Making Efficiency Efficient: Using Low Cost Internet Technology To Reinvent The Traditional Utility Rebate Program

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ABSTRACT

New mandates and regulations around efficiency have accelerated funding and growth of utility efficiency programs—ACEEE reports that efficiency program budgets tripled between 2008 and 2012, to $6 billion (Nowak et al. 2013). However, much of this growth has outstripped utilities' capabilities to meet savings goals and improve cost-effectiveness. Many adhere to outdated tactics and metrics that drive suboptimal results, such as first-come, first-served programs or basing success on the number of CFLs distributed.

This paper examines a successful project by a consortium of eight Massachusetts utilities and energy efficiency service providers that pioneered the use of low-cost data analytics to maximize energy efficiency. The program tracked and benchmarked energy and water use for more than 126,000 low-income multifamily units across Massachusetts, targeting audits and retrofits to buildings with the highest savings potential. This approach allowed administrative costs to be targeted to critical opportunities, and increased total savings achieved via the retrofits—in its first year (2010), the program identified $137M in lifetime utility savings.

This paper will share insights on how low-cost internet technology helps efficiency programs achieve greater savings with less dollars, enabling utilities to meet mandates and improve cost effectiveness as measured by Total Resource Cost (TRC).

Introduction

In most states in the U.S, budgets and goals for utility-sponsored energy efficiency (EE) are higher than they have ever been. [1] Energy efficiency has gradually become recognized as the "fifth fuel," a critical resource to enable utility planners to successfully balance supply and demand (Forster, Wallace, and Dahlberg 2013). In California and other states, energy efficiency is considered before conventional fossil fuels and even before renewables (CEC 2005).

Though the general trend has been an increased focus on energy efficiency, the allocation of EE resources is not always consistent across market segments. Specifically, utility programs have historically faced challenges reaching the multifamily sector—made up of buildings with five or more housing units. Figure 1 displays this disparity for several large metropolitan areas in the U.S. for the year 2011.

[1] For example, see Forbes: http://www.forbes.com/2008/07/03/energy-efficiency-biz-energy_cx_db_0707efficiency_lander.html

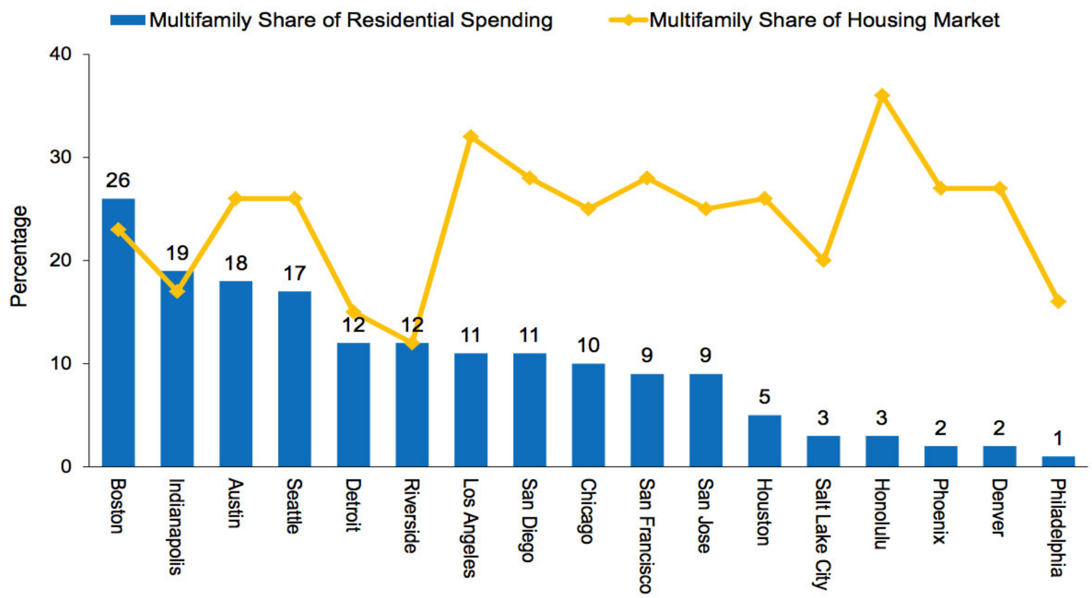

Figure 1. Multifamily EE spending and market share, 2011. *Source*: NHT 2013.

In Massachusetts, this disparity was recognized several years ago, and new programs were designed and implemented to better allocate EE funding across all sectors. For example, the Mass Save® program pioneered a statewide model for consistent branding across individually administered programs (Halfpenny et al. 2012). Under the Mass Save® brand, significant investment was targeted to multifamily buildings (Mass Save 2012; Johnson and Mackres 2013).

Under the Mass Save® umbrella, the Low Income Multi Family (LIMF) initiative is dedicated to energy efficiency in affordable housing. A collaboration of the eight Investor-Owned Utilities, the LIMF program covered the entire state of Massachusetts. By benchmarking a majority of the affordable housing in the state over the program period (2010-2013), more than $137M in potential energy savings was identified, including over 12 million therms of gas and 165 million kWh of electricity. The program provided audits and engineering resources to assist property owners in achieving energy savings. During the same time period, more than 126,000 affordable housing units were upgraded through the program, with annual savings of over one million therms of gas and 17 million kWh of electricity (Johnson 2013). As projects identified in the program continue to be implemented, these numbers continue to rise.

In addition to its unique focus on the typically underserved multifamily sector, the LIMF program applied low-cost Internet technology to reinvent the traditional utility rebate program. Data and analytics improved reach and reduced cost, leading to a highly cost-effective program. The Total Resource Cost score for electric savings in the LIMF program was 1.73. This level of cost-effectiveness is unusual in a sector (affordable housing) that has been viewed as "hard to reach" (Johnson 2013), and that often struggles to meet basic cost-effectiveness criteria (i.e. TRC<1). Because the data and analytics were included from the beginning of the program, it is not possible to conduct a "pre versus post" analysis.

The benefits of applying technology in the program accrued in three main areas: preliminary planning and program design, back office operations and customer experience. As an early example of a large-scale utility program centered on energy data and analytics, there were many lessons learned and findings that will help to optimize programs of its kind in the future.

Innovative Preliminary Planning and Program Design

Technology improved the quality of preliminary planning and program design by directly measuring the pre-retrofit consumption of thousands of buildings, rather than relying on secondary data, modeling, and expert judgment.

Multifamily housing is somewhat of a "black box" for energy efficiency. Because the sector has not been a primary focus in the past for many utilities, planners have little information about the building stock, current consumption patterns and savings potential. Various ownership and building configurations add to the complexity of the sector. In the past, programs have been unable to set targets or craft strategies for implementation without readily available information about their buildings and building energy use.

Traditionally, program planners have turned to the energy efficiency potential study to identify available savings and set targets. Carried out by consultants, a potential study examines all available macroeconomic data about the service territory, as well as characteristic energy consumption and local trends. In some cases, primary research is conducted to develop a more accurate picture of the target market. While better than relying on secondary data and regional sources such as the U.S. Energy Information Agency, primary research still relies on statistical sampling methods and extrapolates findings to the entire population.

In contrast to a detailed potential study, the LIMF program opted for a different approach to develop targets. The program team directly tracked the energy use of their target buildings through an energy benchmarking process. Energy benchmarks were offered at no cost to building owners, and were a prerequisite to obtaining funding through the program. As a result, nearly three-quarters of the affordable housing stock in Massachusetts was benchmarked. Each building was analyzed by utility type (water, electric, gas, oil) and compared to comparable buildings (filtered by climate, building type and heating fuel), pulled from a proprietary database of thousands of multifamily buildings in the state. Figure 2 illustrates the results of this benchmarking.

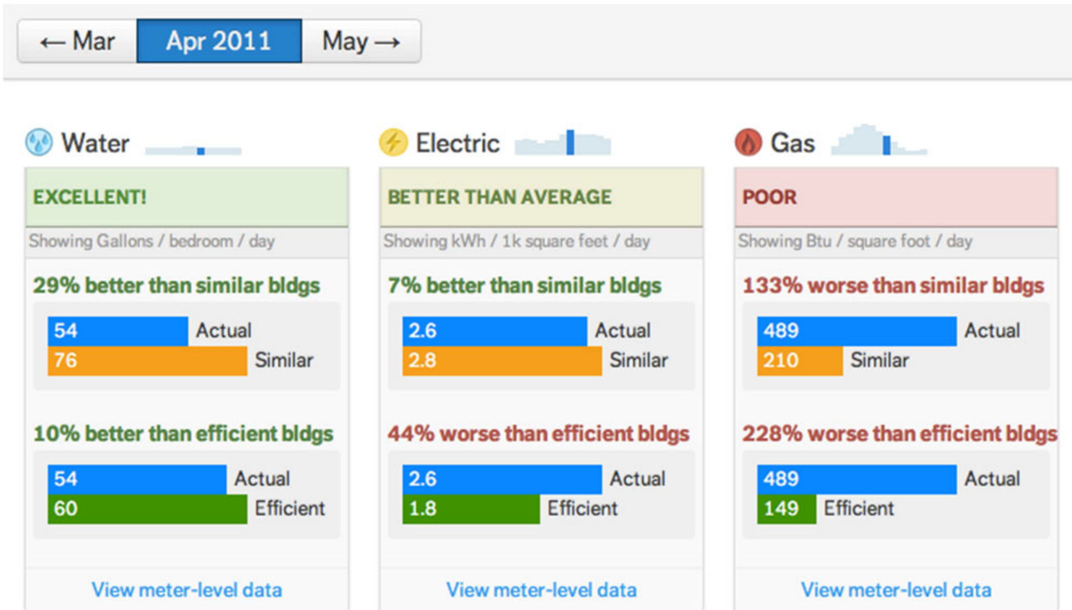

Figure 2. Example benchmarks calculated for each utility type. This was made available for each building in the program.

Using a direct measurement rather than a traditional potential study provided the Massachusetts IOUs with several important benefits:

- The research does not rely on modeling or extrapolation, but actual historical energy usage for each building considered for the program. The result is reliable data at high resolution.
- By taking inventory of the affordable housing stock, the utilities can develop a detailed plan for outreach and program implementation. Instead of a mass-marketing approach, outreach can be specific and focused on potential energy savings.
- With the benchmarking analysis complete, program implementers were able to change the conversation with prospective participants. Where marketing was previously generic in nature, it now becomes highly specific and actionable.

Over four years of the program implementation, more than 10,000 affordable multifamily buildings were benchmarked. This effort provided a unique level of insight to the IOU implementation teams and other stakeholders, ensuring that the program was positioned for success from the beginning.

Table 1 compares the benchmarking inventory approach with the traditional potential study. Depending on the scale of the utility base, the cost can be comparable between the two methods. Timing differs between the two approaches. A potential study is conducted as a single exercise, requiring months or even a year before the program can be rolled out. In contrast, benchmarking can happen in parallel with program outreach, with hundreds of buildings completed each week. In both cases, there is potential for error and uncertainty, with the benchmarking approach relying on quality building-level data.

One critical element of program design is estimating market adoption. On this front, potential studies rely on past experience and expert judgment, while the benchmarking process provides a self-selection effect that reduces the uncertainty around market penetration. The continued benefits of beginning with a benchmark are explored in the following sections.

Table 1. Comparison between potential study and benchmarking inventory approaches

	Traditional potential study	Benchmarking inventory
Cost	Up to $500k (Mosenthal and Loiter 2007)	~$50/building
Time required	4-12 months	~50 buildings per day
Reliability	Quality macro-level modeling depends on large datasets	Direct view with building-level resolution
Sources of error	Missing datasets, estimated values	Missing meters, gaps in monthly reads
Planned market penetration	Estimated based on similar programs	Direct measurement through benchmarking process
Feedback loop	"One and done"	Supports life cycle of program

Enhanced "Back Office" Program Operations

Technology enabled an implementation plan that focused resources on the largest savings opportunities, as opposed to relying on a "first come, first served" approach.

Once underway, the LIMF program applied the same technology used for the benchmarking to the ongoing implementation. Using the same tool for both components allowed for a "running start." For each potential program participant, the implementation team had access to historical consumption for each utility type and their summary benchmarks. This provides "at-a-glance" information about the relative performance of each building being considered. Figure 3 is a graphical representation of a subset of the buildings benchmarked for the LIMF program. Each dot represents a physical structure, plotted in terms of energy intensity (kBtu per square foot on the vertical axis) and absolute scale (energy spend in dollars on the horizontal axis).

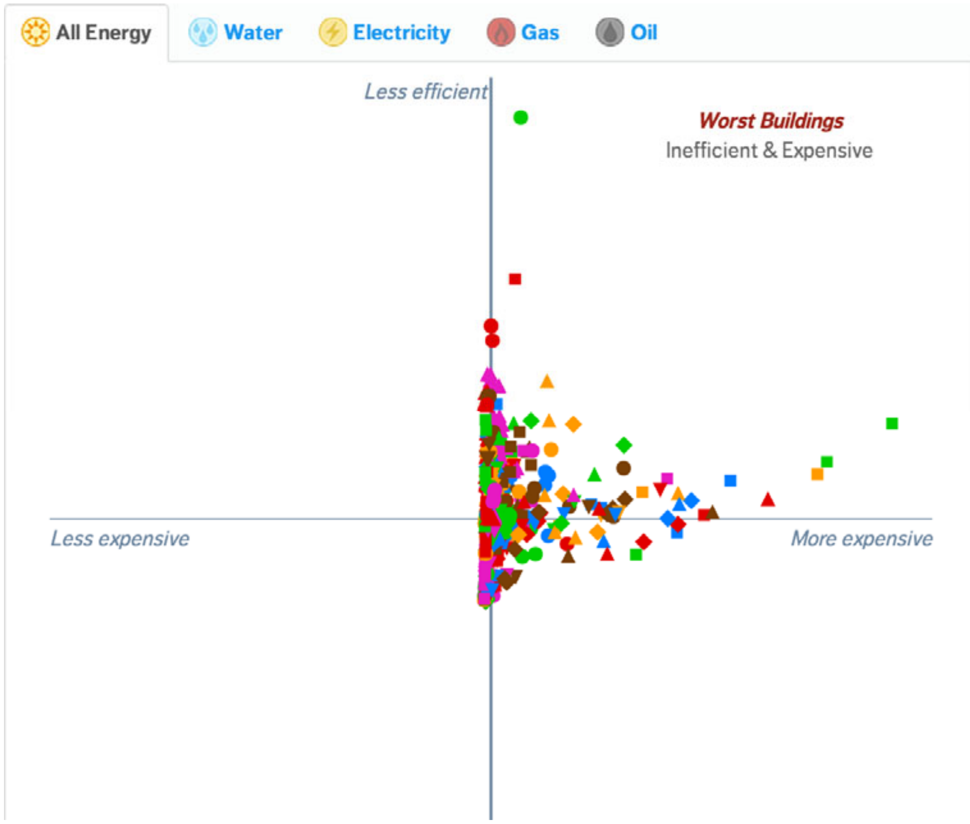

Figure 3. Comparison of Mass. affordable housing buildings in energy intensity and energy cost. The origin of the plot is the median value for the portfolio, and each marker represents a separate multifamily owner.

It is important to note that the data behind this view was already collected and analyzed as part of the benchmarking process. As such, there is minimal additional effort required to deliver this additional insight.

Once packaged in this way, the energy data collected during the benchmarking inventory enable efficient allocation of resources, increasing the cost effectiveness of the program:[2]

- Many of the applicants to the LIMF program were developers or housing authorities with multiple buildings. For example, if a prospective participant has 10 buildings, the program budget and policy may allow funding for only one or two, and the data make it easy to select the buildings with the largest opportunity to save.
- A majority of the buildings benchmarked fall into a middle category, where the potential savings do not necessarily justify a deep retrofit (equipment and envelope improvements targeting reductions of 30% or more), but there are improvements available through measures such as retro-commissioning, controls upgrades and lighting. Benchmarking allows for a quick triage to address smaller savings opportunities in addition to the deep retrofits.

[2] Note that this analysis is limited to cost-effectiveness and does not touch on equity considerations. In practice, nearly all owners that expressed interest in the program had one or more buildings that qualified for funding.

- In some cases, buildings are running at the most efficient end of the distribution, and resources are better allocated to other parts of the owner's portfolio. By benchmarking a priori, administrators can know where there are smaller opportunities without bearing the cost of sending an auditor.

In practice, the underlying building and energy data were analyzed monthly to deliver actionable insights to program administrators. Two spreadsheet reports were generated monthly throughout the LIMF program:

- Benchmark inventory report: Each IOU received a spreadsheet listing the buildings that had received a benchmark in the past month.
- New LIMF applicants report: Each utility received a list of the property owners and building addresses from new LIMF applications. This report includes the benchmark data, as well as a benchmark of the heating energy normalized for heating degree days.

By utilizing these two groups of data, the program implementers were able to prioritize the applicants and allocate program resources in the most efficient way.

Improved Customer Experience

Intuitive, attractive software changed the nature of the conversation between program implementers and participants. Customer experience was improved because of the central role of data.

After more than a decade of ratepayer-funded energy efficiency, Massachusetts end users have become familiar with the economic benefits of various projects. In many cases, a purveyor of an energy efficient technology or a utility program approaches the building owner, shows some technical documentation and lays out a simple business case where the savings more than justify any upfront investment. Depending on the utility program, the initial cost can be offset in part or in whole by rebates and incentives. Even in the most attractive programs, the traditional method of engagement can make it difficult for a property manager to understand the expected benefits *for his or her building*.

In the LIMF program, participants have a noticeably different experience.[3] Each applicant to the program receives a free one-year subscription to the energy management tool (the same technology platform used for the benchmarking and the back office functions described above). Instead of relying on case studies and general examples, the program participant can quantify savings opportunities specific to his or her building. This tool adds value to the prospective participant and increases the likelihood of the retrofits to move to completion in two ways:

- Adding value through energy management. The benchmarking data displayed in Figure 2 is the first stop most building owners make, trying to understand if their building is doing better or worse than the average. Once that foundation is in place, there are additional

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[3] For more information, see "2012 Report of the Massachusetts Energy Efficiency Advisory Council," Energy Efficiency Advisory Council. November 2013, page 13.

visualizations and analysis tools that help managers see their utility consumption and identify ways to improve. See Figure 5 for an example of this type of visualization.

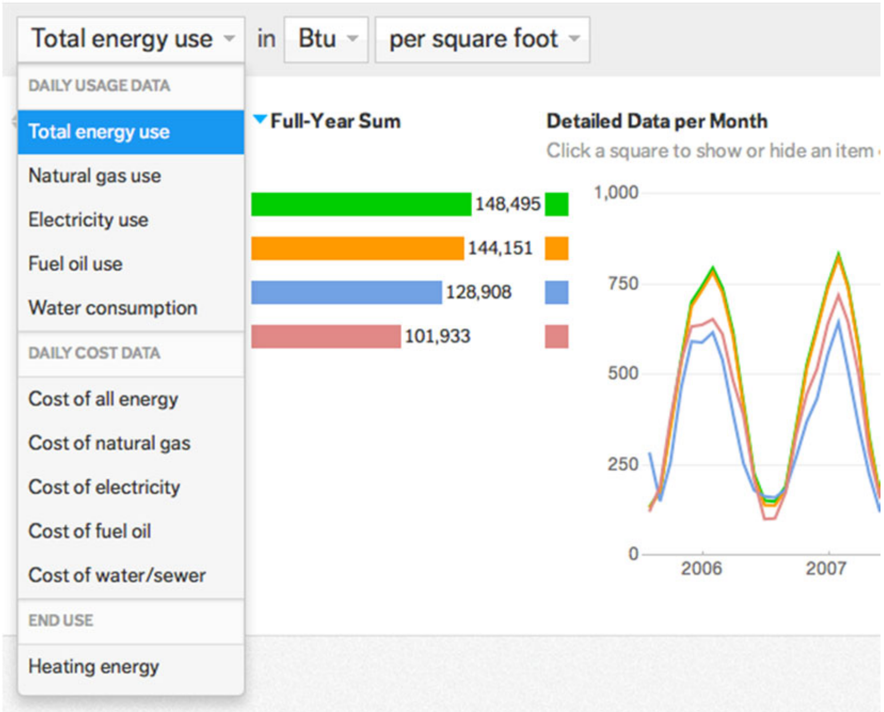

Figure 5. Customizable charts of utility consumption and cost.

An interesting side note from the experience with the LIMF program is that the affordable housing community came to embrace the utility data. In the beginning of the program, owners received the tools somewhat skeptically when they applied for funding through the program. By the fourth year of the program, owners became interested in the program as a result of their desire for energy management tools.

- Changing behavior through data. In recent years, social science research has documented the impact of information on human decision-making. Simply providing energy consumption data in context has led to savings as high as 5%.[4] While there is certainly less evidence outside the single family market, it is reasonable to expect multifamily owners and managers to respond to data-driven messaging. This is an area to be explored in future programs, preferably through carefully designed experiments.

To understand the experience from the end user perspective, it is helpful to examine the benchmarking process. The energy data for the program were provided by the utilities, populated into the software tool by the WegoWise team. To provide appropriate benchmarks and comparisons, the system also collected information such as square footage, number of apartment units and number of bedrooms. To assemble this information, the WegoWise team worked with

[4] From the Journal of Environmental Psychology. Vol. 27, Issue 4. December 2007. "The effect of tailored information, goal setting, and tailored feedback on household energy use, energy-related behaviors, and behavioral antecedents."

program implementers and property owners. Setup required a short spreadsheet with information about the buildings, and was typically completed in less than a week.

Conclusions

The experience of the LIMF program among affordable multifamily housing buildings in Massachusetts demonstrates a new model for applying technology to enhance utility energy efficiency programs. It is important to recognize that the technology used in this program is not extraordinarily complex. In fact, there were no connections installed to the buildings themselves. Instead, the data were extracted directly from the utilities.

A "low-touch" model like the one described here relies on simple, low cost Internet technology. As such, it was feasible within the context of the program to include over 10,000 buildings and still spend significantly less than the combined cost of a detailed potential study and a traditional, labor-intensive administration process for qualifying retrofit projects and engaging participants.

The foundation of data and analytics permeated the program, providing benefits throughout the life cycle:

- Planning and program design – Instead of a detailed potential study based on secondary data and modeling, the program administrators could see the exact utility usage for each building. This allowed for high resolution into the participant pool, and facilitated conversion of prospects throughout the program.
- "Back office" operations – With the benchmarking data for all prospective program participants, implementers can quickly identify the largest opportunities for savings and triage the portfolio to ensure efficient allocation of resources.
- Customer experience – By shaping the conversation around a participant's energy data, the utility administrators ensure a positive and transparent experience.

To the authors' knowledge, this program is the first to apply energy data throughout the life cycle in this way, and almost certainly at this scale. Because of the novel nature of the program, there were several challenges faced and lessons learned.

Lessons Learned

There were several areas where the program implementation adapted over time to better serve the program participants and improve the program administration. These lessons focus on data and analytics; additional insights can be found in the program summary reports.

- Utilities and trade associations are critical to outreach. In a technology-enabled program like LIMF, the first contact with a potential participant is different than in traditional approaches. Instead of an application form or an auditor, the first step is the energy benchmark. As a result, the process for engaging with participants was different in two ways.
    - Scale. Instead of interacting with the small subset of the customer base that expresses interest in the program, the goal was to benchmark as much of the

affordable housing stock as possible. This required semi-automated outreach, and a back-end process that was equipped to handle large quantities of data.
    - Partnership. In the early stages of the program, the implementer and technology partner took responsibility for finding additional buildings to benchmark. This approach did not deliver the desired scale, and was eventually corrected through closer collaboration with utilities and local industry associations for multifamily affordable housing.

- Data collection needs to be easy. In the first years of the program, property owners were asked to log into a simple web-based interface and spend 15 minutes adding information about their buildings. To improve the quantity and quality of the collected data, spreadsheet templates were created for easy compilation of data for large portfolios of buildings. Eventually, the program team made the process even easier by pre-populating the spreadsheets with any information publicly available. Each of these refinements reduced the effort required of the property owner and therefore increased the likelihood of their participation in the benchmarking, which led to higher levels of interest in the retrofit program.

Next Steps

For future iterations of data-driven energy efficiency programs, there are key areas to build upon as next steps:

- Tenant data – When benchmarking buildings, the ideal is a complete picture of the energy consumed at the premise. However, it is often difficult to capture the full utility data because the tenants pay the bills directly to the utility. In these cases, the data collection approach for a whole building benchmark requires cooperation and coordination across a larger group of individuals because each tenant must authorize the sharing of his or her data. Future work will focus on streamlining data collection across multiple tenants.
- Targeted marketing. Due in part to the relatively high incentive levels included in the LIMF program, there was consistently high demand on the part of participants throughout the four years of the program life. However, many programs struggle to find participants. In a low-demand scenario, the technology tools could be used in two ways:

    - Presented as a bonus offering to bolster demand (same effect seen in the LIMF program)
    - Leveraged as a lead targeting tool, with targeted outreach campaigns targeting buildings that meet specific criteria.

- Post-retrofit monitoring. One application of energy data that was not used in the program is tracking the performance of the upgrade projects. Verifying energy savings is a constant theme in energy efficiency, as funding agencies, program implementers, contractors and property owners all have a vested interest in knowing how much energy was saved as a result of the upgrade. Future work will explore the ability of data and analytics to directly measure the impact of retrofits through whole-building analysis and industry standard techniques.

With more experience, challenges will be overcome and the role of data and analytics will expand to provide additional value for utility EE programs. The LIMF program in Massachusetts demonstrated a first step, seeing positive results by incorporating energy benchmarking and tracking at multiple stages of the program. Because of rapidly improving technology and readily available infrastructure, these benefits were achieved at no additional cost, and likely less expensive than traditional approaches to program planning, design and implementation. As more programs adopt a data-centric approach, utilities will see increasingly cost-effective savings and engage with their customers in innovative ways.

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