitment of this level is required from program administrators if they are to move beyond low-hanging fruit and achieve substantial improvement in the hard-to-reach multifamily housing market.

Propositions to Test

1. Reaching individuals through **community-based outreach** where friends or trusted community members are sharing information about energy efficiency will drive more individuals into getting energy assessments and following through with a building retrofit.
2. Exposure to **local success stories** by community ambassadors with shared characteristics (of neighborhood, building type and/or social group) will increase comfort with and uptake of energy efficiency measures.
3. Organizations will communicate more with their members about energy efficiency if **incentivized by rewards** for encouraging members to participate in assessment.
4. Tenants given **effective organizing and outreach tools** will be able to mobilize their neighbors to jointly conduct assessments and encourage landlords to invest in efficiency upgrades.
5. **Personal support** for individual tenants and building owners going through the efficiency process will result in more conversion from interest to assessment and assessment to action in multi-family buildings.
6. **Post-retrofit follow-up** for tenants and building owners will encourage further efficiency upgrades and help these participants act as community ambassadors.

Key Assumptions

Lack of Communication

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In Cambridge's multi-family, short-term environment, there is minimal communication between neighbors and between landlords and tenants. This is a barrier for efficiency programs that require decisions to be made on a whole-house basis with some level of participation from all tenants and landlord.

Social Networks Beyond The Building

There are strong social networks in Cambridge, based around anchor institutions including community groups, religious centers, sports and social activities, and schools, many of which have a real interest in decreasing their members' energy bills and burdens. Leveraging their power in efficiency outreach will provide a more powerful and effective program than existing impersonal marketing campaigns.

Tenant Perception of Helplessness

Tenants stand to gain the most for energy efficiency but feel incapable of making changes to their buildings. They have a latent desire for action on this issue and are able to commit some time to energy efficiency if they are confident something productive will come out of it. Providing personal guidance and clear pathways will help them realize their energy efficiency potential.

Program Description

The Community Based Social Marketing program begins by **incentivizing community organizations to take deeper action** with their members on energy efficiency in member homes, by offering rewards of energy efficiency upgrade subsidies for their group center or other relevant in-kind rewards for any group that refers more than 10 individuals to an assessment. Larger, time-bound prizes would be given to the organizations that refer the most Cambridge citizens to an energy assessment. Referral codes could be spread beyond the anchor institution with one member referring their social network to register using their group's own referral code. Eligible groups could include churches, universities, schools, neighborhood groups, and others, particularly targeted at organizations that have a large tenant population.

Community groups provide more effective inroads into social networks than program implementers are otherwise able to obtain. By bringing these organizations into the recruitment process, program managers gain allies with trusted voices in local communities. Individuals are also incentivized to take action and to organize their friends, based on the knowledge that an organization they care about will be rewarded for their own participation.

Once a community group has expressed interest in participating, they will be provided a community liaison working in close partnership with the selected turnkey project implementer. The community group and implementer liaison would work together to establish an organization-

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appropriate marketing plan that stresses the specific benefits (financial savings, increased comfort, environmental benefits, etc.) that would resonate most deeply in their specific constituency.

This liaison would help explain the benefits of energy efficiency and the energy assessment process to the organization's leadership and members. The administrator could also partner with HEET, an active player in the Cambridge's efficiency scene, to do programmatic follow-up to churches and community centers that HEET serves. Partner organizations would be asked to distribute information through their own internal channels (such as a mention from pastors during church announcements) as well as invite liaisons to address their constituencies.

The community liaisons would work with HEET and energy assessment and retrofit implementation companies to identify local residents who have happily gone through the entire retrofit process and is willing to share their **success story**. While this may not initially include success stories from the specific community group, the success story candidate might share other characteristics of location, interests, or building type. After the first cohort from a given group has gone through, one or more members would be selected to build up more detailed success stories. Both quantitative (energy savings) and qualitative (testimonials about improved comfort and other co-benefits) information regarding landlord and tenant experiences with retrofits would be collected and shared with local communities. Previous retrofit participants would be offered a post-retrofit monetary incentive to share energy data, provide testimonials at community gatherings, and source additional referrals.

This outreach strategy uses social pressure to drive individuals towards retrofit by highlighting neighbors and community members who have had retrofits in their homes and demonstrating the benefits and viability of an efficiency upgrade. This strategy provides trusted and familiar voices in support of energy efficiency. As the pilot continues, the qualitative analysis can become more rigorous, with data benchmarked and analyzed for real savings, and comparisons to projections based on the typology tool.

Based on these two primary modes of engaging and exciting residents to take action, the program would develop a **tenant toolkit** to empower tenants to take leadership in their own home energy efficiency by providing clearer information on process and opportunities. Tenants are given *data-based tools*, such as customized energy savings projections for the homes and testimonial information from designated community ambassadors; *organizing tools*, such as outreach pamphlets, event ideas to bring neighbors together, draft scripts and frequently asked questions; and *process tools*, that outline the exact upgrade process that both tenants and landlords.

The goal of all of these tools is to help individual tenants recruit their building neighbors and their landlords to all agree to have their building assessed. Just as a community organization is used as a point of entry to tenant communities, a single interested tenant would be used a point of entry to the rest of a building's stakeholders. Community organizations and their liaisons will be incentivized to support this local organizing, as both the community group and the program implementer would be given incentives based on the progress that their members make towards retrofit. Incentives to community groups could take the form of free or heavily discounted solar installations and energy upgrades in organization buildings (such as schools, churches, or non-profit headquarters), or in the form of other organization-appropriate incentives. Program implementer incentives could be written into their contract with NSTAR, and the implementer would have performance targets that offer increased payments based on the number of residents that they successfully guide through the program participation pipeline.

The program implementer community liaison would be responsible for managing this process. Once interested tenants are established through community outreach, the implementer would guide them through the process of performing an assessment, contacting neighbors, and building a case to present to landlords.

Once tenants have been able to engage their landlord and conduct a building assessment, the program implementer would support the building owner to determine the highest priority actions, to find the best fit for financing these upgrades, and to follow through with the assessment. A week after the upgrade, six months, and one year after the upgrade, the liaison would contact the tenant coordinator and the building owner to share data on savings, conduct interview on comfort and building performance, and to check in to see if further upgrades might make sense.

Evaluation

Qualitative Interviews

The major purpose of the in-person interviews is to determine how whether our assumptions are correct about what drives people to seek an assessment and move from assessments to action. We hope to determine whether the community groups are indeed more effective at reaching individuals and convincing them to seek energy efficiency improvements as compared to the typical outreach strategies that rely on newspapers, radio, and television ads.

Quantitative Indicators

- Numbers of assessments generated through referrals (direct and indirect)
- Number of community members who actively recruiting others

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- Percent reached who proceed with assessment
- Percent interested who move to whole-building assessment
- Percent of assessments converted to retrofits
- Percent of retrofits that seek greater efficiency gains one or two years
- Percent of assessments resulting from referrals

FINANCING

We propose an energy efficiency pilot program and financing design that streamlines participants' access to zero-interest financing while also addressing the split incentive barrier between landlords and tenants. This design will build off of Mass Save's existing HEAT loan program to feature streamlined processes for energy efficiency loan applications and service delivery. It will create mechanisms for tenants to compensate landlords for making energy efficiency improvements and enable landlords and tenants to model their energy savings projections, while also leveraging the power of energy data to make an affirmative case for financing efficiency retrofits.

Background

Financing challenges have precluded widespread adoption of energy efficiency measures. High upfront costs especially, as well as the split incentive problem, have dissuaded many customers from making investments in energy efficiency. In addition customers often lack information about financing options, or perceive them as costly or time-consuming. Lenders often lack data on energy savings projections and see energy efficiency as a risky proposition in the absence of convincing efficiency payback information (Deutsche Bank 2012). Effective financing programs for multi-family efficiency must address these barriers.

Relying exclusively on utility ratepayer funds precludes energy efficiency programs from achieving more substantial scale and can put utilities in the position of acting as financiers – a role beyond their traditional expertise that can increase overhead costs and expose them to liability under consumer lending laws (Copithorne and Fine 2011). To address these issues, effective programs must leverage outside sources of capital and enable utilities to act as capital intermediaries rather than fund managers. Additional sources of capital include debt financing (e.g. from Community Development Financial Institutions [CDFIs] and banks), equity (e.g. from federal New Market Tax Credits and mission-driven investors) and foundation and government grants. Such sources of capital, along with existing utility ratepayer funds, can be pooled and managed by a non-utility partner with relevant financial expertise.

On-bill repayment presents one promising approach to addressing many of these barriers. Under on-bill repayment utilities and other parties make upfront investments in energy efficiency measures and the ratepayer then pays back these initial investments over time via a monthly surcharge on his/her energy bill. As a result the upfront cost barrier is largely eliminated, and the customer further benefits if the payback terms are structured such that the resulting monthly energy savings exceed the monthly repayments. On-bill repayment can also overcome the split incentive barrier in multifamily and rental properties if the monthly repayments are tied to specific properties via utility meters, thus ensuring that tenants do not have to continue paying the cost of energy efficiency upgrades after they move out of a property. MPower Oregon provides one powerful example of a program that uses on-bill repayment mechanisms and a non-

profit fund manager to leverage utility ratepayer funds, government grants and CDFI capital to target the multifamily affordable housing sector.

We recognize that on-bill repayment is not a feasible strategy as part of a pilot program in Cambridge in the short-term, as it can often require complicated modifications to utility billing systems (Bell, Nadel and Hayes 2011), and NSTAR in the past has declined to implement on-bill repayment in Cambridge for precisely this reason (Cascadia Consulting Group 2008). However given the City of Cambridge's and NSTAR's current mutual interest in developing a multifamily efficiency pilot that can be a model for long-term programmatic change, we encourage these parties to revisit this issue and think critically about strategies to implement on-bill repayment mechanisms in the multifamily sector in the long term. Such an approach can build off of and strengthen many of the program elements discussed in this report.

In the near term we propose several program elements with respect to pilot financing, including a streamlined mechanism to offer zero-interest and no money down financing, a retrofit certification program to enable tenants to compensate landlords for making efficiency upgrades, and an energy efficiency savings calculator to support financing decisions for landlords, tenants and lenders. All of these elements are described more at length in the sections that follow.

Propositions to Test

- A comprehensive energy efficiency loan offering at zero percent interest and no money down, combined with a corresponding outreach campaign, will increase the uptake of energy upgrades in multifamily buildings in Cambridge.
- Landlords and tenants will be more likely to pursue energy efficiency upgrades if there are ways to address the split incentive barrier via a retrofit certification program and related rental agreements.
- Providing data on energy efficiency savings projections can facilitate energy efficiency lending and spur landlords and tenants to pursue energy upgrades.

Program Description

We propose an energy efficiency pilot program and financing design that enables participants to fund energy efficiency retrofits with no upfront costs (zero money down) while also addressing the split incentive barrier between landlords and tenants. This design will build off of Mass Save's existing HEAT loan program to feature streamlined processes for energy efficiency loan approval and service delivery. In addition it will create mechanisms for tenants to compensate landlords for making energy efficiency improvements and enable landlords and tenants to model their energy savings projections, while also leveraging the power of energy data to make an affirmative case for financing efficiency retrofits. The program includes three elements: a comprehensive

and expedited Mass Save HEAT loan offer, a retrofit certification program and an energy efficiency savings calculator.

Comprehensive and Expedited Mass Save HEAT Loan Offer

Mass Save’s HEAT loan program currently offers building owners loans (up to \$25,000 for 1-4 unit buildings and up to \$100,000 for commercial buildings) at zero-percent interest for qualified energy efficiency measures. However, the current HEAT loan process can be cumbersome, as loan applicants have to perform due diligence with respect to selecting a contractor to provide a quote for a loan, then selecting one of the many banks participating in the program. They then often have to wait several weeks before they are approved for the loan, and after that they must perform yet another round of due diligence in selecting a participating contractor. All of these stages prolong the process and increase the likelihood that program participants will not follow through in pursuing energy efficiency upgrades.

For a multifamily pilot design in Cambridge, we therefore propose simplifying and streamlining the HEAT loan process by building targeted partnerships with pre-qualified banks and contractors to offer loan products and perform weatherization work. Contractors will be able to provide participants instant approval for HEAT loan financing upon completion of an energy assessment, and as part of the broader process participants will have direct support from a single program implementer at key decision moments (e.g. selecting a bank or selecting a contractor). The streamlined program offering will also cover all the different energy efficiency measures that are available under the current HEAT loan programs for 1-4 unit buildings as well as commercial buildings.

In addition to creating a consolidated process and covering a comprehensive suite of upgrade measures, the pilot HEAT loan program will incorporate partnerships between banks and utilities to provide credit enhancements and a loan loss reserve via ratepayer funds. This will enable participating banks to ease their loan underwriting standards (thus increasing customer participation and encouraging additional private investment in energy efficiency) while also providing them with an additional layer of security for loan disbursement. Finally, we propose the development of an energy efficiency savings calculator (described more at length below) to enable participating banks to incorporate projected energy savings into their loan underwriting process. The savings calculator will also support a retrofit certification program (described more at length below) that will create avenues for tenants to compensate landlords for making initial investments in energy efficiency upgrades via the HEAT loan.

The streamlined HEAT loan offering will be combined with a HEAT loan outreach campaign to increase the uptake of multifamily energy efficiency. The City of Cambridge, NSTAR, community

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organizations and participating banks all have a role to play in designing and implementing this campaign on a citywide basis. The campaign will ensure that targeted audiences are aware of financing options for multifamily energy efficiency and build their capacity to act accordingly.

Retrofit Certification Program

A viable multifamily efficiency pilot program must ensure that building owners are compensated for investing in retrofits via the HEAT loan when they do not pay the energy bills for individual dwelling units. To this end we propose creating a retrofit certification program that landlords can use as a tool to market “green” units and buildings to prospective tenants and to use in rent negotiations with current and future tenants. The certificate will be presented to the landlord upon completion of weatherization work as part of a collaborative arrangement co-sponsored by NSTAR, the City of Cambridge and the program implementer. It will include information on energy savings potential for particular units based upon modeling results from the energy efficiency savings calculator (described more at length below).

By clearly communicating the amount by which tenants are expected to reduce their monthly energy costs, the certificate will provide justification for landlords to charge tenants slightly higher rents than they would ordinarily pay, as long as the monthly rent increase is less than the projected monthly energy savings. In some respects this is similar to a green lease model, only without the added complication of needing to create a lease addendum, as the additional rent payment will be integrated into the base lease. This arrangement will ensure that tenants can reap the financial benefits of energy efficiency while also enabling landlords to pay back the initial HEAT loan over time via the slightly increased monthly rent payments from their tenants. While the initial certificate will be based upon projected energy savings, the pilot program will track actual energy performance data in the long term, and this data will be presented to landlords and tenants each year via a reissuance of the original certificate. This will enable both parties to make adjustments to the rent if necessary as lease terms expire and are renewed.

It will take a carefully calibrated education and outreach strategy to make sure both landlords and tenants are aware of the retrofit certification program and trust that it will deliver direct benefits to them. We propose that the City of Cambridge and NSTAR convene targeted focus groups with landlords and tenants to better understand how such an initiative might best meet their needs and be marketed to target audiences. Once this is done, the City of Cambridge and community organizations can work together to implement an outreach campaign that is based upon an enhanced understanding of the issues at hand.

Energy Efficiency Savings Calculator (E-Calculator)

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To support the Expedited Mass Save HEAT Loan Offer and Retrofit Certificate Program, we propose developing an Energy Savings Calculator that will forecast their energy use and savings potential for different retrofit measures. The two most important features of such a calculator are: before-retrofit forecasting *predicted energy saving* and after-retrofit tracking *actual energy saving*.

NSTAR currently houses a HomeEnergyCalculator that gives users information about building estimated usage, seasonal factors, and cost-saving recommendations. However, the HomeEnergyCalculator experiences low conversion rate and has several drawbacks that limit its usefulness: first, it is based on static engineering model that has estimation errors that cannot be eliminated over time through self-learning; secondly, it gives cost-saving recommendations without consideration of the building owners' capacity to finance the retrofit, their financing choices, and their risk and return preference.

Because the existing calculator lacks the ability to translate recommendations into reality, we propose a new Energy Savings Calculator that will: 1) eliminate estimation error over the long term through model fine-tuning and evolving by tracking utility data and back-testing; 2) synthesize engineering and financing models that take customized financing methods for energy efficiency retrofits into consideration and generates easy-to-understand cost-benefit measures such as payback period and return on investment to inform investment decision-making with "no-money-down"; 3) integrate seamlessly with the Retrofit Certificate Program and Expedited Mass Save HEAT Loan Offer by providing critical data on cost-benefit risk-return measures of every single retrofit (described above) that will catalyze cost-saving recommendations into reality in "one-stop-shop" fashion.

It should be noted that the Energy Savings Calculator works for different time frames and multiple stakeholders. In the short term, the Energy Savings Calculator will provide landlords and tenants with important energy data to support short-term decision-making around energy efficiency retrofits. In the long run, it has immense scalability: the initial energy savings projections, combined with long-term tracking of energy savings data, will help build a broader case for the value proposition of energy efficiency and enable our proposed pilot program to leverage private sector funding, and thereby achieve significant scale in the medium to long term. Moreover, the calculators will not only show landlords the best and most cost-effective ways for efficiency, but also help financial agencies in their financing decisions by expediting the loan approval process.

NSTAR will house the energy efficiency savings calculator and make it openly accessible to landlords and tenants who want more information on their energy use and to financial agencies

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in need of data to support their financing decisions within the loan approval process. NSTAR will work with the data manager to build the long-run data and energy saving tracking platform and, when necessary, work with third-party energy consulting firms, such as Wegowise and New Ecology, in building, adjusting, and managing the engineering model behind E-Calculator. The program implementer and community liaisons will be responsible for promulgating the calculator.

Evaluation

Comparing rates of HEAT loan uptake in Cambridge pre- and post-pilot launch, as well as comparing rates of HEAT loan uptake post-pilot between Cambridge and surrounding communities, will provide us with metrics to determine whether innovative financing and service delivery models have an impact on the extent to which customers pursue energy efficiency upgrades. Similarly, comparing the savings projections from the energy efficiency savings calculator with actual energy performance data post-retrofit will enable us to assess the tool's efficacy, while also providing a basis to adjust the retrofit certificates and recommend additional upgrade measures. Finally, we propose interviewing landlords and tenants to solicit feedback about the expanded HEAT loan program and the retrofit certification program and making adjustments as needed based upon their comments.

CONTROL TECHNOLOGIES

We propose broadening the energy efficiencies currently available through Mass Save to include promising technologies that are particularly appropriate for the challenges of multifamily housing. Prescribed technologies focus primarily on building control systems primarily for HVAC that bridge the split-incentive gap by offering a higher quality and more marketable product to landlords and lower energy bills for tenants.

Overview

The implementation of control technologies to multifamily buildings is a part of the city-wide program application. The motivation factor here is based on comfort. The majority of multifamily buildings in Cambridge lack control technologies for HVAC systems, forcing tenants to open windows in the wintertime or invest in super-inefficient electric space heaters. The pilot offers these control technologies to tenants and landlords alike to address the split-incentive, as there are motivating factors for both parties which lead to a symbiotic relationship.

Background

75% of Cambridge's multi-family buildings were built before 1950. Many older buildings lack the control systems necessary to save on utility bills and make them less comfortable places to live. Many newer homes also lack controls since these are often eliminated at the end of the construction process because of budget constraints. There are currently no control systems that fit with the technologies prescribed by local utilities in Cambridge. In addition, even if someone wanted to purchase the right to these control technologies, there are neither subsidies nor incentives available.

Installation of control systems is a great way to for achieve energy efficiency. A vast amount of energy delivered to homes is wasted because occupants have no way to control how the gas and electricity are used once they travel through the grid and into the home. Occupants do not have a way to constantly adjust their HVAC systems when they are away from home. As a result, the home's HVAC system is constantly in use, supplying energy 24 hours per day, despite the fact that, on average, customers spend only 12 hours each day in their homes. Approximately 40% of residential energy use involves unused energy services (Meyers, 2008), and, in 2005, RECS reported that only 28% of homes in the US have programmable thermostats (RECS 2008).

The technology we are proposing is far better than a simple "run of the mill" programmable thermostat. Installing the proper control and monitoring systems in homes can achieve energy savings between 3 and 26% (Meyers 2008). IT-enabled monitoring and control technologies have played an important role in eliminating energy waste in other sectors, so it is natural to think that the same kinds of systems could have an impact in homes as well (Meyers 2008).

Comfort has always been a sensitive issue in the multifamily rental industry. Landlords and building managers are constantly receiving complaints about units, and individual rooms, being too warm or too cold, and that utility costs are too high. Given that 95% of multifamily units in Cambridge are rentals, the application of building control technologies makes sense (Census 2011). Control technologies offer solutions to all of these problems, offering tenants enhanced comfort by using machines that know the occupant's behavior and preferences adjusts accordingly.

Building control technologies also help to address the split-incentive problem. The low-cost introduction of these smart technologies offers simultaneous benefits to tenants and landlords alike; tenants experience increased comfort and energy cost savings while landlords market their units more successfully, reducing vacancy rates and turnover. In addition, energy savings and comfort have a direct effect on the overall value of a building. Energy efficiency upgrades can increase a home's value by more than the cost of the upgrade, especially in the face of rising utility savings. A study found that a home's value increases by \$20 for every \$1 in reduction in annual utility costs (USGBC 2009). This same logic in valuation can be applied directly to rents. A more energy efficient and comfortable unit will yield higher returns. Due to this symbiotic relationship, control technologies should have a very high uptake rate if marketed correctly.

Proposition to Test

This pilot should focus on the installation of building control systems that simultaneously increase occupant comfort while producing cost savings for landlords.

Key Assumptions

1. Both tenants and landlords will find enhanced comfort appealing. Building controls give the landlords a more marketable product. This should decrease vacancy and turnover rates as well as complaints about maintenance issues. The tenants will get a comfortable unit and save on monthly utility bills.
2. Tenants will accept the new technology.
3. Tenants will not abuse the thermostat by increasing the heating and cooling loads.

Evaluation of pilot outcomes

Components that need to be assessed include: number of controls adopted by both landlords and tenants, overall satisfaction of tenants' comfort in their homes, energy usage with the prescribed technology. The outcomes of the program will be measured using Wegowise's database and comparing data before and after the installation of the technology.

Scale

In an attempt to market comfort in buildings as an underlying theme of the pilot, these control technologies would be available city-wide. The technology would be distributed first to a cohort of buildings with a minimum deployment of 400 units.

Participation

Building owners and tenants would need to sign on and be aware of the technology installation. (Note: In the case of Radiator Labs technology, every unit in a building would be required to participate. All other technologies would be unit specific). Tenants would ideally plan on living in the unit over an entire year to avoid skewing the data with user behavior differences. Certified contractors or technology professionals would be selected to install new technology properly to ensure optimal performance. Ideal candidates for the technology would already be signed up with Wegowise (allowing a before and after comparison) for energy monitoring or at least be willing to sign up in order to achieve measurable results. Technology companies would participate in an agreement of tech support for tenants using the technology in the case of any user issues. This will avoid having tenants discard of the technology, resulting in wasted efforts.

Technology Prescriptions

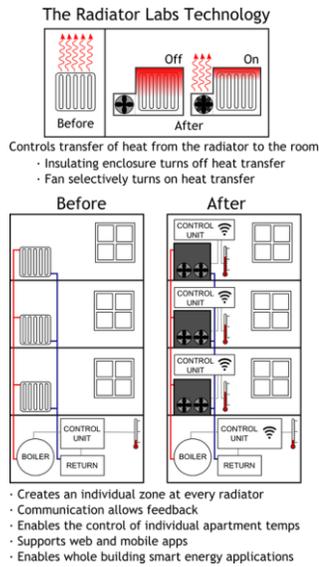
Third parties would respond to an RFP for installing and monitoring building technology.

Real time energy data would be monitored using prescribed energy monitoring software of choice by a third party responsible for installing technology and collecting data. In addition, as mentioned earlier, participants would be required to start a Wegowise account for additional energy monitoring in order to aggregate empirical data. Empirical data should be recorded and analyzed to isolate kWh of energy saved as well as cost savings. Tenants would be asked to fill out surveys before technology installation and one year later to assess the percentage improvement in comfort and satisfaction with their living environment.

Prescribed Technologies

Radiator Labs – Radiator Sleeves: This product is an insulated sleeve that fits over boilers and has an embedded fan and ducting. It also has a temperature sensor that can be programmed to the desired temperature.

Figure 1: Radiator Labs Technology explained (Radiator Labs 2013).



Nest Thermostats: This is a thermostat with an auto-schedule (intuitively remembers temperatures you like and programs itself). The 'Auto-Away' feature turns the temperature down when you are away and is easy for homeowners to install. The 'Airwave' feature turns off the AC early but keeps the fan running, keeping you cool and the AC off as much as possible. The product also logs your energy history.

Figure 2: Nest Thermostat. (Nest 2013).



Ecobee Thermostats: The Ecobee thermostat is similar to the Nest above with a few other perks. It has wifi capabilities to access live weather data, making it capable of providing optimal control of a building's temperature by utilizing outside temperatures intuitively in order to calculate how much a building needs to be heated or cooled. The Ecobee can be accessed from anywhere via apps or iphones. In addition, the Ecobee collects real time energy data and compiles hourly in excel documents for those who are savvy enough to do statistical analysis on the data, such as a clever utility provider. This analysis can assist in adjusting user behavior for optimal efficiency.

Figure 3: Ecobee Thermostats (Ecobee 2013).



Modlet outlets and AC controls: This allows for wireless control of electronic devices such as lighting, electronics, and any other phantom load device such as cell phone or computer chargers. Schedules can be set to manage loads and savings in kWh can be displayed in real time. The real winner is the Modlet Smart AC kit. This includes a cord with a temperature sensor on it and wireless remote for plugging in window AC units. This allows for pre-set on/off schedules, the ability to control the temperature from your smartphone both at home and away, and offers energy tracking in kWh saved. Given the increasing trend in the use of AC (In the Northeast, 50% of units had AC in 1980 and, now, 87% have AC), this could have a tremendous impact.

Figure 4: The Modlet outlets (Modlet 2013)



Costs

Estimated per unit costs of control technology is \$300, including installation and tech support. The proposed pilot would cover 100% of this for the first cohort of buildings. Wegowise monitoring would be covered by the rate-payer. After the one year trial of this cohort, results would be assessed and an appropriate incentive would be established for moving forward.

Benefits

Benefits include increased comfort and satisfaction with utility provider, reducing demand on utility during peak loads, energy savings for tenants, and increased value for landlords.

Data Central Component

OVERVIEW

Data Central is nested within Base Citywide Model and shares the same program implementer and evaluator. Yet, the program operates a smaller scale - in this case a portion of the Central Square neighborhood represented in figure 1 below - with a focus on overcoming data-related barriers. Pilot elements include:

Typology-based Remote Assessment Tool: An online tool to enhance data acquisition. The concept is to create a typology-driven 'one-stop shop' approach to home energy assessments through an online tool. This would offer an alternative to the seven-step approach to home energy assessments. By correlating the building type to the appropriate building technology, there is potential to save more energy within a shorter payback period. The current approach to energy assessments has been largely unsuccessful in the multifamily residential space. The uptake rate is in the single-digits, resulting in a substantial amount of money wasted if a building does not follow through.

Full Energy Disclosure: Data products that can be used during sale and rental transactions, and for building labeling. The absence of actionable information about the potential of efficiency and of relative energy performance across buildings inhibits demand for energy efficiency. Interventions that utilize energy data to unveil efficiency potential and communicate relative energy performance can spark demand.

Energy Map: Interacts with Base Citywide to develop data-related support for spatial mapping of success stories and successful retrofits. The mapping can communicate positive behavior and add carbon emission estimates to broaden awareness.

E-Calculator Development: Supports citywide E-Calculator algorithms used for estimating enhancements using the estimated dollar value of retrofits.

Figure 5: Scale of DATA CENTRAL. By authors.



BACKGROUND

Lack Of Retrofit Uptake Due To High Upfront Costs Of Assessments

Utilizing energy assessments as the primary means of promoting multifamily building retrofits is difficult since this approach has a follow through rate of less than 10%. Each assessment costs about \$400, so there is a lot of money wasted. The typology-driven assessment tool offers a low cost method of identifying homes that need retrofits.

Transparency In The Multi-Family Housing Sector

Ratepayer energy use and detailed building characteristics are not transparent. Without easy access to this information, it is difficult to identify the best way to target energy efficiency efforts. A lack of transparency limits a ratepayer's ability to make informed decisions about where to live, how to reduce their energy use, and how to limit associated costs. It makes it hard to find out a building owner's willingness to retrofit a poorly performing building. Current owners and prospective owners have little insight into the efficiency potential associated with their building's assets. Landlords need tenant permission to find out energy use levels associated with their own properties.

This lack of transparency exists across residential and commercial building markets. Recently, however, some cities have begun adopting data disclosure ordinances that require some building owner to report and make public both energy use and asset data. These mandatory disclosure policies most often apply to large commercial buildings. A few major cities, including Austin, NYC,

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Seattle and Washington D.C. (Cluett and Amann 2013) require some form of disclosure in the multi-family housing sector. Recently, Boston passed a benchmarking and disclosure policy (BERDO 2013) that applies to residential buildings 35,000 square feet or larger or containing 35 units or more. This set a precedent in the region. As of this writing, Cambridge is considering its own benchmarking and disclosure policy, but only for buildings larger than 50,000 square feet or with more than 50 units (City of Cambridge 2013). However, this will exclude the vast majority of multi-family housing in Cambridge.

Benchmarking and disclosure for multi-family housing is particularly challenging for a variety of reasons. While larger properties usually have building managers who can evaluate efficiency improvement, many owners of smaller multifamily properties lack the time, resources and data to estimate energy use or prepare information (Cluett and Amann 2013). Further complicating matters, many multi-family buildings are occupied by renters who pay the energy costs and thus control energy use data.

Data infrastructure challenges also impede the development of benchmarks. Remote energy assessments require reconciling several datasets to generate credible estimates of building energy performance and retrofit potential. Home energy assessments coupled with tax assessor records can help establish requisite asset information. Utilities keep energy use data. However, meter records don't always match up with building characteristics - including addresses and square footage - in assessor records (MIT GIS Professor 2013). Data quality assurance is critical to keeping 'bad' data out of the marketplace.

Surrounding all disclosure efforts are serious privacy concerns. Consumer need for data to make informed decisions must be balanced against concerns about revealing identifiable data. For multi-family buildings with 5 or more units, aggregated energy data can help mitigate most concerns about identification (Regional Energy Consultant 2013) and modeling techniques can produce meaningful benchmarks for buildings with energy use information from as few as 50% of the building units (Regional Energy Consultant 2013).

Even though privacy concerns must be respected, energy use disclosure for multi-family housing makes sense. Cambridge's planned disclosure ordinance focuses on the city's biggest energy users (i.e., R&D Labs and Offices which account for an estimated 33% of City energy use) (Peregrine Energy, 2013). Even though these owners and building managers account for a substantial amount of energy use, the retrofit potential in these relatively new buildings is very. Residential energy use is almost at 38% of the total (Peregrine Energy, 2013) and is more likely, because it involves older buildings, to yield improvements. Much of Cambridge's old housing could benefit from simple upgrades like adding insulation. Since residential units have a diffuse

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set of owners and varied typologies, a more costly ‘retail’ effort to achieve efficiency will probably be needed.

In thinking about designing a pilot program to address energy efficiency in the multi-family housing sector in Cambridge, we have operated under the assumption that an across-the-board mandatory disclosure policy is unlikely in the near term. Only mandatory disclosure for multi-family buildings of 50,000 square feet or more seems imminent. We believe there is demand for energy use data in the multi-family market based on participation and interest in existing data disclosure and analytics programs like Wegowise and Green Button.

Given this policy environment, we considered **two options** to bring more transparency to the multi-family housing community in Cambridge. The first option would be to test mandatory disclosure in a small subset of Cambridge multi-family housing units. The second would be to test a system that solicits voluntary disclosure of energy use data from multi-family residents.

In both cases, the goal is to achieve a level of visibility around energy use and its associated costs that would allow for clear analysis of building performance and more effective decision making while minimizing risks to individual privacy. Both options would seek to facilitate the development of social norms that embrace energy use data disclosure and foster energy awareness that would result in retrofits and beneficial behavior change.

We first investigated the feasibility of implementing a voluntary University-led Student Data Sharing program as a component of a broader pilot. This program would have created a simple opt-out button on a commonly used university web page where students could give NSTAR permission to disclose their energy use data. Participating universities would collectively manage a database to warehouse this data, matching ratepayer energy use information to city tax assessor records and other forms of building characteristics data. We thought of accomplishing this by requiring landlords to submit this information as a condition of being allowed to advertise through university rental forums.

We envisioned this program having a range of benefits:

1. Universities would be able to use the data collected through this program to advance energy efficiency research.
2. Poorly performing buildings with student tenants could be targeted for energy efficiency upgrades, saving students money and improving their living environment.
3. NSTAR could learn more about the willingness to share data as part of a voluntary disclosure program.

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4. Cambridge would surely be home to a robust database containing much-desired information about the multifamily housing sector.

After interviews with key stakeholders at MIT (Various MIT Departments 2013) and the City of Cambridge (City of Cambridge 2013) however, we ascertained that this program would not be cost effective. It would not be implementable on a pilot time scale because of investment of money and time required. And, there would be serious limitations on the ability to secure student participation at a scale large enough to have measurable impact.

The obstacles to achieving a meaningful level of student participation proved to be the strongest argument against a University-led Student Data Sharing. A general benchmark used by energy analytics platform Wegowise is that at least 50% participation of buildings is necessary to draw meaningful conclusions about energy use in the city. Similarly, at least 50% of the units in a building must participate in order to draw conclusions about a given building (McEwen 2013). As mentioned earlier, nearly a third of the rental market in Cambridge is made up of students; however, this statistic includes students from many universities. It is not reasonable to expect that every student in Cambridge would participate, thus limiting what might be learned about multi-family buildings at the city scale through such a pilot. Stakeholders noted other obstacles to achieving a sufficient level of participation.

Those obstacles include:

- Matching student names to NSTAR account numbers, since a name is not a unique account identifier.
- Only the student whose name is on the account is authorized to give NSTAR permission to share data, even if other student off-campus residents agree to participate.
- MIT would most likely require permission from all tenants, even non-MIT students who would not have access to the proposed permissions page.
- Matching student energy use data to volunteered building characteristic data submitted by landlords would be difficult.

Many of the obstacles that stakeholders noted might be resolved in the long term, but did not seem feasible in a short term pilot.

Those include:

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- Securing permission to add a permission button to a frequented university website (e.g., the Address Information page on MIT's Registrar website) will require a long process of due diligence and significant testing.
- Collecting sufficient additional data on building characteristics from landlords without discouraging them from participating in off campus housing forums.
- Creating a long term management plan for the student rental database so that the resources invested in creating it would not be stranded at the conclusion of the pilot.

These obstacles all supported the conclusion that a University-led student data share would not be a cost effective method for piloting voluntary disclosure. We do think that something like this should be considered in the future as a way to raise awareness about energy efficiency and data transparency among the student population.

Given these conclusions, we pursued the development of an alternative pilot based on mandatory disclosure of both energy and building asset data. To address privacy concerns, we suggest notifying ratepayers in 2-4 unit buildings within the pilot area of their right to opt out. We have also incorporated a measure that would require any public display of ratepayer energy use data to be aggregated at the building level, rather than simply publicizing individual unit data.

In pursuing this pilot, we aim to test whether more open access to energy and building asset data can improve energy efficiency programming by helping NSTAR reduce Mass SAVE marketing costs, address obstacles to obtaining building asset data by lowering the average cost of home energy assessments, and improve uptake of retrofits by increasing the amount of energy efficiency claimed under the GCA. The design of this Central Square neighborhood-scale disclosure pilot should be replicable across most of NSTAR's residential service areas. Disclosure may also impact rents and sale prices as consumers take into account of increased information about energy costs. Estimated annual building turnover to test impact of disclosure at point of sale: around 4% for non-condo and around 6% if condo. Thus, ~ 5% of pilot group might turnover each year (Cambridge Tax Assessor's Office 2013). The turnover for the rental market is likely much higher, yet the transaction window within which to test disclosure is much shorter.

This pilot we propose meshes with lessons learned in other cities. Participants can 'opt-out' and building owners are not required to gather data or perform benchmarking. Operating data and thermal imaging will be used solely to confirm typology-based estimates of building energy performance.

Developing benchmarks for disparate categories of units within the multifamily housing sector means that the pilot design must carefully consider which subset of buildings to use.

Implementers might consider choosing a sub-set of buildings for which it might be easier to develop energy scoring and where disclosure is most likely to influence market value (DOER, 2012). This could mean focusing on buildings with separate unit-scale mechanical systems or just targeting 2-4 or 5-20 (DOER representative 2013). If just 5-20, this could alleviate privacy concerns and avoid potential Mass Save programming conflicts.

Using An Energy Map To Encourage Performance-Based Decision-Making

An important consideration in designing a disclosure policy is how disclosed information will be presented to the public. Energy information could be displayed in an interactive energy map. This would give renters estimates of monthly electricity and gas bills. Buildings could be color-coded so that relative energy performance in the area is clear (e.g. red is a high energy user, yellow is moderate, and green is low). Users could click on a building to see average monthly electricity and gas bills (in kWh, therms, and dollars) as well as heating fuel type. Other potential information on the map could include: a benchmark or efficiency potential score, available rebates with the appropriate links, and estimates of potential savings.

A map is the optimal energy display tool in this market for many reasons. Renters will likely be looking at a map to determine whether the potential housing location suits them. Other online resources already use maps, so this is a comfortable tool for many people. For example, Yelp - an online public review platform for restaurants, bars, and other places - pairs entries with a Google Maps location. Craigslist displays rental listings in a map and many renters in the Cambridge housing market use Craigslist to find apartments. Walk Score is a popular mapping platform which ranks the walkability of different neighborhoods. Renters are familiar with maps and would be comfortable using an energy map tool.

Displaying disclosed energy information on an energy map could also open a door to implementing more efficiency upgrades in multi-family buildings. For many tenants, utility costs are unknown when they sign a lease and can significantly increase their monthly living expenses. If prospective tenants were able to understand their expected utility bills prior to making a housing decision, they would be able to choose apartments within their budget or ones that they perceive to be “greener” if that is something they value. Landlords would realize that tenants were selecting certain apartments over others because of the unit’s energy performance. This could prod them to invest in efficiency strategies so their rental units would become more desirable.

If energy information on multi-family rental units is displayed publicly, landlords may feel some social pressure to make their buildings more efficient. The visual display of building performance in colors (e.g., green, yellow, red, etc.) may establish new social norms that encourage landlords

to upgrade their buildings. A 3-year study conducted by researchers at California State University and Arizona State University showed that people are more likely to reduce their energy consumption when told that their neighbors are implementing conservation and efficiency measures. Using descriptive normative information was more effective in reducing energy consumption than presenting information on potential monetary savings, environmental benefits, or social responsibility (Cialdini and Schultz 2004). Similarly, displaying information on a public energy map may set new norms for energy behavior when property owners see how their energy consumption differs from their neighbors.

Additionally, other interested parties such as government agencies and energy contractors could use the map to target neighborhoods for energy efficiency outreach. The map could be used to organize community-based social marketing efforts and to identify buildings with great energy potential.

An energy map would need to use a benchmarking system that can be applied to many types of homes, with possibly limited data streams, and that is accurate enough to establish user confidence. The energy map could also make a distinction between a building's asset rating versus its operational rating (since frequently electricity consumption is largely impacted by occupant behavior), either by giving two scores or making it clear which rating is being displayed. Distinguishing between an operational score and an asset score could alleviate concerns of landlords that even if they upgrade their buildings, tenants would make poor energy decisions and negatively impact their building's rating.

A key challenge to developing an energy map include accessing data from multiple databases, including energy data from NSTAR and building characteristic information from public sources such as tax assessor records. However, these challenges could also be addressed through the development of a typology-based tool and E-calculator. Similar to concerns about privacy regarding disclosure, some people may be concerned about displaying information in a map. To address this concern, property owners could be allowed to opt-out of displaying their building on the map. However, a current energy map which displays individual building energy consumption in Gainesville, Florida has received mainly praise from the public while very few owners choose to opt out (Davis 2013).

Propositions to Test

Typology-based Tool: Creating a typology-driven 'one-stop shop' approach to home energy assessments via an online tool will offer an alternative to the seven-step approach to home energy assessments, getting straight to the point by correlating building type to the appropriate

retrofit options and building technology capable of saving the most energy at the quickest payback for the home.

Full Energy Disclosure: Disclosing meaningful energy data in the form of estimated building energy performance and estimated efficiency potential alleviates some existing market inefficiencies that have hindered informed decision-making by both existing and prospective building owners and tenants. We propose displaying information on an interactive online energy map.

Key Assumptions

1. Developing a typology-driven energy efficiency assessment tool will gain widespread use by offering easy access at a very low initial cost and will lead to more acceptance of energy efficiency upgrades as a result of education of owners and tenants.
2. Testing the impacts of disclosure might manifest differently within various segments of the real estate and rental markets. The market for the buying and selling of homes has a longer transaction window and involves a longer-term decision. The rental market's low vacancy rate and predominantly short term, student leases, shortens the decision-making window and might limit data availability. However, since the turnover rate for rentals is much higher, more opportunities exist to test impacts.
3. Developing meaningful data for disclosure leads to improved data infrastructure (e.g., greater alignment of datasets: tax assessor records, energy assessment data and utility meters) and a more streamlined home energy assessment process.

Scale

This pilot will include a selection of primarily wood-framed multi-family buildings between 2-20 units within Central Square neighborhood of Cambridge. The scope would include approximately 1,000 buildings to target 40% adoption, resulting in approximately 400 units. Both propositions will be tested using the same buildings.

PROGRAM DESCRIPTION

Year One

The pilot begins with an RFP to build a data development team. The database development can begin with existing energy database architecture. This could mean using DOE SEED platforms, Wegowise, and possible EarthAdvantage - the database used for current, building MPG pilot that focuses on residential up to 3 units. Using this platform, most of the year one efforts will focus on creating the functionality and interface for the Typology-based Remote Assessment Tool as follows: Using a typology driven approach, this tool utilizes an address as a starting point to scrape public data about building characteristics in order to put together a moderately accurate

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depiction of the performance of a building as well as prescribe one of many high-return building technology components to implement energy efficiency measures. After being prompted to enter more detailed energy characteristics and actual energy data about the home, the tool can also assist in suggesting lifecycle technology in addition to providing other easy efficiency upgrades. Additional steps will include defining descriptions and number of building typologies to be related to building characteristics. Then, through regression analysis, link building characteristics to performance to be conveyed and embedded in each building typology.

Ratepayers in buildings with only 2-4 units will be notified that energy use data will be disclosed on an aggregated basis only, and that they can opt-out (insert into paper bill or notification at online bill pay). We understand that ratepayers in buildings with 5-20 units might not have the level of privacy risk when using aggregated data, and we therefore recommend that it may not be necessary to achieve ratepayer consent – especially since the aggregated use data is meant for internal analysis to help the data manager test and calibrate energy estimates. Disclosed information will be a blend of actual energy use and building characteristics. The energy use data will be added to the data-engine that will ultimately support both the Typology Tool and the Full Disclosure test.

As the data-engine for the tool is created, the data developers should reconcile datasets across tax assessor records, GIS building layers and match NSTAR meter records to addresses. This critical step in data quality assurance enables use of this data-engine not only for the tool, but also the test of disclosure, energy mapping and the E-Calculator. In the second half of the first year, the developers should build a typology interface to be user friendly with a one-click method as the end-goal. It will then be scripted for follow up questions and insertion of energy data.

At the same time, the development team should explore the building subsets, such as condos vs. non-condos, 2-4 units vs. 5-20, to make more informed decision about data disclosure options. They will develop prototype energy maps that can display both neighborhood and citywide scales. For the citywide model, the data developers will need to capture data related to retrofit successes and certificate program recipients.

Year Two

Upon completion of development phase of the typology tool, the product would be launched in the specified neighborhood. Participants will receive a letter describing the opt-out program where they will have one month to go online and answer the tool's questions. Incentives for participation might include a nest thermostat to the extent practicable. The program implementer will assign someone to follow-up with participants that neither opted-out nor

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completed the tool. Comprehensive follow up on the tool would include surveys to assess clarity and helpfulness of the tool as a whole.

Several data points are needed to build and calibrate credible energy scores, yet not all data points need to be disclosed. Data gathered from the typology tool will be critical to estimating efficiency potential. Operating data and thermal imaging can help calibrate building asset characteristics to improve the accuracy of a disclosed asset score. Operating data can be aggregated and averaged to provide consumers with non-identifiable data that could inform an average energy use benchmark. By the middle of the second year, these measures will be ready for a disclosure test.

Disclosure Vehicles to Test Impact

Estimated energy performance of buildings can be disclosed within multiple listing services for both the rental and sales markets. This disclosure takes informed estimates of likely energy costs to help consumers make better decisions, while at the same time, the data does not reveal the personal energy use of specific energy use to the public. This improved decision-making should influence discussions between buyers and sellers and landlords and tenants when negotiating prices. Also, point of sale is when retrofitting is optimal, since the change of occupants often means a temporary window for contractors to make efficiency upgrades within an empty building without disturbing occupants. In-building energy labels can be posted to allow building occupants to understand how their building performs – similar to how consumers understand the fuel efficiency of their vehicles.

The data team will release an interactive, online **Energy Map** that would allow potential tenants to view and compare the energy performance of various rental units. This can be expanded to include energy estimates for units outside of pilot area and for all of Cambridge. A data visualization expert would work with data manager to develop a few map options to test, including other measures such as carbon emissions, gas only, electricity only, etc. The mapping information layer can interface with various online apartment brokerage applications such as Zillow, university housing boards and real estate listing services.

Year Three:

Pending successful results from typology tool's beta testing period during year two, the tool can then be launched citywide. Once available to the entire city, this tool is likely to bring an incredible cost-effective enhancement to the entire assessment process. The free, online tool will allow users to take several steps towards making informed retrofit decisions without having to take time off of work or await written reports after a comprehensive assessments. Mostly, the

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tool will tap into consumer initiative to research the situation in the comfort of their home at more convenient times. As more people make use of the tool and share specific building characteristics, the tool's energy modeling algorithms will become more reliable creating even greater value. If the tool reaches such critical mass, NSTAR will likely see average home assessment costs decline, assessments that lead to retrofits increase and less investment in locating efficiency potential.

As the assessment process improves, so will the reliability of energy performance estimates that can be disclosed to a broader audience. NSTAR can extend building disclosure to a wider scale within Cambridge in the third year.

Testable pilot outcomes

- Increased retrofit adoption
- Improved consumer decision-making
- Increased building market value for sales and rentals
- Improved cost-effectiveness of Mass Save program target marketing
- Lower, average cost of home energy assessment
- Increased awareness of options for energy efficiency upgrades
- Assessments identify particular inefficiencies in buildings, leading to more defined and focused physical assessments with higher work adoption rates
- Empirical data concerning % improvement in a specific neighborhood that can be used to support a wider prescription area such as all of Cambridge.

Evaluation of Data Central results

- First survey to test reactions to Typology tool
- Second survey to test reactions to disclosure vehicles
- Third survey (potentially combined with second, though probably better later) to try to discern which tool influenced change in behavior/decision-making amongst those who have had a retrofit.
- Survey to gauge perceptions of privacy concerns and trust in credibility of data (tenants)
- Exit interview for building owners that choose to opt out of Typology Tool and ratepayers that opt out of energy disclosure

EVALUATION PLAN

As a pilot program, it is crucial that this effort contribute to the field's understanding of how barriers to multifamily energy family can be effectively addressed. Therefore, we propose that NSTAR conduct a formal assessment of the pilot's impact at the end of its deployment. The timing of this evaluation can be arranged to be consistent with the end of the 2013-2015 program cycle and the evaluation of NSTAR's other efficiency programs.

Third party evaluation, measurement, and verification (EM&V) efforts are common in the efficiency field and both ensure that utility programs are resulting in real energy savings in a cost-effective manner and provide a place for learning and improvement within the established utility program framework. We propose the NSTAR put out a competitive bid for the pilot program as it would for its other programs, but that it request additional information that would maximize the learning that results from this initiative. Specifically, we propose that NSTAR request three key elements in an evaluation: an impact evaluation, a process evaluation, and an assessment of market transformation that results from the pilot.

The **impact evaluation** would assess the quantitative outcomes of the citywide pilot and determine the pilot's effectiveness in enabling larger amounts of energy savings than has historically been obtained in the multifamily sector in Cambridge and similar towns. The key outcomes of interest are the number of homes receiving substantive energy upgrades and the aggregate amount of energy savings (along with a cost-benefit analysis). The specific savings impacts of the experimental control technologies would be a specific area of interest for this evaluation.

The **process evaluation** would probe the program structure of the pilot for strong and weak points. Specifically, we believe it is important to have a more in-depth knowledge of why residents choose to participate or not participate in the pilot. This will mean conducting in person interviews with program participants as well as residents in the targeted population that did not participate. This would allow NSTAR to pinpoint the elements of the pilot's structure—such as a single program implementer, the use of success stories, or easier financing. Additionally, the process evaluation would look at the number of potential participants that reach distinct stages in the program participation pipeline (such as expressing initial interest, completing an audit, and completing a retrofit) and compare it to comparable numbers in standard programs. With this knowledge, we would be able to pinpoint the exact areas where the pilot's structure has facilitated project completion and where further attention is needed.

Finally, a **market transformation assessment** would determine how the tools being developed in the neighborhood data central program component have changed the way that residents think

about and approach efficiency. The evaluator would determine how targeted participants are using the data typology tool and the data products that result from the disclosure policy. This assessment would inform how effective these tools are in moving markets to increase take-up of energy efficiency.

CONCLUSION

Using this pilot design, we've addressed a number of market barriers that have hindered the efficacy of energy efficiency programming in the multifamily housing sector. At the Base Citywide scale, by simplifying both the assessment and financing process and streamlining program administration, building owners and ratepayers should experience less frustration and more support as they attempt to evaluate and upgrade their homes. The proposed process improvements combined with community-based social marketing targeted at community networks will serve to help Cambridge residents learn about and take advantage of the range of benefits already available to them through Mass SAVE as well as the energy efficiency benefits offered through the pilot. These elements will directly mitigate the current complexity of program processes, obstacles to understanding energy efficiency programs, and low awareness about the range of programs, from low free technologies to low interest financing, available to multifamily residents

Participating building owners and citizens will also learn about new tools and strategies to communicate with each other about desired improvements and more accessible financing mechanisms. Tenants will also have opportunities to receive new technologies that offer more control over comfort and energy use. These treatments will mitigate the split incentive barrier between tenants and landlords

At the Data Central neighborhood scale, remote assessments and building performance scores will shed light on how a subset of Cambridge buildings use energy and which buildings perform better than others. Maps and other disclosure tools will create transparency for decision makers, without compromising privacy, in a market that for too long has been forced to operate blind to energy performance.

As with most creative processes, not every idea we explored this semester is included in this proposal, even if it addressed a market barrier in some way. Those exclusions are part of the process of creating an integrated program, but that does not mean these ideas have no application in other settings. Other ideas proposed throughout the generation of this pilot proposal that could be topics for future research or other energy efficiency programs include:

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- University-led student data share
- Shared Customer Relationship Management System
- Green Lease Addendum

Also, themes, such as marketing ‘comfort’ are partly explored by our propositions, but can be further developed by stakeholders during and beyond the pilot.

The advantage of a pilot is that it is time and scale-limited, but these constraints still leave open the question of what, precisely, the pilot should inform. Should a pilot act as a microcosm to groundtruth ideas that could be deployed throughout the city, the state, the country? And, importantly, should a pilot lead to empirically testable results or provoke learning that guides the future of energy efficiency programming at a range of scales?

Ultimately, we approached our pilot design with the intention of elucidating the kind of learning that would inform an ongoing program within Cambridge, advancing the partnership between the City and NSTAR around energy savings goals. And even though we addressed market barriers specific to the Cambridge multifamily market, most of our proposals address challenges that resonate elsewhere. Most of our pilot framework could be adapted to multifamily housing in other Massachusetts and US cities, as well.

This is relevant because energy efficiency program design has yet to register meaningful improvements in multifamily housing, despite the fact that the State of MA and its utilities have demonstrated nationally recognized leadership in developing a regulatory and programmatic framework for efficiency improvements. Cities all over the country, not just Cambridge, have the most to gain from addressing these challenges for several reasons: multifamily housing is most prevalent in cities and often occupied by tenants with modest resources. This housing, especially in older neighborhoods, is often in need of efficiency improvements and tenant comfort measures.

This pilot is an opportunity to rethink the needs of the multifamily housing sector and embrace new approaches to these seemingly intractable challenges. We recognize the scope of this pilot is broad and complex, but we believe that this latticework of treatments can support the City, NSTAR, and the community update homes, maximize comfort, minimize electricity bills, save energy, and demonstrate efficiency leadership to cities around the country.

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APPENDIX A: Gant Chart (separate document)

APPENDIX B: LIST OF INTERVIEWEES

- John Bolduc, City of Cambridge
- Pat Coleman, Massachusetts Department of Energy Resources
- Colliers International, property management firm for MIT's off-campus housing
- Ed Connelly, New Ecology, Inc.
- Ryan Davis, EnergyIT
- John DiFava, Chief of Police
- Travis Estes, Next Step Living
- Bill Footer, Conservation Services Group
- Eric Gardner, New Ecology, Inc.
- Joseph Gifun, MIT Department of Facilities
- Jonathan McIndoe Hunt, IS&T
- DeWitt Jones, Boston Community Capital
- Steve Lanou, MIT Sustainability
- Linda Patton, MIT Residential Life and Dining
- Peter Shapiro, Just-a-Start
- Audrey Schulman, Cambridge HEET Squad
- Megan Shaw of the Cambridge Energy Alliance
- Josh Sklarsky, Peregrine Energy Group

APPENDIX C: LIST OF SYMPOSIUM ATTENDEES

- Helen Aki, MAPC
- Elena Alschuler, DOE
- Allison Bard, Cadmus
- Cressica Brazier, MIT
- Jan Carbone, Homeowners Rehab
- Christina Charlton, CSG
- Pat Coleman, MA DOER
- Beverly Craig, Homeowners Rehab
- Mayor Henrietta Davis, City of Cambridge
- Beth Williams Delahajj, National Grid
- Travis Estes, Next Step Living
- Bill Footer, CSG
- Eric Gardner, New Ecology
- Peter Graham, Just-a-Start
- Julia Greene, City of Cambridge
- Marc Hoffman, Consortium of EE
- Lyn Huckabee, MA DOER
- Russell Koty, City of Somerville
- Julia Ledewitz, MIT Physical Plant
- Ed Londergan, NEEP
- David Lutes, City of Somerville
- Eric Mackres, ACEEE
- Jeff Mekler, MIT
- Nikhil Nadkarni, European Building Labeling
- Jocelyn Newhouse, MIT
- Katy Newhouse, ICF
- Christoph Reinhart, MIT
- Kurt Roth, Fraunhofer
- Carolyn Sarno, NEEP
- Audrey Schulman, HEET
- Peter Shapiro, Just-a-Start
- Meghan Shaw, City of Cambridge
- Josh Sklarsky, Peregrine Energy
- Bill Stack, NSTAR
- Brad Swing, Boston Mayor's Office
- Allison Webster, NEEP
- Alissa Whiteman, MA DOER

APPENDIX D: ESTIMATED PILOT COSTS

Citywide Program Estimated Budget: \$580,000

- Selection of Program Implementer and Financial Partners (staff time at NSTAR and program implementer): \$10,000
- Program Administrator Operating Costs (includes program manager and support staff and 2 community liaisons): \$150,000/year
- Development of E-Calculator Tool: \$100,000
- Marketing costs (1 part-time staff or consultancy): \$50,000
- Creation of Tenant Toolkit: \$30,000
- Printing and Distribution of Marketing Materials and Post-Retrofit Certificates: \$10,000
- Additional Marketing and Outreach: \$40,000
- Cost of Experimental Control Technologies (estimated \$300 cost for 400 units): \$120,000
- Community Group Incentives (\$5,000 solar installations for top 5 organizations, \$2,000 efficiency upgrade for first 10 organizations to recruit 10 members): \$45,000
- Program Evaluation: \$25,000

Data Central Estimated Budget: \$220,000

- Program Implementer (part of Base Citywide)
- Program Evaluation (part of Base Citywide)
- Data Developers:
 - Typology-based interface (est. \$10,000 minimum + \$100 per participant)
 - Participation incentive programs (est. \$50,000)
 - Full Energy Disclosure (est. \$75,000)
 - Thermal image data (est. \$5,000)
 - Energy Map (est. \$25,000)
 - E-Calculator (see Base Citywide discussion)
- Administrative Costs (est. \$15,000)

Total Estimated Budget: \$800,000