The Promise and Potential of Comprehensive Commercial Building Retrofit Programs

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Executive Summary

Commercial buildings consume 20% of the total energy used in the United States, a significant portion of which can be saved through efficiency in design, systems, and operation. Since buildings have a long lifespan, it is reasonable to assume that a majority of buildings in use today will still be in operation for decades to come. While new building construction is subject to compliance with building energy codes, existing buildings tend to lag behind in adopting efficient technologies. We can make these buildings more efficient through comprehensive retrofits of their energy systems.

Utility ratepayer-funded programs have traditionally focused on providing incentives for energy efficiency measures that target specific equipment or components. Buildings, however, consist of a number of systems such as lighting, heating and cooling, ventilation, and hot- and cold-water delivery. These systems are interrelated; changes in one often affect the energy use in the others. Maximum efficiency gains can be achieved by analyzing the building as a whole and taking into account the interactive effect of the energy use of its various systems. This report delves into this comprehensive retrofit approach and, based on interviews with program administrators and review of program literature, recommends pathways for program adoption.

KEY FINDINGS

We looked at programs that have implemented comprehensive energy retrofits in commercial buildings to glean good practices that will help other programs new to this area. We group these practices around the various stages of a program, from prospecting and design to measurement and verification.

Prospecting

The majority of programs to date have focused on large customers. However opportunities for comprehensive retrofits exist with all kinds of customers: for example, large, medium, and small businesses, diverse sectors such as office buildings, and more cohesive sectors like healthcare and education buildings. To create a pipeline of prospects, programs can offer low-cost energy assessments and audits as a starting point. The increasing sophistication of remote data analytics is enabling a higher number of energy audits at a fraction of the cost. Some programs pair energy audits with benchmarking tools such as the ENERGY STAR™ Portfolio Manager.

To increase the effectiveness of outreach efforts, programs have also benefitted from developing a network of partners such as trade allies, local government agencies, regional efficiency organizations, building owners and management associations, and other regional utilities.

While energy savings from comprehensive retrofits are attractive, communicating the non-energy benefits of comprehensive retrofits makes for a stronger business case. These benefits include increases in property value, lower operating expenses, greater occupant comfort and satisfaction, and improvement in air quality through emissions reduction.

Design and Implementation

In most cases, comprehensive retrofits are part of, or a variation on, the custom-projects incentives that programs have been offering for a long time. To move away from isolated efficiency measures, some programs make implementing multiple measures a necessary condition of participation, and others offer a bonus incentive above the one for standard prescriptive measures.

In addition to efficiency rebates, it is good practice to bundle other benefits into the program package. Programs commonly provide access to a no-cost or cost-subsidized energy audit, and they also offer technical support in the form of remodeling, design improvements, and operational assistance. To overcome the high upfront investment for comprehensive retrofits, some programs link up with private or government agencies to offer low-cost loans, extended terms, and/or relaxed underwriting.

In terms of implementation, not all projects are completed in one go. Some use a phased approach, with each phase lasting about a year and targeting successively deeper savings. This approach reduces the upfront capital cost and helps secure a longer-term commitment to efficiency.

Evaluation, Measurement, and Verification (EM&V)

EM&V serves a variety of purposes: verification of savings, establishing a basis of incentive payment, reducing uncertainty of savings estimation, monitoring post-retrofit systems performance, and finding additional opportunities for savings. The U.S. Department of Energy (DOE) has published a whole-buildings analysis protocol under the Uniform Methods Project.[1] It provides M&V approaches based on an analysis of the billing data pre and post retrofit. Some programs use the U.S. Environmental Protection Agency's (EPA) ENERGY STAR Portfolio Manager to track savings impacts, and they collect performance reports from Portfolio Manager to support evaluation efforts. A few programs include ongoing commissioning requirements and post-installation verification of savings.

RECOMMENDATIONS

We found a variety of strategies that programs have adopted to improve the market penetration and effectiveness of comprehensive retrofits. To begin with, quite a few administrators now have segment-specific programs. Facilities such as restaurants, schools, nursing homes, and warehouses have similar energy-use characteristics within their own type and can be good targets for comprehensive retrofits.

On the other hand, each comprehensive retrofit project is unique and requires a sophisticated approach to simplify the relationship with the customer through modeling, measure selection, financing, and implementation. Programs that provide streamlined, end-to-end support tend have more satisfied customers. Effective programs identify savings, help procure funding, provide technical assistance, and offer incentives for ongoing optimization. We recommend

[1] See https://www1.eere.energy.gov/wip/pdfs/53827-8.pdf.

structuring program incentives to encourage a whole-building analysis and installation of multiple measures.

Since comprehensive retrofits are time- and capital-intensive, some programs offer a phased approach to successively deeper savings. While efficiency measures are identified through a comprehensive whole-building energy audit, the implementation is staggered over a period of time, thus alleviating the disruption to operations and reducing upfront investment.

Granular real-time energy-use data and advanced analytical capabilities are creating new opportunities for whole-building assessments, identification of comprehensive savings, and automated monitoring and tracking of energy-systems performance. Effective programs are increasingly making use of these tools, especially to complement in-person energy audits.

Trade allies are an indispensable partner in the outreach and implementation of comprehensive retrofits. Programs looking at a long-term strategy should develop a network of trade allies and offer them training, certification, program materials, and an incentive to participate.

Finally, we underscore the need to align program benefits with the business mission of the prospect. Efficiency retrofits provide non-energy benefits such as health, safety, comfort, and productivity improvements in conjunction with energy savings. Helping customers achieve their primary business or institutional mission through efficiency is more effective than trying to sell the benefits of efficiency on their own.

Introduction

The U.S. commercial building space consists of more than 80 billion square feet (EIA 2013), of which approximately 30% was due for renovation as of 2010 and therefore ideal for comprehensive energy retrofits (Zhai et al. 2011). Worldwide, the number of retrofits in commercial and public buildings has been growing, and the market for such projects is expected to almost double from $68.2 billion in 2014 to $127.5 billion by 2023 (Navigant 2014). Programs that encourage customers to adopt energy efficiency measures at the time of commercial building retrofits have tremendous energy savings potential.

Utilities and other efficiency program administrators have long been running programs incentivizing energy efficiency measures that target lighting; heating, ventilation, and air conditioning (HVAC); building shell; refrigeration; and other building systems. However most program participants have chosen to focus on specific equipment or components of a system, even where programs have offered comprehensive tracks. While these partial retrofits have contributed to substantial energy savings, the future energy saving potential from these prescriptive measures is shrinking, in part due to the increasing stringency of building energy codes and energy conservation standards.

We can trace the history of comprehensive retrofits to the 1990s when Pacific Gas and Electric Company (PG&E) first demonstrated an integrated design approach to retrofits through a project that achieved energy savings ranging from 40% to 50% of baseline energy consumption (Elberling et al. 1998). These results have been validated by numerous subsequent retrofit projects, and there has been a growing recognition that buildings should be treated as a series of interacting systems rather than as a collection of isolated components. As a result, efficiency programs across the country have started including whole-building retrofits in their portfolio.

ACEEE first looked at comprehensive retrofits in a report published in 2005 (Amann and Mendelsohn 2005). Since then, the experience of an increasing number of early adopters has made it possible to review and assess what has worked and what has not. New technologies and approaches have also arisen that simplify the process of identifying energy savings opportunities and quantifying their benefits. This report highlights good practices for comprehensive retrofits that we hope will be useful to program administrators and other buildings efficiency stakeholders. Its objective is to help retrofit programs become more widespread and achieve deeper savings.

Case Study: Munich Reinsurance America

BACKGROUND

The headquarters of Munich Reinsurance America, a leading financial services firm, includes 417,400 square feet of interior space located on 40 acres in Princeton, New Jersey. In 2009, the four buildings on the campus were between 23 and 25 years old and together consumed 16 million kWh/year of electricity. From 2009 to 2012, the company partnered with the New Jersey Pay For Performance (P4P) program (see Appendix A) to undertake a comprehensive retrofit of its campus with the aim of significantly reducing energy use.

PROJECT IMPLEMENTATION

To participate in P4P, the first step was to prepare an energy reduction plan to define a comprehensive package of measures capable of reducing the existing energy consumption of a building by 15% or more. Working with program support, Munich Re America's facility team identified several energy-saving technologies and then employed a consulting firm funded through the P4P program to create more detailed energy models to estimate savings.

BUILDING AUTOMATION SYSTEM (BAS)

The first component of the project was to upgrade to a web-based advanced building automation system (BAS). The BAS allowed more accurate modeling of the energy use of various systems, improved HVAC scheduling, eliminated simultaneous heating and cooling, and increased the comfort of employees.

HVAC

Existing series fan-powered units (FPUs) were replaced with FPUs using electronically commutated motors (ECMs) controlled by the BAS. Additionally, the entire HVAC system was retrocommissioned as part of the project.

LIGHTING

More efficient lighting fixtures were installed across the campus. Occupancy sensors and dimming controls further reduced energy consumption. Additionally, daylight harvesting was used in the company's atrium areas, where sensors and relays continuously measured the amount of daylight entering the space and reset artificial lighting levels accordingly.

CHILLER

With design assistance from P4P, the team replaced the existing 24-year-old chillers with smaller high-efficiency units and reconfigured the piping to reduce energy consumption while meeting cooling requirements.

PROJECT COST AND RETURNS

The total project cost was estimated at $3.7 million. The NJ P4P program incentives covered roughly a third of this amount ($1.38 million). The retrofits resulted in energy savings of 6,700,000 kWh over a two-year period, about a 40% reduction from the baseline. These energy savings reduced the annual campus energy costs by an estimated $825,000, giving the project a payback of under three years.

Definitions

To begin with, the term "retrofit" is widely applied to any energy efficiency improvement, including adding to or modifying part of an energy system, or upgrading or replacing an entire system altogether. The term "renovation" indicates larger changes to the building structure and

systems, often involving major construction. Renovations can open up more comprehensive retrofit opportunities and may trigger code compliance requirements.

Pacific Northwest National Laboratory (PNNL) classifies three different levels of retrofits:

- Existing building commissioning, also known as retrocommissioning (RCx), focuses on improving the operations and maintenance of a building.
- Standard retrofits, which are typically cost effective and low risk, involve replacing existing equipment with more efficient technology.
- Comprehensive retrofits, also referred to as "deep retrofits" or "deep energy retrofits," go beyond standard retrofits by taking an integrated whole-building approach. They usually include equipment replacement and recommissioning. (PNNL 2011)

There are multiple criteria for characterizing a retrofit as comprehensive or deep. The Advanced Energy Retrofit Guide defines deep retrofits as "projects [that] affect multiple building systems and assemblies (e.g. envelope, lighting, and HVAC), and the retrofit of each system and assembly must be designed in close consideration of the other retrofits" (PNNL 2011, 71). According to this guide, deep retrofits can help achieve energy savings of 45% or more compared to prior energy use. Other studies such as Zhai et al. (2011) classify deep retrofits based on achieved energy savings.

On average, the retrofit projects analyzed in this report have achieved a range of energy savings from 10% to 40% of baseline. While comprehensive retrofits should aim for the higher end of this range, instead of specifying a number we would like to emphasize an approach that can lead to much deeper savings than simple prescriptive retrofits. With this in mind, we define comprehensive retrofits as *a suite of measures, across multiple energy systems, undertaken to improve building energy efficiency by using an integrated whole-building approach to achieve savings larger than those possible from the installation of isolated measures.*

It is appropriate here to distinguish between comprehensive retrofits and custom programs. Many ratepayer-sponsored programs offer custom rebates whereby customers can apply for monetary incentives for energy efficiency measures that fall outside the standard list of prescriptive measures. Whereas almost all comprehensive retrofit projects are customized to meet the unique energy needs of the customer, not all custom retrofits are comprehensive, since many of them target only a single energy system.

Some projects that target only one energy system may also achieve significant energy savings. For example, retrofitting the lighting in a building or a space with high-performance lamps and ballasts, including task lighting and daylight dimming and controls, could significantly reduce lighting energy use. However, as per our definition, we emphasize the need to look at multiple energy systems in a building to yield the maximum possible savings by leveraging the interactive effects of various end uses.

A key feature of comprehensive retrofits is the use of integrated design, which calls for a whole-building analysis for optimal energy management. Energy-efficient lighting and windows, for instance, can diminish heat loads and make it possible to reduce supply-air flow rates, allowing

smaller fans to be installed and possibly requiring a smaller cooling plant (EDR 2006). Figure 1 illustrates how a comprehensive suite of measures can reduce required cooling capacity. As additional measures such as efficient lighting, high performance windows and skylights, cool roofs, and better insulation are introduced, the heat load on the building successively decreases.

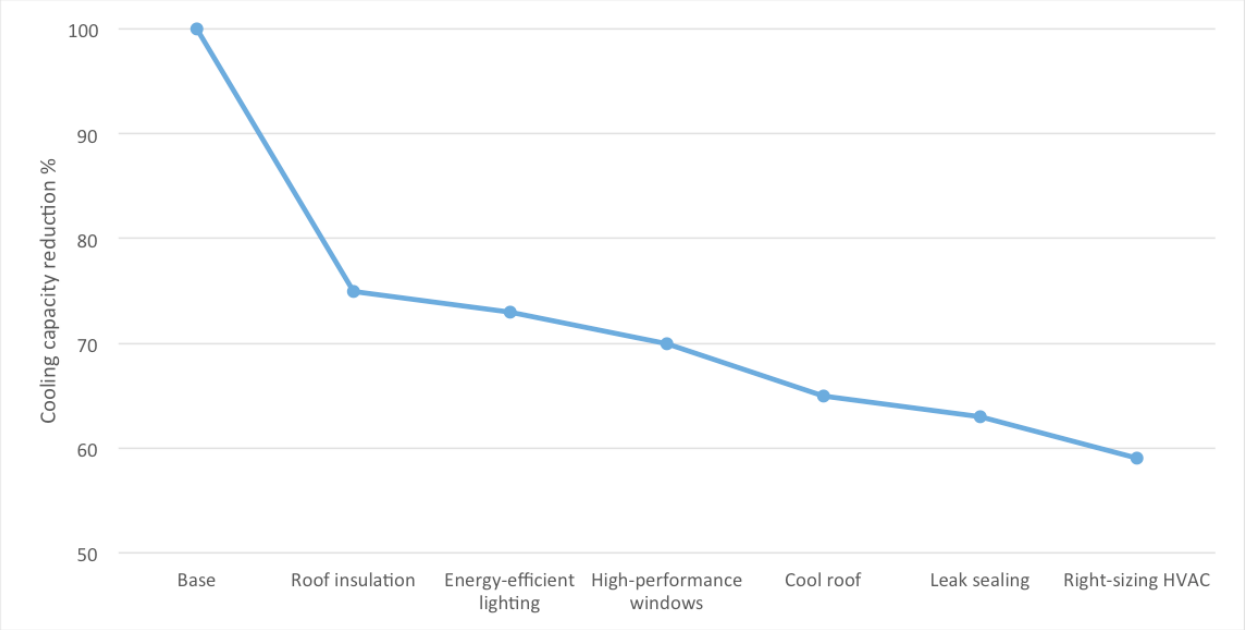

Figure 1. Impact of integrated design. *Source:* Integrated Building Design (EDR 2006) based on California Energy Commission Pier Building Program.

Methodology and Scope

This report analyzes retrofit programs in various types of commercial buildings. Our research is based on published program information and interviews with program administrators.

While our objective is to highlight good practices that are replicable and scalable across the country, the extent of energy savings in a particular region will vary by the climate type and by the profile of existing building stock. Savings will be more attractive where they displace high-cost new electricity generation, as in the Northeast or California. The program cost (and consequently the cost of savings/kWh) may also vary.[2] Moreover, although comprehensive retrofits are appropriate for a variety of buildings, the particular strategies used may vary for properties owned by small businesses versus large corporate portfolios, and also for those that have dominant process loads (e.g., food service). We highlight these differences as appropriate in the report.

As per our definition, we have selected programs that encourage a whole-building approach rather than standard preapproved (prescriptive) efficiency measures. Many retrocommissioning

[2] Nevertheless, the cost of saved energy (CSE) is usually lower than the cost of avoided capacity, which itself is lower than the full cost of service or the retail price.

(or recommissioning or ongoing commissioning) programs also take a whole-building approach to energy savings, and, with the increasing availability of building energy information, we acknowledge that these programs present exciting possibilities and regard them as complementary to comprehensive retrofits.

Our research found that program outcomes vary widely. However, instead of ranking programs, we decided to look at key elements within each program to identify good practices. Table 1 lists the criteria we applied.

Table 1. Criteria for selecting good practices

Program element	Criteria
Prospecting	Marketing and outreach effectiveness Defining and reaching the target segment Brand recognition and trust
Program design and offer	Ease of enrollment Incentive structure to encourage a deeper retrofit Percent of the total project cost covered
EM&V	Simplicity of administration Cost-effectiveness measures used
Outcomes	Participation Energy savings Cost of saved energy

We elaborate on each of these program elements in the findings section of this report.

Opportunity

As depicted in figure 2, there is enormous potential to increase the number of retrofits performed as well as the average savings per project. In terms of square feet of floor space, the current commercial building stock is being retrofit at an estimated rate of approximately 2.2% per year (NEEA 2011; Zhai et al. 2011). These retrofits typically reduce the energy consumption per building to 11% below the 2003 national average (Zhai et al. 2011). Both these numbers have a significant potential to go up, broadening and deepening savings from retrofit projects.

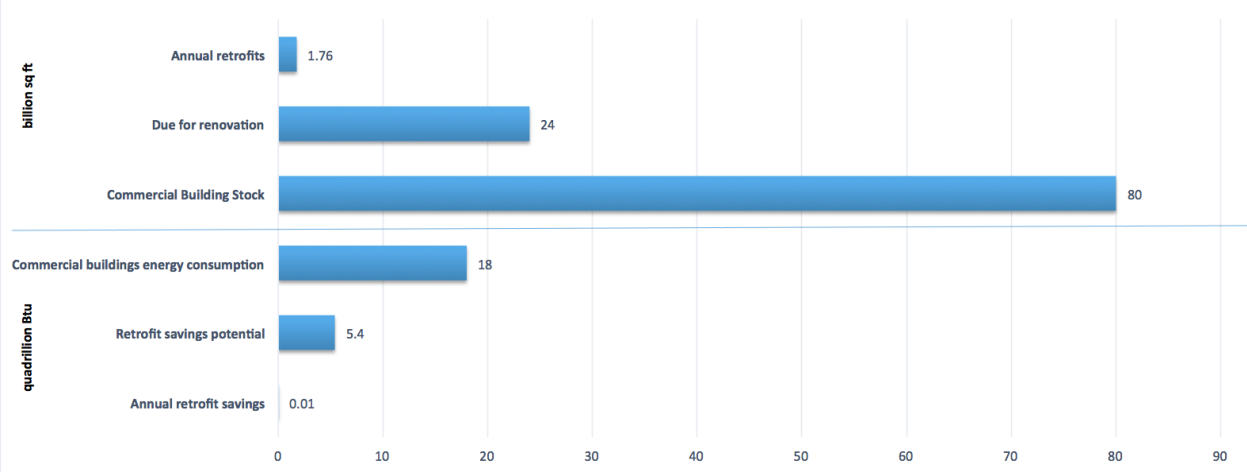

Figure 2. Depth and breadth of energy savings potential from commercial retrofits. Assumes average 30% savings from retrofits. *Source:* Based on EIA (2013) and Zhai et al. (2011).

Studies indicate that improving energy efficiency in the U.S. commercial building sector is not only cost effective but can also achieve substantial returns. Two separate analyses, one by McKinsey & Co. and the other by the National Academy of Sciences, show that energy consumption can be reduced by 28% by 2020 (Granade et al. 2009) and 32% by 2030 (NAP 2010) in a cost-effective manner. Goldman et al. (2005) reviewed close to 200 commercial retrofit projects and found that the great majority achieved an internal rate of return (IRR) greater than 15%. Since almost 60% of existing office buildings were constructed before 1980, many are past due for equipment, systems, and assembly upgrades (PNNL 2011).

While energy savings are considerable in themselves, numerous non-energy benefits (or co-benefits) may also be attractive and valuable to commercial building owners and occupants.

In many states, regulations require energy utilities to achieve efficiency targets, which they do by offering efficiency programs to their customers.[3] Often these budgets are set in response to a state energy efficiency resource standard (EERS), which is a long-term, binding energy savings target currently in place in 25 states across the nation.[4] ACEEE estimates that the combined annual savings from these states' current EERS targets will be equivalent to 6.2% of the electricity sales in the United States in 2020 (Downs et al. 2014). Meeting these targets will be challenging, especially since, in the view of some analysts, the era of easy savings is over as baseline efficiency is rising, building codes are becoming more stringent, and equipment and appliances more efficient (Misuriello et al. 2012). If savings opportunities from traditional resource acquisition programs are in fact diminishing, comprehensive retrofits present an attractive opportunity for the next level of savings.

[3] The total U.S. electric and gas demand-side program expenditure was close to $7 billion in 2012 as per the CEE annual industry report. See http://www.cee1.org/annual-industry-reports.

[4] For the current status see http://www.aceee.org/files/pdf/policy-brief/eers-07-2013.pdf.

In addition, several jurisdictions across the country have recently adopted energy-use rating and disclosure policies. These policies are likely to further stimulate the demand for improved building energy performance.

In a large-scale survey of corporate executives and sustainability managers conducted by McGraw-Hill Construction in 2011, 78% of the respondent firms planned to undertake energy efficiency retrofits in the next two years (McGraw-Hill 2011). The biggest incentive was the expected savings from utility bills. Of the retrofits implemented by respondents, 85% of the projects were funded from capital budgets and company profits; 16% were financed from performance contracting, 6% from bank loans, and virtually none from efficiency program incentives.

Again, the potential for retrofits is enormous. Program incentives can provide the right nudge to help retrofit projects clear financial hurdles. Efficiency improvements are naturally market driven as businesses strive to become leaner in order to stay competitive. Therefore efficiency retrofits are bound to become more common and more comprehensive. If efficiency programs do not participate, they will have lost a major opportunity.

The fact is that programs are in a good position to take advantage of this opportunity. In addition to their efficiency investment budgets, utilities generally have technical expertise in building equipment efficiency and energy modeling, as well as relationships with stakeholders like building owners, contractors, engineers, and consultants.

Here are some of the roles that program administrators can play in driving comprehensive retrofits:

Raise awareness. Either directly or through their trade allies, program administrators often have multiple touch points with commercial building owners and managers. They can leverage their marketing and outreach efforts to educate property managers about the business case for comprehensive retrofits.

Identify opportunities. With access to metered building energy-use data, it is easier for utilities to benchmark the performance of comparable buildings and help identify and prioritize energy savings opportunities, especially for customers with a large portfolio of buildings.

Create a market for efficiency. Efficiency is a low-cost resource to meet rising energy demand. Since they "buy" kWh saved with incentives and rebates, utility programs often set the "price" for efficiency. Program benefits including financial incentives can help create a market for energy savings through comprehensive retrofits.

Assist with project management. Comprehensive retrofit projects often involve coordination with multiple stakeholders. Since most incentives require monitoring and verification of savings, program administrators have a long-term interest in the implementation and completion of the project. Program staff and partners can provide the coordination to keep things running smoothly.

Help with financing. Program incentives can play a significant, if not decisive, role in determining the fate of a retrofit project. Comprehensive approaches may include energy efficiency measures that may not meet financial requirements (e.g., payback or IRR) on their own (Amann and Mendelsohn 2005).

Barriers

Due to a number of barriers that we discuss here, customers avail themselves of comprehensive retrofit opportunities less frequently than they undertake more modest incremental retrofits. Alongside the barriers, we also offer simple approaches to overcome them; we discuss these in more detail in the findings section.

Awareness. Customers rarely begin with complete knowledge of the benefits of a comprehensive retrofit; they usually have specific energy saving measures in mind. Malfunctioning or end-of-life equipment often drives them to look for equipment-specific retrofits or upgrades.

Programs can overcome such demand-side barriers by using marketing and outreach to raise awareness of the potential savings from a whole-building approach. An energy assessment or audit can be a first step towards creating a roadmap for deeper savings arising from the proactive replacement of inefficient equipment and systems.

Financing. More than other efficiency projects, comprehensive retrofits have to compete for funds with other investment opportunities. Some customers can fund incremental retrofits from operations budgets or small pools of internally available capital, whereas a major all-at-once retrofit involves accessing new capital. This frequently requires engaging higher levels of financial or corporate management and involves competition with other strategic business opportunities for capital. Managers typically prefer projects with a short payback period, whereas comprehensive retrofits involve multiple measures, some of which have longer payback periods. For small and medium-sized businesses, internal capital may simply not be available.

On the other hand, research suggests that savings from retrofits carry a low risk from an engineering perspective as long as financing is available (Pike 2010). The amount and design of program incentives can go a long way to alleviate capital concerns. Some programs link up with local or state government agencies to provide low-cost loans. It is also helpful to choose the right financial metric for evaluating savings. Although a very popular metric, the payback period does not always give the right picture of investment risk. For instance, even projects with a simple payback period of seven years can produce a rate of return of about 10%, which is large enough to clear internal hurdles in many organizations (EDR 2006).

Comprehensive efficiency upgrades will become even more attractive as the premium market value of high-performance buildings is factored into appraisals. As shown in figure 3, recent studies have found that high-performance buildings command up to 15% higher rents and up to 20% higher sales prices than otherwise comparable buildings (Eichholtz et al. 2009; Fuerst and McAllister 2009).

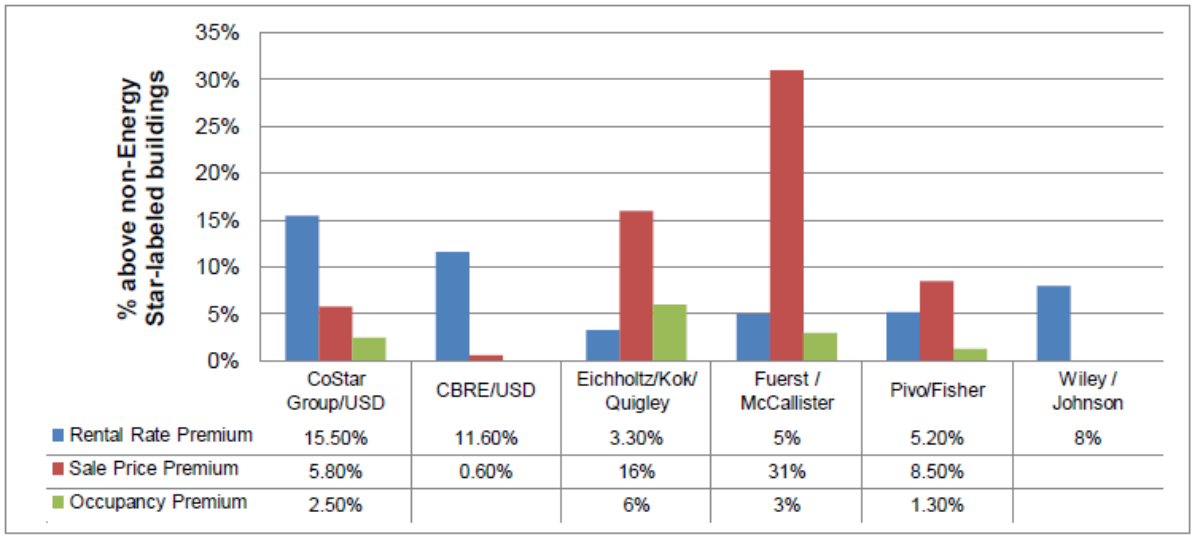

Figure 3. Impact of energy efficiency on rental and property value. *Source:* Institute for Market Transformation (IMT).

Split incentives. The commercial real estate sector is also particularly vulnerable to the complication of split incentives between building owners and tenants. For example, in a net-lease structure, tenants bear full utility costs, and so the building owner does not benefit enough from energy-cost savings to justify an energy efficiency upgrade. Multi-tenant commercial buildings, on the other hand, are often not sub-metered to the individual tenants, who pay a calculated proportion of the overhead expenses. This diminishes their motivation to implement efficiency measures. Moreover, because commercial buildings see frequent turnover in ownership and tenants, the payback period for deeper retrofits can often be longer than the ownership or tenancy periods (Bell et al. 2013).

To overcome these barriers, some programs target owner-occupied buildings first and then leverage that experience to approach other buildings with different leasing arrangements. Utilities may also be able to tailor marketing messaging to ensure that building owners in net-lease structures are fully aware of retrofits' non-energy benefits. "Green leases" may incorporate clauses aligning owners' and tenants' interests.[5] The length of the lease can provide a window for retrofits before a new client moves into the space, as well as an opportunity for green leasing in the future.

Complexity. On the supply side, utilities may find it difficult to administer custom comprehensive programs due to their complexity and the need to create tailored incentive structures. Furthermore, whole-building approaches require technical expertise and knowledge of energy modeling software, yet service providers may have limited experience in these areas. Programs that involve such time-consuming and technical work may be less attractive to utilities. Finally, complex measurement and validation (M&V) requirements may discourage

[5] For instance, the Natural Resources Defense Council (NRDC), New York State Energy Research and Development Authority (NYSERDA), and others have collaborated to come up with these guidelines: http://www.nrdc.org/greenbusiness/cmi/energy-efficiency-leases.asp.

customers as well as service providers. For example, public utility commissions (PUCs) may impose M&V standards that can be quite onerous, and comprehensive retrofits in particular may require long-term M&V.

On the contractor side, comprehensive retrofits often require more expensive studies, a longer sales cycle, and more subcontracting arrangements. High levels of savings often rely on a precise configuration of controls and equipment that exceeds standard practice and requires experienced management, higher-cost labor, and more laborious quality control. All these factors can increase prices and inhibit sales.

On the customer side, management of a larger and more technically complex project on a longer time line can exceed the capabilities and available hours of customer staff, even if there is a turnkey contractor. Contracts are more complex, and often require more engagement by legal resources in the customer organization. Longer time lines can disrupt normal operations if the retrofit is not part of a larger remodel.

Faced with these difficulties, programs can avail themselves of various strategies to manage the complexity of comprehensive retrofits. These include using standard modeling and simulation tools like eQuest and Portfolio Manager, measuring savings through utility-bill analysis, and incentivizing trade allies to conduct M&V. We discuss some of these approaches later in the report.

Attribution. When a building is renovated, it is typically subject to new building energy codes, which in most states require far more efficiency than is found in many existing buildings. Therefore, efficiency programs cannot claim the credit for all the savings from a retrofit unless they influence the building owner to make a major capital investment years earlier than would have occurred without program engagement. Programs may also garner additional credit by influencing a customer to upgrade a building beyond code requirements.

Findings

We analyzed over 25 programs across 20 different states. Quantitative information on program effectiveness is limited: many programs have a lifespan of two to three years and some of them have not yet published evaluation metrics. Table 2 summarizes key metrics from a subset of the programs we analyzed. More details are available in Appendix A.

Table 2. Key program metrics

Program	Key incentives	Participation	Energy savings/project/yr	Cost	Program energy savings/year
Arizona Public Service (APS) Energy Efficiency Solution for Business[1]	$0.09/annual kWh savings for retrocommissioning, 50% rebate on energy audit (including ASHRAE Level II or ENERGY STAR benchmarking)	1,677 in 2010, 1,806 in 2011, 1,781 in 2012	153.8 MWh	$25 million/year, $0.002 per lifetime kWh	274,000 MWh in 2012
Savings By Design, California[2]	$0.10 - $0.30/annualized kWh savings compared to Title 24, $1.00/therm or $100/peak kW.	531 in 2004, 565 in 2005	315.1 MWh, roughly 54 kBtu/sq ft average 23% from the baseline	Average TRC of 2.27	172,686 MWh
Pay for Performance, New Hampshire and New Jersey	$0.10 to $0.18 per sf paid on review and approval of Energy Reduction Plan; $0.22/kWh and $22.00/MMBTU saved on installation completion; $0.08/kWh and $8.00/MMBTU on actual first-year savings	Approximately 100 applications/yr, 154 completed projects	779 MWh, ~ 26% from the baseline	$47.1 million 2009-2013	12,000 MWh and 875,000 MMBTU 2009-2013
PNM Commercial Comprehensive Program[3]	Custom measures: $0.06/estimated first-year kilowatt hour (kWh) savings. Maximum: 100% of incremental measure costs or 50% of total project costs.	926 in 2012	36.5 MWh	$5.7 million, levelized cost of $0.0139/kWh	410, 459 MWh lifetime savings (2012)
Rocky Mountain Power Energy FinAnswer, Utah	$0.12/kWh annual energy savings, $50/kW demand savings. At least 50% of savings from non-lighting measures.	Not available	Not available	Average $5.9 million per year, levelized $0.039 per lifetime kWh	Average 37,500 MWh per year 2005-2008

Program	Key incentives	Participation	Energy savings/project/yr	Cost	Program energy savings/year
Rocky Mountain Power Energy FinAnswer, Idaho	$0.12/kWh annual energy savings, $50/kW average monthly on-peak demand savings. Lighting kWh savings limited to 50% of project savings.	5 in 2008	53.4 MWh	$0.12 million	267 MWh in 2008
Western Massachusetts Electric Company (As a part of Mass Save initiative)[4]	$0.075/kWh annual energy savings, $0.75/therm saved for low-cost/no-cost measures	63 new construction and major renovation, 175 large retrofits, 403 small retrofits	43.6 MWh	$2.5 million	27,958 MWh
NSTAR Energy Star Benchmarking Initiative, Massachusetts	Comprehensive rebates up to 75% of total project cost	13 in 2006, 27 in 2007, total of 107 2003-2008	91.5 MWh		Projected net savings of 3,659 MWh and 503,000 therms for 2006 and 2007
National Grid Large Commercial Retrofit and Whole Building Assessment Initiative	Technical assistance to develop energy management plan and rebates for comprehensive retrofits	529 in Rhode Island in 2012	72.5 MWh	$ 11.2 million, $0.024 per lifetime kWh	
NorthWestern Energy E+ Business Partners, Montana	Energy study is co-funded only if it considers a comprehensive retrofit.	35 in 2009, 39 in 2010, 34 in 2011	88.0 MWh		3,407 MWh in 2009, 2,657 MWh in 2010, 3,440 MWh in 2011

Program	Key incentives	Participation	Energy savings/project/yr	Cost	Program energy savings/year
NYSERDA Existing Facilities Program[5]	Performance-based $0.12 to $0.16/kWh and $15 to $20/MMBtu. Maximum incentives of up to $2,000,000 per facility.	1,431 in 2009, 2,564 in 2010, 2,074 in 2011	70.5 MWh		161,000 MWh in 2009, 152,000 MWh in 2010, 115,000 MWh in 2011

Source: Annual reports, program evaluations and literature, and personal interviews; see Appendix A for details. [1] Total savings from the business program including prescriptive measures; about 25% of these are comprehensive projects. [2] Savings By Design primarily targets new construction but also covers major renovations. [3] From PNM 2013. [4] Data include both commercial and industrial program results. [5] NYSERDA provides incentives for whole building design through its New Construction Program which also covers substantial renovation projects.

PROSPECTING

Programs should tailor their marketing and outreach efforts to specific groups of customers in order to achieve the greatest savings. To a certain extent, similar businesses exhibit homogeneity of energy use and building characteristics, and they can be targeted through customized marketing material. Larger programs such as the NYSERDA Existing Facilities Program (EFP) target a diverse range of sectors such as healthcare, commercial real estate, education, and retail. Sectors like healthcare represent a good opportunity for efficiency upgrades because they usually own their facilities and their distinct yet sectorally homogenous energy-load profile makes for a somewhat standardized combination of measures. Within a portfolio of accounts, a good place to start is buildings that show poor energy performance compared to similar properties. For companies and institutions that own multiple buildings, beginning with one building as a pilot can show savings potential and create a template for other buildings.

Small and medium-size businesses like food sales, nursing homes, K-12 schools, and warehouses may also be attractive targets. Small businesses may be interested in enrolling since they typically have limited capital for building upgrades and are likely to value efficiency incentives. It is also usually easier to reach key decision makers in smaller enterprises.

Program administrators attract and retain customers in various ways. Some of their strategies are as follows.

Follow-up from energy assessments and other programs. Programs often provide free energy assessments/audits or cost-shared energy studies to identify potential efficiency improvements in existing buildings. Findings from these assessments are commonly used to prepare a roadmap of deeper efficiency improvements. Administrators can also reconnect with customers who have previously participated in another program but who have only installed one or two measures.

*Remote audits***.** With the growing availability of energy-use data through smart meters and networked devices, data analytics are increasingly used to conduct offsite energy audits, often on a large portfolio of buildings and with minimum staff deployment.[6] Such audits use metered interval data, geospatial imaging, and sophisticated algorithms to benchmark building energy consumption segregated by end use, and to suggest operational and retrofit opportunities. While still in their early days, remote analytics have the potential to automate, expedite, and lower the cost of screening and auditing while not excessively compromising the accuracy of results.[7]

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[6] Our interviewees suggest that while remote analytics are useful to prioritize projects from a portfolio of buildings, remote findings should be followed by personal contact to convert leads into real projects.

[7] According to the PG&E emerging technologies program report, "The average difference in energy cost savings opportunities between estimates made via traditional on-site scoping audits and recommendations generated using FirstFuel's Rapid Building Assessment was found to be 8% of annual usage. Four of the seven sites produced differences in savings of less than 5%. Because both approaches (Audit and FirstFuel) carry an inherent amount of uncertainty in their cited results, the average difference is considered to be well within an acceptable range." (Summers, Chan, and Hilger 2013, 2) For details see:
http://www.etccca.com/sites/default/files/reports/ET%2012PGE3341_First%20Fuel_Final.pdf

The intersection of software technology and energy efficiency is a dynamic field with many emerging vendors providing a range of innovative solutions. A few leading players that programs have worked with are listed here.

First Fuel	Retroficiency	Energy Savvy	Aquicore	C3 Energy
•Screening, benchmarking, and remote audits •Key account management and portfolio planning •Measuring and tracking savings •firstfuel.com	•Screening, benchmarking, and remote audits •Segmentation and customized mass messaging •Continuous engagement •retroficiency.com	•Demand-side program management •Online energy audits (residential) •energysavvy.com	• Portfolio benchmarking • Sub-metering and ongoing commissioning •Tenant management •aquicore.com	• Supply-side solutions for smart grid • Demand-side customer energy analytics and benchmarking •c3energy.com

Retrocommissioning. Ideally, commissioning should follow retrofits. In cases when it does not, retrocommissioning can help create a pipeline of projects scheduled for comprehensive retrofits at a future date. By reconnecting with the owners of buildings that have been retrocommissioned in past years, program administrators can target their outreach efforts to customers who already have seen the benefits of investing in energy efficiency.

Trade allies. Some programs provide training to partners and incentivize them to bring in projects. When multiple agencies are communicating the benefits of a retrofit, they can create a higher brand recall and trust for the program. Partners also augment outreach efforts that may be constrained by limited program budgets.

To determine which customers have the most potential in terms of energy savings and financial returns, program administrators may use a variety of metrics to screen and qualify their customers:

- *Annual energy use* specified in kWh (or MMBtu for natural gas) is the most common qualifier. Incentives are usually based on kWh/MMBtu saved.
- *Peak demand* in kW, a related metric, is used particularly for programs that include demand response.
- *Facility size* differentiates the size of the customer and hence the type of incentive. Some programs allow retrofits of multiple locations under the same application.
- Some programs specify the *minimum estimated incentive* that the project must meet to be selected.
- Many programs calculate *payback period* both with and without incentives and prescribe a range for qualification.
- Some programs require measures spanning *more than one energy system* in order to make retrofits more comprehensive.
- A few programs require that major renovation projects result in *beyond-code efficiency* above a specified level.

Effectiveness in reaching the target segment

Effectively connecting and communicating with prospective customers is an important part of the marketing and outreach process. Program administrators may choose to advertise through various channels based on the opportunity areas they have identified. While utilities tend to have strong, established connections with their larger customers, they may want to consider extending these relationships to a wider set of potentially less energy-efficiency-savvy clients. Given the capital- and time-intensive nature of comprehensive retrofits, higher-level, longer-term relationships may be necessary to get customers to develop more organizational focus and devote more labor and capital toward the project.

Examples of potential partnership opportunities that may help with marketing include the following:

- Educating and training *trade allies* on the latest program offerings can enhance marketing efforts. Allies such as HVAC contractors often have annual contracts with a building and are trusted for their advice on retrofits. Energy-service companies are another important ally, especially for targeting municipalities and state agencies. Trade-ally partnerships should be mutually beneficial and lead to increased business for both parties.
- Some programs have benefited from appointing *account representatives* or *account managers*. Each representative handles a number of accounts and is in a good position to understand the specific needs and priorities of his/her customers.
- *Regional energy efficiency organizations and trade associations* such as business councils, and the Building Owners and Managers Association (BOMA) are also good partners and can help with program marketing.
- Coordinating with *other regional utilities* on programs can create a strong brand and lead to more projects. An umbrella brand appeals to clients who own multiple properties across a region.

Raising awareness

One of the primary barriers facing retrofit programs is customers' lack of understanding of the full benefits of energy efficiency measures, particularly in deep retrofits. Administrators can generate participation by clearly communicating these benefits in marketing efforts and materials. To make the proposition stronger for all stakeholders, programs should communicate non-energy benefits beyond the core kWh savings.

Non-Energy Benefits of Efficiency Retrofits

Reduced O&M expenditures. For office buildings in particular, reducing utility costs by 30% or more through a deep retrofit can significantly reduce total operating costs. It may even increase net operating income for some income-producing properties, since energy costs can be as high as 30% of overall operating expenses.

Extended equipment life. Upgrading lighting, for example, may reduce space conditioning loads and extend the life of HVAC equipment.

Increased rental and sales value. Recent studies have found that high-performance buildings command up to 15% higher rents and up to 20% higher sales prices than otherwise comparable buildings (Eichholtz et al. 2009; Fuerst and McAllister 2009). See a related graphic at http://www.imt.org/policy/efficiency-and-value.

Increased occupancy rates. Studies have observed significantly higher occupancy rates for buildings with green and efficient certifications. A list of studies that indicate up to 18% higher occupancy rate for ENERGY STAR and LEED certified buildings is at http://www.institutebe.com/InstituteBE/media/Library/Resources/Green%20Buildings/Green-Building-Valuation-Fact-Sheet.pdf.

Marketing and PR value. Projects such as the Empire State Building retrofit in New York clearly show the positive brand association with energy saving practices and improved sustainability.

Improved indoor environmental quality. Higher environmental quality in turn leads to more satisfied building occupants and higher productivity. See a list of five studies at http://blog.vista-films.com/2013/02/green-building-productivity.

All marketing communications should be clear and easy to understand. Simple, comprehensible program requirements and incentives can make a difference, particularly for new customers who are tentative about proceeding (Bloch et al. 2012). A good website with program eligibility and incentives, useful tools like savings and cost calculators, and case studies of similar projects can go a long way to address common concerns.

Creating brand recognition and trust

Finally, creating a recognizable brand and maintaining the trust of customers are essential to recruiting and retaining program participants. Participants have indicated, for instance, that the reputation of the program administrator plays a role in their decision to undertake efficiency projects through the program (Bloch et al. 2012).

Good Practices: Prospecting
In the **Pay for Performance (P4P) Program** in New Hampshire and New Jersey, the initial marketing effort was targeted towards recruiting efficiency providers to become Program Partners. Once selected, partners provide program marketing and outreach support as they search for potential clients.
Avista Washington's Custom Grant Program uses Avista Account Executives (AEs) to conduct outreach for the program. AEs oversee projects and are held accountable for their involvement in the achieved savings. Their performance is tracked against savings goals, and they receive credit for both custom and prescriptive measure savings. AEs thus have an incentive to push clients to achieve greater savings in their retrofits.
NYSERDA's Existing Facilities Program (EFP) previously existed as two separate efforts, but the agency found that merging the two programs and creating a consolidated umbrella offering simplified marketing and helped build a better brand image. In terms of partners, EFP views energy service companies (ESCOs) as important trade allies.
Utilities and energy efficiency service providers in **Massachusetts** came together to form **Mass Save**, which provides incentives, training, and information to promote energy efficiency. Not only has this consolidation made it easier for customers to find programs in their area, but Mass Save has become a successful brand by providing an umbrella for all things energy efficiency.
CenterPoint Energy's Healthcare Energy Efficiency Program is designed specifically for small to medium-sized healthcare facilities (300 beds or less) such as clinics, hospitals, assisted living/nursing care, and medical offices. They also have a **Sustainable Schools Pilot Program** that offers no-cost energy assessments to public and private schools.
ComEd's Building Performance with ENERGY STAR program positions retrofits as a business opportunity rather than just an energy efficiency opportunity. ComEd leverages the relationship between ENERGY STAR scores and asset value to make a more convincing argument to commercial office building owners. ComEd has partnered with U.S. Equities Realty, a Chicago real estate brokerage firm, to collect data for the ENERGY STAR Portfolio Manager system. U.S. Equities has direct relationships with property managers across the city, so this has proven to be an effective way of reaching prospective customers. Because multi-tenant office buildings are a focus market for ComEd's program, split incentives and short ownership are a challenge. ComEd addresses these issues by offering bonus incentives to owners who reach out to tenants about the program (R. Jericho, ComEd, pers. comm., August 23, 2013).
Xcel Colorado conducts ASHRAE Level 2 audits that help identify savings opportunities and match potential efficiency improvements with specific demand-side management program offerings. They have found that getting key decision makers involved at the early stages (i.e., during the meeting where the audit findings are presented) helps persuade customers to perform retrofits.
Arizona Public Service Solutions for Business program expanded consumer education offerings, added new tools to communicate with customers, and collaborated with outside entities to promote energy efficiency to targeted customers and through special channels.
Baltimore Gas and Electric (BGE) initially tried to target large commercial complexes, but quickly realized that many of these customers (e.g., universities and hospitals) already had advanced building operations staff and therefore ran their buildings rather efficiently. Instead, BGE found that its second-tier customers (e.g., nursing homes, schools, and rehabilitation centers) had the most energy-savings potential. They were not large enough to have enough capital and technical staff to properly maintain their buildings, but not small enough to pay close attention to their energy consumption. BGE has leveraged the competition between institutions to drive demand for retrofits. For example, it reached out to all counties in its service area to raise awareness about poor energy efficiency in schools. Howard County was the first to take action, appointing a sustainability manager who then created a team of operators to go from school to school to upgrade their systems and operations. By showcasing to other counties what Howard was able to achieve, BGE was able to get all counties on board to improve energy efficiency in their schools.

DESIGN AND IMPLEMENTATION

The most common program incentives are direct financial incentives per unit of energy saved, equipment rebates, and subsidized capital improvement loans. Comprehensive retrofits should look beyond simple equipment rebates and instead create incentives to promote improvements in whole-building energy performance. This requires implementing multiple energy conservation measures. However even custom programs are often dominated by single-measure projects, as shown by the analysis of the Puget Sound Energy custom program in 2011 in figure 4.

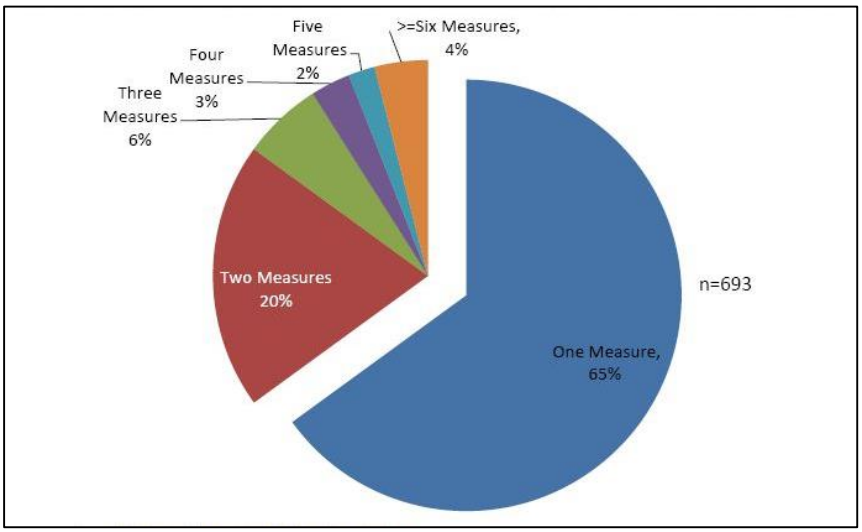

Figure 4. Measure frequency distribution in Puget Sound Energy custom program 2011. *Source:* Navigant 2012.

In order to persuade program participants to pursue deeper energy savings, incentives need to be designed so that maximum incentive caps do not discourage multiple energy efficiency measures. Incentives for comprehensive retrofits should also be sufficiently high to overcome the marginal cost—both financially and in terms of time and effort—of installing measures that are less cost effective on their own. The California Savings by Design Program provides a good incentive model for comprehensive retrofits. As shown in figure 5, this program's financial incentive is a step function that increases with the depth of savings instead of following a constant linear relationship, as is quite often the case.

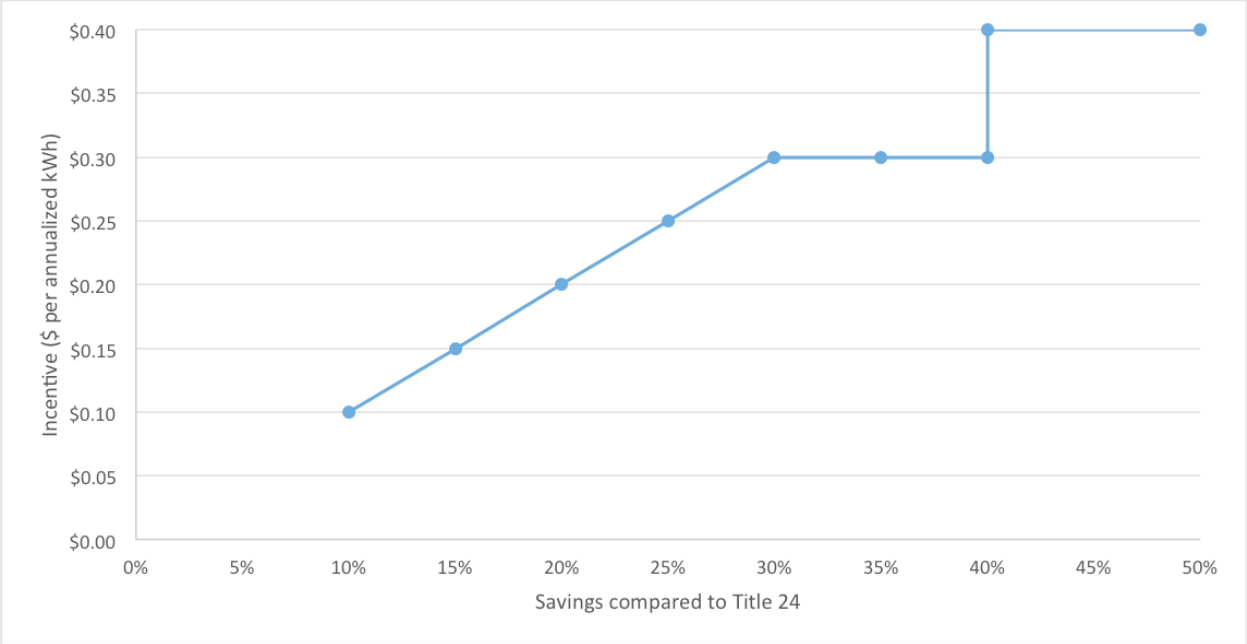

Figure 5. Step-function incentive to encourage deeper savings. *Source:* California Savings by Design Program.

In addition to the financial incentives discussed above, it is a good practice to budget for indirect incentives such as low-cost or no-cost energy audits, developing a network of qualified contractors, training and certification of trade allies, and technical support in the form of remodeling, design improvements, and operational assistance. Some exemplary programs push the boundaries even further by creating incentives for the continuous energy-efficient operation of the facility and even for retrocommissioning after the retrofit. As discussed above, for capital-constrained customers or large capital-intensive projects, some programs link up with other private or government agencies to make available loans at low cost, with extended terms, or with relaxed underwriting.

Good Practices: Design and Implementation
Baltimore Gas & Electric Comprehensive Systems for Existing Buildings requires that program participants install or replace at least three measures.
Pepco offers its business customers in Maryland an additional 10% bonus financial incentive for installing multiple energy-efficient measures.
ComEd's Building Performance with ENERGY STAR program uses the Portfolio Manager tool to structure a phased retrofit plan for the customer, with each phase targeting successively deeper savings. This strategy reduces the upfront capital cost and helps gain a longer-term commitment to efficiency.
The Savings by Design program offered by five California utilities requires participating facilities to achieve a level of efficiency at least 10% better than Title 24 specifications. Projects achieving higher savings get a higher incentive rate, thus motivating customers to explore deeper savings.
ConEdison Custom Rebates have a similar tiered incentive system in order to encourage savings of 20% or higher.

The Pay For Performance Program in New Jersey and New Hampshire requires at least two unique measures where lighting makes up no more than 50% of total projected savings. The program has a phased incentive payout beginning with up to $50,000 for New Jersey and $40,000 for New Hampshire paid upon the approval of the energy reduction plan, and including two other payouts scheduled at the installation of identified measures and after one year of savings.
The NYSERDA Existing Facilities Program provides free energy assessments to small businesses and not-for-profit organizations, and cost-shared energy studies to large commercial customers. NYSERDA also selects and enlists firms to work as project consultants. Program incentives are offered not just for electric and gas efficiency but also for energy storage, demand response, and monitoring-based commissioning, all through a consolidated funding application.
NorthWestern Energy has developed a separate team of professionals whose sole purpose is to find qualified E+ Business Partners Program leads among commercial and small industrial customers and refer those leads to the contractors and vendors.
ComEd contracts with CB&I, a leading energy infrastructure and real estate development firm, for project implementation. This collaboration with an established real estate player helps ComEd reach the CB&I network of large commercial customers.
NSTAR/CL&P have a long-term contract with large customers such as MIT, the City of Boston, and Stop and Shop for ongoing efficiency improvements.

EM&V

A key objective of program evaluation is to estimate the energy savings relative to the costs incurred, with the goal of reaching the maximum number of eligible participants in the most cost effective manner. Choosing an evaluation methodology is a key element of program design. In an ideal experimental methodology, participants are randomly assigned to a treatment group (those who are offered the program) or a control group (those who are not offered the program). However a randomized control treatment design leaves some potential participants out of the program offering. For this reason, program designers usually use other ways of creating comparison and treatment groups. One strategy is to create a group of customers who have not participated in the program but otherwise satisfy the qualification criteria. This control group of nonparticipants can be assumed to have energy-use characteristics similar to the treatment group (i.e., the participants) and can provide an estimate of non-program impacts.

At a project level, M&V of savings often follows the implementation of retrofit measures. M&V serves to verify savings, establish a basis of incentive payment, reduce the uncertainty of savings estimation, monitor post-retrofit systems performance, and find additional opportunities for savings. Energy savings verified from a sample of projects can be statistically extrapolated to the entire population of projects to calculate total energy savings at the program level. Regulations often require ratepayer-funded programs to demonstrate achieved savings through approved M&V protocols.

The process of technical quality control usually begins even before a retrofit project when the baseline energy usage of the building is established, most commonly through an energy audit. This baseline information helps building owners set energy performance goals, create energy management plans, and prioritize potential upgrade opportunities. Since comprehensive retrofits involve the installation of multiple measures, the calculation of total savings must capture the integrated effect of all of them. Although various states have different M&V standards, the International Performance Measurement and Verification Protocol (IPMVP)

provides common principles and best practices for verifying the results of efficiency projects.[8] IPMVP Option C, which measures savings at the whole-facility level, is recommended for comprehensive retrofits, especially those that structure their incentives on actual performance improvement. Projects for which programs pay up front typically use simpler M&V; they evaluate a sample of buildings, often using IPMVP or similar procedures. Consistent with the IPMVP, DOE has published a whole-buildings analysis protocol under the Uniform Methods Project.[9] It provides M&V approaches based on an analysis of the pre- and post-retrofit billing data. Finally, the Northeast Energy Efficiency Partnerships (NEEP) is leading a regional effort to increase the consistency and transparency of evaluation.[10]

Increasingly, many modern commercial buildings have building automation systems (also called building management systems) that can record and present annual energy-use information for various energy systems. The accuracy of evaluation techniques is bound to improve as interval utility-metered data become increasingly available.

Unlike prescriptive rebate programs, comprehensive retrofits require a more sophisticated approach to program evaluation. It is common to have third-party contractors perform evaluation, and each one brings his/her own approach to the process. If the difference between estimates and evaluated savings, called the realization rate, is too low, the differential ends up as a cost burden on the ratepayers and undermines regulators' confidence in the program (Kaufman and Palmer 2010). Consistent reporting and sharing learning across programs can help minimize this risk.

Good Practices: EM&V
The Retail Energy Management Challenge program run by **Focus on Energy Wisconsin** uses Portfolio Manager to track savings and support evaluation.
The Pay For Performance Program in New Jersey and New Hampshire uses utility bills and Portfolio Manager scores for M&V. Actual whole-building energy consumption is used to calculate savings via pre- and post-retrofit weather-normalized utility data.
PacifiCorp Energy FinAnswer, Utah includes a commissioning requirement and post-installation verification of savings.

Recommendations

Our research suggests a number of strategies that programs can consider to improve their effectiveness. Most of these simply involve a different approach and do not require any significant increase in program spending.

Target underserved segments. Most programs have traditionally focused on the largest commercial customers and overlooked smaller opportunities. However, as mentioned earlier, although it may not be cost effective to target small and medium-sized commercial buildings as

[8] For more on the IPMVP, see the Efficiency Valuation Organization (EVO) website: http://www.evo-world.org/index.php?lang=en

[9] https://www1.eere.energy.gov/wip/pdfs/53827-8.pdf

[10] See the EM&V forum website for details: https://neep.org/emv-forum/

single units, collectively they present a significant program opportunity. Facilities such as restaurants, nursing homes, clinics, and warehouses tend to have similar energy-use characteristics within their own type. According to program administrators who have field experience with segment-focused programs, such niche customers are more receptive to program incentives and are often driven by competitive pressures to improve their operations.

Transition from incentives to comprehensive solutions. Here we refer to an integrated program strategy that provides not just financial incentives but also technical support and help with financing. Programs that offer end-to-end support that spans identification of savings, implementation, and verification tend have more satisfied customers. As mentioned earlier, a long-term engagement with customers helps unlock the greatest savings and provides the best opportunity to evaluate program effectiveness.

Incentivize deeper savings. We recommend structuring program incentives in a way that encourages a whole-building analysis and the installation of multiple measures. Using a step function instead of a linear function to calculate incentives as a function of savings is one way to provide a higher level of payout for deeper retrofits. Providing a bonus payout for including multiple systems is another.

Streamlined project management. Each comprehensive retrofit project is unique and requires a sophisticated approach to engaging the customer through modeling, measure selection, financing, and implementation. Streamlining this process is an important goal, and simplifying enrollment is a good first step. Streamlining can include a single consolidated application form, an easy-to-navigate website with savings and cost calculators, and straightforward incentive payouts.

Phased implementation. Comprehensive retrofits can be time and capital intensive, and some customers have concerns about disruption of their business operations. Phased implementation can help with these issues. Although a comprehensive whole-building energy audit identifies all the project measures up front, the implementation is staggered over a period of time. This approach reduces the upfront capital investment, alleviates the need for operational interruption, gives time for the savings from the earlier phases to start accruing, and provides interim milestones for verification of savings.

Remote energy analytics. We believe that remote analytics has the potential to help scale up and prioritize the pool of prospects for comprehensive retrofits. Although most products in this space are initially focused on operational savings, some have the capability to identify capital improvements. Programs should continue to explore the best ways of incorporating remote analytics into their portfolios.

Trade allies as partners. Trade allies play various roles. Some projects are intensively managed by the customer, some have a turnkey contractor, and others have a performance contractor. The best programs demonstrate that trade allies are indispensable partners for outreach and project implementation. Long-term programs should invest in developing a network of trade allies and equip them with training, certification, program materials, and an incentive to participate.

Evaluation consistency. Our research suggests that the evaluation of comprehensive retrofit projects often requires the use of informed judgment since energy savings assumptions vary

among evaluators. This variance makes it difficult to share learning across programs and creates uncertainty in the minds of lenders and regulators. Efforts are underway to come up with standard evaluation protocols (e.g., the Uniform Methods Project), and early results are encouraging. With new technologies such as sub-metering, smart metering, and intelligent building systems becoming more widely available, it should be even easier to track and verify program-related savings and hence improve realization rates.

Consolidation. Leading programs such as the Existing Facilities Program (New York), Mass Save (Massachusetts) and Savings by Design (California) have benefited from the synergies of working across utility boundaries. A consistent statewide design helps reinforce the brand in the minds of the customers, deepens relationships with designers, contractors and building owners who often work across utility boundaries, and provides synergistic benefits such as cross-referrals and information sharing.

*Comprehensive benefits***.** Finally, we would like to underscore the need to communicate non-energy benefits such as health, safety, comfort, and productivity improvements in conjunction with other program benefits. Our ability to understand and characterize these benefits is growing. They add to the true value of efficiency retrofits, and they are important motivators for property owners as well as occupants. Cost-effectiveness tests should incorporate these indirect benefits so that program administrators get due credit for achieving them.

Conclusions

Buildings are remarkably durable structures, usually outliving their equipment and often even their occupants. Given their large impact on energy consumption, it is imperative to make buildings as efficient as possible. Comprehensive retrofits of commercial buildings have great potential to achieve significant energy savings and commensurate co-benefits.

While building retrofit activity is growing, the total number of projects undertaken through efficiency programs is still miniscule. Although most utilities have some comprehensive program offerings, performance results suggest that there is a tremendous potential for targeting even deeper savings. Barriers exist to customer participation and program development, but exemplary programs manage to address these rather well. New capabilities in tracking, monitoring, and analyzing energy-use data at a whole-building level are promising developments that should catalyze the market for comprehensive efficiency retrofits in the years to come.

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Appendix A. Programs Studied

As discussed in the body of the report, most programs offer a suite of custom measures to their business customers, and a number of them have incorporated elements to encourage comprehensive retrofits. Here we summarize the key features of the programs we looked at. This is by no means a complete list of programs, and it should be construed as supplemental to the overall findings of this report.

ARIZONA PUBLIC SERVICE (APS) SOLUTIONS FOR BUSINESS

Overview

The APS Solutions for Business program provides custom incentives for nonresidential buildings including schools, small businesses, industrial facilities, and public agencies. Under the Express Solutions program, schools of any size and businesses with a demand of 100 kW or less can receive incentives covering up to 75% of the incremental project costs.

Key Features

- Offers cash incentives, training, and energy information services
    - Training workshops are open to customers and industry professionals on a variety of program-specific information as well as specific energy-related topics and technologies; over the past two years, more than 600 participants have attended this training.
    - Financing is available through partnership with National Bank of Arizona; low interest rates are offered to customers who qualify for incentives through the Solutions for Business program.
    - Contractors are invited to apply for membership in a trade ally program. Members of the program market the APS incentives directly to customers as a key component of their own energy-related services.
- Incentives in both new construction and existing buildings, including prescriptive, custom, technical assistance, and whole-building incentives
    - Custom incentives paid at an annually set price per kWh; savings up to a percentage of incremental costs
- Program covers up to 50% of the cost of initial energy audit

Performance

- Since inception, the program has paid over $73.5 million in incentives to more than 4,000 unique customers, which represents more than $926 million in lifetime energy savings.
- Based on 2011 results, lifetime benefits of installed energy efficiency measures (societal benefits): $148 million
- Estimated societal effectiveness (benefit to cost): 3.0
- Program cost per lifetime kWh saved : $0.00228 per kWh

References

- Performance from Nowak et al. (2013)
- Program incentives : http://www.aps.com/library/solutions%20for%20business/rebates-quicklook.pdf

AVISTA CUSTOM INCENTIVES, IDAHO/WASHINGTON

Overview

Site-specific (custom) incentives program run by Avista focuses on hard-to-realize energy savings measures, with a higher incentive for measures with a longer simple payback period.

Simple payback period	Incentive level (per first year kWh saved)
1 to under 2 years	8 cents
2 to under 4 years	12 cents
4 to under 6 years	16 cents
6 to under 8 years	20 cents
13 years and over	0 cents

Key Features

- A unique feature of the Avista custom grant program has been the use of dedicated customer relationship managers designated as Avista Account Executives (AEs).
- Avista tracks AE performance against savings goals. While AEs generally target medium/large customers, they also cold-call throughout a neighborhood to reach small customers.
- Program is largely run in-house with audits provided by Avista engineers.

References

- Program website: http://www.avistautilities.com/business/rebates/washington/Pages/incentive_5.aspx
- Avista Account Executives: http://www.avistautilities.com/business/accountexec/Pages/default.aspx
- Navigant 2012

BALTIMORE GAS & ELECTRIC ENERGY (BGE) SOLUTIONS FOR BUSINESS PROGRAM

Overview

The BGE Energy Solutions for Business Program employs a systems-level approach to maximize energy savings from comprehensive retrofits. The program's Comprehensive Systems track offers financial incentives for properly sizing replacement equipment and implementing comprehensive, system-wide energy efficiency measures in existing facilities.

Key Features

- Projects applying for Comprehensive Systems incentives require a building performance modeling study to help identify and analyze potential energy efficiency opportunities. BGE provides funding for up to 50% of the study costs.
- Chiller replacements are a common feature of the comprehensive program. However BGE requires that the project must include a minimum of three measures that provide substantial energy savings and reduce chiller load.
- BGE offers a RCx option broken into two: full RCx and enhanced O&M. They have not had many full RCx companies/projects come to the table. Enhanced O&M is more popular as it does not require the baseline study (but M&V is more difficult in this case).

Performance

- During the first three years, BGE targeted very large complexes (hospitals, universities, etc.). These institutions are knowledgeable about how to operate their systems.
- The second-tier systems in these sectors are the ones most in need of help since they do not have the technical staff or budget to keep systems up and operating. Facilities such as nursing homes, schools, and rehabilitation centers are vulnerable in how they manage their energy systems.
- Small business owners have a real reason to monitor what is happening in their facility and are very conscious of their energy bill. However they usually do not have the personnel to maintain the building in an optimal manner. The real opportunities are those customers who do not pay their energy bill or may not know what is on it. The benefits of turning up/down the thermostat are not evident to them.
- When a school gets an electric bill, it goes to some finance department in the county. However, BGE was able to target the savings that were achieved in one particular school, and the school actually received the benefits from the efficiency upgrades.

References

- Program website: http://www.bgesmartenergy.com/business/energy-solutions-business/comprehensive-systems
- J. Libertini, BGE, pers. comm., August 8, 2013.

CALIFORNIA SAVINGS BY DESIGN

Overview

Savings by Design is a multi-utility program in California which first began in 1999. The primary target of the program is nonresidential new construction, but major renovations are also covered.

Key Features

- A consistent statewide program design helps deepen relationships with designers, contractors, and building owners who often work across utility boundaries.
- Utilities can provide cross-referrals for projects outside their service territory and share information on design and results.
- The program requires a minimum of 10% savings compared to Title 24 and offers a nonlinear incentive function to encourage higher savings.

Performance

Key program outcomes are summarized below.

Utility	2005			2004		
	Number of projects	Total MWh	Total therms	Number of projects	Total MWh	Total therms
PG&E	231	61,305	459,980	188	47,551	5,677,265
SCE	212	71,680	154,261	216	81,390	177,882

Utility	2005			2004		
	Number of projects	Total MWh	Total therms	Number of projects	Total MWh	Total therms
SoCal Gas	42	7,424	36,396	28	10,898	34,961
SDG&E	80	18,376	251,492	99	46,208	1,878,701
Statewide	565	158,785	902,129	531	186,588	7,768,809

References

- Evaluation report (RLW 2008)
- Program website: http://www.savingsbydesign.com/owners

CENTERPOINT ENERGY HEALTHCARE ENERGY EFFICIENCY PROGRAM

Overview

This program is specifically designed for small to medium-sized healthcare facilities with 300 beds or less such as clinics, hospitals, assisted living/nursing care, and medical offices within CenterPoint Energy's electric service area.

Key Features

- The program offers cash incentives to commercial customers for implementation of eligible energy conservation measures (ECMs). Cash incentives are based on the type of ECM implemented and services rendered.
- Technical services that are available for eligible customers include:
  - savings calculations
  - project processing
  - benchmarking
  - assistance with measurement and verification
  - energy assessments
  - recommendations for operational improvements

References

- Program website: http://www.centerpointenergy.com/cehe/bus/efficiency/healthcaremarket/

COMED BUILDING PERFORMANCE WITH ENERGY STAR®

Overview

ComEd's Building Performance with ENERGY STAR (BPwES) for Commercial Real Estate is a strategic energy management program focused on multi-tenant commercial office buildings. In Northern Illinois, Nicor Gas subsequently submitted a program plan to the Illinois Commerce Commission for a Building Performance With ENERGY STAR program, and has developed an offering that is sponsored jointly by the two organizations and offers customers a truly comprehensive whole-building package.

Key Features

- Initial baseline assessments and benchmarking are done using ENERGY STAR Portfolio Manager®.
- The program establishes a long-term relationship with the customer using strategic action plans. These action plans are effective in engaging senior management in reviewing and prioritizing energy performance of all buildings and also ensure that sufficient capital is allocated for improvements.
- For buildings that have never been commissioned, ComEd wants to begin with Building Performance, then do RCx to reduce energy loads, and then fix the central plan.
- Although the program features case studies of successful projects, their experience is that many buildings think they are unique and may not react well to case studies.
- Customers ultimately decide the level of comprehensiveness. The program tries to lay out a roadmap showing breadth of possibilities.
- The program uses BPwES rather than incentives to incentivize deeper retrofits by leveraging the association between ENERGY STAR scores and asset value.
- For custom programs, M&V is on a per-project basis (not as per Portfolio Manager).

Performance

- Since savings essentially accrue over a longer term, the first program year (2012) has seen 5-10% energy savings per building.
- Savings are not just for the base building; tenants account for over 40% of energy reductions.
- As per a ComEd fact sheet, Commercial Real Estate participants have developed energy-savings plans averaging nearly 750,000 kWh per building.

References

- R. Tonielli, ComEd, pers. comm., July 31, 2013
- R. Jericho, ComEd, pers. comm., July 31, 2013
- Program website: https://www.comed.com/Documents/business-savings/fact-sheets/BPwESCommercialRealEstate_FS.pdf

CON EDISON CUSTOM REBATES

Overview

Consolidated Edison Company of New York (Con Edison) offers the Custom Program for its business customers. A distinguishing feature of the Custom Program is the focus on projects rather than on measures. Instead of a pre-established per-unit savings for measures, savings are individually calculated for each energy-efficiency measure and then calculated to obtain the total savings for the project. Adjustments are made for interactions among measures that would increase or decrease savings.

Key Features

- The completely online application is user friendly and reduces the need for extensive documentation.
- The program features a tiered incentive system to encourage higher savings (>20%).
- Only those measures that meet the Total Resource Cost (TRC) evaluation test are incentivized.

References

- Program website: https://www.conedci.com/Custom.aspx

FOCUS ON ENERGY, WISCONSIN

Overview

Focus on Energy is funded by Wisconsin's investor-owned energy utilities and participating municipal and electric cooperative utilities. Programs benefit from a strong network of trade allies that are trained and certified by Focus On Energy. In 2012 Focus on Energy partnered with the Building Performance With ENERGY STAR® program to launch the Retail Energy Management Challenge aimed at comprehensive efficiency retrofits in retail businesses across the state.

Key Features

- To participate, an organization must operate multiple locations in Wisconsin, with an average facility size of 25,000 square feet or greater.
- Participants must benchmark the energy performance of stores across Wisconsin in Portfolio Manager, with a minimum of 50% of Wisconsin stores for large fleets, or 100% of stores for retailers with 10 or fewer locations in Wisconsin.
- Focus on Energy staff and Energy Advisors conduct walk-through energy assessments of two of the customer's five poorest-performing properties.
- Focus on Energy encourages prioritization of projects based on Portfolio Manager scores and incentivizes measures with a payback period of at least 1.5 years or more. The customer is required to commit $10,000 towards other measures with a shorter payback period.
- The program uses Portfolio Manager to track savings impacts, and collects performance reports from Portfolio Manager to support evaluation efforts.

Performance

- First-year participants, including Kohl's, ShopKo, Blain's Farm & Fleet, and Gander Mountain Sports, represented over 100 stores and almost 10 million square feet of floor space.
- In the first program year, Blain Supply, a specialty discount retailer that operates 14 stores in Wisconsin, achieved approximately $156,000 in cost savings.

References

- Program profile on Energy Star website: http://www.energystar.gov/ia/partners/reps/ci_program_sponsors/downloads/BPwES_Early_Experience.pdf
- Focus on Energy website: http://www.focusonenergy.com/business/efficient-facilities
- Retail program description: http://www.energystar.gov/ia/partners/reps/ci_program_sponsors/downloads/FoE_BPwES_Flyer.pdf
- Press release: http://www.focusonenergy.com/about/news-room/focus-energy-recognizes-wisconsin-retailers-energy-savings-accomplishments

IDAHO ENERGY FINANSWER®

Overview

Rocky Mountain Power offers various versions of the Energy FinAnswer program in its service territories in Idaho, Utah, and Wyoming. The program started with loan-based financial offering in the early 90s and then transitioned to cash incentives in 2006.

Key Features

- The program offers to qualified customers a no-cost, vendor-neutral, investment-grade energy analysis to identify efficiency opportunities.
- The program requires savings from lighting upgrades be limited to 50% of project savings. If lighting kWh savings exceed the limit, lighting measures are adjusted for purposes of calculating the incentive.
- To help ensure the persistence of electric savings from measures receiving an incentive, Rocky Mountain Power requires that the owner commission most mechanical measures prior to receiving an incentive payment. If the customer chooses not to commission the project when required, he/she receives only a partial incentive.

Performance

In 2008, the Energy FinAnswer program was responsible for 11% of the savings that the utility realized from commercial and industrial efficiency programs within Idaho. Using 2008 IRP decrement values, the program was cost effective from multiple perspectives (Cadmus 2010a).

References

- PacifiCorp Energy FinAnswer 2008 Idaho Program Evaluation prepared by Cadmus
- Program website: http://www.rockymountainpower.net/bus/se/idaho/ilc/ef.html

NATIONAL GRID PROGRAMS

Overview

National Grid offers a large commercial retrofit in their comprehensive retrofit program to promote the installation of energy-efficient electric equipment such as lighting, motors, and HVAC systems in existing buildings. All commercial, industrial, and institutional customers with greater than 200 kW average demand are eligible to participate.

National Grid's Whole Building Assessment Initiative takes a holistic look at the energy usage of buildings and, in partnership with ENERGY STAR, helps their business customers develop a comprehensive energy management plan.

Key Features

The National Grid program follows a sectoral approach, targeting grocery stores, municipal buildings, and datacenters in addition to other commercial and industrial facilities.

Performance

- In Rhode Island, the large commercial retrofit program saved 38,398 MWh in 2012 over 529 projects.
- The total cost of the program was $11.2 million, which translates to $0.024 per lifetime kWh

References

- National Grid Year-End Report 2013 (PUC 5-31-13)
- Program website: https://www.nationalgridus.com/nantucket/business/energyeff/4_whole_building.asp

PAY FOR PERFORMANCE, NEW JERSEY AND NEW HAMPSHIRE

Overview

In 2009 New Jersey's Office of Clean Energy launched the Pay for Performance Program, a whole-building energy efficiency incentive program for commercial and industrial buildings. New Hampshire's Public Utilities Commission launched a similar program model in New Hampshire in February 2011.

Key Features

- Not equipment based; all measures are eligible
- Building simulation modeling required; M&V is primarily front-loaded
- Requires 15% source energy reduction
- Maximum of 50% savings from lighting
- Must include at least two distinct measures

Performance

Taken together, the two programs have received approximately 600 applications since inception. Of these, 154 projects have been completed as of May 2014. On average, these projects achieved savings of 26% from baseline energy use. Key performance outcomes from inception to 2014 are summarized below.

	New Jersey		New Hampshire	
	Budget	Actual	Budget	Actual
Program budget	$65,766,949	$43,231,341	$4,209,000	$3,825,914
kWh savings	212,672,000	95,197,000	13,161,435	12,598,852
dKh savings	1,101,184	555,388	52,851	83,079
kW savings	n/a	21,078	4,108	1,442

References

- Rooney 2014; Rozanova et al. 2012
- G. Coleman, TRC, pers. comm., February 06, 2014

NORTHWESTERN ENERGY E+ BUSINESS PARTNERS PROGRAM, MONTANA

Overview

NorthWestern Energy's E+ program targets electric and natural gas commercial and small industrial customers in Montana. Package proposals include a comprehensive retrofit of the retail and warehouse lighting systems in addition to other more specialized measures.

Key Features

- The program provides co-funding for the energy study only if it encompasses a comprehensive retrofit of all energy-consuming systems/equipment and the facility envelope, as appropriate.
- Outside service providers (vendors) are contracted to seek out E+ business partners projects and work them to completion. These contractors receive incentives from NorthWestern.
- NorthWestern has developed a team of professionals to generate qualified leads for the program among commercial and small industrial customers, and to refer those leads to the contractors and vendors.
- The program seeks custom applications that, ideally, involve multiple measures or system redesign and not simply the change of a single piece of equipment.

Performance

Key performance outcomes of the E+ Business Partners program are summarized below.

	2011	2010
Electric program expenditure	$65,766,949	$43,231,341
Gas program expenditure	212,672,000	95,197,000
Net electric savings (kWh)	3,406,881	2,657,135
Net gas savings (dKt)	2,597	1,944
Number of projects	35	39

References

- Nowak et al. 2013

NYSERDA EXISTING FACILITIES PROGRAM (EFP)

Overview

NYSERDA is authorized by New York's Public Service Commission to administer energy efficiency incentives. The primary target audience for the EFP is large energy users that may yield high electric and natural gas savings. The program focuses on custom, systems-based approaches that encourage comprehensive solutions.

Key Features

- Offers performance-based incentives which are typically higher than those for prequalified measures
- Provides a suite of incentives to support comprehensive building retrofits
- Typically requires performance incentive applicants to perform M&V for lighting projects that are expected to save more than 1,000,000 kWh/year and non-lighting projects that are expected to save more than 500,000 kWh/year or 10,000 MMBtu/year of natural gas

- End users and service providers value non-financial program elements, especially NYSERDA's reputation as a trustworthy source of information and a source of technical expertise
- The EFP has recently starting using a key account manager strategy to become more engaged with large end-users. Through this approach NYSERDA proactively engages large to mid-size energy users in the healthcare, commercial real estate, education, and retail sectors, forming long term relationships to assist with energy needs.

Performance

Key performance outcomes of the EFP projects for electric energy completed between January 1, 2006 and September 30, 2009 are summarized below.

Program reported savings	Realization rate	Evaluated gross savings	Net to gross ratio (NTGR)	Evaluated net savings
577,787 MWh/yr	1.03	595,121 MWh/yr	1.28	761,755 MWh/yr

References

- Nowak et al. 2013; Patil et al. 2012 ; Bloch et al. 2012

PACIFICORP ENERGY FINANSWER, UTAH

Overview

PacifiCorp offers the Energy FinAnswer program throughout the five-state service territories where it manages demand-side management programs. The program applies to retrofit projects as well as major renovations and the construction of new facilities.

Key Features

- Includes vendor-neutral investment-grade energy analysis and cash incentives based on energy savings and project costs
- Requires commissioning and post-installation verification of savings for qualifying projects
- Design assistance services and special incentives available for new construction and major renovation projects

Performance

Within Utah, the program was responsible for 44% of the savings that the utility realized from commercial and industrial (C&I efficiency) programs in 2008. After a net-to-gross ratio of 87% was applied to the evaluated savings (with 13% freeridership), the net program savings were 130,878 kWh.

Reference

- Cadmus 2010b

PUGET SOUND ENERGY (PSE) CUSTOM RETROFIT GRANTS PROGRAM

Overview

PSE offers incentives to commercial and industrial electricity and natural gas customers for customized energy retrofits.

Key Features

- The program leverages a network of trade allies. PSE educates them about the programs, trains them on the technologies and services that are eligible for PSE incentives, and provides them with tools to market the programs to their customers.
- The program focuses on specific sectors such as office buildings and hospitals.
- PSE funding is typically $.30/kWh and $5/therm of annual energy savings, reaching up to 70% of the cost of mechanical retrofits that save electricity or natural gas. The incentives for most lighting upgrades are slightly lower: $.20/kWh of annual energy savings and covering up to 50% of costs.

Performance

- The custom grant program (excluding EnergySmart Grocer and Building Energy Optimization programs) accounted for 64% of all kWh savings, 97% of all therm savings, and 81% of all C&I participants
- The program has the highest average incentive cost per first-year kWh savings, at $0.27. The average incentive cost per first-year therm is $4.56.
- During 2009 and 2010, the majority of participants implemented only one measure, with 85% implementing one or two measures. 4% implemented six or more measures.

Reference

- Navigant 2012