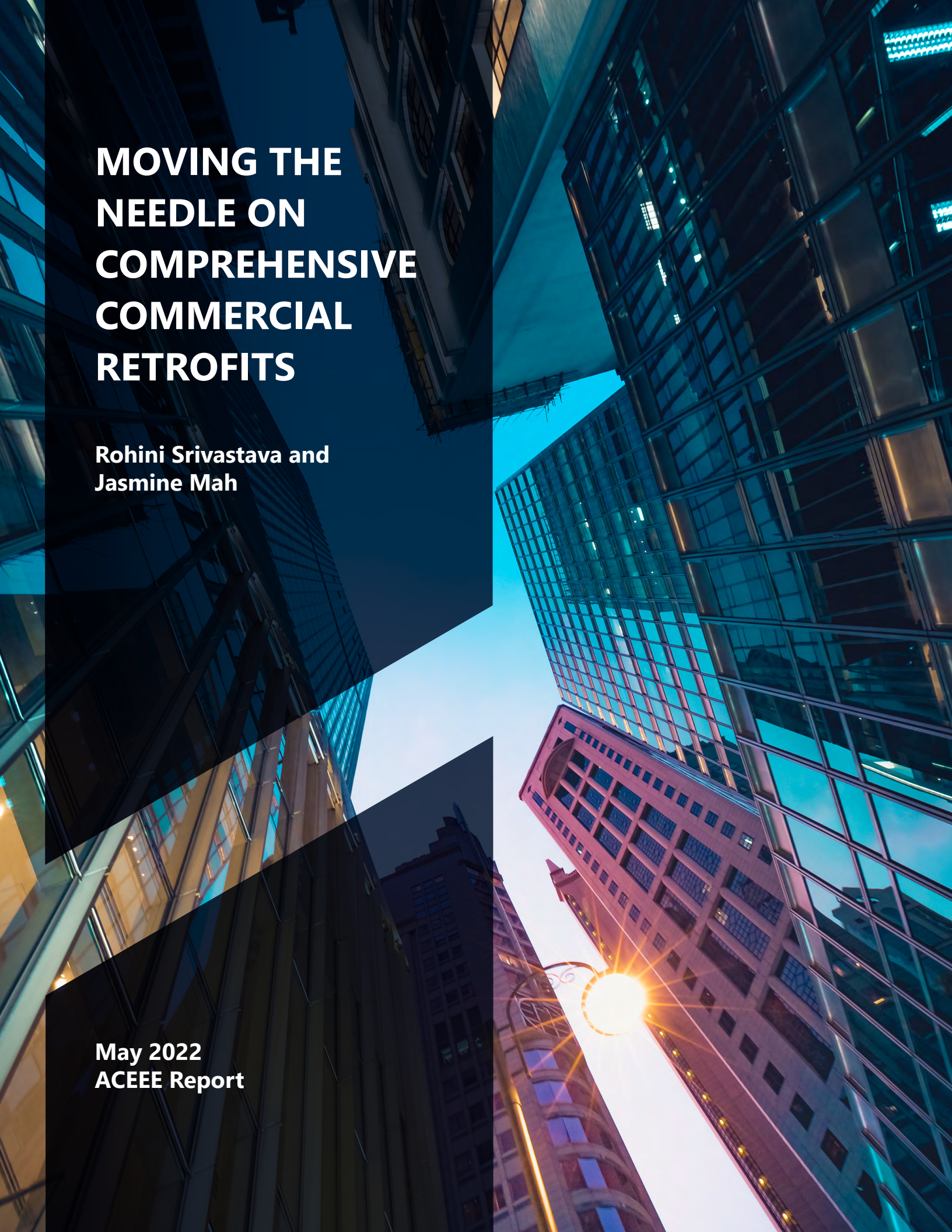

# MOVING THE NEEDLE ON COMPREHENSIVE COMMERCIAL RETROFITS

**Rohini Srivastava and Jasmine Mah**

**May 2022**
**ACEEE Report**

# Contents

# About ACEEE

The **American Council for an Energy-Efficient Economy** (ACEEE), a nonprofit research organization, develops policies to reduce energy waste and combat climate change. Its independent analysis advances investments, programs, and behaviors that use energy more effectively and help build an equitable clean energy future.

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# Executive Summary

## KEY FINDINGS

- Comprehensive retrofits achieve 15–40% energy savings in participating buildings, which is 2.5 to 7 times more savings than typical single-measure strategies attain.
- These comprehensive approaches typically involve efficiency measures in two or more building systems (commonly lighting and HVAC) with one building-wide energy savings goal. Owners and service providers work together to achieve savings through a customized solutions package.
- We identified five program approaches that encourage comprehensive retrofits while offering varying levels of energy savings: (1) existing building commissioning (EBCx) with recommendations for capital improvements, (2) custom programs, (3) performance-based programs, (4) programs based on energy consumption patterns, and (5) programs encouraging high-performance certifications. Most of these approaches include facility assessments along with low-cost operational improvements to ensure buildings are performing up to their full potential.
- Programs based on performance or on energy consumption patterns provide promising pathways to scale comprehensive retrofits, but they are often more administratively complex and costly to implement than other options.
- Programs that collaborate with existing market providers are likely to see greater participation than those that do not. We found that custom, EBCx, performance-based, and energy consumption–based programs generally partner with a third-party implementer or an energy service provider.
- Programs should emphasize the multiple benefits of comprehensive retrofits when communicating with customers to encourage greater program uptake. This strategy raises awareness but nonetheless remains uncommon.
- Administrators can take the following steps to scale programs: employ new strategies for program design and delivery, such as new methods to evaluate savings from multi-measure projects; create better value propositions for customers; and ensure broader customer and workforce education.

Comprehensive commercial retrofits provide greater whole-building energy savings and opportunities for reducing buildings-related emissions than do single-measure improvements. Sometimes described as "deep retrofits" or "systems-based retrofits," comprehensive retrofits use a suite of efficiency measures across multiple building systems. These often include improving operations and maintenance practices, optimizing building system operations, and making capital investments in well-established component-level replacements (e.g., equipment upgrades) to deliver more energy savings than what is possible from isolated measures. This approach offers several high-value benefits beyond energy savings, including increased comfort, higher employee productivity, increased asset

value and net operating income, improved air quality, and reduced greenhouse gas emissions. Despite their impacts, however, comprehensive retrofits are not happening at the scale needed to meet energy and climate goals.

For this report, we assessed the landscape of programs that support and advance comprehensive retrofit projects. We reviewed the literature, interviewed experts, and analyzed existing utility programs to develop recommendations and resources to help increase the scale and scope of commercial retrofit programs.

## BUILDING BLOCKS OF COMPREHENSIVE PROGRAMS

Comprehensive retrofit approaches vary in the types and scope of services they include. They often give customers a suite of coordinated offerings that streamlines the process of building energy assessment, development of scope of work, financing, implementation and commissioning, and measurement and verification of savings. The first important stage in all programs is the retrofit design phase, and in many programs this phase includes services for gathering building energy use data through facility assessments and benchmarking. Typically a scope of work is also prepared; this helps customers make informed decisions about capital investments that achieve deeper savings. Customers are then referred to utility retrofit programs or encouraged to implement existing building commissioning (EBCx) processes, or both.

## PROGRAM APPROACHES

After analyzing 50 programs through expert interviews and a literature review, we classified them into five types: programs offering EBCx with recommendations for capital improvements, custom programs, performance-based programs, programs based on energy consumption patterns, and programs encouraging high-performance certifications and voluntary standards. These programs can help buildings achieve energy savings of 15–40%.

- **EBCx programs** provide opportunities for low-cost efficiency improvements and help participants identify capital projects.
- **Custom programs** require implementation of multiple efficiency measures and may offer a bonus incentive when measures are bundled (for instance, when a project includes insulation, air sealing, and system upgrades together).
- **Performance-based programs** provide customers with financial incentives according to the level of savings achieved over a specified period and have requirements for measurement and verification of savings for incentive payment. Programs typically use whole-building meter data to quantify the impacts and include both upfront and performance-based incentives to reduce financial and performance risks.
- **Programs based on energy consumption patterns** are a type of performance-based program. They leverage whole-building meters and smart meter infrastructure to customize engineering calculations that help estimate and track savings, and incentive payments are based on energy consumption data collected at the

building's meter. The implementer and customer together choose a combination of efficiency solutions that are appropriate for the building to maximize savings.

- **Programs encouraging high-performance certifications** are less common than the others but offer alternative approaches to compliance to save energy and improve performance.

## SCALING COMPREHENSIVE RETROFIT PROGRAMS

Some notable approaches are encouraging and delivering comprehensive retrofits. As these retrofits become a key strategy in reaching deeper levels of energy savings, we will need policies, innovative program designs, a clear value proposition for program participants, and broader customer and workforce education to scale these approaches. State and local policymakers, particularly those targeting existing buildings, could create benchmarking and energy disclosure requirements, building tune-up policies, and building performance standards to encourage building owners to invest in comprehensive retrofits that yield deeper savings. Policymakers can also encourage utilities serving customers in those jurisdictions to design and implement new programs.

Regulators can enable the breaking down of utility program silos and change existing design and evaluation practices to simplify program delivery. This will enable utilities to focus on more system-based retrofits and allow flexibility in meeting performance goals. Utility programs that clearly define the customer value proposition and recognize the transaction costs and efficiencies of implementing multiple measures together can reduce program costs and improve overall cost effectiveness. As comprehensive retrofit programs expand, there will be a need for a skilled workforce to implement and operate multi-measure retrofits. Utilities and policymakers can help ensure that professionals receive specialized education and training to design and implement retrofits.

## STRATEGIES FOR DESIGNING PROGRAMS

Programs must communicate the full range of benefits from comprehensive retrofits in ways that engage consumers and motivate them to go above and beyond single-measure retrofits. Program administrators can adopt several effective strategies to help comprehensive retrofit programs best serve their customers.

- *Secure funding and necessary resources.* Combining federal, state, and local funding sources can help development of new programs and expansion of existing ones.
- *Offer a one-stop service.* Designing programs to offer one-stop service including energy assessments, financing options, technical assistance, and post-installation follow-up can ensure that performance and savings continue.
- *Design incentives to meet customer needs*. Providing upfront and performance-based incentives, rebates, and financing options for comprehensive retrofits can help customers overcome first-cost and total-project-cost barriers.

- *Bundle and stage measures*. Bundling a combination of measures with long-term paybacks and short-term paybacks can create an acceptable return and much higher value for customers. Splitting a retrofit into stages can make the process and the investment less overwhelming.
- *Deploy more new technologies*. Creating a package that incorporates energy efficiency measures and grid-interactive efficient building technologies can drive additional savings and demand reductions. The technology solution may vary according to customer needs and utility program goals.
- *Develop a network of partners*. Identifying key partnerships can enable utilities to offer turnkey services and increase program participation and success.
- *Improve access to meter data and enable analytics*. Accelerating the deployment of analytical tools that leverage advanced metering infrastructure data can support program implementation, provide better visibility into building operations, and improve accuracy of measurement and verification processes.
- *Increase participation through multiple benefits*. Characterizing and quantifying the multiple benefits from comprehensive retrofits can support efforts to reach relevant decision makers, get more buildings to do retrofits, and provide policymakers compelling evidence of the value of comprehensive retrofits in meeting city, state, and federal energy and climate goals.

# Introduction

More than half of all commercial buildings that exist in the United States today were built before 2000, including many that were constructed prior to today's more efficient technologies and codes. Even newer buildings that comply with more recent codes may not perform as intended due to faulty installation, lack of maintenance, or normal wear and tear. Older inefficient buildings and underperforming newer structures lead to higher energy use, which has significant negative impacts on achieving U.S. energy and climate goals.

ACEEE analysis has found that energy efficiency can cut energy use and greenhouse gas emissions in half by 2050, with one-seventh of the emissions savings coming from existing buildings (Nadel and Ungar 2019). Significant commercial building retrofits, including adoption of smart technologies and electrification measures, can provide close to one-fifth of the total efficiency opportunity in buildings, if coupled with policies and programs to reach most of the existing building stock (Nadel and Ungar 2019). Getting more building owners to complete comprehensive retrofits is therefore a priority for reducing energy use and emissions in the commercial buildings sector.

Recent research analyzing results from more than 12,000 commercial building retrofits completed through federal, utility, and energy service company programs demonstrates that comprehensive, integrated, building systems-based retrofits achieve higher energy savings than do single end-use or measure-based approaches (see figure 1).[1] Despite their impact, however, comprehensive retrofits are still far less prevalent than single-focus upgrades (Regnier et al. 2020).

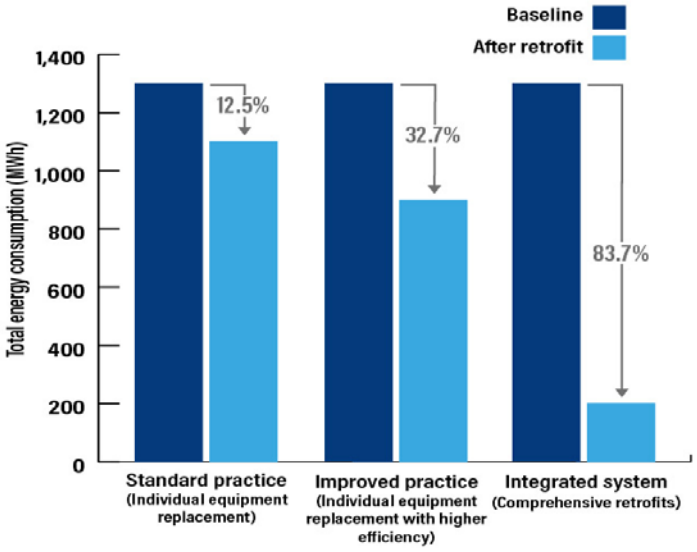


**Figure 1. Comprehensive retrofits provide 2.5 to 7 times more energy savings than single measure–based retrofits. Source: Regnier et al. 2018.**

[1] We use the Alliance to Save Energy (ASE) definition of a building system "A building system is a combination of equipment, operations, controls, accessories, and means of interconnection that use energy to perform a specific function." (ASE 2016).

The lag in uptake has persisted even as programs have expanded custom incentive offerings and added other mechanisms to make multi-measure retrofits more attractive. The lack of participation is due to ongoing barriers including project cost and complexity of implementation, emphasis on short paybacks among owners, conflicting priorities and split incentives between owners and occupants, limited data on retrofit cost effectiveness, and the lack of adequate contractor training and customer education.

In this report, we assess the landscape of programs that support and advance comprehensive retrofit projects. The barriers for comprehensive approaches are not insignificant—especially measure-level cost effectiveness requirements, long implementation timelines, and making a strong enough business case for the customer. The report highlights different ways to implement programs and the barriers they can overcome, presents case studies of utility programs, and discusses how multiples benefits are communicated to increase participation. We continue with a discussion on the role of policy, new approaches to program design and delivery, and workforce education in expanding comprehensive retrofits.

### Defining Comprehensive Retrofits

Many terms are used to describe comprehensive retrofits, including "deep retrofits," "deep energy retrofits," and "systems-based retrofits." According to the Pacific Northwest National Laboratory, deep retrofits "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).

We define comprehensive retrofits as projects that take an integrated, whole-building approach to identify and implement a suite of efficiency measures across different end-use systems to achieve higher savings than those possible from the installation of individual measures and component-based efficiency improvements. These projects seek to maximize health and environmental benefits while also optimizing energy usage and benefits for occupants and owners. A comprehensive retrofit project will typically combine operational improvements and component-level replacements of existing equipment and assembly with more efficient technology to deliver greater cost and energy savings.

The goal of this report is to present a comprehensive review and recommendations to help increase the scale and scope of commercial comprehensive retrofits programs. The primary audiences for this report include utilities and program administrators interested in developing and offering comprehensive retrofit programs. Policymakers, particularly those exploring state and local policy targeting existing buildings, may also find this report relevant.

# Multiple Benefits of Comprehensive Retrofits

Comprehensive retrofits reduce energy usage, helping customers save on utility bills and operating costs. Reduced energy use also means lower greenhouse gas emissions and associated adverse human health outcomes and mortalities (Guidehouse 2020). The multiple benefits from individual energy efficiency measures, such as lighting or HVAC system upgrades, are well documented (RMI 2015). These benefits include lower operating costs;

better indoor air quality; increased occupant comfort, health, and safety; and higher employee productivity. Building owners who complete a large-scale efficiency overhaul of their property through a deep retrofit can increase the asset value of their property, allowing them to charge higher rents, attract quality tenants, and reduce tenant turnover (Pearce, Dearth, and Schantz 2018). Because comprehensive retrofits include multiple measures across building systems, they can deliver several benefits simultaneously (see table 1).

**Table 1. Examples of potential benefits from deep retrofits of office buildings**

| Category of benefit | Impact |
|---|---|
| Maintenance cost | Reduces by 9.0–14% |
| Occupant satisfaction | Increases by 27–76% |
| Rental premium | Increases by 2.1–17% |
| Occupancy premium | Increases by 3.14–18% |
| Property sale price premium | Increases by 11.1–26% |
| Employee productivity | Increases by 1.0–10% |
| Employee sick days | Reduces by 0–40% |

**Adapted from the figure on page 6 in RMI Practice Guide: The Path to a Deep Energy Retrofit Using an Energy Savings Performance Contract (RMI 2015).**

The economic, environmental, and health benefits of comprehensive retrofits can impact building owners, the utilities serving the buildings, and the surrounding communities (Rogers and Junga 2017). These benefits fall into two categories, quantitative and qualitative (PNNL 2011). Quantitative benefits include reduced operations and maintenance (O&M) expenses, extended equipment life, and increased rental value. Qualitative benefits include improved indoor environmental quality and marketing value of the energy-saving practices and sustainable features. Utilities can communicate both the quantitative and the qualitative benefits to bring attention to the full value of efficiency measures, raising awareness and incentivizing participation in programs.

# Research Methodology and Scope

To understand the landscape of comprehensive retrofit programs, we reviewed the literature, interviewed experts who plan and implement comprehensive retrofits, and analyzed existing utility programs. The review of literature and the expert interviews provided insight into existing approaches, measures frequently included in programs, and the multiple benefits of comprehensive retrofits.

Our literature review was a starting point to identify retrofit programs and results. Most of the utility programs reviewed in this report emphasize multisystem retrofits and are

relatively recent, starting after the earlier ACEEE studies were published (Amann and Mendelsohn 2005; Kwatra and Essig 2014). We reviewed a sample of publicly available program filings from utilities with whole-building programs evaluated for ACEEE's *Utility Scorecard* (Relf et al. 2020), as well as case studies of successful municipal utility programs. This helped us analyze which approaches drive multisystem retrofits and achieve higher savings.

We conducted interviews with eight building experts, consultants, and professionals from energy service companies to gather data on the program approaches that support comprehensive retrofits. The interviews covered existing program approaches, potential savings from programs, and how highlighting or effectively communicating the multiple benefits of comprehensive retrofits (as opposed to only energy savings) can increase participation and improve program evaluations.

We also interviewed 10 utility program administrators who have offered comprehensive commercial retrofit programs. These interviews yielded information about program outreach strategies and evaluations, challenges in achieving savings targets, and approaches that can increase savings and improve cost effectiveness.

## PROGRAM ANALYSIS AND LIMITATIONS

In total, we reviewed more than 50 programs serving different building types, including office buildings, multifamily buildings, and public sector facilities. We excluded other building types such as retail, restaurants, and hospitals as there are limited programs for those building types. We selected programs if they encouraged systems-based retrofits by either requiring or supporting implementation of multiple efficiency measures across different building end-use systems to achieve a minimum of 10% energy savings. The analysis identified widely used approaches, trends, and elements that can be replicated.

This report focuses on utility programs for comprehensive commercial retrofits. These programs are often more administratively complex, and more costly, than deemed savings programs (i.e., programs in which the energy or demand savings from an installed energy efficiency measure [or measures] are predetermined, based on validated estimates or analytical methods), and it can be hard for smaller utilities to offer the same kind of programmatic benefits. Additionally, these programs are most cost effective when applied to customers that have substantial energy savings potential. As a result, they tend to focus on large commercial facilities or energy-intensive buildings.

Quantitative information on program results was limited because many programs are recent and have been offered for only two to three years. A few programs are in the pilot phase and therefore have not yet published evaluation reports. Even programs that have been operated for several years do not always publish their evaluation data. In addition, the COVID-19 pandemic and ensuing lockdowns have slowed many programs since 2020. As a result, the most recent program data are from 2018 or 2019, when available. To develop our

recommendations, we aggregated program data with the findings from expert and program administrator interviews.

# Building Blocks of Comprehensive Programs

Most current utility retrofit programs include services for gathering building energy use data using facility assessments and benchmarking.[2] They may include whole-building analysis to develop the scope of work and use building simulation tools or energy consumption data for the analysis. Programs may direct customers to financing and incentive options to cover the cost of the project. Figure 2 illustrates the key elements.

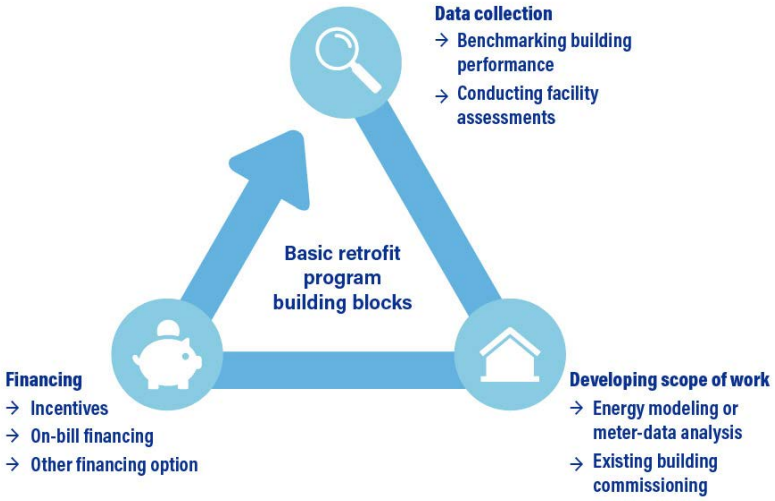


**Figure 2. Common components of a retrofit program**

Comprehensive retrofit programs vary in the types and scope of services they offer. Many programs include not only facility assessments but also opportunities to implement existing building commissioning (EBCx) processes such as retrocommissioning[3] (RCx) or continuous monitoring. EBCx reduces energy use through low-cost measures such as calibrating and tuning equipment and controls programming, creating a new energy use baseline that helps identify deeper savings opportunities. Programs may include options to finance upgrades, an implementation phase to install and commission new systems, and a measurement and

[2] Benchmarking helps customers establish an energy baseline by tracking usage data and comparing results to similar buildings, past consumption, or a reference performance level.

[3] Retrocommissioning is a periodic process to improve how existing building and equipment systems are functioning together.

verification (M&V) phase. Figure 3 describes the different elements of a comprehensive retrofit program.

It is worth noting that whole-building considerations are needed for deep energy retrofits. Newly installed equipment must be commissioned as soon as it is installed and then monitored to ensure it continues to operate optimally within the whole building. For example, when installing and commissioning new equipment, it is desirable to do RCx so that whole-building operations can be optimized with all new equipment in place. This needs to be an integrated process to ensure quality installations and optimal operations, and it should include considerations for ongoing tune-ups, maintenance, and repairs.

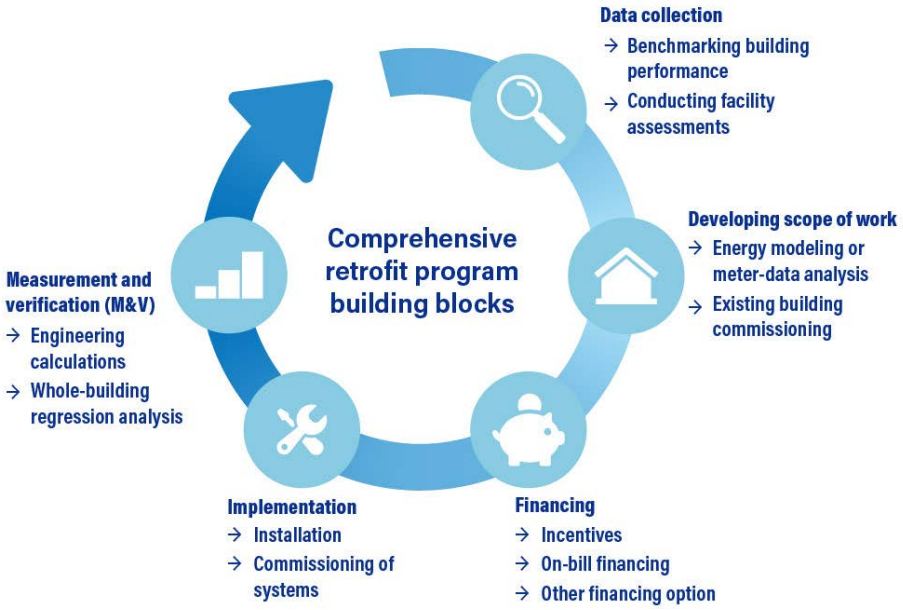


**Figure 3. Progressive complexity of a retrofit program**

## DATA COLLECTION AND INVESTIGATION

A facility assessment is the first step in most utility-run comprehensive retrofit programs, often at no cost to the customer. Facility assessments help customers make informed decisions about future capital investments and plan for improvements in their buildings. Following an assessment, customers receive detailed information on their building's energy use, and sometimes a customized energy savings proposal with recommendations for potential improvements and details of utility incentives.

Some utility programs include virtual assessments or cost-share energy audits that meet or exceed Level II standards of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) procedures for commercial building energy audits. An example is Duke Energy's virtual energy assessment program for large and medium-size facilities. Besides virtual facility assessment and building energy modeling, the program

helps customers choose trade professionals and secure financing. The program also directs customers to other Duke incentives for qualifying efficiency measures.

Programs may also include energy benchmarking. ENERGY STAR® Portfolio Manager is the industry standard tool for benchmarking and disclosing building energy performance. For example, Consumers Energy's ENERGY STAR service program uses ENERGY STAR Portfolio Manager to benchmark facilities, identify those that are running efficiently, determine what improvements can be made, and decide which upgrades need to be implemented first. A walk-through assessment of all buildings is conducted to identify easy, low-cost process changes to save energy. A detailed analysis may follow to find additional savings. Participants get a plan with the efficiency measures that will have the highest savings and an implementation schedule with payback periods. The use of established industry tools, which are easy to use, can be attractive for owners of small and medium-size buildings who have limited funds and technology support.

## SCOPE OF WORK

After initial data collection using facility assessments, a few comprehensive retrofit programs support development of a scope of work based on more detailed analysis at the whole-building level. This requires use of either building simulation tools or customized engineering calculations using utility meter data. According to the resulting recommendations, customers are referred to other utility retrofit programs or encouraged to implement EBCx processes (including RCx and ongoing Cx), or both.

As part of the utility program, RCx and ongoing Cx improve the efficiency of an existing building through no-cost and low-cost operational improvements. Typical measures include calibration of existing equipment; tuning equipment and systems through scheduling, sequencing, and controls programming; optimizing economizer performance; and resetting supply air temperature.

RCx yields operational savings but the process can take many months. The RCx process involves the identification, implementation, and verification of one set of energy-saving operational improvements. Ongoing commissioning, also called monitoring-based commissioning (MBCx), follows the RCx process to its end, then goes back and looks for more improvements to the updated building's operational practices. MBCx involves repeating the RCx cycle two or more times, as long as additional savings can be found. It also encourages regular customer engagement to prioritize and achieve ongoing savings.

When paired with building energy monitoring and information analysis tools, MBCx can unlock even deeper savings. The adoption of energy management information systems (EMIS) in MBCx programs continues to grow as software tools simplify monitoring, visualization, and analysis of a building's energy performance (Kramer et al. 2020). Building managers can use the data to operate their facility more efficiently and improve occupant comfort. For example, equipment failure and improperly set controls can lead to overly hot or cold spaces and comfort-related complaints. EMIS can help facility managers proactively

evaluate performance and make it easier to find problems that can cause discomfort. Many programs recognize the value of ongoing Cx and the data it provides to save energy.

# Comprehensive Retrofit Program Approaches

We identified more than 50 utility-run commercial building retrofit programs nationwide that integrate the services discussed above (see Appendix A for list of programs). These programs give customers a suite of coordinated offerings that streamlines the process of assessing building energy use, developing scope of work, enabling or providing financing mechanisms, implementation and commissioning, and M&V of savings. Programs require customers to implement efficiency measures, and they pay out incentives at certain milestones or level of energy savings achieved.

Based on the scope of services offered, we categorized all 50 programs into one of five general approaches. As shown in table 2, these five approaches include programs that offer EBCx with recommendations for capital improvements, custom programs that require implementation of multiple measures, performance-based programs, programs based on energy consumption patterns, and programs encouraging high-performance certifications.

Limited data from 30 utilities and statewide administrators indicate that annual program budgets range from $900,000 to $14.6 million. The program costs in table 2 are indicative of the magnitude of spending and investments in comprehensive programs. Costs vary by the size of the utilities or organizations offering programs, the size of the territory served, and the utility revenues. Because many comprehensive retrofit programs are new, participation rates range from just 9 completed projects to as many as 850 projects. Energy savings ranged from 7 MWh for relatively new programs to as much as 25,000 MWh.

**Table 2. Summary of different comprehensive retrofit program approaches**

| Approach | Average savings from programs | Program costs† | Examples‡ |
|---|---|---|---|
| Existing building commissioning with some capital improvements | 10–15% | $900,000–$8 million total cost | Puget Sound Energy MBCx program,* Ameren RCx Lite, ComEd RCx programs, Consumers Energy RCx Defined Actions, Efficiency Maine Long-Term Care Building Tune-Up |
| Custom programs that encourage implementation of multiple measures together or in phases; programs may include | 10–20% | $3–8 million total cost; $2–4 million additional incentives cost | LADWP Custom Performance Program,* ComEd Comprehensive Energy Savings program, Baltimore Gas and Electric Energy Solutions for Business, Puget Sound Energy |

| Approach | Average savings from programs | Program costs† | Examples‡ |
|---|---|---|---|
| emerging technologies and demand flexibility measures | | | Multifamily Retrofit, Xcel Energy/CenterPoint Energy Multi-Family Building Efficiency Program |
| Performance-based incentive programs, including pay-for-performance, efficiency as a service, and performance contracting | 15–40% | $6–8 million incentives cost; $1–1.5 million administration and program development | New Jersey Clean Energy Program P4P Existing Buildings,* Energy Trust of Oregon Pay for Performance, Puget Sound Energy Pay for Performance Program, Seattle City Light Energy Efficiency as a Service* |
| Energy consumption pattern–based programs, including customized engineering calculations that leverage utility meter and submeter data and strategic energy management (SEM) programs | 10–25% | $2–5 million total cost | Pacific Gas & Electric Commercial and Public Sector Whole Building Performance Based Retrofit Program,* National Grid and Con Edison Business Energy Pro, DC Sustainable Energy Utility P4P program, Puget Sound Energy Commercial SEM program, Energy Trust of Oregon Commercial SEM program* |
| High-performance certification and voluntary standard programs, including net zero, LEED, or Passive House | Varies according to certification level | Varies | Consumers Energy Zero Net Energy Companion Program, Louisville Gas and Electric and Kentucky Utility Business Rebate program, Potomac Edison Custom – Building Improvements |

**†Total cost includes administrative and incentive costs; sources for program budgets include annual reports, program evaluation and literature, and personal interviews. ‡Appendix A has more detail on these programs. *Programs with detailed case studies.**

In the following sections, we describe each of the program approaches in greater detail. We outline the general structure, compare different types of models, and highlight program examples.

## EBCX WITH CAPITAL IMPROVEMENTS

A few EBCx programs take a whole-building approach to energy savings and help program participants save up to 10% on annual energy costs. These programs provide

recommendations for efficiency improvements and identify energy-saving capital projects. We found two types of EBCx programs: RCx programs, which support implementation of O&M measures and refer participants to other programs to cover the cost of capital measures, and MBCx programs, which encourage continuous monitoring and tuning of measures to optimize performance and ensure ongoing savings. MBCx programs also provide recommendations for capital measures eligible for utility incentives. Table 3 shows potential savings, efficiency measures implemented, and examples of existing RCx and MBCx programs.

**Table 3. Retrocommissioning and monitoring-based program models**

| Program approach | Range of possible savings* | Efficiency measures | Examples |
|---|---|---|---|
| RCx with advanced analytics | 10–15% | Measures include optimizing and scheduling economizer performance, resetting supply air temperature and chilled water supply temperature, optimizing HVAC and adding variable frequency drive on supply fan and return fan, schedule lighting. Customers are referred to other programs to fund capital measures. | Consumers Energy RCx program, Efficiency Vermont EBCx, ComEd RCx Flex, Ameren RCx Lite, Efficiency Maine Long-Term Care Building Tune-Up Pilot |
| MBCx with energy analytics and EMIS | 10–15% | Measures include optimizing, scheduling, commissioning of controls, building tune-ups. Capital measures identified as part of the program may be eligible to receive rebates or incentives through other utility programs (savings from capital measures may be netted out from the total savings). | Puget Sound Energy MBCx program,* ComEd MBCx program |

***Values aggregated from estimated and measured savings from utility programs and projects.**

An established RCx program improves the energy performance of a building. However, a few offerings also help identify the best opportunities to save more with capital improvements. ComEd's Retro-Commissioning Flex program and Seattle City Light's Existing Building Commissioning program, among others, refer participants to other retrofit programs that offer capital improvement incentives. When RCx is being performed, it can also be an ideal time to implement load flexibility measures to reduce energy use and demand (Carmichael, Esau, and Taylor 2021).

MBCx enables facility operators to monitor and analyze the performance of energy systems and can be combined with standard RCx practices, helping maintain or improve operations (Mills and Mathew 2012). For example, monitoring and analyzing HVAC and lighting system performance with EMIS tools can help identify when system performance drifts from optimal. Catching an issue early allows facility operators to resolve it before it turns into a problem that can impact occupant comfort and safety and system reliability. Puget Sound Energy (PSE) offers an MBCx program that recommends low-cost measures and capital measures eligible for other incentives. The MBCx program relies on a whole-building-level assessment and uses software to collect, analyze, and report data to optimize savings and recommend capital measures. Further details of the program are in the example below.

Puget Sound Energy Monitoring-Based Commissioning Program

The MBCx program started in 2021 and has had slow uptake due to the COVID-19 pandemic. Customers are eligible to participate in the program if their building runs on automated controls and has at least 50,000 square feet of conditioned space.

Before enrolling in the program, eligible customers receive an assessment of their building's energy use. After enrollment, Puget Sound Energy (PSE) offers onsite reviews of building energy systems. These reviews allow PSE to recommend the best low-cost O&M improvements and capital projects that can improve energy efficiency. Finally, customers receive training to track their energy savings from O&M improvements and a facility guide that instructs them in how to operate their building for maximum savings (PSE 2022).

Customers receive three incentives. The first is earned after the building assessment is completed. Once the Cx work, staff training, and documentation are finished, the customer receives an implementation incentive based on the building's square footage. After one year, customers who achieve at least 6% building energy savings receive a third incentive based on kilowatt-hours saved or therms saved (PSE 2022).

As the program started only recently, there are few current projects and the program has no evaluation data to report (J. Hyatt, senior project manager, pers. comm., September 21, 2021).

## CUSTOM PROGRAMS

Many utility programs offer custom rebates for energy efficiency measures that are outside the standard list of prescriptive measures for lighting, HVAC, and process loads. A number of these programs focus only on a single energy end use (e.g., lighting or HVAC equipment). However, custom programs can support deeper retrofits through multiple end use system upgrades. The key is to address enough end uses to be genuinely comprehensive.

We identified three types of custom programs: those that implement all measures together, those that implement measures in stages, and those that encourage the use of emerging technologies and demand flexibility measures. Table 4 details savings, efficiency measures, and examples of notable programs.

**Table 4. Custom program approaches**

| Program approach | Range of possible savings* | Efficiency measures | Examples |
|---|---|---|---|
| All measures implemented at once | 10–15% | Upgrades of lighting system, refrigeration controls and cooler, HVAC system and controls, motor or drive controls, compressed air system, pipe insulation, showerheads, faucet aerators | Baltimore Gas and Electric Energy Solutions for Business, Mass Save Multi-Family program |
| Phased implementation of measures | 15–20% | Upgrades of lighting, HVAC (chiller, rooftop unit, geothermal, rooftop unit controls, and Variable Speed Drive (VSD) on primary fans or pumps), refrigeration, and other equipment (air-side economizer, lab filters, commercial kitchen equipment, fume hoods) | ComEd Comprehensive Energy Savings program, Xcel Energy/CenterPoint Multi-Family Building Efficiency Program |
| Emerging technologies and flexible load management measures | Varies | Implementation of energy storage (thermal or ice storage) and load-shifting measures, smart thermostats, electric vehicle charging | LADWP Custom Performance Program, Massachusetts ConnectedSolutions program, National Grid custom program, Duke Energy Smart $aver Custom Incentive Program |

***Values aggregated from estimated and measured savings from utility programs and projects.**

While the possible savings in table 3 are low in general, they are not indicative of the actual energy savings potential, especially if operational savings are considered. According to ENERGY STAR, the average commercial building wastes 30% of the energy it consumes (ENERGY STAR 2022). There are also some emerging programs that attempt much deeper levels of savings (up to 35%). There is an opportunity to reach much deeper whole-building energy savings with new and innovative program strategies.

Custom programs may offer incentives for implementing multiple efficiency measures in stages. Because comprehensive retrofits can be capital and time intensive, staggering the implementation can reduce the upfront capital investment and operational interruption and provide time for savings from earlier upgrades to accrue. ComEd uses this model in its custom solutions program for commercial and public sector buildings. The program offers

participants a 20% additional cash incentive for implementing three to five eligible energy efficiency measures in a single project, either in phases within two years or all at once (ComEd 2021). Eligible measures include installation of smart technologies and advanced controls, such as occupancy and daylighting controls for lighting, as well as whole-building lighting management systems, building management systems, demand-controlled ventilation, and high-efficiency air compressors.

Only a handful of programs include incentives for implementing new technologies such as demand flexibility measures, which deliver operational and peak energy savings. National Grid's custom program enables participants to identify demand response opportunities to reduce consumption during peak pricing periods. It focuses on peak demand and energy-saving measures that enable flexible load management. Another program, the Custom Performance Program offered by LADWP, provides incentives for thermal energy storage systems. The example below shows how the program encourages customers to implement a variety of measures.

### Custom Performance Program, Los Angeles Department of Water and Power

LADWP's custom program helps businesses choose the best energy efficiency measures for their buildings. The program is open to buildings of any size and promises that the combined measures will meet or exceed industry standards. Areas for efficiency improvements include controls, lighting, HVAC/refrigeration, and envelope. Envelope measures range from installing ENERGY STAR windows to retrofitting cool roofs that comply with California's Title 24 energy requirements. Customers also have the option to install thermal energy storage systems.

Interested businesses must submit information on their building, types of measures they wish to implement, and the scope of their project in an Excel workbook. If applicable, they can also submit energy savings calculations or an energy M&V plan. Once LADWP approves a project, the customer has up to 12 months to install the measures. Afterwards, the customer must submit an installation report, an IRS form, and a payment assignment form.

The program incentives are broken down by retrofit category and specific measure. Incentives range from $0.08/kWh saved from lighting fixture retrofits to $0.30/kWh saved from installation of high-efficiency HVAC/refrigeration equipment and variable-speed drives. Incentives of up to $750/kW are offered for thermal energy storage. Except for lighting, all measures within a specific retrofit category are eligible for the same incentive. All non-lighting incentives are capped at 75% of total cost, while lighting incentives may cover 100%.

Custom programs can meet the needs of different building types (e.g., offices, schools, and hospitals), building sizes (e.g., small to medium-size offices), and customer requirements. For example, upcoming renovations or equipment replacement projects present ideal opportunities to add new energy measures covered under custom programs to the scope of work. However, it is important to ensure that projects target multiple energy systems to achieve the maximum possible savings and leverage the interactive effects of measures.

## PERFORMANCE-BASED PROGRAMS

Performance-based programs provide customers financial incentives in tiers or phases depending on the level of savings achieved and require measurement and verification of savings for incentive payment. The programs target multiple measures across building systems with one building-wide energy savings goal. Building owners and energy service companies work together to achieve savings through a customized package of measures.

We identified three models within this approach. The first is a pay-for-performance model that can take several different forms. The second is performance contracting delivered in the form of an energy savings performance contract (ESPC) or a utility energy savings contract (UESC). The last is an efficiency-as-a-service agreement. Table 5 indicates the potential savings from the three models, typical efficiency measures implemented, and examples of existing programs.

**Table 5. Performance-based incentive program models**

| Program approach | Range of possible savings* | Efficiency measures | Examples |
|---|---|---|---|
| Pay for performance | 15–20% | HVAC equipment upgrades, lighting system upgrades, envelope improvements, O&M improvements, and behavioral measures | New Jersey Clean Energy Program (NJCEP) P4P Existing Buildings, Energy Trust of Oregon Pay-for Performance, Seattle City Light Deep Retrofit Pay for Performance |
| Performance contracting including energy service performance contracts (ESPCs) or utility service performance contracts (USPCs) for public buildings | 30–40% | HVAC equipment upgrades, lighting efficiency upgrades, envelope improvements, RCx measures, and plug-load energy reductions | U.S. General Services Administration National Deep Energy Retrofit program, NJCEP Energy Savings Improvement program |
| Efficiency-as-a service or energy service agreements | 20–25% | Equipment or building systems installation including lighting and HVAC upgrades, implementation of capital projects, O&M improvements; may also include energy storage, electric vehicles, and EV charging infrastructure | Seattle City Light Energy Efficiency as a Service pilot, Southern Company + Sparkfund Energy as a Service, Ameren Illinois Energy Service Partnership |

***Values aggregated from estimated and measured savings from utility programs and projects.**

## *Pay for Performance*

Commercial sector pay-for-performance programs have existed for 20 years (NEEP 2019a). These programs pay customer incentives based on energy savings as they occur, typically tracking them by examining utility meter data. Because the savings are estimated and measured using normalized meter bill data, this model can support assessment of savings from complex, multi-measure retrofits, including those from operational and behavioral measures, that are harder to determine (Szinai, Borgeson, and Levin 2017).

Depending on the program design, a pay-for-performance approach shifts the responsibility of achieving energy savings from the utility or efficiency program administrator to an individual customer or implementer. This can ensure that savings persist, as the customer bears the performance risk and is accountable for installing and maintaining the energy-saving measures (NEEP 2019a).

Pay-for-performance utility programs attach incentive payouts to certain milestones and energy savings performance targets. For example, Duke Energy's Smart $aver Performance Incentive program for commercial and industrial customers in North Carolina, South Carolina, and Indiana offers customers incentives in two phases to support projects with capital and operational measures. The initial incentive is based on a portion of the savings projected at the time of installation of efficiency measures. Customers receive the final incentive based on the actual savings achieved, at the end of the M&V period. Monthly utility meter data are used to estimate savings and develop performance reports for customers. Program models may also include additional stages for awarding incentives and may include extra payments when customers achieve deeper savings, implement non-lighting measures, or report demand reductions. For example, the Pay for Performance—Existing Buildings program formerly run by New Jersey Clean Energy Programs pays incentives in three phases. The example below describes how this program distributes incentives based on measures implemented and energy saved.

### Pay for Performance—Existing Buildings, New Jersey Clean Energy Programs

In 2009 NJCEP launched a pay-for-performance program for commercial, industrial, and institutional buildings with a peak demand exceeding 200 kW in any of the preceding 12 months, and for multifamily buildings with peak demand exceeding 100 kW. The program is funded through a Societal Benefits Charge on utility bills and uses a comprehensive, whole-building approach to offer incentives linked to participant savings.

Participants use a comprehensive package of measures to reduce energy use by 15% or more. They work with an approved program contractor who develops an energy reduction plan (ERP). The contractor conducts an energy audit, uses whole-building energy simulation to model proposed improvements, and prepares the ERP. The contractor also installs the measures and submits the commissioning report. The ERP includes a comprehensive, fuel-neutral scope of work with upgrades in at least two end uses of lighting and HVAC, financial

plans for funding, and an installation schedule. In the efficiency package, lighting upgrades cannot contribute more than 50% of the savings, and some measures, like RCx and onsite renewables, are excluded. After 12 months, a third party performs M&V to verify the savings.

Customer incentives are paid in three phases. The first incentive is paid upon review and approval of the completed ERP and is contingent on moving forward with the installation of proposed measures. The second incentive is available after the installation and commissioning of recommended measures, and the third payment is made upon the completion and approval of a post-construction report showing the achieved savings. The second and third incentives are split to provide upfront financial assistance.

Over the past 12 years, the program has resulted in significant savings. To date, more than 850 customers have participated. For the 2019–2020 period, the program reported electricity savings of 19,087 MWh and gas and other fuel savings of 64,118 MMBtu (NJCEP 2020).

### *Performance Contracting*

Performance contracting allows customers to achieve energy savings while financing the costs of their projects through a third party. The project costs are paid back over time, with payment amounts based on the expected energy savings from the project. Typically, performance contracting is delivered in the form of an ESPC or a USPC (Jungclaus et al. 2017). Mostly, ESPCs and USPCs enable public sector and institutional buildings to make energy- and water-related improvements to their facilities without any upfront capital expenditure.[4]

In an ESPC or USPC, the owner contracts with an energy services company (ESCO). The ESCO performs a building audit, identifies opportunities for savings, and implements measures to achieve the level of energy savings specified in the contract. The savings from the customer's utility bills are then used to pay back the ESCO. The customer makes recurring payments to the ESCO for the contracted services such as M&V, maintenance, and repair. Because the ESCO guarantees a certain level of savings, if the building does not achieve those savings, the ESCO makes up the difference in payment (NASEO 2021).

ESCO projects are usually comprehensive, employing a range of measures across multiple systems to achieve savings. Projects may include high-efficiency lighting, heating, and air-conditioning; efficient motors; energy management systems; and building shell upgrades. The combination of lower-cost measures with those that require larger initial capital

[4] Public and institutional buildings are typically owned by state and local agencies, municipalities, universities, schools, and hospitals, among others.

investment and have longer payback periods (15–20 years) allows ESCOs to offer shorter blended paybacks and a means to include measures that are otherwise costly to implement.

A successful ESPC program example is the National Deep Energy Savings program from the General Services Administration (GSA). The program supports longer-term cost-effective retrofits to help federal facilities move toward net zero energy consumption, reduce water consumption, and use innovative technologies and renewables without major tenant disruptions. More details on the program are included in the example below.

National Deep Energy Retrofit Program, General Services Administration

The National Deep Energy Retrofit (NDER) Program was begun by GSA in 2011 to demonstrate deep energy savings using ESPCs. The program aimed to move federal buildings toward net zero energy consumption and encourage the use of innovative technologies and renewable energy. Several ESCOs and staff from GSA, the U.S. Department of Energy's Federal Energy Management program, national laboratories, and the U.S. Department of Defense worked together to expand the ESPC process.

GSA identifies potential candidates for NDER projects through a screening tool. Following that, an ESCO performs an energy audit of the facility and completes an analysis to determine relevant conservation measures. Program results show that combining the available efficiency opportunities into a single project helps achieve deeper savings than individual projects could attain. On average, buildings that undergo a comprehensive retrofit under the program realize energy savings greater than 34%.

Round 1 of the program served 23 buildings that covered 14.7 million square feet, resulting in average energy savings of 38.2% (Carmichael and Gartman 2015; Jungclaus et al. 2017). In comparison, similar federal ESPC projects reported energy savings of 19% (Jungclaus et al. 2017). GSA also achieved a shorter project award cycle time: 15.9 months after ESCO selection for NDER projects, as opposed to 20.9 months for other federal ESPC projects.

Based on the success of the program, the GSA, the Department of Defense, and other federal agencies developed a set of best practices for federal ESPC and other energy projects. The recommendations align with different stages of an ESPC project such as preplanning, project initiation, preliminary assessment, contractor selection, construction, occupancy, and verification.

Increased collaboration between utilities and ESCOs can help scale comprehensive commercial retrofits. Such partnerships will require changes in the way regulatory structures and program models enable utilities to recover costs or benefit from longer-term comprehensive projects. Utilities typically invest in energy efficiency improvements with shorter paybacks to minimize the cost to utility customers (Price and Scerbo 2019). Changes in M&V requirements, data management, and valuation of the multiple benefits of systems efficiency improvements can help utilities and ESCOs work together more closely.

## *Efficiency as a Service*

The efficiency-as-a-service (EaaS) model helps customers implement energy and water efficiency measures with no upfront capital expenditure. The building owner contracts with a service provider who designs the project scope, finances the material and construction costs, maintains project equipment, and monitors performance to validate energy savings. The customer pays a monthly, quarterly, or annual fee for the services received. Generally, the payment is directly or indirectly based on the energy savings realized on utility bills. Experience to date with this service-based model reveals energy savings potential of 20–25% (ACEEE 2019).

EaaS differs from ESPC in how a project scope is defined and who finances and owns the measures installed. ESPC tends to be used for large projects in groups of buildings that can support multiple types of efficiency measures. The EaaS model supports both large, multisite, multi-measure projects and a portfolio of smaller buildings that add up to a bigger footprint and provide opportunities for greater savings and a simplified contracting process. Unlike the ESPC structure, where the building owner owns the equipment and finances or uses external funds to cover the costs, in EaaS the service provider purchases, installs, and owns the equipment. There is no asset or liability added to the owner's balance sheet.

EaaS also differs from traditional, measure-based incentive programs in that it offers a pathway for ongoing communication and an advisory role for the utilities and other program administrators. Program administrators can function as market facilitators and offer guidance to customers on proposed approaches, technology packages, implementation plans, and service contracts. To offer these services, administrators will need to identify, vet, and select independent providers to deliver energy services.

There are limited examples of utility EaaS programs. The Southern Company offers a comprehensive energy efficiency technology subscription with the energy services provider Sparkfund. The utility and the provider work together to fund, design, install, and manage a complete energy system upgrade and provide ongoing maintenance and repair of all existing technology. The customer receives a detailed proposal with the expected savings, monitoring services for all technologies to optimize performance, and recommendations for replacing underperforming assets. The service fee and incentives are all aligned with savings.

Seattle City Light is also currently offering an EaaS program to overcome customer barriers around access to funds and the ability to pay for capital measures from operational budgets. Its Energy Efficiency as a Service pilot program, begun in 2021, is also testing a mechanism to address split incentives and encourage owners to invest in deep retrofits. Details are given in the box below.

### Energy Efficiency as a Service Pilot Program, Seattle City Light

Seattle City Light launched an EEaS pilot for retrofitting commercial buildings in 2021. Eligible customers must own a commercial building and have a positive history of financial transactions with Seattle City Light. The pilot relies on long-term service agreements to deliver deeper

energy retrofits and tests a new mechanism to address the problem of split incentives: the discrepancy between the party that pays for a retrofit (the owner) and the party that benefits financially from it (the tenant). In practice, after a retrofit is complete, the owner or tenant continues to pay the same energy utility bill they would have paid if no energy improvements were made, while getting the energy efficiency benefits generated in their building. The owner earns additional cashflow from the energy efficiency developer (investor) who provides the upfront capital for the efficiency improvements and implements them. The utility quantifies the monthly savings from energy efficiency measures and financially compensates the party responsible (energy investor). It uses a portion of the customer payments, which include the cost of actual electricity used and a service fee, to buy the energy efficiency benefits from the party that installs the measures.

Besides Seattle City Light, the participants, and an energy efficiency (EE) developer, the EEaS program involves an M&V consultant who quantifies energy savings and monitors data. The M&V consultant measures the pre-retrofit energy use to build a baseline model. Participants sign an agreement with Seattle City Light, promising to pay the utility's energy efficiency service fee. Seattle City Light also signs a power purchase agreement with the EE developer, promising to pay for the efficiency work. After the agreements are signed, the EE developer completes the retrofit. In the project performance stage, the EE developer and the M&V consultant report savings, and the participant pays the service fee. Seattle City Light may conduct an evaluation to assess overall performance and participant satisfaction.

The program's first project cycle began in January 2021 and accepted applications through the end of April (Seattle City Light 2022). Participating projects are expected to reduce electricity consumption by 25% or more relative to the building's baseline. Since this program is ongoing, no evaluation data are yet available. In addition to improving commercial energy efficiency, the EEaS program aims to meet or exceed Seattle's citywide workforce development goals.

## PROGRAMS BASED ON ENERGY CONSUMPTION PATTERNS

Energy consumption pattern–based performance programs leverage whole-building analysis and smart meter infrastructure in commercial and public sector buildings to inform energy savings goals and identify efficiency measures. Energy consumption data from the utility meter are used to prioritize customers that may be good candidates for the program, track and monitor savings impacts, and settle performance payments. These programs enable building owners and service providers to focus on tracking and maintaining energy savings and efficiency measure performance, instead of only reporting them (Jump et al. 2020).

To enable this program design, a robust data M&V infrastructure is needed (Best, Fisher, and Wyman 2019). Third-party market-based solutions can help utilities calculate and verify savings and align incentives. These solutions leverage advances in metering infrastructure and M&V tools to offer embedded savings measurements and provide visibility to the grid impacts of location- and time-dependent savings. One example of this model is the Recurve platform, which utilizes CalTRACK whole-buildings methods and open-source software

(OpenEEmeter) for calculations and ongoing savings tracking. It also provides utilities and implementers with a full audit record for the performance settlement within the program.[5]

We identified three types of program models based on energy consumption patterns: whole-building meter programs that use monthly bill records to establish baseline and savings estimates; advanced metering infrastructure (AMI) programs that rely on interval data to develop facility baselines and evaluate savings after any interventions or operational changes are made; and strategic energy management programs, in which organizations implement efficiency projects and develop management practices to improve their energy performance and maintain savings. For each approach, Table 6 shows the potential savings, efficiency measures, and examples of existing programs.

**Table 6. Program models based on energy consumption patterns**

| Program approach | Range of possible savings* | Efficiency measures | Examples |
|---|---|---|---|
| Whole-building monthly meter data | 10–15% | Capital, behavioral, and operational measures | Southern California Edison Public Sector Performance-Based Retrofit High Opportunity program, Duke Energy Smart $aver Performance Incentive program |
| Advanced metering infrastructure | 5–15% | Capital, behavioral, and operational measures | Pacific Gas & Electric Commercial and Public Sector Whole Building Performance Based Retrofit Program, Con Edison and NYSERDA joint Business Energy Pro program, DC Sustainable Energy |

[5] CalTRACK (www.caltrack.org) is a set of open-source, standard M&V methods used for calculating changes in energy consumption by comparing weather-normalized pre- and post-retrofit energy use for a given customer. CalTRACK methods are used in OpenEEmeter, an open-source calculation engine.

| Program approach | Range of possible savings* | Efficiency measures | Examples |
|---|---|---|---|
| | | | Utility Pay for Performance program |
| Strategic energy management (SEM) | 10–15% | Capital, behavioral, RCx, and operational measures. Customers may be referred to other programs to fund capital measures | Puget Sound Energy Commercial SEM program, Energy Trust of Oregon Commercial SEM program; Bonneville Power Administration SEM program; BC Hydro SEM program |

***Values aggregated from estimated and measured savings from utility programs and projects.**

### *Whole-Building Monthly Meter Data*

In this model, whole-building monthly bill records are used to calculate baseline energy use, estimate avoided energy consumption from implementing measures, and deliver incentive payments when projects meet the performance threshold. Because energy reduction is tracked at the whole-building level, this model promotes comprehensive energy upgrades and allows customers to combine behavioral, capital, and O&M measures (CEE 2018). This reduces participant transaction costs as customers are aggregated at the building level and lowers the administrative, implementation, and M&V costs of this type of program.

Typically, monthly meter data–based programs are combined with the pay-for-performance model. A combined approach can break down silos between programs and enable greater integration of efficiency measures by allowing the implementation of a broad range of technologies in a single project if they can meet program savings requirements (Gold, Waters, and York 2020).

Few programs recognize the value of utilizing utility revenue meter data to qualify customers and track savings or the way these data can reduce the complexity of M&V for multi-measure retrofits. One that does is Southern California Edison's Public Sector Performance-Based Retrofit High Opportunity program, which combines multiple offerings into a single program with meter-based feedback to help customers achieve greater energy savings. The program begins with an audit and technical assistance to identify savings opportunities, and customers are paid incentives based on actual energy savings at 3, 12, and 24 months. Other notable examples of programs that leverage whole-building meter data include Duke Energy's Smart $aver Performance Incentive program, the Commercial Whole Building Demonstration pilot run by Pacific Gas & Electric (PG&E), and Efficiency Vermont's Power Saver Pilot.

### *Advanced Metering Infrastructure*

AMI enables two-way communication between utilities and customers through an integrated system of smart meters, communication networks, and data management systems. It provides several important functions for utilities and customers, including the ability to remotely measure electricity use, connect service, identify and isolate outages, and offer time-of-use pricing (DOE 2016). AMI can also support delivery of whole-building-level energy efficiency programs that are based on assessments of energy use reduction at the customer's site (NEEP 2019b).

Like whole-building monthly meter programs, this type of program allows customers to combine behavioral, capital, and operation and maintenance measures. Because AMI provides granular data, program managers can perform geographically targeted analyses to identify good prospects for comprehensive retrofits, review consumption data, and make program changes to improve performance (Gold, Waters, and York 2020). AMI can also support continuous M&V, which helps evaluators of comprehensive programs gain better understanding of a program and the impact of implemented measures (NEEP 2019b). Consistent measuring and monitoring enable utilities and customers to make smarter investments and avoid settlement disputes with the entity doing the performance calculations.

Only a handful of utilities are using AMI's ability to support customer energy efficiency and improve program design and evaluation. A notable example is Pacific Gas and Electric's Commercial and Public Sector Whole Building Performance Based Retrofit program. The example below describes how smart meter data inform the choice of energy-saving measures and help determine customer incentive payments. Other programs, like the DC Sustainable Energy Utility Pay for Performance program and Con Edison and NYSERDA's joint Business Energy Pro program are in early stages of implementation.

#### Commercial and Public Sector Whole Building Performance Based Retrofit Program, PG&E

PG&E launched this program in 2020 to help commercial and public sector buildings save energy by leveraging smart meter data. Participating buildings must be at least 50,000 square feet and have whole building level metering. The program encourages implementation of multiple measures at once and uses meter data to determine how well the measures work together to achieve greater, more persistent whole-building energy savings. The program verifies energy savings using the normalized metered energy consumption (NMEC) method. The NMEC method relies on measuring and comparing metered energy consumption data before and after a retrofit to quantify energy usage and savings.

The program employs a team of professionals. An account representative communicates with customers, while a program manager oversees general operations. An implementer installs efficiency measures and monitors savings. Additional staff are responsible for the project's M&V plan and NMEC procedures.

There are three phases in the program. In the first, the baseline phase, the account representative and the implementer scope out the customer's building, compile meter data,

and determine potential savings measures. This allows the implementer to draft an M&V plan that will help the building achieve at least 10% energy savings. The second phase is the installation period. Once the program manager submits a project approval agreement letter, PG&E can allocate funds for NMEC payments, and the implementer can begin installing measures. After all measures are installed, commissioned, and operational, the implementer submits a post-installation report that documents the measures and re-estimates energy savings. The last phase is the performance stage, in which the customer, implementer, or other designated payee receives a payment based on the project's 12-month savings report. The savings are determined using the 12 months of baseline-period metered energy use and 12 months of performance-period energy use.

The program offers incentive payments in two stages. The first post-installation NMEC payment is based on estimated energy savings. Program implementers must submit a 12-month savings report that outlines savings calculations based on the original M&V plan. Once it is approved, the designated payee receives the second 12-month incentive payment.

### *Strategic Energy Management (SEM)*

SEM programs enable large commercial, institutional, and industrial customers to implement energy efficiency projects and develop management practices to improve their energy performance. These continuous improvement programs include multiple services to help customers manage energy across a large site or multiple sites. Programs may include energy management training to help participants identify and quantify opportunities, support for developing a facility action plan, incentives for savings, and allowances for training customers to improve their energy management skills (Burgess et al. 2018).

SEM programs focus on how a whole building can use its existing equipment and systems to optimize energy use and maximize savings. Energy savings opportunities typically include behavior, retrocommissioning, and operational strategies, but may include capital measures such as lighting upgrades (Lanciani et al. 2020). Some notable program examples are BC Hydro's SEM program, Energy Trust of Oregon's Commercial SEM program, and the Bonneville Power Administration SEM program (Baker et al. 2020). The Energy Trust example, below, examines factors related to the program's success.

Commercial Strategic Energy Management Program, Energy Trust of Oregon

Energy Trust of Oregon's commercial SEM program helps customers develop best practices for saving energy. Participants learn how their buildings use energy and how they can change operational practices to reduce usage (Energy Trust of Oregon 2022). The Commercial SEM program was based on Energy Trust's Industrial SEM program. Although the original program focused on one building at a time, the commercial program lets owners opt for a portfolio approach to achieve savings across multiple buildings (Alliance to Save Energy 2020).

Energy Trust pairs customers with energy coaches who provide guidance throughout the program. Initially the energy coach helps the customer set a savings goal, identify opportunities for reaching the goal, and draft a practical plan of action. Customers can then attend

workshops to learn from energy experts and collaborate with other SEM participants. Energy coaches help participants track their savings through a performance tracking tool. Depending on results, customers can continue good practices or change their behavior to achieve greater savings. Customers are also encouraged to increase program participation among employees, ideally through creating a company energy team.

In 2019 the program operated at 282 sites that collectively produced annual energy savings of 12.9 million kWh and 600,000 therms. Overall, the program successfully achieved more than 90% of anticipated energy savings. As the program has grown, the cost of conducting evaluations has also risen, likely the result of participants not recording their information properly with the performance tracking tool. Going forward, Energy Trust plans to simplify the tool so participants can more accurately report their energy savings.

### CERTIFICATION AND VOLUNTARY STANDARDS

Voluntary programs such as Leadership in Energy and Environmental Design (LEED) certification for existing buildings and spaces, the EnerPHit—Passive House standard for existing buildings, and net zero goals offer customers pathways to meet their energy and climate objectives. Utility programs designed to accommodate common certification programs and voluntary standards can leverage these alternative approaches to save more energy and improve building performance.

Program administrators can use existing technologies and marketing materials to reach a wider base of customers and offer incentives if they meet high performance standards. One challenge, however, is determining the best way to assess the savings of a third-party program as part of a utility's internal program valuation that may have different metrics or calculations. Very few utilities offer programs based on voluntary certification programs. An example is Consumers Energy's Zero Net Energy program. The program offers commercial buildings considering a deep retrofit project (upgrading a minimum of two whole-building energy systems) incentives to achieve zero net energy levels.

## Scaling Comprehensive Retrofit Programs

There is evidence that comprehensive retrofits provide greater whole-building energy savings than one-measure approaches. For instance, a retrofit that includes energy-efficient lighting and envelope measures like upgrading to high-performance windows is likely to reduce lighting, cooling, and heating loads. This helps downsize HVAC equipment, yielding even more savings. This approach also helps reduce project contracting costs and time. Notably, some approaches, like utility-offered performance-based incentive programs and those involving ESCOs, encourage and deliver comprehensive retrofits. As these retrofits become a key strategy for reaching deep levels of energy savings, we will need policies, innovative program designs, and broader customer and workforce education to scale these approaches.

## FEDERAL, STATE, AND CITY MANDATES

Government policy and support can play a significant role in improving the performance of existing commercial buildings. There are mandates in place for energy use and carbon reductions in federal buildings, and many state and local governments and agencies are setting goals around enhanced energy efficiency, carbon reductions, and climate resilience (Jungclaus et al. 2017). Comprehensive retrofits can be vital in helping federal, state, and local governments meet their sustainability goals and mandates.

City policies such as a benchmarking and energy disclosure requirements can provide information about building energy use and opportunities for improvement that can motivate building owners to invest in upgrades. These policies can even help building managers prioritize buildings suitable for deep retrofits and show utilities which energy-saving measures make sense for a given customer. For example, when California and Washington State passed commercial building benchmarking and disclosure regulations, utilities were required to provide whole-building energy usage data to landlords to help them comply with benchmarking requirements. The mandates accelerated data collection and facilitated better understanding of energy use in different building sectors. Because benchmarking provides actionable information on energy management and savings opportunities, utilities can explore the role of data access as a customer service offering. This service may also act as an avenue of entry for customers into other utility programs.

Another example of a policy that can motivate investments in upgrades is a building tune-up requirement. Such progressive policies help building owners determine inefficiencies in existing buildings and identify ways to reduce energy waste and costs. A few cities including Seattle, Philadelphia, Miami, New York, and Salt Lake City are requiring commercial buildings of 50,000 square feet or more to conduct tune-ups. Building owners and operators are expected to carry out assessment of their building's energy systems and controls to identify operational inefficiencies and opportunities for low- and no-cost repairs and adjustments. Retuning requirements may even encourage utilities to design and implement new programs for customers in areas where such a policy is in force. For example, the Seattle City Council enacted a tune-up policy as a key part of the city's climate action plan, which includes a goal to reduce commercial building energy use by 45% and overall emissions from buildings by 82% by 2050, relative to a 2008 baseline (Seattle Office of Sustainability & Environment 2017). In response, Seattle City Light, the municipal electric utility, developed the Building Tune-Up Accelerator Program for buildings of less than 100,000 square feet. The utility offered building owners and energy service providers a per-square-foot financial incentive for building tune-ups, along with a package of tools and technical support to encourage them to participate.

A few jurisdictions are also beginning to enact building performance standards (BPS). Currently, two states and six cities have established targets to improve performance of their building stock, including goals for reducing energy, gas, and water consumption as well as emissions and peak energy demand (IMT 2021). President Biden's creation of the National Building Performance Standards Coalition reflects a growing interest among jurisdictions in

establishing targets to improve performance of their existing buildings. As of March 2022, the coalition consisted of 33 state and local governments (National BPS Coalition 2022). Comprehensive retrofits will likely play a key role in meeting and complying with the BPS targets, especially among small and medium businesses (SMBs), which lack the technological expertise and the funds to do deep retrofits. Comprehensive retrofit programs can help customers reach their savings targets. A utility-offered program with trusted efficiency partners can provide SMB customers turnkey services, including identifying suitable measures for deep savings, financing, implementation, verification of savings, and the persistence of ensuing savings.

## NEW APPROACHES TO PROGRAM DESIGN

Comprehensive retrofits can be a key strategy in delivering near-term energy savings and longer-term greenhouse gas reductions. Many programs reviewed in this report were designed to conserve energy and reduce customer costs. However, aligning utility energy efficiency goals with decarbonization goals can further efficiency investments that address the time, seasonal, and geographic value of energy efficiency; lead to greater emissions reductions; and provide many nonenergy benefits to customers and society (Specian, Gold, and Mah 2022). This alignment will require breaking down utility program silos and changing existing design and evaluation practices so programs can focus on system-based measures and allow flexibility in meeting performance goals. This in turn will help expand the scope of existing comprehensive retrofit programs, enabling the inclusion of new technologies or the development of new programs.

Our review shows comprehensive retrofits include a combination of energy efficiency measures, demand flexibility technologies, and other distributed energy resources. Legislated utility goals can limit the bundling of measures if utility energy efficiency programs get credit only for energy savings and not for demand reductions. Additionally, regulatory proceedings require separate internal utility business teams to handle each of the technology areas. These teams are responsible for planning, obtaining approval, budgeting, marketing, education and outreach, and administration. More communication and coordination among teams will be needed to develop and deliver comprehensive programs.

Existing utility regulatory policies may prohibit the combination of measures in incentive program cost-effectiveness tests. Often these tests require efficiency measures to pass individually rather than collectively as a package (Regnier et al. 2020). New approaches to evaluating savings from multi-measure projects, such as using metered energy consumption data to report energy usage and savings, could support engagement in more comprehensive multisystem retrofits. In California the normalized metered energy consumption (NMEC) approach has been adopted through legislation. NMEC utilizes whole-building meter energy consumption data to measure and verify energy usage and savings from an efficiency project.

Some program approaches, especially the pay-for-performance and performance contracting models, can overcome implementation and evaluation challenges to support

multi-measure retrofits. These program models are designed to reduce financial and operational risks and focus on retrofits with good returns. ESCOs recognize the base transaction cost when a service provider is working on site and leverage that to implement additional measures at the same time. Utility retrofit programs may not be designed to recognize the impact of these transaction costs and the greater efficiency of implementing more measures together. By offering a suite of technologies and enabling their implementation at the same time, utilities can reduce administration costs and improve their program's overall cost effectiveness.

## VALUE PROPOSITION USING MULTIPLE BENEFITS

While comprehensive retrofits are more complex than standard energy efficiency upgrades, they offer customers a greater array of value propositions. Despite producing multiple benefits, however, few utilities are raising awareness of these benefits and incentivizing participation in their programs.

A utility retrofit program for large commercial customers could highlight more sustainable business operations as a benefit. For example, promotional materials for Ameren Illinois's SEM program advertise it as a way for companies to reach their environmental and sustainability goals (Birschbach 2020).

The building type will likely influence the kind of benefits that are communicated. Retrofit programs for offices could detail greater health and productivity for employees, while a program for schools could detail better student learning and higher test scores. A multifamily program could highlight enhanced comfort and quality of life for residents. For example, Mass Save's Multi-Family program advertises energy efficiency upgrades that can make participants more environmentally responsible, enhance property value, and increase tenant satisfaction. The examples below show how programs incorporate multiple benefits into their promotional materials.

| Public Sector Programs, ComEd | Multi-Family Program, Mass Save |
|---|---|
| ComEd programs for existing buildings are designed to meet the needs of different building sectors, including offices, schools, multifamily buildings, and health-care facilities. For each building type, marketing materials clearly state the relevant nonenergy benefits. For example, the website for the K–12 schools program explains that through energy efficiency, schools can cut energy costs, improve students' learning experiences, and enhance the indoor environment through improvements in lighting effectiveness, indoor air quality, and thermal comfort. It also includes information on available incentives, | Mass Save educates customers on their multifamily offerings and the benefits energy efficiency upgrades bring to building owners, tenants, and condo unit owners. It highlights that through efficiency upgrades, building owners lower their O&M costs, enhance their property's value, increase occupancy rates, become environmentally responsive, and increase tenant satisfaction. Tenants and condo owners benefit too. They can reduce energy costs, increase comfort, improve their indoor air and lighting quality, and make their complex green. Marketing materials highlight the program's whole-facility approach in |

| | |
|---|---|
| case studies of projects, fact sheets, and application materials to raise customer awareness and participation. | identifying eligible measures and incentives and includes information on program eligibility, measures included, and case studies. |

Nonenergy benefits, like lower O&M costs and reduced equipment downtimes and failures, have clear value for building owners and occupants. A combination of these benefits from a single program can be a key driving force for certain types of comprehensive retrofits. For example, a comprehensive program could offer both capital improvements—such as LED lighting upgrades—and ongoing commissioning. The program could emphasize that the combination of measures reduces maintenance costs for LED lights due to their long life and avoids high-cost equipment failures because of continuous monitoring of systems.

Utilities should translate the benefits of comprehensive retrofit programs into language customers will find compelling. While promoting kWh savings, programs could communicate how the incentive payments are designed and delivered to minimize risk and provide long-term benefits. Staggering incentive payments, as in PG&E's Commercial and Public Sector Whole Building retrofit program, could motivate customers to participate in long-term retrofit projects because it not only reduces upfront project costs but also provides compensation for delivered savings. Other benefits programs could highlight increases in asset value and net operating income from O&M cost savings, enhanced tenant comfort, and the ability to achieve internal and tenant sustainability goals. Providing frequent updates on a building's performance, in terms of energy savings and return on investment, can help reduce customer uncertainty and give greater visibility to benefits.

Along with touting them in marketing materials, some utilities incorporate limited societal health and environmental benefits (e.g., water savings, reductions in emissions) in cost-effectiveness evaluations of programs. However, this is still not a common practice due to the lack of regulatory requirements to collect nonenergy data for program evaluations. Traditional valuation of energy efficiency has focused on resource costs and deemed savings. Of the five common cost-effectiveness tests for energy efficiency, the societal cost test (SCT) factors in environmental and other nonenergy resource savings (Guidehouse 2020). Currently just a handful of states and the District of Columbia use the SCT as their primary cost-effectiveness test (NESP 2021). A few other states use traditional cost-effectiveness tests like the total resource cost test and incorporate a dollar or percentage value for nonenergy benefits (Guidehouse 2020, ACEEE 2018). Accounting for benefits beyond energy savings can make implementation of comprehensive retrofits more cost effective and support design of appropriate program incentives and compensation.

## EDUCATION AND WORKFORCE SKILLS DEVELOPMENT

As utilities look to expand their comprehensive retrofit programs, they will need a skilled workforce to implement and operate systems-based measures. The U.S. Department of Energy (DOE), through the Workforce Accelerator, national laboratories, universities, and nongovernmental organizations, has generated robust technical resources and tools to develop the necessary workforce. For example, the Better Buildings Workforce Guidelines

effort and the Green Buildings Career Map help identify critical professional competencies needed and the programs and resources that can advance commercial and institutional construction and retrofit activities.

Program administrators can leverage their market power in promoting efficiency measures to demand higher-quality work while helping to ensure that professionals receive the relevant skills training to install and operate systems and maintain them over their life cycles (Srivastava, Awojobi, and Amann 2020). Shorter utility-led trainings can provide technology-specific skill sets as they evolve and educate professionals on how to implement, operate, and analyze systems-based retrofits. Specialized education and training on systems design and performance modeling, technology integration, optimization of operations, and data analytics can help professionals identify retrofit opportunities and ensure that they deliver deep savings.

Support for education and training programs for building staff and service providers, such as the Building Operator Certification (BOC) program, can improve the success of comprehensive retrofits.[6] Training could provide information on good energy management practices and ways to optimize performance through low- or no-cost measures. Educating staff and facility managers on the value proposition of comprehensive retrofits can improve the acceptance of newly installed measures and maximize both measure-driven and behavior-driven savings.

# Strategies for Success

Comprehensive retrofit programs provide a unique opportunity for utilities to act as trusted advisers to their customers and play an active role in their decision-making process. Utilities can educate customers on the most relevant energy-efficient technologies and the combination of measures that can help them achieve deeper savings, provide information on available incentives, and refer them to qualified service providers who can optimize building performance and verify the savings.

The five approaches discussed in this report that can help advance comprehensive retrofits fall into three tiers according to energy savings, the complexity of implementing, the measures included, and resource needs. This tiered approach helps building owners and managers take steps toward the maximum achievable energy performance.

- *Tier 1* approaches deliver lower savings with smaller budgets, as they leverage existing utility programs. This tier includes EBCx programs that coordinate with and

[6] Developed by the Northwest Energy Efficiency Council, the BOC® program achieves measurable energy savings by training individuals responsible for daily operations of buildings on energy-saving operational strategies.

refer customers to other utility programs that incentivize capital improvements to help customers achieve greater savings.
- *Tier 2* approaches deliver medium savings and require a greater degree of coordination to offer measures across multiple systems. This tier includes custom and voluntary certification programs that tie in existing offerings and accommodate high-performance certification programs to help meet customer goals.
- *Tier 3* approaches deliver the highest level of energy savings but are more complex to administer and more costly to implement. This tier includes pay-for-performance programs and programs based on energy consumption patterns, which have more requirements for analysis and documentation as well as lengthy M&V periods.

On the basis of our review of existing programs, we identified multiple strategies utilities can adopt to scale their comprehensive retrofit programs. Figure 4 shows how program administrators can expand programs and best serve their customers. For utilities looking to start new programs, there is a range of approaches from simple to most complex. For utilities expanding existing programs, there is a list of practical actions ranked in order of priority and amount of time needed to implement.

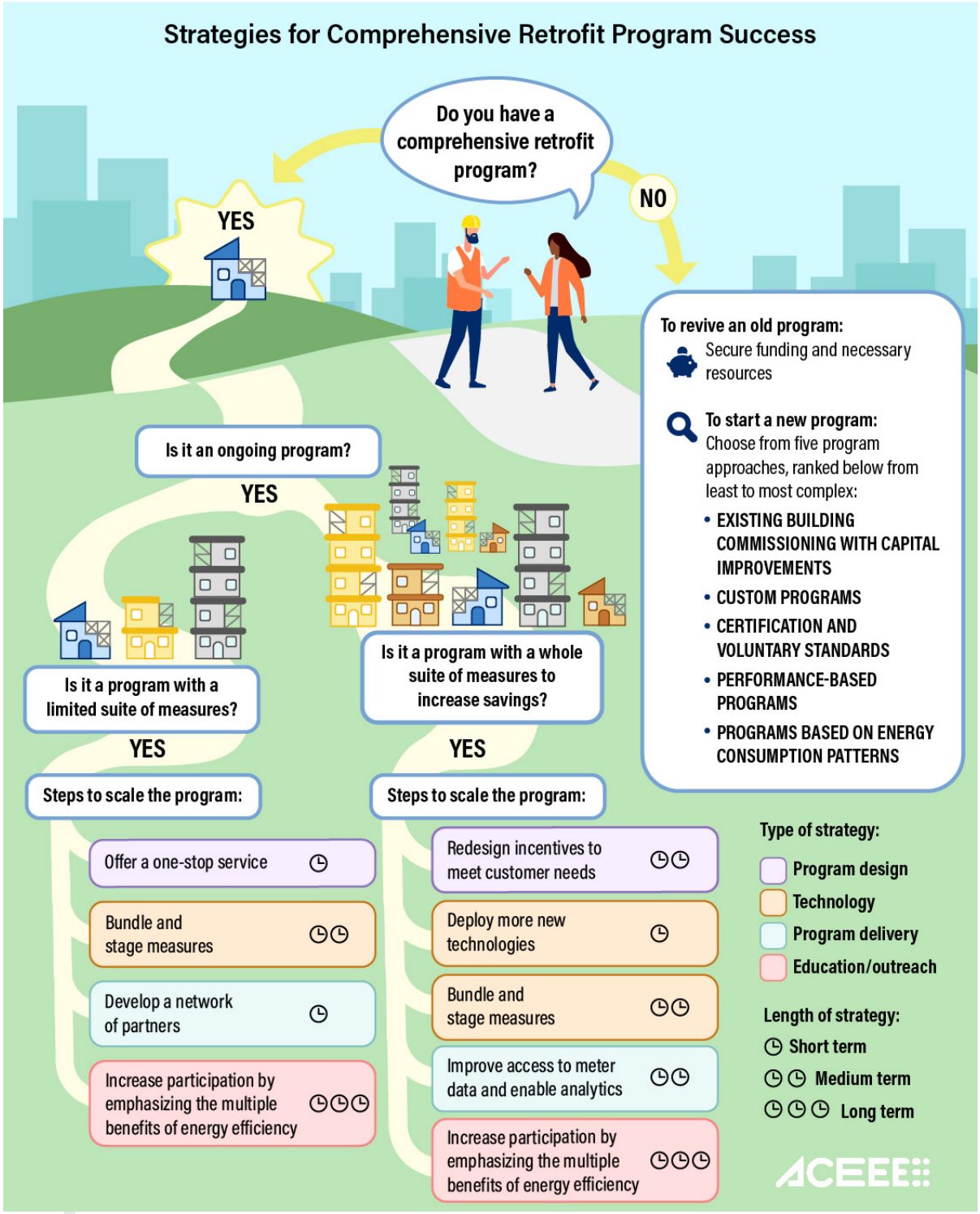


**Figure 4. Strategies for program administrators to scale their programs and best serve their customers**

## SECURE FUNDING AND NECESSARY RESOURCES

Utilities can tap into a variety of federal, state, and local funding sources as they develop new retrofit programs and expand existing ones. One promising source is the DOE's State Energy Program (SEP), which directs funding to state energy offices for local retrofits,

strategic energy management, and other energy efficiency work (DOE 2022). Despite SEP's broad reach, it is not the only funding source that utilities can leverage for a single program. Utilities can combine multiple funding streams in a practice known as braided funding; this is notably effective when a project can accomplish multiple goals at once, such as a weatherization program that simultaneously improves energy efficiency and tenant health (Hayes and Gerbode 2020). Legislators and regulators can encourage more extensive retrofit projects by making it easier for utilities to access braided funding.

## OFFER A ONE-STOP SERVICE

Programs can be designed to offer one-stop service including energy assessments to develop project scope, significant incentives and financing options, technical assistance, and post-installation follow-up to ensure that performance and savings continue. This model is successfully used by ESCOs, which bring together multiple professionals to manage aspects of project scoping, implementation, and management.

Utilities could partner with local cities to create programs that offer streamlined services for large and medium-size buildings and connect customers with energy efficiency service and technical assistance. For example, the city of Cambridge, Massachusetts, has partnered with the local investor-owned utility, Eversource, to help building owners, operators, and tenants reduce their energy use, save money, and lower carbon emissions. The Cambridge Building Energy Retrofit program serves buildings of more than 25,000 square feet or 50 units and offers a one-stop shop combining energy efficiency services with technical support (City of Cambridge 2020). The program incorporates comprehensive planning, expert guidance from Eversource's energy efficiency team including vendor referrals, tailored offerings and incentives, and training for facilities staff.

## REDESIGN INCENTIVES TO MEET CUSTOMER NEEDS

Utility incentives, rebates, and financing options for comprehensive retrofits can help customers overcome first-cost and total-project-cost issues. Because comprehensive retrofits combine multiple measures and strategies across end uses, regulatory changes may be needed to enable new programs to offer incentives that support system retrofits with longer lifetimes and payback periods. This requires moving away from incentive payments tied to measure-based savings and program evaluations that require individual measures to pass cost-effectiveness tests.

A combination of front-loaded incentives to implement a package of measures and performance-based incentives can reduce the financial and performance risk for customers and program administrators while driving deeper energy savings. This can be especially important for certain customers with limited access to investment capital and financing, such as multifamily property owners and small businesses.

Front-loaded incentives address the upfront cost associated with comprehensive retrofits. Such incentives help customers offset total project costs and ensure they do not pay the higher first-costs associated with comprehensive retrofits. Performance incentives are paid

to the customer according to the actual energy savings after one year or on a more frequent basis. They are made only after program M&V requirements are met and targeted savings are achieved. Almost all pay-for-performance programs use this combination approach in designing customer incentives. For example, NJCEP's program for existing buildings paid incentives in three phases: after initial review and approval of a project proposal; after installation and commissioning, and after the approval of a 12-month report showing that savings targets have been achieved. Two out of the three incentives were paid out early in the process to help reduce customers' costs.

Incentives can also help reduce project expenses and increase program participation by covering costs for energy modeling and/or energy audits prior to developing a scope of work. Simplifying M&V requirements and including payments for persistent savings can encourage deeper cuts in energy usage.

## BUNDLE AND STAGE MEASURES

One of the key barriers to comprehensive retrofits is their cost and long payback period. Federal buildings are allowed 10 years for cost recovery and in certain cases even longer. In contrast, commercial building owners consider three to five years, or sometimes even less, as the threshold for cost recovery from building investments. Combining measures with long-term paybacks and those with short-term paybacks can create an acceptable return and much higher value for customers. Performance contracting models typically follow this pattern and combine capital measures with occupant-behavior and O&M measures in the scope of work.

The deployment of more comprehensive projects can help reduce material and labor costs, due to economies of scale and improvements in installation and commissioning processes. This will also bring down the cumulative payback period and make comprehensive retrofits financially acceptable.

Even though bundling energy efficiency measures enables deeper energy savings, many building owners and managers are unable to implement a whole suite of measures at once. A staged retrofit offers the customer the option to split a comprehensive project into multiple phases, making the process and the investment less overwhelming. It allows building owners to address immediate needs first while ensuring ongoing engagement to support the completion of a full retrofit over time.

Staging can also help programs scale up retrofit projects and achieve deeper savings (Amann, Srivastava, and Henner 2021). ComEd uses this approach in its custom solutions program for commercial and public sector buildings. Under the program, participants have the option to implement multiple measures in a single project, in phases over two years compared to all at once, and still receive the additional incentive payment (ComEd 2021). Staggering the implementation of measures not only reduces the upfront capital investment, but also provides time for savings from the earlier upgrades to build up, and these can be used to finance the remaining measures.

## DEPLOY MORE NEW TECHNOLOGIES

Comprehensive retrofits are often perceived as complex projects because they require identification and implementation of multiple efficiency measures. Creating standardized packages of efficiency measures can streamline the process for customers. Additionally, incorporating demand flexibility and grid-interactive efficient building (GEB) technologies with traditional efficiency measures can drive deeper energy savings, demand reductions, and carbon savings. Advanced technologies such as connected lighting, EMIS with GEB control, and battery storage help optimize energy use for grid service, meet occupant needs, and reduce customer costs. They can even provide better integration with customer-sited distributed energy resources and grid support. Programs can partner with product manufacturers to identify opportunities for combining new technologies and controls, and they can work with contractors to deploy packages that lower energy use in more buildings.

Simple design for these newer technology packages, as well as easy installation and assessment methods, can help alleviate customer hesitancy. Few programs we reviewed have already done this and relied on building simulation tools or customized engineering analysis of meter data to identify measures and estimate and verify savings. Even though this process can be burdensome for both the customer participating in a program and the implementer who evaluates it, easy-to-use tools that can analyze monthly meter data and provide recommendations for multi-technology packages can help make such packages more accessible.

## DEVELOP A NETWORK OF PARTNERS

Utilities should identify key partnerships that can increase program participation and success. This type of partnership can enable utilities to offer turnkey services for comprehensive retrofit projects. Programs can be designed with pre-approved partners who conduct impartial assessments, develop project scopes with measures that deliver high energy savings, install and commission the measures, and perform M&V to ensure that the project delivers the savings.

Depending on the type of comprehensive retrofit program, utilities and program managers should evaluate whether it makes sense for them to partner with a third-party implementer or an energy service provider. For example, NJCEP successfully contracted with TRC Companies to implement its Pay for Performance—Existing Buildings program to reduce energy consumption in commercial, industrial, and institutional buildings. Similarly, Ameren Illinois partnered with energy service provider Allumia to offer customers funding, design, installation, and management services for upgrades.

This type of partnership can increase the pool of technically competent service providers and contractors who can deliver comprehensive retrofits. To ensure success, program managers may need to offer select partners one-on-one training on complex projects so they can learn how to deliver deep retrofits. Some programs may even require approved partners and contractors to receive training on a regular basis to remain in the program. This ensures that partners stay current with new skills and proficiencies.

## IMPROVE ACCESS TO METER DATA TO ENABLE ANALYTICS

Utilities and energy service providers should accelerate the deployment of analytical tools that leverage AMI data to identify measures, estimate and verify savings, and visualize performance. Getting data from the utility meter to the program administrator, customer, or third-party contractor supporting implementation can simplify the program M&V process, including the development of building energy-use baselines.

Analytical tools provide real-time energy use and emissions data to program implementers. They also offer actionable insights and recommendations for customers and improve transparency on savings achieved and program progress. The use of data analytics can also help program administrators identify good prospects, support targeted outreach efforts to those customers, and help them achieve deep savings.

## INCREASE PARTICIPATION BY EMPHASIZING THE MULTIPLE BENEFITS OF ENERGY EFFICIENCY

Studies show that improved health and safety are among the most compelling reasons for customers to invest and participate in energy efficiency (ACEEE 2018; Wilson et al. 2016; Gillingham et al. 2021). Studies have estimated that quantifiable nonenergy benefits, including improved comfort and health, make up 25–50% of the total benefits from energy efficiency (Russell et al. 2015; Livingston et al. 2014). Yet many utilities do not take advantage of the opportunity to communicate these benefits from comprehensive retrofits. The data are often not collected, as several state utility regulators do not require that this information be reported. Evaluating these additional benefits to the extent possible and improving analytical methods can aid utilities and regulators, providing ways to include the full set of value streams in programmatic and regulatory approaches.

Efficiency programs have sometimes relied on surveys to evaluate nonenergy benefits from building retrofits. User surveys are a popular method for measuring benefits that are typically difficult to quantify, like health and safety, comfort, and new knowledge. Since these values are quite subjective, programs may use interviews to supplement survey data and compare and rank benefits. This can expand the way comprehensive programs are evaluated and incentivize participation.

Utilities can also promote broader societal benefits from comprehensive retrofits, such as reducing greenhouse gas emissions and improving public health by lowering the incidence of respiratory diseases. Comprehensive retrofit program evaluations could incorporate the relevant nonenergy benefits from the Neighborhood and Built Environment category objectives outlined under the social determinants of health (SDOH) framework, developed

by the World Health Organization.[7] SDOHs are commonly discussed in housing work but can provide commercial program administrators a basis for evaluating the multiple benefits of comprehensive retrofits. In the context of SDOH, residential retrofits have been associated with reduced asthma rates, and general building improvements like air sealing are linked to improved respiratory health (Denson and Hayes 2018). Demonstrating these benefits from comprehensive retrofits could encourage more customers to participate.

Program implementers should consider characterizing and quantifying the occupant and societal benefits of comprehensive retrofits. Once documented, the data could support efforts to reach individual customers and relevant decision makers to increase program participation and provide policymakers compelling evidence on the value of comprehensive retrofits in meeting city, state, and federal energy and climate goals.

# Conclusion

A large portion of the commercial buildings that will be standing in 2050 have already been built. Therefore, retrofitting existing commercial buildings is critical to achieving U.S. energy and climate goals. Our research shows comprehensive retrofits with measures implemented across building systems are likely to achieve deeper savings than single-measure retrofits.

Several approaches show promise in increasing the number of participating projects and are providing valuable pathways to achieve deeper savings and make existing buildings more efficient. These approaches offer a scope of services including data collection through facility assessments and benchmarking, development of scope of work using meter data and energy modeling, financing options, implementation and commissioning of efficiency measures, and rigorous M&V of savings.

Many programs we reviewed are administratively complex and more costly than deemed programs and are cost effective only when applied to customers that have substantial energy savings potential. As a result, they tend to be focused on large commercial facilities or those that are energy intensive. Program administrators can better design their programs to appeal to a broader group of customers. EBCx-based approaches present savings opportunities for the small and medium-size business sector, but solutions can be hard to scale due to high transaction costs. Packaged solutions offered through a one-stop service program model and workforce training can help lower administrative burdens and increase accessibility to programs. Effective retrofit programs will still require adequate budgets and

[7] The Centers for Disease Control and Prevention (CDC) defines SDOH as "conditions in the places where people live, learn, work, and play that affect a wide range of health risks and outcomes." SDOH includes five domains: economic stability, education, health and health care, neighborhood and built environment, and social and community context. The topics in the neighborhood and built environment domain include quality of housing, access to transportation, air and water quality, availability of healthy foods, and neighborhood crime.

strong regulatory support. Programs that articulate the services and benefits customers receive are likely to see greater participation.

Although comprehensive commercial retrofits are nowhere near the scale needed to meet emissions-reduction goals in the building sector, the programs identified in this research prove just how powerful comprehensive retrofits can be. Building owners and managers wanting to meet their energy and emissions goals are fortunate to have an array of compelling models to choose from and would do well to prioritize comprehensive over single-measure approaches.

# References

ACEEE. 2018. *Cost-Effectiveness Tests: Overview of State Approaches to Account for Health and Environmental Benefits of Energy Efficiency*. Washington, DC: ACEEE. www.aceee.org/topic-brief/he-in-ce-testing.

———. 2019. *Emerging Opportunities: Energy as a Service*. Washington, DC: ACEEE. www.aceee.org/topic-brief/eo-energy-as-service#:~:text=This%20brief%20explores%20energy%20as,based%20on%20the%20energy%20saved.

Amann, J., and E. Mendelsohn. 2005. *Comprehensive Commercial Retrofit Programs: A Review of Activity and Opportunities*. Washington, DC: ACEEE. www.aceee.org/research-report/a052.

Amann, J., R. Srivastava, and N. Henner. 2021. *Pathways to Residential Deep Energy Reductions and Decarbonization*. Washington, DC: ACEEE. www.aceee.org/research-report/b2103.

ASE (Alliance to Save Energy) 2016. *Greater than the Sum of Its Parts: The Case for a Systems Approach to Energy Efficiency*. Washington, DC: ASE. www.ase.org/greater-sum-its-parts-case-systems-approach-energy-efficiency-full-report

———. 2020. *Commercial Strategic Energy Management Program: Energy Trust of Oregon Program Summary*. Washington, DC: ASE. www.ase.org/energy-trust-oregons-commercial-strategic-energy-management-program.

Baker, M., L. Paulo, C. Smith, and R. Ridge. 2020. "Digging into Industrial SEM—A Comprehensive Evaluation Design for a Comprehensive Program." *Proceedings of the 2020 ACEEE Summer Study on Energy Efficiency in Buildings* 4: 393–405. Washington, DC: ACEEE. www.aceee.org/files/proceedings/2020/event-data.

Best, C., M. Fisher, and M. Wyman. 2019. "Case Study: Policy Pathways to Meter-Based Pay-for-Performance." *Recurve*, September 3. www.recurve.com/blog/policy-pathways-to-meter-based-pay-for-performance.

Birschbach, J. 2020. *Strategic Energy Management*. Peoria: Ameren Illinois. amerenillinoissavings.com/wp-content/uploads/2021/01/PY20-JULY2020-July-Webinar-SEM-FINAL.pdf.

Burgess, J., L. Thomas, K. Belkhayat, J. Raker, and R. Tonielli. 2018. "A Comparative Analysis of Customer Success Factors in Meter Data-Driven Whole Building Programs." *2018 ACEEE Summer Study on Energy Efficiency in Buildings* 4: 1–11. Washington DC: ACEEE. www.aceee.org/files/proceedings/2018/index.html#/event/event-data/details.

Carmichael, C., and M. Gartman. 2015. *Deep Energy Retrofits Using Energy Savings Performance Contracts: Success Stories*. Basalt: RMI (Rocky Mountain Institute). rmi.org/insight/deep-energy-retrofits-using-energy-savings-performance-contracts-success-stories/.

Carmichael, C., R. Esau, and E. Taylor. 2021. *Grid-Interactive Efficient Buildings Made Easy: A GSA Building Manager's Guide to Low- and No-Cost GEB Measures*. Basalt: RMI (Rocky Mountain Institute). Washington, DC: GSA (General Services Administration). sftool.gov/Content/attachments/No-Cost GEB Measures Guidance.pdf.

CEE (Consortium for Energy Efficiency). 2018. *Comparative Analysis of Meter Data-Driven Commercial Whole Building Energy Efficiency Programs*. Middleton, MA: CEE. library.cee1.org/content/commercial-whole-building-performance-committee-program-summary/.

City of Cambridge. 2020. "Cambridge Building Energy Retrofit Program: Community Development." www.cambridgema.gov/Services/buildingretrofitprogram.

ComEd. 2021. *Comprehensive Energy Savings Worksheet*. Chicago: ComEd. [https://webtools.dnvgl.com/projects62/Portals/3/TA_Files/2019Worksheets/ComprehensiveEnergySavingsWorksheet.pdf]

Denson, R., and S. Hayes. 2018. *The Next Nexus: Exemplary Programs That Save Energy and Improve Health*. Washington, DC: ACEEE. www.aceee.org/sites/default/files/publications/researchreports/h1802.pdf.

DOE (Department of Energy). 2016. *Advanced Metering Infrastructure and Customer Systems: Results from the Smart Grid Investment Grant Program*. Washington, DC: DOE. www.energy.gov/sites/prod/files/2016/12/f34/AMI Summary Report_09-26-16.pdf.

———. 2022. "State Energy Program Guidance." www.energy.gov/eere/wipo/state-energy-program-guidance.

Energy Trust of Oregon. 2022. "Commercial Strategic Energy Management." www.energytrust.org/commercial/strategic-energy-management/.

ENERGY STAR. 2022. "Small and Medium-Sized Office Buildings." www.energystar.gov/buildings/resources_audience/small_medium_offices

Gillingham, K., P. Huang, C. Buehler, J. Peccia, and D. Gentner. 2021. "The Climate and Health Benefits from Intensive Building Energy Efficiency Improvements." *Science Advances* 7 (34): p.eabg0947. www.science.org/doi/pdf/10.1126/sciadv.abg0947.

Gold, R., C. Waters, and D. York. 2020. *Leveraging Advanced Metering Infrastructure to Save Energy*. Washington, DC: ACEEE. aceee.org/research-report/u2001.

Guidehouse. 2020. "Non-Energy Benefits and Public Goods." beccconference.org/non-energy-benefits-and-public-goods-understanding-and-overcoming-the-cost-effectiveness-challenges-of-programs-that-address-equity/.

Hayes, S., and C. Gerbode. 2020. *Braiding Energy and Health Funding for In-Home Programs*. Washington, DC: ACEEE. www.aceee.org/sites/default/files/pdfs/h2002.pdf.

IMT (Institute for Market Transformation). 2021. Comparison of U.S. Building Performance Standards. Washington, DC: IMT. www.imt.org/resources/comparison-of-u-s-building-performance-standards/.

Jungclaus, M., C. Carmichael, C. McClurg, M. Simmons, R. Smidt, K. Hydras, S. Conger, A. Zhivov, F. Winter, J. Shonder, and C. Nasseri. 2017. "Deep Energy Retrofits in Federal Buildings: The Value, Funding Models, and Best Practices." *ASHRAE Transactions* 123 (1): 55–70. rmi.org/wp-content/uploads/2017/06/ASHRAE-D-LV-17-006.pdf.

Jump, D., B. Maloney, R. Chude, W. Hon, M. Blum, and G. Towns. 2020. "Playing the Long Game: Case Studies of Three Meter-Based Programs." 2020 ACEEE Summer Study on Energy Efficiency in Buildings 4: 140–53. Washington, DC: ACEEE. www.aceee.org/files/proceedings/2020/event-data.

Kramer, H., G. Lin, C. Curtin, E. Crowe, J. Granderson. 2020. *Proving the Business Case for Building Analytics*. Prepared by Berkeley Lab. Washington, DC: DOE. doi.org/10.20357/B7G022.

Kwatra, S., and C. Essig. 2014. *The Promise and Potential of Comprehensive Commercial Building Retrofit Programs*. Washington DC: ACEEE. www.aceee.org/sites/default/files/publications/researchreports/a1402.pdf.

LADWP (Los Angeles Department of Water and Power). 2019. "Custom Performance Program."www.ladwp.com/ladwp/faces/ladwp/commercial/c-savemoney/c-sm-rebatesandprograms/c-sm-rp-cpp;jsessionid=2RGHhXrS82Kv1n61RW0VvpScfpM1C6qtyTyDvsGGv3Z3Tr2WqDtr!-153507283?_afrLoop=53371433894986&_afrWindowMode=0&_afrWindowId=null#%40%3F_afrWindowId%3Dnull%26_afrLoop%3D53371433894986%26_afrWindowMode%3D0%26_adf.ctrl-state%3Dcporf6e4l_4.

Lanciani, A., J. Smith, W. Larsen, D. Ouellette, M. Zeller, N. Altfeather, N. Minderman, and S. Warkentin. 2020. "Strategic Energy Management: Evaluating the Savings from Behavior, Operations, Maintenance, and Capital Improvements." *Proceedings of the 2020 ACEEE Summer Study on Energy Efficiency in Buildings* 4: 169–81. Washington DC: ACEEE. www.aceee.org/files/proceedings/2020/event-data.

Livingston, O., P. Cole, D. Elliot, and R. Bartlett. 2014. *Building Energy Codes Program: National Benefits Assessment, 1992–2040*. Prepared by PNNL. Washington, DC: DOE.

www.energycodes.gov/sites/default/files/documents/BenefitsReport_Final_March20142.pdf.

Mass Save. 2015. *Improve Your Bottom Line: Energy Efficiency Services for all Types of Multi-Family Facilities*. Boston: Mass Save. www.masssave.com/-/media/Files/PDFs/Save/Energy-Assessment/MultiFamilyProgramBrochure.pdf?la=en&hash=1A2EAE6397E702A045594AF7761E66ACE0A90DF5.

Mills, E. and P. Mathew. 2012. *Monitoring-Based Commissioning: Benchmarking Analysis of 24 University Buildings in California*. Prepared by Berkeley Lab. Washington, DC: DOE. www.osti.gov/servlets/purl/1173151.

Nadel, S., and L. Ungar. 2019. *Halfway There: Energy Efficiency Can Cut Energy Use and Greenhouse Gas Emissions by Half in 2050*. Washington DC: ACEEE. www.aceee.org/research-report/u1907.

NASEO (National Association of State Energy Officials). 2021. "Energy Savings Performance Contracting (ESPC) and Related Models." www.naseo.org/issues/energy-financing/espc.

National BPS Coalition. 2022. "About the National BPS Coalition." nationalbpscoalition.org/.

NEEP (Northeast Energy Efficiency Partnerships). 2019a. *Is Pay for Performance Performing?* Lexington, MA: NEEP. neep.org/sites/default/files/resources/P4PWebinarIsPayForPerformancePerforming2.pdf.

———. 2019b. *Readiness for Advanced Measurement and Verification in the Northeast*. Lexington, MA: NEEP. portal.ct.gov/-/media/DEEP/energy/Advanced-Measurement-and-Verification/2019-NEW-ENG-readiness-for-AMV-WEB.pdf.

NESP (National Energy Screening Project). 2021. "Database of Screening Practices (DSP)." Accessed September. www.nationalenergyscreeningproject.org/state-database-dsesp/database-of-state-efficiency-screening-practices/.

NJCEP (New Jersey's Clean Energy Program). 2020. *New Jersey's Clean Energy Program Report Submitted to the New Jersey Board of Public Utilities.* www.njcleanenergy.com/files/file/NJCEP%20Quarterly%20Reports/FY20/4QFY20%20Report%20-%20FINAL.pdf

Pearce, E., F. Dearth, and M. Schantz. 2018. "Getting Ahead of the Savings Curve: Utility Pay-For-Performance Program Design for Commercial Real Estate Customers." *Proceedings of the 2018 ACEEE Summer Study on Energy Efficiency in Buildings* 4: 1–12. Washington, DC: ACEEE. www.aceee.org/files/proceedings/2018/index.html#/event/event-data/details.

PG&E (Pacific Gas and Electric). 2021. *PG&E Manual for Commercial and Public Sector Whole Building Performance Based Retrofit Program Offering.*

www.pge.com/pge_global/common/pdfs/save-energy-money/facility-improvements/custom-retrofit/PGE-Whole-Building-Program-Manual.pdf

PNNL (Pacific Northwest National Laboratory). 2011. *Advanced Energy Retrofit Guide: Practical Ways to Improve Energy Performance—Office Buildings*. Prepared by PNNL. Washington, DC: DOE. www.pnnl.gov/main/publications/external/technical_reports/PNNL-20761.pdf.

Price, R., and M. Scerbo. "How Can Energy Service Companies and Utilities Partner More Closely to Boost System-Level Efficiency?" Washington, DC: Alliance to Save Energy. www.ase.org/blog/how-can-energy-service-companies-and-utilities-partner-more-closely-boost-systems-level

PSE (Puget Sound Energy). 2022. "Monitoring-Based Commissioning." www.pse.com/business-incentives/commissioning-programs/monitoring-based-commissioning.

RMI (Rocky Mountain Institute). 2015. *The Path to a Deep Energy Retrofit: Using an Energy Savings Performance Contract*. Washington, DC: GSA (General Services Administration). d231jw5ce53gcq.cloudfront.net/wp-content/uploads/2017/04/2015-02_Path_to_DR_using_ESPC.pdf.

Regnier, C., P. Mathew, A. Robinson, J. Shackelford, and T. Walter. 2020. *Systems Retrofit Trends in Commercial Buildings: Opening Up Opportunities for Deeper Savings*. Prepared by Berkeley Lab. Washington, DC: DOE. buildings.lbl.gov/sites/default/files/Regnier%20-%20Systems%20Retrofit%20Trends.docx__1.pdf.

Regnier, C., K Sun., T Hong., and M. Piette, 2018. "Quantifying the benefits of a building retrofit using an integrated system approach: A case study." Energy and Buildings, Volume 159, 332-345. ISSN 0378-7788. https://doi.org/10.1016/j.enbuild.2017.10.090. www.sciencedirect.com/science/article/pii/S0378778817318832)

Relf, G., E. Cooper, R. Gold, A. Goyal, and C. Waters. 2020. *2020 Utility Energy Efficiency Scorecard*. Washington, DC: ACEEE. www.aceee.org/sites/default/files/pdfs/u2004rev_0.pdf.

Russell, C., B. Baatz, R. Cluett, and J. Amann. 2015. *Recognizing the Value of Energy Efficiency's Multiple Benefits*. Washington, DC: ACEEE. aceee.org/research-report/ie1502.

Seattle City Light. 2021. *Energy Efficiency as a Service—Program Manual*. Seattle: Seattle City Light. powerlines.seattle.gov/wp-content/uploads/sites/17/2021/01/ProgramManualEEaSV2.1-1.pdf.

———. 2022. "Energy Efficiency as a Service." powerlines.seattle.gov/eeas/.

Seattle Office of Sustainability & Environment. 2017. "About Building Tune-Ups." www.seattle.gov/environment/climate-change/buildings-and-energy/building-tune-ups/about-building-tune-ups.

Specian, M., R. Gold, and J. Mah. 2022. A Roadmap for Climate-Forward Efficiency. Washington, DC: ACEEE. www.aceee.org/research-report/research-report/u2202.

Srivastava, R., M. Awojobi, and J. Amann. 2020. *Training the Workforce for High-Performance Buildings: Enhancing Skills for Operations and Maintenance*. Washington, DC: ACEEE. www.aceee.org/research-report/b2003.

Szinai, J., M. Borgeson, and E. Levin. 2017. *Putting Your Money Where Your Meter Is: A Study of Pay-for-Performance Energy Efficiency Programs in the United States.* New York: NRDC (National Resource Defense Council). doi.org/10.1016/j.apcata.2009.06.029.

WHO (World Health Organization). 2021. "Social Determinants of Health." www.who.int/teams/social-determinants-of-health.

Wilson, J., D. Jacobs, A. Reddy, E. Tohn, J. Cohen, and E. Jacobsohn. 2016. *Home Rx: The Health Benefits of Home Performance – A Review of the Current Evidence*. Prepared by NCHH (National Center for Healthy Housing). Washington, DC: DOE. www.energy.gov/eere/buildings/downloads/home-rx-health-benefits-home-performance-review-current-evidence.