
# Realizing the Energy Efficiency Potential of Small Buildings

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A REPORT BY:

National Trust *for* Historic Preservation
Preservation Green Lab

IN PARTNERSHIP WITH:

nbi new buildings institute

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The market analysis and characterization of the small building sector (Part I) and many of the recommendations (Part II) presented in this report are

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# ABOUT THE PROJECT PARTNERS

## NATIONAL TRUST FOR HISTORIC PRESERVATION

(www.PreservationNation.org)

NTHP, a privately funded nonprofit organization, provides leadership, education, advocacy, and resources to save America's diverse historic places and revitalize our communities. Recipient of the National Humanities Medal, the Trust was founded in 1949, and now has more than 300,000 members and supporters nationwide.

## PRESERVATION GREEN LAB

(www.PreservationNation.org/greenlab)

PGL is a sustainability think tank and national leader in efforts to advance the reuse and retrofit of older and historic buildings. PGL collaborates with partners to develop innovative research, advance public policy, and increase private investment to reduce demolitions and improve building performance. By providing proven solutions to policy makers and building professionals, PGL curbs carbon emissions and enhances the unique character of vibrant neighborhoods. PGL is based in Seattle, Wash. and is a project of NTHP.

## NEW BUILDINGS INSTITUTE

(www.newbuildings.org)

NBI is a nonprofit organization that works collaboratively with commercial building market players — governments, utilities, energy efficiency advocates, and building professionals — to remove barriers to energy efficiency.

## NATIONAL RENEWABLE ENERGY LABORATORY

(www.nrel.gov)

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

## U.S. DEPARTMENT OF ENERGY, OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY

(www.eere.energy.gov)

The U.S. DOE's Office of Energy Efficiency and Renewable Energy invests in clean energy technologies that strengthen the economy, protect the environment, and reduce dependence on foreign oil.

# EXECUTIVE SUMMARY

Small commercial buildings – those smaller than 50,000 square feet – offer substantial and immediate energy efficiency opportunities and cost savings. The Small Buildings and Small Portfolios (SBSP) sector contains 95 percent of all commercial buildings by number and represents 47 percent of the energy consumption in all non-mall commercial buildings. However this building stock has received little attention in the growing energy efficiency marketplace compared to larger and institutionally owned counterparts, in part because of the market's vast scale, physical diversity, and the disparate interests of its stakeholders.

**While acknowledging these challenges, this study estimates that profitable investments in energy conservation can generate $30 billion in annual energy cost savings, improving the financial performance of millions of small businesses throughout the United States.**

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In support of the development of a national roadmap for energy efficiency in the SBSP sector by the U.S Department of Energy, this report summarizes three years of research by Preservation Green Lab (PGL) about the characteristics of small commercial buildings, analyzes the defining elements of the SBSP sector, and recommends key actions that are necessary to realize the technical potential for energy savings that exists in small buildings and businesses.

## KEY RESEARCH FINDINGS

### THE SMALL COMMERCIAL BUILDINGS MARKET IN THE U.S. IS VAST, AND MAXIMIZING ENERGY PRODUCTIVITY IN THESE BUILDINGS COULD REDUCE TOTAL ENERGY CONSUMPTION IN THE OVERALL COMMERCIAL SECTOR BY AS MUCH AS 17 PERCENT USING CURRENT, COST EFFECTIVE TECHNOLOGY.

The SBSP sector represents 4.4 million small buildings, with an average size of approximately 8,000 square feet. These buildings contain 7.0 million business establishments, 84 percent (5.9 million buildings) of which are owned by small businesses, or firms with fewer than 500 employees. Conversely, approximately 16,000 larger firms hold portfolios totaling 700,000 buildings – an average of 46 buildings per firm.

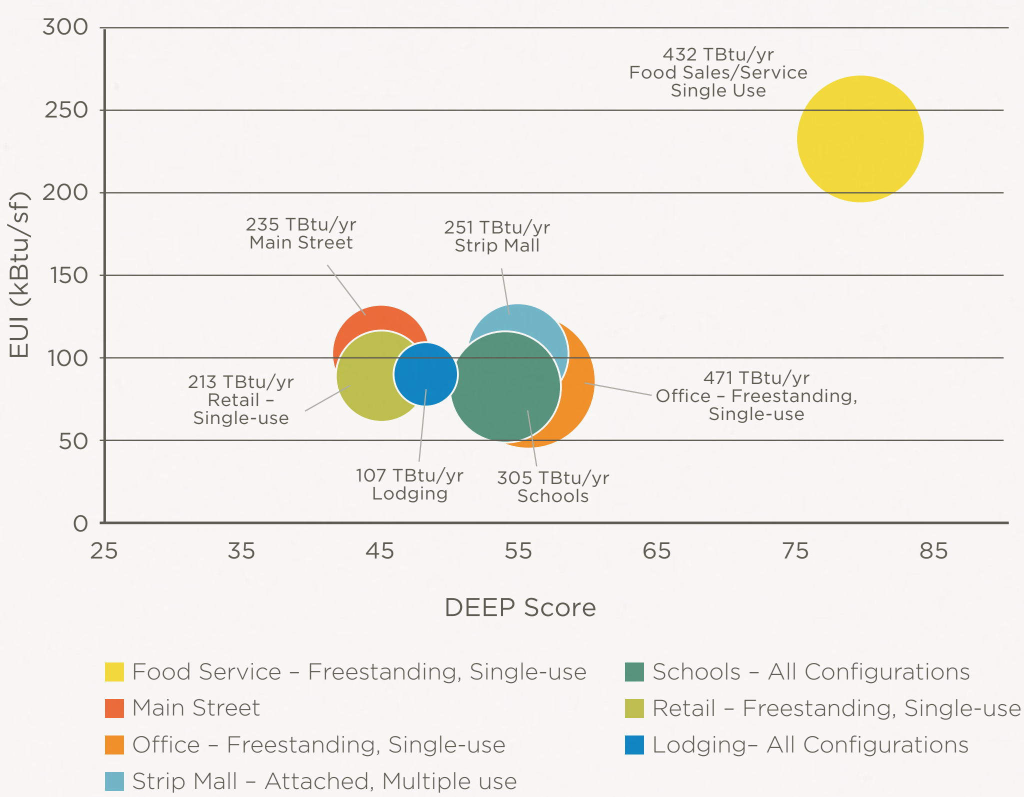
Cost effective energy savings of more than 45% are possible in small commercial buildings. Compiling research conducted by the National Renewable Energy Laboratory, the Pacific Northwest National Laboratory, the Energy Star program, and the American Society of Heating, Refrigeration, and Air Conditioning Engineers, PGL estimates that the current potential for economically viable savings in buildings typical of the SBSP market ranges from 27 percent to 59 percent of current energy use, depending on building type, and can yield annual energy savings of 1.07 Quadrillion Btu or 17 percent of energy consumption in the commercial sector as a whole.

**A high proportion of energy use in small commercial buildings is concentrated in a few building types, making a fragmented market easier to access with targeted programs.**

Seven primary building types represent the majority of sector energy consumption at 2.0 Quadrillion Btu of energy annually: food service, Main Street (defined as attached, multiple-use) buildings, strip mall, lodging, retail, office, and schools. These types represent more than 2 million buildings, 19 billion square feet, and 3.6 million businesses.

Buildings typical of Main Street style commercial districts are especially noteworthy because they are energy intensive and offer significant potential for deep energy savings due to of their unique physical features. The close relationships between owners and occupants also help to alleviate a significant barrier to entry in this market.

## Deep Energy Efficiency Potential (DEEP) Rating for Target Building Types with Average Energy Use Intensity and Total National Energy Use




Source: CBECS 2003

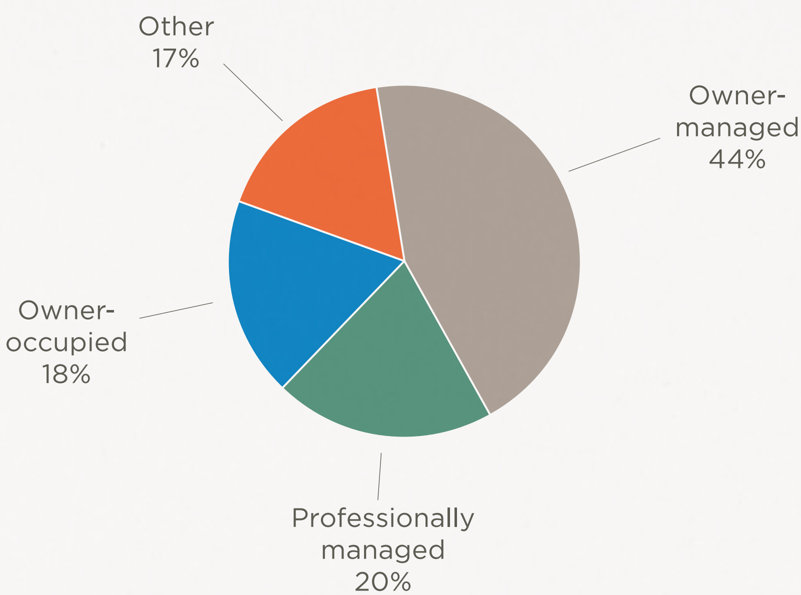


The DEEP score is an index that assembles four components onto a single scale of 0 to 100. The index ranks building types by their potential for achieving broad market acceptance for deep energy efficiency retrofit: energy density, EUI ratio, market factor, and scale factor. Descriptions of DEEP components can be found in Appendix B.

**There are great similarities between the residential sector and the small commercial sector, especially the need for simple and scalable solutions.**

Both sectors have millions of buildings and decision makers who are motivated by convenience and emotional drivers. In the case of small commercial buildings, owners and tenants are often motivated by improving business identity and by relationships with peers in the direct vicinity.

Owners are involved with operational decision making in two-thirds of small commercial buildings. The success of utility-based "direct install" conservation programs in serving residential and small commercial customers suggests that both sectors benefit from reliable information and turnkey solutions that minimize the time and capital required to undertake energy-saving projects.

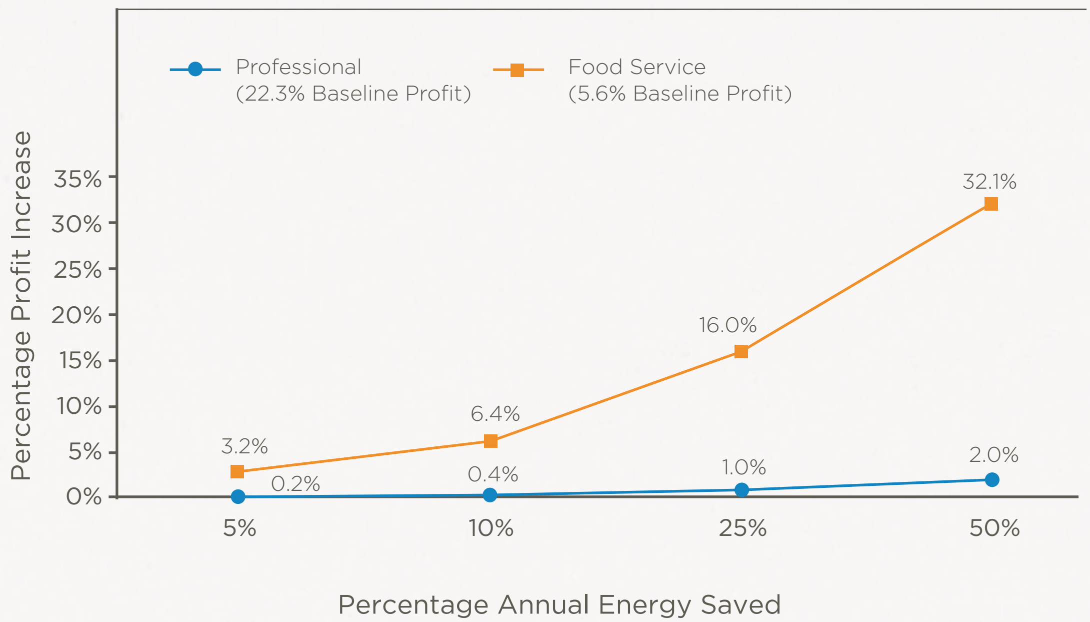





**Buildings that serve businesses with lower profit margins and high energy costs, such as grocery stores and restaurants, often stand to gain the most from energy conservation.**

Small businesses in this market segment have many competing priorities for time and capital, and they tend to adopt energy conservation practices when turnkey solutions to installation and financing are provided.

## Increased Business Profit from Utility Savings




Sources: Internal Revenue Service,
National Trust for Historic Preservation



**Small commercial buildings are often aggregated in business districts of similar building types with high potential for energy savings.**

Most businesses want and need a single point of contact to manage energy projects for them, and existing staff within business districts therefore offer a key to unlocking potential savings in small commercial buildings. District- or neighborhood-scale solutions which take advantage of similar physical building characteristics, business identity motivations, and relationships with peers offer a clear way to address the diverse and fragmented SBSP market, enabling economically scalable applications of retrofit strategies across large numbers of buildings.

## RECOMMENDATIONS

The research and analysis presented in this report show a tremendous opportunity to reduce energy consumption in small commercial buildings nationwide. However, the technical and economic potential of the market must be met with new sources of capital to fund the most promising approaches and technology. Subtle shifts in the business alignment between the sectors stakeholders could have a profound impact on the flow of private capital available to long term energy conservation efforts.

### IDENTIFY WASTE AND MEASURE RESULTS.

*To realize the full energy saving potential of small buildings, energy policy makers must support solutions that measure, motivate, and monetize real energy performance.* While seemingly counter-intuitive, large investments that fundamentally reduce energy demand put long term downward pressure on utility rates. However, many utilities currently make less money if they sell less energy, and so they have few incentives to save besides regulated mandates. Regulators such as utility commissions can play a pivotal role in allowing utilities to make more money saving energy than they now do generating or distributing it. Critical to achieving this shift without forcing additional costs onto ratepayers is allowing utilities to invest in energy saving projects on the customer's side of the meter. Pilot projects are needed that establish and pay fair market value for energy savings that are measured within these conservation projects. At scale, multi-year utility contracts for persistent and verifiable savings can replace the construction of costly power plants and transmission infrastructure.

To realize the full energy saving potential of small buildings, energy policy makers must support solutions that measure, motivate, and monetize real energy performance.

### PLAN FOR IMPROVEMENT.

*To optimize energy efficiency in small buildings, investors must align the timing of energy saving improvements with natural opportunities in the life cycle of a building*, such as during acquisition, operational initiatives, tenant improvements, renovations, and equipment replacement. In contrast, most utility funded conservation incentives occur one time and are intended to support installation of a single piece of equipment. More relationship oriented approaches between utilities, third party service providers, and energy customers tend to deliver utility investments and incentives alongside much more substantial sources of capital and construction expertise, creating opportunities for more comprehensive energy retrofits.

### ENCOURAGE INNOVATIVE NEW BUSINESS MODELS.

The millions of diverse businesses in small buildings represent a large, untapped market for energy efficiency services. As heating, cooling, and lighting system controls become increasingly digital, new hardware and applications are automating how energy customers can save energy. National data standards, such as the Green Button initiative, are enabling the creation of large networks that can mine building energy data and help save customers money. These technological advancements enable new ways to sell energy services. *Utilities* *and local energy regulators must collaborate with industry champions in pilot projects, demonstrating how new technologies can more easily and cost effectively reach small businesses in different types of buildings.*

## KEY ACTIONS FOR STAKEHOLDERS

This report recommends discrete actions for the sector's stakeholders to maximize the energy performance of small buildings and enhance the financial performance of the businesses that rely on them.

| STAKEHOLDER (Primary / Supporting) | DOE | National Labs | National Standards | Energy Regulators | Jurisdictions | Utilities | Industry Champions* | Technology Providers | Energy Service Providers | Government Lenders | Real Estate Associations | Business Associations | Small Businesses | Building Owners | Property Managers |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **STRATEGY 1: Identify Waste, Measure Results** | | | | | | | | | | | | | | | |
| ***1. Quantify the national impact of conservation investments:*** | | | | | | | | | | | | | | | |
| a. Analyze the aggregate impacts on U.S. and state employment, GDP, mineral reserves, and carbon emissions of gradually replacing existing generation and distribution resources with energy savings generated through conservation investments. | Primary | Supporting | | | | | | | | | | | | | |
| ***2. Create the data network necessary to measure energy savings:*** | | | | | | | | | | | | | | | |
| a. Promote the ongoing development of a strong national standard that makes business-level energy data seamlessly available to utility customers, regulators, jurisdictions, financiers, and service providers. | Supporting | Supporting | Primary | Supporting | Supporting | Supporting | Supporting | | | | | | | | |
| b. Invest in the further research and development of technologies that measure energy savings in new and existing buildings and that are compliant with the International Performance Measurement and Verification Protocol for establishing whole building energy performance. | Primary | Supporting | | | | Supporting | Supporting | Supporting | | | | | | | |
| c. Assure customer data privacy and security compliance with Fair Information Practice Principles. | | | Primary | Supporting | Supporting | Supporting | Supporting | Supporting | | | | | | | |
| ***3. Communicate the economic value of eliminating energy waste:*** | | | | | | | | | | | | | | | |
| a. Provide guidance to local energy regulators, utilities and jurisdictions that defines the benefits and costs of measuring the energy used by buildings and paying for realized energy savings. | Primary | Supporting | | | | | Supporting | | | | | | Supporting | Supporting | Supporting |
| ***4. Tie energy standards to measured performance:*** | | | | | | | | | | | | | | | |
| a. Promote solutions to measured energy use in the development of international model codes that are acceptable and cost effective for small building owners and businesses. | Primary | Supporting | Supporting | Supporting | Supporting | | Supporting | | | | Supporting | Supporting | | | |
| b. Develop energy use targets for currently regulated and unregulated loads in both new construction and existing buildings, recognizing the distinct physical and market characteristics of existing buildings to save energy. | Primary | Supporting | Supporting | Supporting | Supporting | | | | | | | | | | |
| ***5. Transform the market through demonstration projects:*** | | | | | | | | | | | | | | | |
| a. Support the implementation of federal, state, and local pilot projects that utilize utility Power Purchase Agreements (PPA) to pay for measured energy savings and that encourage the aggregation of savings across portfolios or districts of small buildings. | Primary | Supporting | Supporting | | | Supporting | | | Supporting | | | | | | |
| b. Support a private market for energy conservation financing that is secured by utility PPAs for measured energy savings. | Supporting | Supporting | | Primary | | Supporting | Supporting | Supporting | Supporting | Supporting | Supporting | Supporting | | | |

| STAKEHOLDER<br>★ Primary<br>★ Supporting | DOE | National Labs | National Standards | Energy Regulators | Jurisdictions | Utilities | Industry Champions* | Technology Providers | Energy Service Providers | Government Lenders | Real Estate Associations | Business Associations | Small Businesses | Building Owners | Property Managers |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **STRATEGY 2: Plan for Improvement** | | | | | | | | | | | | | | | |
| ***1. Recognize the full value of energy efficient buildings:*** | | | | | | | | | | | | | | | |
| a. Establish a national standard for building energy labeling that is based on actual use and is tuned to the characteristics of small buildings. | Primary | | Supporting | | | Supporting | Supporting | Supporting | | Supporting | Supporting | Supporting | Supporting | Supporting | Supporting |
| b. Implement Small Business Administration, Federal National Mortgage Association (Fannie Mae), and Federal Housing Administration underwriting guidelines that require energy use disclosure on appraisals. | Supporting | | | | | Supporting | Supporting | Supporting | | Primary | Supporting | | | | |
| c. Add criteria for energy evaluation to the professional guidelines and standards for tax assessors, appraisers and real estate brokers. | | | Primary | | | Supporting | Supporting | Supporting | | Supporting | Supporting | | | | |
| ***2. Make energy opportunities transparent between owners and occupants:*** | | | | | | | | | | | | | | | |
| a. Collaborate with real estate professional associations to create standardized contract amendments for owners and tenants in small buildings that define the responsibilities, benefits, and costs of energy planning between landlords and tenants. | Primary | | Supporting | | | | Supporting | | | | Supporting | Supporting | | | Supporting |
| b. Estimate the capital needed from different sources to deliver the maximum, cost-effective energy conservation at different points in the building life cycle for each of the different types of small buildings. | | Primary | | | | Supporting | | Supporting | Supporting | | Supporting | Supporting | Supporting | Supporting | Supporting |
| ***3. Create partnerships that support small business and building owners:*** | | | | | | | | | | | | | | | |
| a. Leverage business districts and associations to convene energy planning workshops that include building owners, businesses, contractors, manufacturers, and utility advisors. | | | | | | Primary | Supporting | Supporting | Supporting | | Supporting | Supporting | Supporting | Supporting | Supporting |
| **STRATEGY 3: Align New Business Models Behind Solutions that Scale** | | | | | | | | | | | | | | | |
| ***1. Support R&D that implements information gathering at national scale:*** | | | | | | | | | | | | | | | |
| a. Encourage development of large data sets, essential to statistically significant models that can analyze energy use in small commercial buildings. | Primary | Supporting | Supporting | | | Supporting | | Supporting | | | | | | | |
| b. Create open data platforms that share aggregated building characteristics across multiple utilities to encourage private investment in research, development, and commercialization. | Primary | Supporting | Supporting | Supporting | Supporting | Supporting | Supporting | Supporting | Supporting | | Supporting | | | | |
| c. Continue support of standards for customer-specific data platforms that may remain closed and proprietary to encourage private investments in research, development, and commercialization. | Primary | Supporting | Supporting | | | Supporting | Supporting | Supporting | Supporting | | Supporting | Supporting | Supporting | Supporting | Supporting |
| ***2. Create turnkey solutions for small buildings and businesses:*** | | | | | | | | | | | | | | | |
| a. Recommend packages of 1) low and no cost operating strategies for businesses and for building owners, 2) retrofit measures that produce stable, long-term rates of return within small buildings that could be funded with long-term, external capital, and 3) maintenance strategies for small businesses. | Supporting | Supporting | | | | Primary | Supporting | Supporting | Supporting | | Supporting | Supporting | | | Supporting |
| b. Tailor the content of the packages to smaller general contractors, HVAC contractors, and electricians. | | | | | | Primary | Supporting | Supporting | Supporting | | Supporting | Supporting | Supporting | | |
| ***3. Encourage nationally coordinated programs and business models:*** | | | | | | | | | | | | | | | |
| a. Support national pilot programs that integrate data collection, evaluation, implementation, and measurement and verification. | Primary | Supporting | | Supporting | Supporting | Supporting | Supporting | Supporting | Supporting | | Supporting | Supporting | | | |
| b. Create innovative partnerships to deliver new sources of capital to energy conservation projects, including conventional and tax credit equity, as well as on- and off-balance sheet financing. | | | | Supporting | Supporting | Primary | Supporting | Supporting | Supporting | Supporting | Supporting | Supporting | | | |

*Industry champions: Private sector organizations conducting research, development, funding and public affairs to advance national and local energy conservation.

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# DEFINITIONS

| | |
|---|---|
| Btu | British thermal unit |
| CBECS | Commercial Buildings Energy Consumption Survey |
| DEEP | Deep Energy Efficiency Potential |
| DOE | U.S. Department of Energy |
| EBCx | existing building commissioning |
| ESCO | energy service company |
| EUI | energy use intensity |
| HVAC | heating, ventilation, and air conditioning |
| MUSH | municipal and state governments, universities and colleges, K-12 schools, and hospitals |
| NBI | New Buildings Institute |
| NREL | National Renewable Energy Laboratory |
| NTHP | National Trust for Historic Preservation |
| PGL | Preservation Green Lab |
| PNNL | Pacific Northwest National Laboratory |
| PPA | power purchase agreement |
| SBSP | Small Business and Small Portfolios (sector) |
| sf | square foot |

# INTRODUCTION & BACKGROUND

This report was produced under contract with the National Renewable Energy Laboratory (NREL) to support the effort by the U.S. Department of Energy (DOE) to create a roadmap that serves the energy needs of small buildings and small portfolios (SBSP). The goal of the SBSP roadmap is to identify DOE goals and strategic priorities to pursue in the SBSP sector through 2015. This report focuses on a data-informed analysis of the energy efficiency potential of existing small buildings, and recommends specific strategies and key actions to maximize energy savings in this sector.

## AN IMMEDIATE OPPORTUNITY

There is a tremendous opportunity to reduce energy consumption in commercial and residential buildings, which account for 40 percent of the nation's total energy use. According to Pike Research, energy efficiency projects could save commercial building owners and businesses $35.3 billion in annual energy-related spending by 2020. [1]

There is reason to believe that buildings smaller than 50,000 square feet offer substantial and immediate energy efficiency opportunities and cost savings. Small buildings comprise 95 percent of all commercial buildings by number and more than 40 percent of all commercial floor area. The small buildings segment also represents 47 percent of energy consumption in the commercial sector. [2]

Yet small commercial buildings have received little attention in the growing energy efficiency marketplace. Large commercial office buildings and MUSH market (municipal and state governments, universities and colleges, K-12 schools, and hospitals) buildings are the major focus of financial and technical efficiency programs and services. ENERGY STAR Portfolio Manager includes almost 60,000 commercial office buildings in its benchmarking portfolio, but the median size is 70,000 square feet. [3] Energy service companies (ESCOs) focus almost exclusively on large buildings — public and institutional markets accounted for about 84 percent of ESCO industry revenues in 2008. [4]

Focus on large, institutional buildings is indeed the path of least resistance. The homogeneity of newer buildings with similar physical and use characteristics allows investors and service providers to apply common strategies across large portions of the commercial building stock, achieving consistent energy savings and returns on investment. By focusing primarily on large buildings and conservative energy efficiency targets, the ESCO industry achieved annual revenues greater than $7 billion in 2011. [5]

Small buildings therefore represent a major untapped market for energy conservation. According to a study by Pacific Northwest National Laboratory (PNNL), small, fast food restaurants have the potential to save 45 percent of current energy used on a nationally adjusted basis, providing a 28 percent to 66 percent simple rate of return. [6] Grocery stores can increase profit 16 percent and sales per square foot by $50 by reducing energy costs by 10 percent. [7] Improving both energy and financial performance in this segment is a real and significant opportunity.

This report draws from the PGL research findings to present an important step toward better understanding the characteristics of small buildings and proposes a set of strategies for unlocking the energy saving potential of the small buildings sector.

## BUILDING CHARACTERIZATION

PGL is an ongoing partner with the New Buildings Institute (NBI) to maximize energy savings in the small commercial building sector. PGL provides background research, analysis, and national program implementation; NBI develops technical tools and resources to unlock the energy saving potential of small buildings. Part 1 of this report draws from the team's past research and presents the summary-level findings.

Analysis of the SBSP sector attempts to break a complex building-energy delivery system into its fundamental components:

- Physical characteristics of the sector's buildings
- The sector's participants
- The sector's embedded rules, behavior, and inertia
- The business purpose of the sector's participants.

Realizing substantial energy efficiency gains from a sector relies on first understanding how the buildings operate in the energy industry and on the capacity of businesses that own, operate, and occupy them to save energy.

The PGL team characterized the SBSP sector's buildings according to 1) the business uses within them, using the 2003 Commercial Buildings Energy Consumption Survey (CBECS), and to 2) common physical characteristics of each building type by conducting field surveys of select business districts nationwide. This hybrid approach to building characterization is necessary to evaluate the size of the SBSP sector, the effectiveness of possible physical interventions for energy efficiency, and the associated energy saving potential.

PGL surveyed 779 buildings in ten U.S. markets to establish a comprehensive building typology, adding detail to building types derived from the CBECS database and identifying regional variations that influence energy use. PGL and its consultant JDM Associates conducted a comprehensive market analysis of the small buildings sector.

## DELIVERING ENERGY EFFICIENCY

Part 2 of this report is an analysis of the relationship between the basic elements of the SBSP market delivery system — **what** small buildings look like, **who** the decision makers are, and **when and why** they are motivated to act. It provides context for strategies that define **how** to move the system toward a state where the maximum potential energy savings from the sector can be fully realized.

Three major solution sets emerge from the understanding of the defining elements of the sector:

I. *Identify Waste, Measure Results:* The U.S. energy conservation model is a "broad and shallow" approach, targeting individual conservation measures in a building and applying very limited incentives. This system fails to measure actual savings and delivers only incremental improvements. Yet available technologies and strategies can cost effectively reduce energy use by 45 percent or more. ***New solutions are needed that measure, motivate, and monetize real energy performance improvements in existing buildings.***

II. *Plan for Improvements:* Energy efficiency investments must be targeted to opportunities in the building life cycle — intervention points such as time of sale, regular renovations, and emergency and scheduled maintenance. As of 2010, the total U.S. building stock was approximately 275 billion square feet. Annually, renovations total approximately 5 billion square feet, and by 2035, approximately 45 percent of existing buildings will have been renovated. ***The next 25 years will see major changes to half of all buildings in use today.*** [8] ***A clear plan must be in place to deliver the tools and resources needed by small buildings when these opportunities for improvement arise.***

III. *Align New Business Models Behind Solutions That Scale:* To capture energy savings from the millions of diverse businesses in small buildings, new business models for energy efficiency must respond to compatible regulations, motivated and organized customers, and products whose time has come. Technical and financial resources must be tailored to enhance the performance and profitability of the businesses that occupy small buildings, aligning with these firms' needs and business motivations. ***Only when technical solutions and financial tools are convenient and profitable for these businesses will savings be unlocked at a scale to match the opportunity in the SBSP sector.***

Small buildings require simplified approaches that deliver better energy performance with little time, technical expertise, or direct financial investment required from the business paying the utility bill. Identifying approaches that maximize energy savings in the face of these obstacles requires a thorough understanding of the small buildings sector on par with that of large and institutional buildings. This report offers a detailed look at small buildings and a path to enhancing the energy and financial performance of the businesses that occupy them based on the unique context of the sector.

# PART 1: CHARACTERIZING THE SMALL BUILDINGS SECTOR

## RESEARCH OBJECTIVES

PGL has conducted national research that defines market segments of small existing buildings with high energy use. The objectives were to:

- Identify which types of small commercial buildings in the United States have the greatest opportunity for contributing to meaningful energy use reduction at national scale.
- Quantify the relative magnitude of market influences that affect the adoption of energy saving strategies in the identified building types.
- Determine common characteristics and regional variations for the target building types that can be used to enhance the energy performance of small commercial buildings.

The research is intended to inform the development of low-cost energy analysis tools and scalable energy conservation strategies for small commercial buildings. The outputs of this research include building profiles that describe typical buildings, descriptions of regional variations in the building population, and mapping of surveyed buildings in select business districts to assess the feasibility of district-level or neighborhood approaches to program implementation. Further, analysis of the research outputs is performed to recommend ways to maximize the energy savings yield for the SBSP roadmap effort.

## BUILDING CHARACTERIZATION METHODOLOGY

This approach to market segmentation emphasizes the use and physical characteristics of the building, including the number of uses and the building's attachment to other adjacent buildings. The building characterization effort included market analysis to better align the energy saving opportunities in small buildings to the needs of the owners and businesses that occupy them.

Compared to the relative homogeneity of large, newer buildings — such as commercial office, municipal, hospital, and education buildings — the population of buildings in the SBSP sector is more complex. Their physical characteristics are diverse, especially in older buildings that have a wide range of architectural styles and have often undergone changes of use and systems. The goal of the characterization effort is to identify the common building types and characteristics that define the SBSP sector and establish market sub-sectors that allow scalable application of energy solutions.

The research team considered multiple physical and contextual factors when selecting building types for inclusion in the study, and prioritized market segments according to those that are:

- Most in need of investment
- Under-served by existing utility conservation and/or energy services programs
- Culturally and economically valuable or endangered
- Representative of a substantial portion of the existing building stock nationally.

The data were collected and analyzed in three major steps:

I. **CBECS Data Analysis.** Filtering and analysis of CBECS micro-data, including cluster analysis and comparison of major groupings with other characterization efforts, resulting in the creation of seven primary building types that include 26 building sub-types.
II. **Market Prioritization.** Working with a third-party consultant to identify ownership patterns, operations and maintenance practices, and available resources for market sub-sectors.
III. **National Building Survey.** Examining actual buildings in each of the seven primary building types, in ten cities. Survey data include physical characteristics, ownership information, and permit data where available.

## CBECS DATA ANALYSIS

Analysis of CBECS micro-data focused on cluster analysis specific to physical building characteristics. Clusters of buildings with similar physical characteristics were further categorized according to use types and relative market share, creating discrete building types.

Although buildings can be grouped according to similar physical characteristics, which are crucial to the determination of retrofit strategies, PGL's CBECS analysis showed that energy consumption depends more on "non-permanent" characteristics, which can be altered, than on "permanent" attributes that cannot be easily changed (if at all):

Permanent Physical Characteristics (Building Attributes That Cannot Change)

- Building area
- Age
- Number of floors
- Exterior wall construction
- Percent glazing area
- Glazing location
- Glazing size
- Glazing type
- Configuration (freestanding versus attached)
- Shape
- Location/climate zone.

Systems and Operating Characteristics (Building Attributes That Can Change)

- Current building use
- Number of uses
- Heating, ventilation, and air conditioning (HVAC) equipment
- Major fuel source
- Lighting, refrigeration, and plug loads
- Energy consumption (Btu)
- Roof composition.

Understanding the differentiation of permanent building physical characteristics and systems and operating characteristics resulted in the development of 26 building types in the SBSP market. These were differentiated primarily according to size, vintage, number of stories, exterior wall construction type, glazing area, configuration (attached or freestanding), corridor location (exterior or interior), heating fuel type, and use type.

Use types were filtered according to CBECS categories:

| INCLUDED USE TYPES | EXCLUDED USE TYPES |
|---|---|
| Education | Healthcare |
| Food Sales | Hospital |
| Food Service | Nursing Home |
| Lodging | Public Assembly |
| Office | Public Order and Safety |
| Retail | Religious Worship |
| Warehouse | Service |
| Mixed-Use | Shopping Mall |

Excluded types were deemed either too diverse in physical characteristics to allow building-type definition or too small in terms of market share.

The 26 building types were analyzed by a panel of national architecture experts to provide additional information about typical building characteristics for specific vintages and architectural styles.

Consultation with NBI led to reordering of the 26 building types according to the most important factors for energy retrofit potential, based on NBI's experience in thousands of building retrofit projects. The 26 types were then consolidated based on use type, size, and configuration. Appendix A includes the initial and final lists.

## MARKET PRIORITIZATION

### Market Share

CBECS micro-data were used to estimate 1) the total size of the small buildings sector, 2) the relative size of each building type in the entire commercial sector and in the small buildings sector, and 3) the energy consumption of the entire commercial sector, of the small commercial buildings sector, and for each building type. Each building type was analyzed by its share of the number of buildings, amount of square footage, and aggregate energy consumption.

The initial list of 26 building types was reorganized according to building use, quantity of uses in each building, and configuration of adjoining walls with other buildings (see Figure 1). The list was then consolidated into seven primary building types based on the share of total number of buildings, square footage, and energy use that each building type represented in the small commercial sector.

## Figure 1: PGL Building Characterization Types

| | Original Characterization Types | Final Types |
|---|---|---|
| 1 | 1 story; freestanding; post-WWII; restaurant | Food service & food sales; freestanding; single use |
| 2 | 1 story; freestanding; pre-WWII; restaurant | |
| 3 | 1 story; freestanding; post-WWII; grocery store | |
| 4 | 1 story; freestanding; pre-WWII; office | Office; freestanding; single use; |
| 5 | 1 story; freestanding; post-WWII; office | |
| 6 | 2+ story; freestanding; post-WWII; office | |
| 7 | Freestanding; pre-WWII; school; primary and secondary | Schools |
| 8 | Freestanding; pre-WWII; school; conversion to retail, offices, multi-family, etc. | |
| 9 | Freestanding; post-WWII; school | |
| 10 | 1 story; attached; post-WWII; strip mall | Strip Mall |
| 11 | 1 story; freestanding; pre-WWII; retail | Retail; freestanding; single use; |
| 12 | 1 story; freestanding; post-WWII; retail | |
| 13 | Freestanding; post-WWII; lodging; external circulation | Lodging |
| 14 | Attached or freestanding; pre-WWII; lodging; boutique hotel | |
| 15 | 2+ Story; attached; converted warehouse/showroom; pre-WWII; office over office | Main Street |
| 16 | 2+ Story; attached; converted warehouse/showroom; pre-WWII; office over retail | |
| 17 | 2+ story; attached; converted warehouse/showroom; pre-WWII; office over restaurant | |
| 18 | 2+ story; attached; converted warehouse/showroom; pre-WWII; multi-family over office | |
| 19 | 2+ story; attached; converted warehouse/showroom; pre-WWII; multi-family over office | |
| 20 | 2+ story; attached; pre-WWII; Main Street; office over office | |
| 21 | 2+ story; attached; pre-WWII; Main Street; office over retail | |
| 22 | 2+ story; attached; pre-WWII; Main Street; office over restaurant | |
| 23 | 2+ story; attached; pre-WWII; Main Street; multi-family over restaurant | |
| 24 | 2+ story; attached; pre-WWII; Main Street; multi-family over retail | |
| 25 | 2+ story; attached; pre-WWII; Main Street; multi-family over office | |
| 26 | 1 story; attached; pre-WWII; neighborhood storefront rows | |



PGL's initial characterization, based on CBECS cluster analysis, resulted in 26 building types. Additional analysis led to aggregation to seven building types.

### Market Influences

PGL and its consultant JDM Associates analyzed specific market information for the seven building types to determine the barriers and opportunities in each market segment for implementing energy retrofits. Market analysis used CoStar and McGraw-Hill/Dodge databases[9], relevant industry reports, and direct project experience.

Market influences were studied for the building types, including:

- Owner, operator, and occupant influence
- Energy management practices, operator skill level, and approach to renovation and maintenance
- Real estate market fundamentals, regulations, and the dynamics of macroeconomic forces
- Impact of energy costs, financial motivations, availability of capital, and alignment of utility incentives.

Market scorecards (see Appendix B) were developed to assess the feasibility of implementing energy conservation strategies for each building type. Food service and retail were combined into a single category for the market analysis, because of similarities in ownership and market characteristics.

### Market Assessment

PGL used the filtered CBECS micro-data to develop a market assessment tool called the DEEP (Deep Energy Efficiency Potential) score, an index that quantifies the energy efficiency potential of buildings. The index measures four principal indicators:

- Energy Density: Annual energy use per building of the market segment
- Energy Use Intensity (EUI): Ratio of average market segment EUI to national average EUI
- Scale Factor: Ratio of the annual energy use of the market segment to the total national energy use for the commercial building segment
- Market Factor: Rating of the potential for customer adoption of energy efficiency strategies for the market segment, as determined from the market influence scorecards.

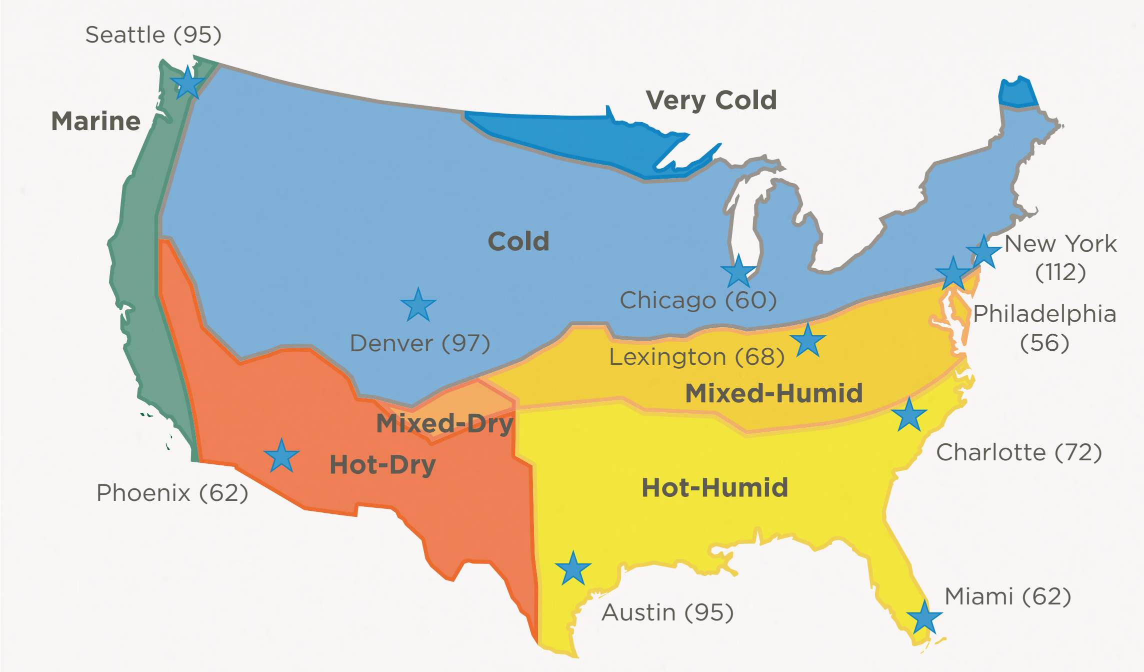
## NATIONAL BUILDING SURVEY

PGL used the seven building types to conduct a national survey in ten cities. The goal was to answer several questions:

- What characteristics are common to each building type nationally?
- What characteristics can be determined that are not captured in CBECS data?
- What characteristics of buildings have the most regional variations?
- How do climate zones influence these regional characteristics?
- Which characteristics are most likely to influence energy consumption?
- What are the physical and legal characteristics of business districts?

The survey was conducted by a team of university graduate students, student coordinators, and faculty in ten distinct climate regions (see Figure 2): Seattle, Philadelphia, Lexington, Charlotte, Austin, Phoenix, Denver, Chicago, Miami, and New York City. Each region had a student coordinator who assembled and managed a team of student surveyors, and a lead faculty member who provided support and guidance to the student coordinator.

## Figure 2: PGL National Survey Cities and Survey Returns by U.S. Climate Zone




Source: NREL Advanced Energy Retrofit Guide – Grocery (2012). Adapted from DOE



Extensive outreach and marketing of the survey opportunity resulted in partnerships with graduate departments and one volunteer organization. The University of Washington College of Built Environments conducted the pilot survey in Seattle. Participating universities included University of Washington, University of Colorado, University of Pennsylvania, University of Kentucky, University of North Carolina – Charlotte, University of Texas – Austin, Arizona State University, School of the Art Institute of Chicago, and The New School. The Miami survey was conducted by Townhouse Center, an advocacy organization.

The complete building survey consisted of approximately 100 questions that resulted in 73 discrete variables, collected through the following avenues:

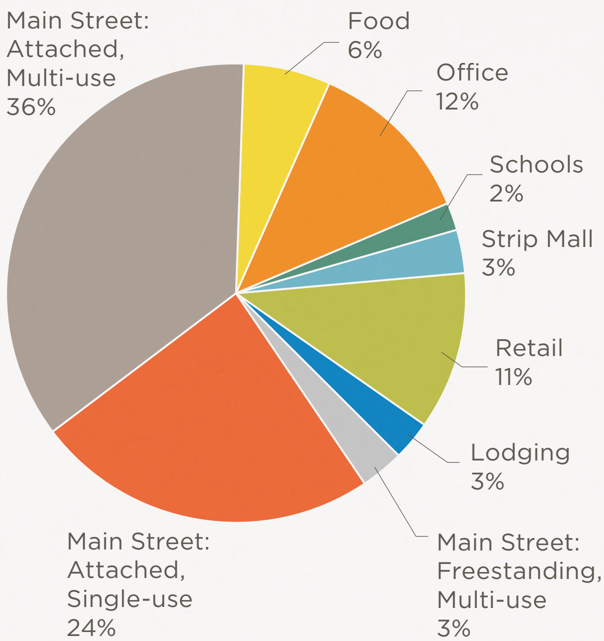
- Online building information — basic building information derived from municipal data such as tax assessor records and Google Earth
- Site visit — exterior building and site characteristics
- Permit history — derived from municipal records
- HVAC system records — derived from municipal records and onsite surveys
- Narratives — observations by surveyors
- Images.

A survey submission web tool collected building data and photos. Building characteristics (from the survey responses) were grouped into low, medium, and high categories related to the significance of their influence on building energy use, based on NBI's experience. Appendix C shows the energy significance all characteristic data collected in the survey.

Survey data for 779 buildings (see Figure 3) include physical building characteristics, original and current use descriptions, ownership information, municipal assessor data, surrounding neighborhood information, and permit history for construction activity specific to building envelope, mechanical systems, and changes of use.

## Figure 3: PGL National Survey Results by Market and Type

| CLIMATE REGION | NUMBER OF BUILDING SURVEYS |
|---|---|
| Austin | 95 |
| Charlotte | 72 |
| Chicago | 60 |
| Denver | 97 |
| Lexington | 68 |
| Miami | 62 |
| New York | 112 |
| Philadelphia | 56 |
| Phoenix | 62 |
| Seattle | 95 |
| **TOTAL** | **779** |



Survey data include 73 variables, unique building characteristics that were derived from the initial set of survey responses. Qualitative analysis by PGL and NBI resulted in prioritization into three categories according to impact on energy efficiency potential — the analysis in this report focuses on the 40 highest-priority (Priority A) variables. (See Appendix C for a list of all survey variables.) Common building characteristics, both within and across types, as well as variations attributable to vintage or location (geographic or climate zone) were determined from the data.

## SUMMARY OF RESEARCH FINDINGS

The primary findings from the building characterization research are:

**1. Almost all commercial buildings in America are small, diverse in physical characteristics and use patterns, and offer substantial energy efficiency opportunities.**

Ninety-five percent of commercial non-mall buildings are smaller than 50,000 square feet (by number). There are 4.35 million small buildings totaling approximately half of non-mall commercial floor area, and the average commercial building is smaller than 8,000 square feet. PGL estimates that small commercial buildings are home to 7.0 million businesses establishments nationwide, including 5.9 million small businesses with less than 500 employees. [10]

The small buildings sector consumes 2.8 Quads of energy — 47 percent of the national total for all non-mall commercial buildings. The average EUI of small buildings is 80 kBtu/sf/yr, compared to 92 for all CBECS buildings and 102 for buildings larger than 50,000 square feet (see Figure 4). The EUIs of small buildings vary widely across uses, from 27 kBtu/sf/yr for warehouses to 86 for single use office to 451 for fast food restaurants.

## Figure 4: Total Buildings by Size and Vintage with EUI


Source: CBECS 2003



Assuming a maximum potential energy savings of 45 percent, the SBSP sectors represent 1.07 Quads of annual site energy savings potential, or $30.04 billion in potential end use energy savings per year. Potential savings represent 6.6 percent of total building sector energy end use for both the residential and commercial sectors, based on 2011 data (16.02 Quads). Source energy savings potential is 2.81 Quads, or 2.9% of the national total of all energy used in the United States in 2011. [11, 12, 13]

**2. A high proportion of energy use in the small buildings sector is concentrated in a few primary building types.**

Results from the preliminary DEEP assessment of the small commercial building market indicate that the seven building types, or market segments, in the DEEP assessment comprise about 49 percent of all non-mall commercial buildings by number and one third of all energy use by non-mall commercial buildings (see Figure 5).

## Figure 5: Key Commercial Sub-Sectors to Target Energy Efficiency

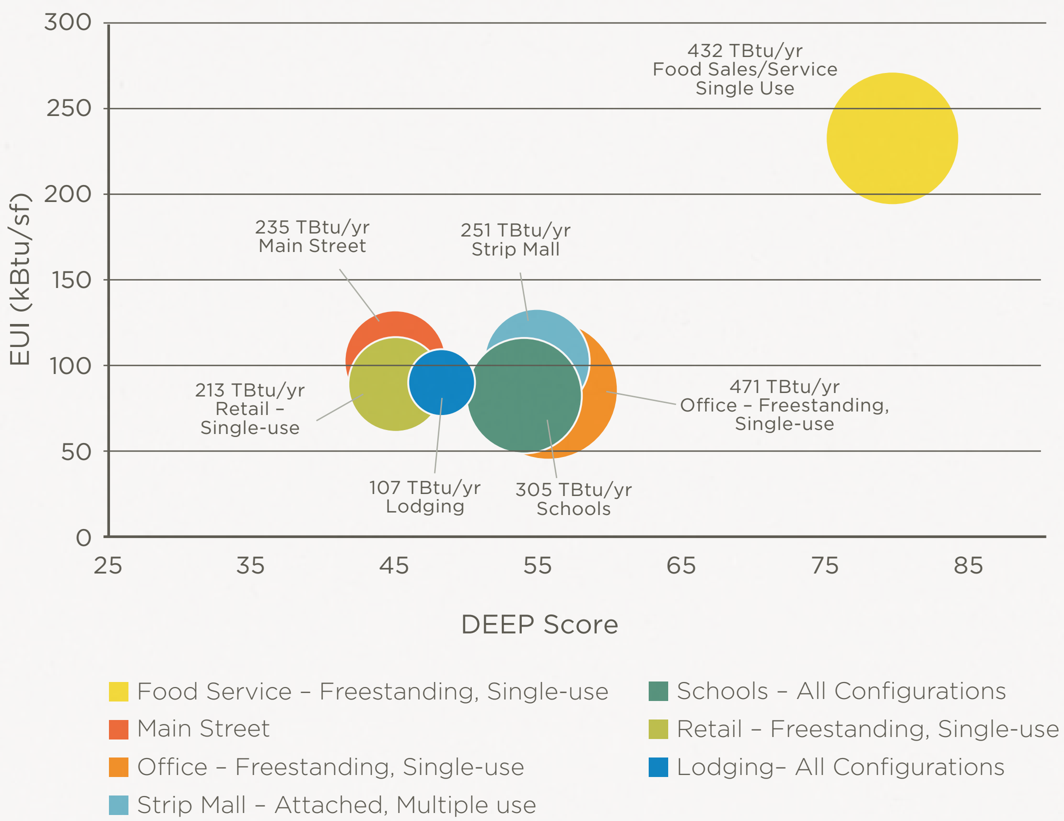
| TARGET BUILDING TYPES | AVERAGE EUI (KBTU/SF) | SHARE OF BUILDINGS | SHARE OF ENERGY | ANNUAL CONSUMPTION (TBTU) |
|---|---|---|---|---|
| Food Service – Freestanding, Single-use | 233 | 8% | 7% | 432 |
| Main Street | 105 | 7% | 4% | 235 |
| Strip Mall – Attached, Multiple Use | 104 | 4% | 4% | 251 |
| Lodging – All Configurations | 91 | 2% | 2% | 107 |
| Retail – Freestanding, Single-use | 89 | 6% | 4% | 213 |
| Office – Freestanding, Single-use | 86 | 14% | 8% | 471 |
| Schools – All Configurations | 83 | 7% | 5% | 305 |
| All Selected Building Types | 105 | 49% | 33% | 2,014 |



Seven building types represent one third of all commercial building energy consumption. Figures are expressed as the share of all non-mall commercial buildings represented in the CBECS database.

This subset of buildings represents more than 70 percent of the total energy used by all small commercial buildings — 2 Quads of energy consumption annually. PGL estimates that more than 2 million discrete buildings fall within the seven segments represented in the DEEP assessment, totaling almost 19 billion square feet of space and 3.6 million business establishments with at least one employee (see Figure 6).

## Figure 6: Deep Energy Efficiency Potential (DEEP) Rating for Target Building Types




Source: CBECS 2003



The DEEP score is an index that assembles four components onto a single scale of 0 to 100. The index ranks building types by their potential for achieving broad market acceptance for deep energy efficiency retrofit: energy density, EUI ratio, market factor, and scale factor. Descriptions of DEEP components can be found in Appendix B.

These seven types represent energy savings potential of more than 1,000 TBtu annually — 17 percent of overall commercial energy consumption — based on estimated improvement of 45 percent or better as predicted by the Advanced Energy Retrofit Guides. In general, retrofit measures are categorized as low, medium, and high as follows: [14, 15]

- 0 to 15 percent: Existing Building Commissioning (EBCx) or Retrocommissioning
- 15 to 45 percent: EBCx, O&M improvements, Basic Lighting, and HVAC improvements
- 45 percent and greater: Comprehensive Retrofits — EBCx, Integrated Approach to Lighting, HVAC, Envelope, Controls, Operations and Maintenance, and Plug and Process Loads.

Figure 7 shows savings potential at "low" and "high" levels of potential efficiency improvements:

## Figure 7: DEEP Building Types and Estimated Energy Savings Potential

| TARGET BUILDING TYPES | POTENTIAL COST EFFECTIVE SAVINGS | ANNUAL ENERGY USE (TBTU) | EUI (KBTU/SF) | POTENTIAL SAVINGS – LOW (TBTU) | POTENTIAL SAVINGS – HIGH (TBTU) |
|---|---|---|---|---|---|
| Food Service – Freestanding, Single-use | 27% - 45% (PNNL 2010) (NREL 2012) | 432 | 233 | 117 | 194 |
| Main Street – All Configurations | 27% - 59% (PNNL 2010) (NREL 2012) | 235 | 105 | 63 | 139 |
| Strip Mall – Attached, Multiple use | 38% - 59% (PNNL 2010) | 251 | 104 | 95 | 148 |
| Lodging – All Configurations | 20% - 30% (Energy Star) | 107 | 91 | 21 | 32 |
| Retail – Freestanding, Single-use | 38% - 59% (PNNL 2011) | 213 | 89 | 81 | 126 |
| Office – Freestanding, Single-use | 33% - 53% (PNNL 2011) | 471 | 86 | 155 | 250 |
| Schools – All Configurations | 30% - 50% (ASHRAE 2011) | 305 | 83 | 92 | 153 |
| All Selected Building Types | | 2,014 | 105 | 625 | 1,042 |

Sources: PNNL Advanced Energy Retrofit Guides (various);
NREL Advanced Energy Retrofit Guide – Grocery (2012);
Energy Star website; ASHRAE Energy Efficiency Guides for Existing Commercial Buildings (2011)

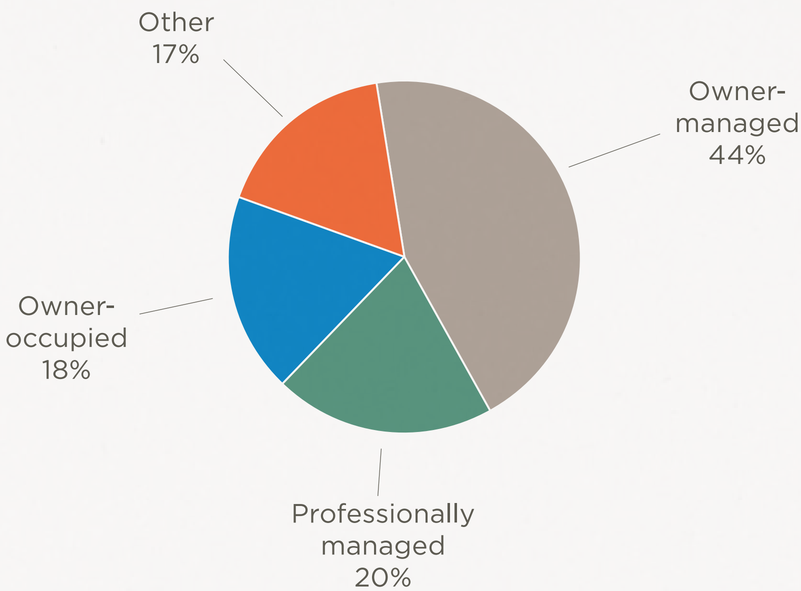


The ranges of potential cost- effective savings are determined from the maximum savings shown for projects that undertake all cost- effective operational and physical improvements as proposed in the referenced sources.

**3. There are more similarities between the residential building market and the small commercial sector than between large and small commercial sectors.**

Figure 8 shows that owners are involved with operational decision making in approximately two thirds of small commercial buildings in the PGL survey. One in five small buildings are owner-occupied, and almost half are owner-managed (but not owner-occupied).

## Figure 8: PGL Survey — Small Buildings Ownership and Management






This is in sharp contrast to large office buildings, which are most often managed by professional services companies. And, although MUSH-market buildings are often owner-occupied, they are most often managed by dedicated facilities staff. Small buildings and their owners are often resource-constrained. An exception to this is portfolio owners of small buildings. Of the 7.0 million business establishments cited in the first finding of this report, 15.9 percent (an estimated 700,000 buildings) are held by fewer than 16,000 large firms. [16]

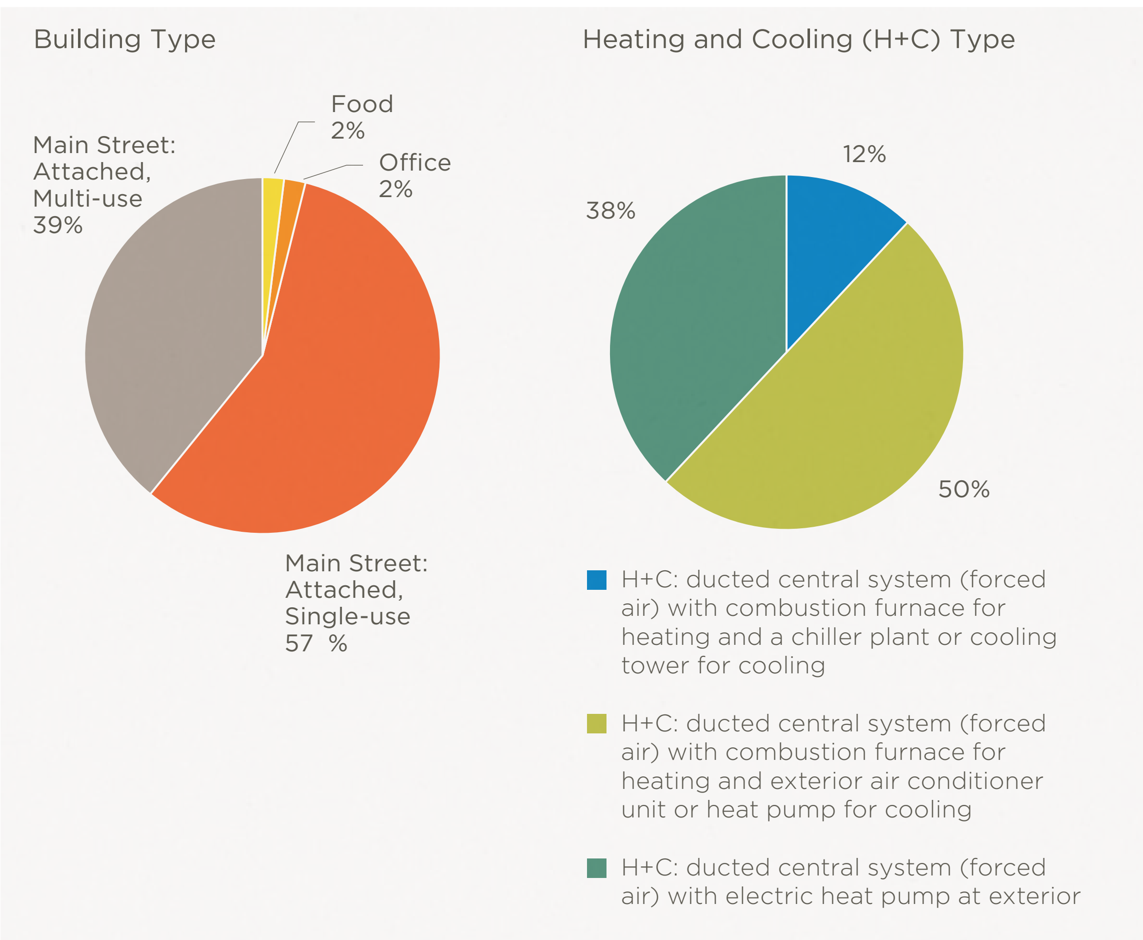
Although financial motivations are important in the retrofit decision by small-building owners and operators, non-financial incentives are equally important. Decisions in the small buildings sector are largely motivated by convenience — the "hassle factor" of building improvements is often cited by owners and service providers — and emotional drivers such as business identity and relationships with peers in the direct vicinity.

**4. Small commercial buildings are often aggregated in business districts of similar building types with high potential for energy savings.**

PGL's unique look at small buildings in context of their locations reveals clusters of similar buildings that are geographically linked (see Figure 9). Survey data for 22 contiguous business districts in ten cities show that on average, 75 percent of buildings in a given district are of similar construction type and size, and 80 percent of small buildings in a given district have similar mechanical systems. Although HVAC systems differ by building type and region, clusters of buildings in a given district are remarkably similar (see Figure 10).

## Figure 9: Surveyed Buildings in Austin's 6th Street Neighborhood


## Figure 10: Building Type and Heating and Cooling Systems in Austin's 6th Street Neighborhood



Looking at buildings in close proximity to each other and in areas with common business interests allows comparisons of areas that often have organizing interests or paid staff, such as business improvement districts or Main Street associations. These organizations act as conduits for delivering building improvements to businesses and building owners. District- or neighborhood-level aggregation is a clear way to address the diverse, fragmented SBSP market and to enable economically scalable applications of retrofit strategies.

The buildings and communities in most need of retrofit — those older, small buildings suffering from chronic disinvestment — often are Class B and Class C properties, as defined by the Building Owners and Managers Association. [17] A 2012 PGL survey showed rents ranging from $8/sf for Class C property in the smallest markets to $23/sf for Class B space in larger cities. For the oldest buildings most in need of investment, energy retrofits can achieve reductions in total facility costs of more than 10 percent, or $1.09/sf. Thus, the communities most in need stand to benefit most, creating a business alignment in favor of energy conservation in these locations.

***The PGL survey focused on Main Street building types; however, the cluster or aggregation approach to building characterization could be applied to other building types or districts such as suburban retail and service corridors.*** The focus on contiguous buildings and blocks enables a scaled approach to building improvements.

The National Trust for Historic Preservation's Main Street Center represents a network of more than 1,200 of these districts in 50 states, the District of Columbia, and four U.S. territories, with the common goal of advancing economic development in these communities. Other organized business districts with professional staff include business improvement districts, local service areas, downtown associations, and some historic districts (see Figure 11).

## Figure 11: Estimated U.S. Business Districts and Associations

| COMMUNITY ASSOCIATION TYPE | NUMBER OF ORGANIZATIONS |
|---|---|
| Main Streets | 1,200 |
| Business Improvement Districts | 1,200 |
| Downtown Associations | 700 |
| Historic Districts | 2,300 |
| TOTAL ASSOCIATIONS | 5,400 |

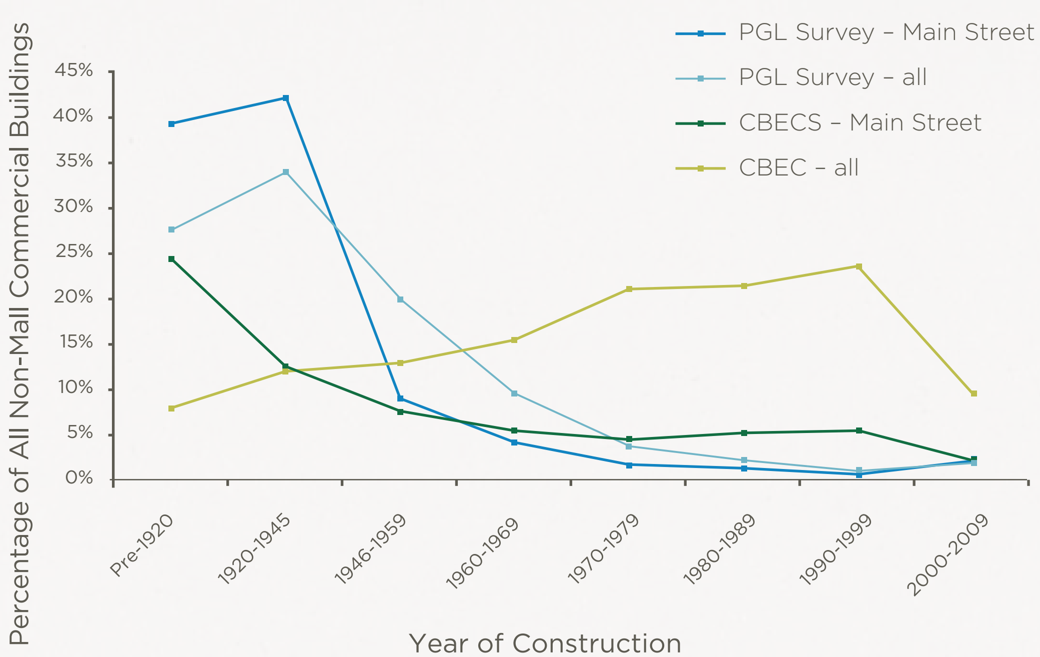
The cluster or aggregation approach is also relevant to buildings that are not in geographical proximity. Other small building types in the PGL DEEP analysis, such as freestanding office buildings and small school buildings, can also be addressed in aggregate. Portfolio managers or school districts can achieve economies of scale and streamline evaluation, design, implementation, and financing for owners and operators who are wary of the hassle factor.

**5. Buildings typical of Main Street are energy intensive and offer significant potential for deep energy savings because of their unique physical features and the close relationships between owners and occupants.**

Twenty-nine percent of commercial buildings were constructed before 1960, and almost 97 percent of these older buildings are smaller than 50,000 square feet, a higher proportion than in the commercial stock overall. PGL has delineated a distinct building type in this set of older, smaller buildings — Main Street. These buildings are predominantly mixed-use, with office, retail, restaurant, and residential mixes.

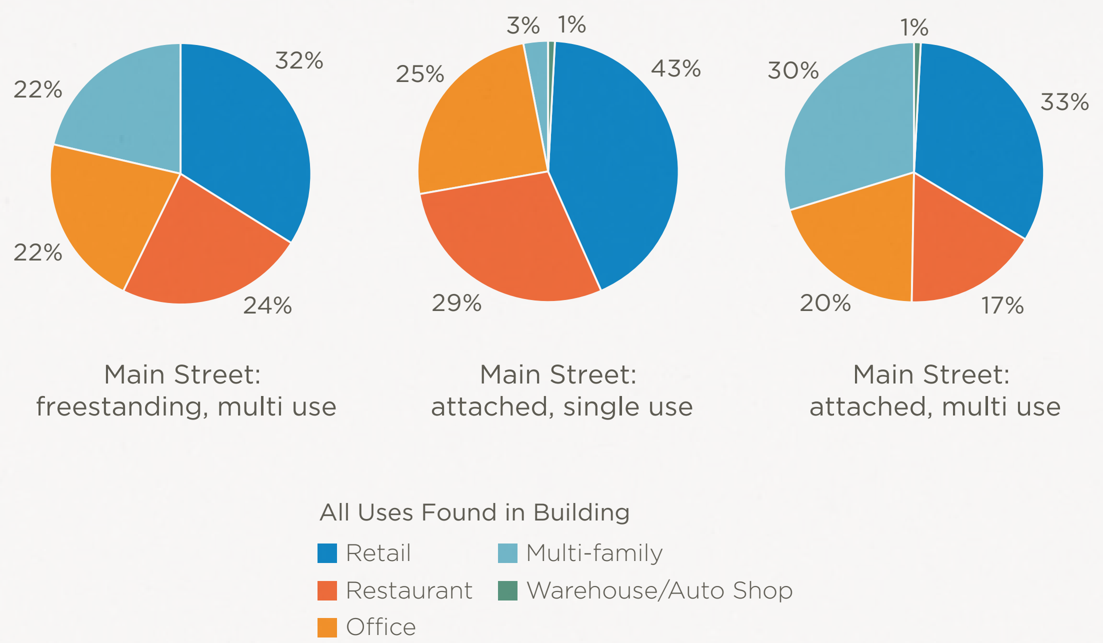
Figure 12 shows a consistent vintage pattern for CBECS data sorted by Main Street building types and the PGL survey data — most Main Street type buildings were constructed before 1960. In contrast, most commercial buildings in the CBECS database were constructed after 1960. Buildings in the PGL database tend to be older, because surveys were conducted exclusively in older commercial districts and historic districts.

## Figure 12: Comparison of CBECS Main Street Buildings with PGL National Survey Buildings



Main Street buildings consume 4 percent of all commercial building energy, and use types in Main Street buildings are more energy intensive on average than the national average for each given use (see Figure 13). In Main Street buildings, owners and occupants are resource-constrained, and tenants have few if any incentives to conserve energy.

## Figure 13: Primary Uses in Main Street Buildings

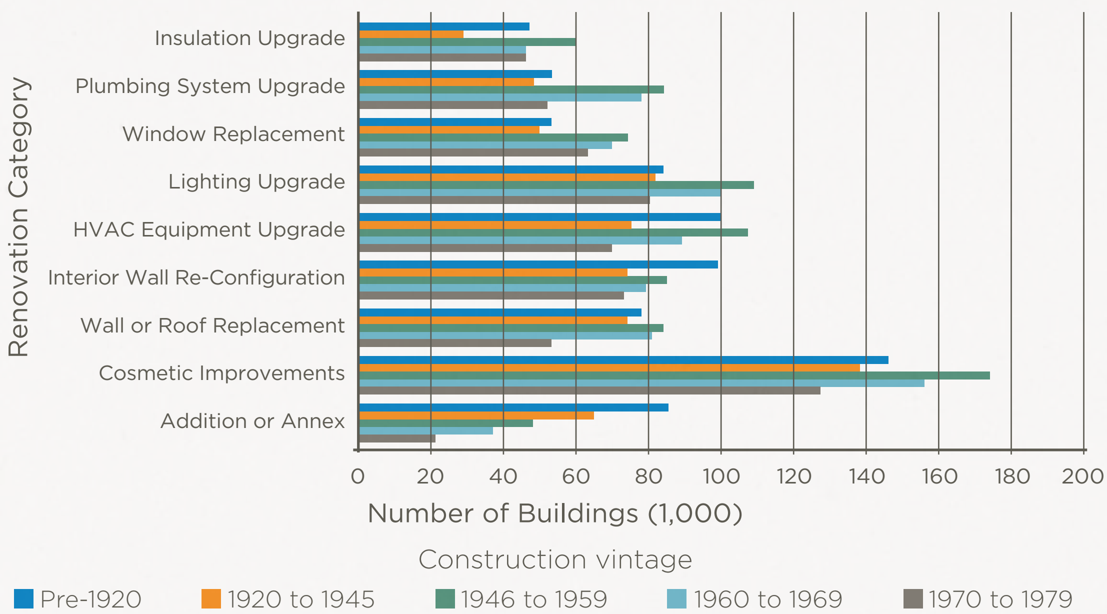





Main Street buildings predominantly include historic features that contribute to energy efficiency, if properly maintained. Awnings and shading devices reduce solar gain, operable windows allow for natural ventilation, and high ceilings offer opportunities for daylighting. Combined with massive walls, these create potential for innovative thermal management strategies. Low glazing area is often a beneficial factor in the inherent energy efficiency of these buildings, and there are other unique opportunities for greater efficiency, especially mechanical and envelope improvements. Low-cost but human-resource intensive interventions in operations, maintenance, and behavior can yield big savings, but are rarely pursued.

Older, smaller buildings typical of Main Street have a higher renovation rate than the building stock in general. Figure 14 shows that buildings constructed before 1960 have a higher renovation rate in 14 common categories than their newer counterparts. These regular interventions offer opportunities for energy efficiency improvements in concert with regular or emergency maintenance and improvements. Figure 15 shows that older buildings have on average fewer establishments than their newer counterparts, so whole-building retrofit approaches are less complex.

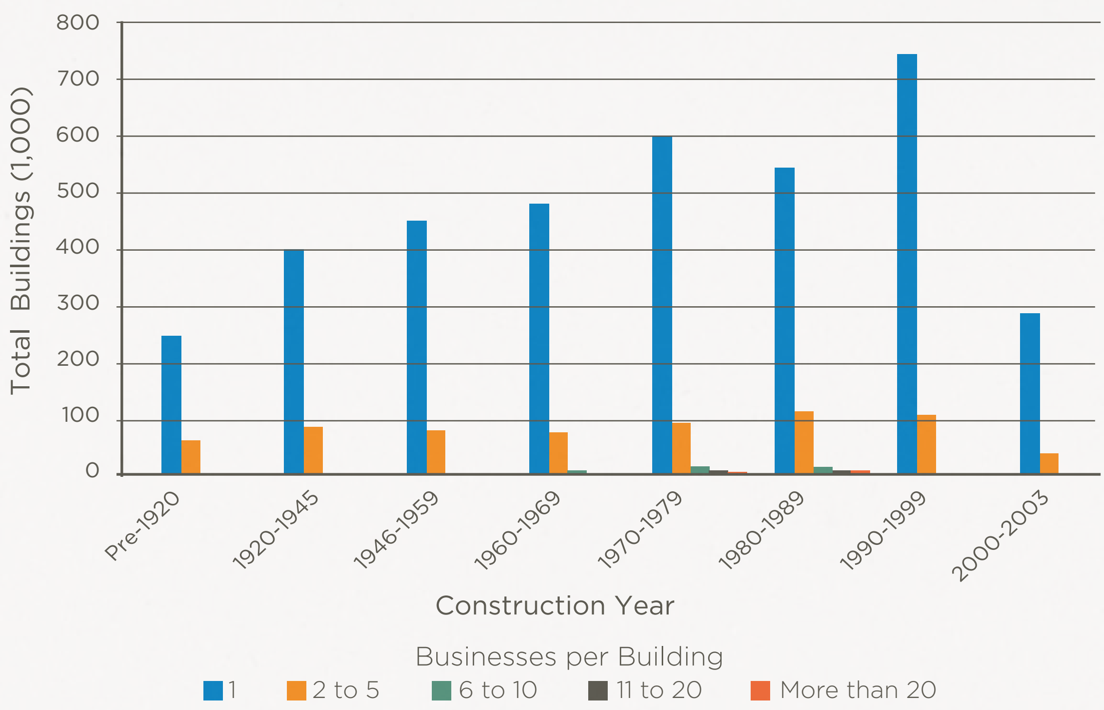
## Figure 14: Renovation Types by Construction Vintage




Source: CBECS 2003, BUILDINGS < 50,000 SF



## Figure 15: Number of Establishments by Construction Vintage




Source: CBECS 2003, BUILDINGS < 50,000 SF

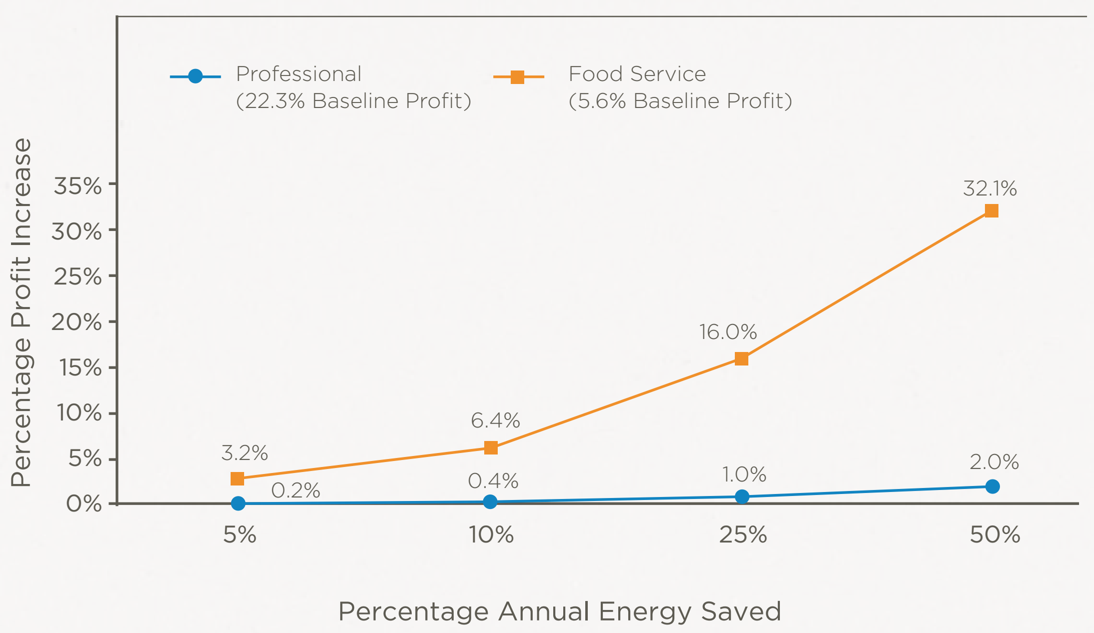
**6. Freestanding food service and sales establishments have the highest EUI of all small buildings (see Figure 16).**

There are 389,200 food service and food sales (grocery) establishments smaller than 50,000 square feet in the United States, with an average EUI of 233 kBtu/sf/yr (food service: 280; food sales: 187). Fast food establishments have the highest average EUI: 451. The typical building has a ceiling higher than 12 feet, a flat roof, and an exterior, ducted mechanical system. These offer substantial opportunities for daylighting, additional insulation, and high efficiency equipment upgrades. Lighting, heating, and cooling loads are immediate opportunities for energy efficiency improvements — studies of building retrofit potential indicate an average of 27 percent savings available for grocery and 45 percent for fast-food restaurants. [18, 19]

Freestanding food service and sales buildings were typically constructed after 1960 and are owned and managed by individual or family entities or franchise portfolio owners. The opportunity to directly increase business profitability is greatest in these buildings (see Figure 17).

## Figure 16: Freestanding Food Service Buildings


## Figure 17: Increased Business Profit from Utility Savings




Sources: Internal Revenue Service,
National Trust for Historic Preservation



Investments in energy savings can substantially improve net profits for food service businesses, where utility costs are a higher percentage of total business operating costs than for professional service firms. PGL estimates are based on Internal Revenue Service business data.

**7. Retail establishments and strip malls are vastly different sub-sectors.**

Freestanding and Main Street buildings with retail uses in the small buildings sector are diverse and often linked to local business improvement initiatives. These are often organized around a common goal of driving customer visits, which are directly tied to neighborhood amenities, building character, and quality. These buildings are more likely to be owner-occupied or owner-managed. Relative to the commercial and small buildings sectors in general, retail buildings use comparatively less energy. They comprise 10 percent of small commercial buildings by number and 5 percent of floor area, but account for just 4 percent of commercial energy consumption (EUI 71).

Strip mall buildings comprise an entirely different sub-sector, with completely different characteristics. Strip malls are designated as freestanding multiple-use buildings, attached by common walls. These buildings are predominantly owned by one entity and professionally managed. In contrast to retail uses in freestanding or Main Street buildings, strip mall buildings are more energy intensive than the national commercial average, with an average EUI of 104 kBtu/sf/yr.

## Figure 18: Retail Uses in a Business District (Philadelphia) and Strip Mall (Charlotte)

The differences in characteristics define relative ease of access to these sub-sectors (see Figure 18). Where available, business districts and other retail associations can be leveraged to provide access to buildings and tenants with economies of scale, aligning owners and tenants to remove the hassle factor and to address the split incentive problem — misalignment of the direct beneficiary of energy efficiency (the tenant) and the source of capital (the owner). However, strip mall buildings are often isolated geographically and lack onsite ownership or management. This problem highlights an important role for property managers and leasing brokers in the adoption of energy saving strategies at the time of lease renewal or tenant turnover.

# PART 2: RECOMMENDATIONS

Small buildings have been left behind in the energy efficiency marketplace as financial and technical resources flow to larger and more homogeneous commercial buildings. However, the opportunity for achieving energy savings from small buildings is great if the business interests of the sector's participants can be aligned. Understanding the relationship between the basic elements of the SBSP market delivery system — **what** small buildings look like, **who** the decision makers are, **when and why** they are motivated to act — provides context for strategies that define **how** to move the system toward a state where the maximum potential energy savings from the sector can be fully realized.

## DEFINING ELEMENTS OF THE SECTOR

### Smaller Buildings and Portfolios Have Inherent Strengths

Findings 4 and 5 from the PGL building characterization show that older buildings often have features that were designed to satisfy the comfort and performance needs of occupants in an era of energy and fuel scarcity. However, current retrofit programs and incentives do not typically consider the energy saving potential of features such as high mass, daylight, natural ventilation, and proximity to other buildings. Most retrofit programs are not designed to leverage the inherent strengths of these buildings, even though integrated technologies that restore and enhance the operations of these traditional energy management approaches can do a better job optimizing returns from energy investment than many utility-funded individual measures that encourage system replacement.

Collections of small buildings are often located in business districts, or held in portfolios, where staff is paid to align the interests of diverse businesses or divisions around multiple shared goals. Successful business district associations drive economic development, customer outreach, and community improvement. For example, local program coordinators of the National Trust for Historic Preservation's Main Street Center offer technical assistance, convene business leaders, and conduct research on critical issues that impact the sustainable economic development of their communities.

Further, national portfolios of small buildings provide an opportunity to standardize energy efficiency solutions and achieve more scalable savings. For the portfolios, savings can be dramatic and sustained. PNC Bank's portfolio, for instance, has achieved energy savings for new bank branches of 35 percent compared to conventional branch locations and has a companywide goal of reducing energy use by 30 percent by 2020. [20]

### The SBSP Sector Is Large, Fragmented, and Misaligned

The U.S. building energy sector is large and highly fragmented. It includes:

- 9,554 electricity generation, transmission, and distribution utilities [21]
- 17.6 million commercial electricity customers [22]
- 2,377 gas utilities [23]
- 4.65 million commercial gas customers. [24]

Further, the sector's large and complex network of participants — business occupants, property managers, building owners, investors, lenders, designers, contractors, code officials, utilities, conservation managers, and public utility commissions — are not in business alignment around the goal of conserving energy. In fact, conservation goals often only come from regulatory requirements, which limit success as to what can be accomplished through subsidies and mandates.

PGL estimates that there are approximately 16.72 million electricity bill payers and 4.4 million gas bill payers in the SBSP sector, located in 4.4 million buildings. This large quantity of institutions and establishments is subject to regulations, costs, and information availability that dramatically differ by state and by local jurisdiction — representing more than 39,000 unique regulatory environments. [25] This fragmentation is further reinforced by practices and policy that keep information about energy use and cost very opaque, which limits the industry's opportunity for research, development, and innovation.

In a 2011 survey of more than 200 small building owners and managers in North America, the Institute for Building Efficiency found significant misalignment of risk and reward for building owners, managers, investors, and lenders as they contemplate investments in energy efficiency projects, citing the three most significant barriers to energy efficiency in the U.S. commercial building market: [26]

- Lack of available capital for investment in projects
- Inability of projects to meet the organization's financial payback criteria
- Lack of certainty that promised savings will be achieved.

The financial misalignment for business bill payers is perhaps the most acute. Businesses such as restaurants, groceries, convenience stores, and lodgings with high energy costs and low profit margins stand to benefit most from investments in energy efficiency, but often overlook opportunities because of competing priorities for money and time. Businesses with lower average energy use, such as professional services firms, have poor financial alignment unless investments can also be shown to improve employee productivity, customer satisfaction, or business image.

### Decision Makers Lack Information and Motivation

The owners and operators of smaller buildings are unlikely to have the time or technical knowledge to implement energy conservation measures, and the small contractors that serve these businesses typically do not have the training or experience to apply advanced technical strategies. Although efforts have been made to deliver low- or no-cost energy information services to the commercial sector (ENERGY STAR Portfolio Manager, for example), such efforts have been targeted to larger buildings and portfolios. As building size declines, the time necessary to manually enter information into these tools overwhelms the available resources of the small businesses.

The Institute for Building Efficiency 2011 survey found two major information needs of owners, managers, and investors to increase energy efficiency investments:

- Awareness of opportunities for energy savings
- Technical expertise to design and complete projects. [27]

Buildings are complex machines with hundreds of thousands of individual parts. To achieve energy savings, owners and businesses in small buildings rely on technical information from trusted vendors, which further amplifies the gap in the credentials and expertise of designers, contractors, and service providers.

To respond to the need for technical information about energy retrofits, DOE, together with PNNL and NREL, have produced Advanced Energy Retrofit Guides that provide detailed information about how to achieve energy savings in existing buildings. These guides provide very detailed analyses of successful approaches to existing building commissioning and retrofit strategies, mapping out technology solutions that apply to large and small building markets and that can achieve energy savings greater than 45 percent. Currently, three guides address three of the seven primary building types in the SBSP sector — grocery, retail, and office. Additional guides for restaurants, schools, lodging, and Main Street type buildings will reach 75 percent of the small building sector. However, they are targeted to owners, professional managers, and ESCOs, not to small contractors and vendors that provide services to the small building sector.

### Energy Codes Are Poorly Aligned to the Opportunity in Existing Buildings

Building energy codes are overwhelmingly tailored to new buildings, using minimum standards, acceptable assemblies, and prescriptive checklists that are inappropriate for the large stock of existing small buildings. Although intended to reduce review time, design cost, and energy use, these same codes generate significant unintended obstacles to energy conservation in existing buildings. Energy codes:

- Ignore actual energy use, instead relying on packaged or predicted solutions to achieve estimated savings.
- Limit energy use only from the elements of the building that are decided on during design and construction and provide no incentive to establish systems and controls that encourage energy saving behavior.
- Neglect the interactions of multiple building elements that can and do influence energy use, because actual building systems and the businesses in them are complex.
- Are a minimum legal standard and have no influence over operations, best practices, or business norms.
- Have no positive feedback loop to determine effectiveness.

Further, because they are fundamentally designed to meet the needs of new construction, energy codes can force minor and major upgrades to meet requirements that are unsuitable for existing buildings. By focusing on approach rather than outcome, these codes unintentionally reduce the investment in — and sometimes spur the demolition of — viable smaller buildings as owners seek to avoid more stringent requirements. These codes may also favor the removal of character-defining features of older buildings such as historic windows and high-mass masonry walls unless alternative approaches to energy compliance are available in lieu of the tested assembly requirements of prescriptive or modeled code compliance paths.

## STRATEGIES FOR THE SECTOR

### 1. IDENTIFY WASTE, MEASURE RESULTS

To realize the full energy saving potential of small buildings, energy policy makers must support solutions that measure, motivate, and monetize real energy performance. Regulators such as utility commissions can play a pivotal role in allowing utilities to make more money saving energy than they now do generating or distributing it. While seemingly counter-intuitive, fundamentally shifting supply and demand will put a long-term downward pressure on utility rates in response to declining energy demand. Pilot projects that establish the fair market value for measured energy savings will demonstrate the effectiveness of the private sector at driving down ratepayer consumption and costs.

#### Why is the strategy needed?

The U.S. energy conservation model is a "broad and shallow" approach, targeting individual conservation measures in a building and applying very limited incentives. This system fails to measure actual energy saved at the building meter and delivers inconsistent improvements. Yet case studies developed by NBI and PGL and the Advanced Retrofit Design Guides show that energy waste can be cost effectively reduced at the building level by at least 45 percent using readily available technology and strategies. [28] *The underlying challenge is a misaligned business and regulatory model for energy conservation that incentivizes inaction at worst and incremental performance improvement toward a regulated mandate at best.*

The challenge presented by a conservation model that targets specific measures is particularly acute for small existing buildings. Outreach to smaller customers is a high, fixed cost for utilities. Thus, the limited pool of mandated utility incentives tends to flow to projects with more energy saving measures and greater potential for larger savings per customer.

### How will the strategy achieve the desired result?

PGL has identified three leverage points to stimulate a market-oriented response to this challenge at national scale, fostering a beneficial cycle that encourages reinvestment of financial returns generated from energy conservation into additional energy saving projects.

***Measure***

Utility systems should be rewarded for measuring the actual performance of buildings and be allowed by regulators to invest in energy projects on the customer's side of the meter that generate verified savings. If energy conservation were a long-term investment to be maximized rather than a short-term cost to be minimized, utilities would have a financially attractive alternative to capital investments in new generation or transmission infrastructure.

To enable this shift, utility regulators should measure actual ratepayer energy expenditures (by customer and class) instead of using the projected impact on rates alone as an indicator of the cost effectiveness of conservation. To achieve verifiable reductions of energy use over time in new and existing buildings, building energy codes should measure actual energy use, rather than evaluating prescribed or predicted use. The nationally recognized Green Button initiative should enable the development of applications that provide data to utilities, regulators, and code jurisdictions to accomplish this element of the strategy. [29]

***Motivate***

Utility systems should be fairly rewarded for generating energy savings through conservation investments, rather than penalized through increased costs, lost revenue, or reduced returns. Utility revenue decoupling is a step toward better motivation for utilities, but falls short of encouraging savings beyond what is mandated by regulators. Investments in measured energy conservation would instead encourage utilities to save as much energy from buildings as could be reasonably financed and supported by long-term customer demand. Customers likewise should be fairly rewarded for investing time and capital to generate measurable energy savings, because these savings lower utilities' future capital costs and substantially reduce source carbon emissions. These are benefits that customers cannot currently sell.

***Monetize***

Measured energy savings at the building level should be a commodity that can be sold by the party who owns the savings — the utility, the customer, or a third party — depending on whoever develops and finances the resource. Energy productivity should also be properly valued, as was done with the development of the Renewable Energy Credit, which enables consumers to pay a premium for that added value provided by renewable energy. Peak demand reduction, avoided infrastructure investment, and long-term carbon avoidance from energy conservation should be factored into the price paid for measured energy savings generated from buildings.

### What stakeholders are needed to sustain the strategy to its end?

- DOE and national laboratories
- U.S. Department of Commerce — National Institute of Standards and Technology
- State and local energy regulators
- Utilities
- Local jurisdictions
- Industry champions including private sector organizations (for-profit, non-profit, and foundations) conducting research, development, funding, and public affairs to advance national and local energy conservation
- Technology providers; energy service providers; real estate associations including lenders, investors, building owners and managers; business associations and districts including small business and franchise owners.

### What are key actions to support the strategy?

I. *Quantify the national impacts of conservation investments:* Analyze the aggregate impacts on U.S. and state employment, gross domestic product, mineral reserves, and carbon emissions by gradually replacing existing generation and distribution resources with energy savings generated through conservation investments.

II. *Create the data network necessary for measuring energy savings:* Promote the ongoing development of a strong national standard that makes business-level energy data seamlessly available to utility customers, regulators, jurisdictions, financiers, and service providers. [30,31,32] Invest in the further research and development of technologies that measure energy savings in new and existing buildings and that are compliant with the International Performance Measurement and Verification Protocol for establishing whole building energy performance. Ensure customer data privacy and security compliance with national and local regulations and industry best practices. [33]

III. *Communicate the economic value of eliminating energy waste:* Provide guidance to local energy regulators, utilities, and jurisdictions that defines the benefits and costs of measuring the energy used by buildings and pay for realized energy savings.

IV. *Tie energy standards to measured performance:* Promote solutions to measured energy use in the development of international model codes that are acceptable and cost effective for small building owners and businesses. Develop energy use targets for the currently regulated and unregulated loads in new construction and existing buildings, recognizing their distinct physical and market characteristics to save energy.

V. *Transform the market through demonstration projects:* Support the implementation of federal, state, and local pilot projects that utilize utility Power Purchase Agreements (PPA) to pay for measured energy savings and that encourage the aggregation of savings across portfolios or districts of small buildings. Support a private market for energy conservation financing that is secured by utility PPAs for measured energy savings.

## 2. PLAN FOR IMPROVEMENT

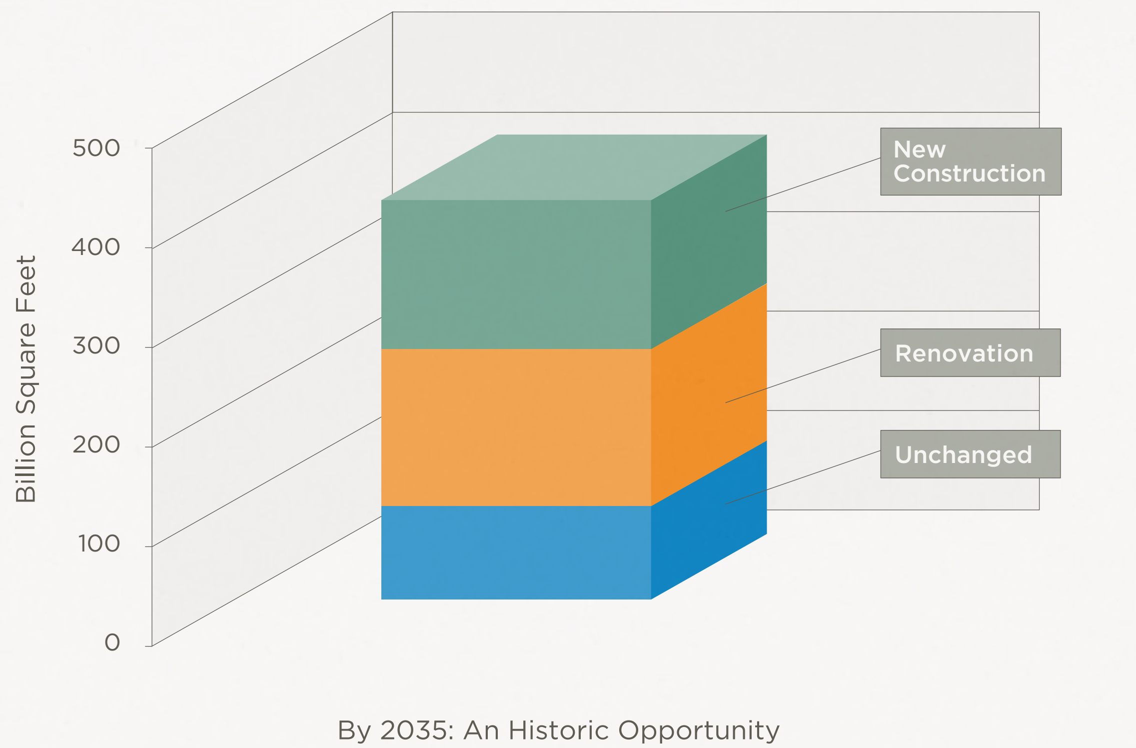
To optimize energy efficiency in small buildings, investors must align the timing of energy saving improvements with natural opportunities in the building life cycle, such as time of purchase, operational initiatives, regular renovations, emergency and scheduled maintenance, and the ultimate sale of the asset. Long term relationships and communication between lenders, investors, service providers, and energy consumers are critical to attract new sources of capital to energy projects at these milestones.

### Why is the strategy needed?

As of 2010, the total U.S. building stock was approximately 275 billion square feet. Annually, renovations total approximately 5 billion square feet, and by 2035, approximately 45 percent of existing buildings will have been renovated. [34] Figure 19 shows that the next 25 years will bring major changes to half of all buildings in use today.

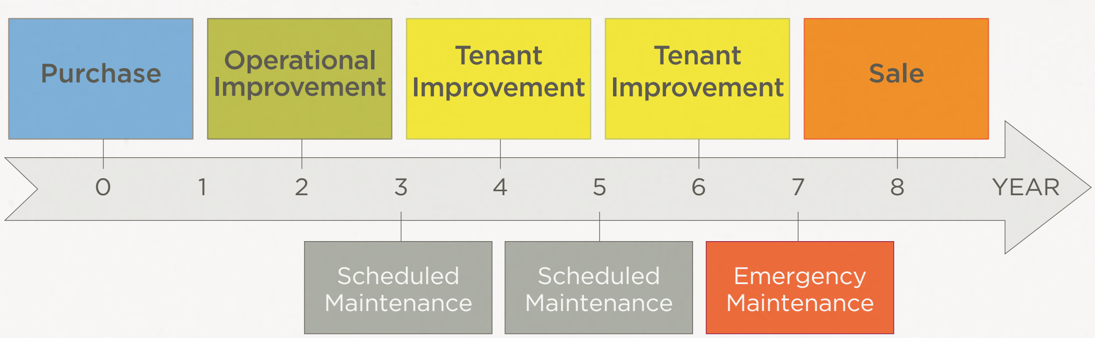
The ownership and occupancy pattern and schedule in a building dictate when and how much investment in energy efficiency that building or business can support, especially if that investment is coming from the building owner or the business. Figure 20 shows the major intervention points for energy improvements in a single generation of ownership for a typical small building. At each point tools, resources, and capital are necessary to optimize the investment in energy conservation in part or all of the building.

## FIGURE 19: Projection of Renovated Building Area




Sources: 2030, Inc. / Architecture 2030, U.S. Energy Information Administration

## FIGURE 20: Sample Building Life Cycle: Single Generation of Ownership



### How will the strategy achieve the desired result?

According to the Institute for Building Efficiency's 2011 survey of building owners, "Organizations that set goals, analyzed energy data more frequently, deployed more internal/external personnel resources, and leveraged external capital implemented more energy efficiency improvement measures…" To ensure that a building's energy saving potential is fully realized, investors in energy efficiency need:

I. Goals established for cost-effective energy performance that enhance business value
II. A plan to follow that guides implementation over the ownership life cycle of a building
III. Technical and financial resources when opportunities for energy improvements are present.

This focus on timing and planning is necessary whether the investor is the building, owner, the business owner, or a third party.

***Purchase***

Besides the initial design and construction of a building, another opportunity for energy efficiency is at the time of purchase, because of the capital and technical resources available. Brokers, underwriters, and appraisers provide critical analyses that determine building value and the amount of supportable financing for a building. When ownership transfers, these parties should evaluate data that compare relative energy costs across comparable properties.

***Renovations***

Planned renovations present a significant opportunity for energy efficiency investment, as they are intended to change or increase the financial performance of a building. Substantial alterations most often use a combination of loans and cash, whereas tenant improvements are usually paid for with loans, reserves, or cash. The potential for energy efficiency upgrades can be maximized if technical and financial resources are both available at this point in the building life cycle.

***Operations***

According to PGL's research, building operations are largely dictated by owners, who either occupy or directly manage 70 percent of small buildings. However, most energy use in buildings is driven by the behavior of the businesses that occupy them. Greater financial and operational alignment is needed between building owners and businesses to enable low- or no-cost investments in energy saving strategies. A contract that establishes common goals, roles, and responsibilities, and allocation of benefits and costs can support investments in operational improvements that can yield energy savings up to 15 percent from commissioning and facilities management.

### *Maintenance Planning*

The useful lives of building systems that provide light, thermal comfort, ventilation, and power for business functions last a fraction of the life of the whole building, and often less than a generation of business occupants. Replacement schedules do not always synchronize with renovations, placing pressure on operating cash flow. A successful plan to optimize efficiency should specify high performance equipment in advance of either emergency or scheduled replacement and allocate reserves or advance approval for any increase in capital cost to optimize the return from energy savings and performance of the equipment.

### *Sale*

Building sale is an opportunity to: 1) capitalize on the value of buildings with energy performance, because of their higher net operating income, and 2) increase the awareness of buyers about the building's relative energy performance compared to peer buildings.

## What stakeholders are needed to sustain the strategy to its end?

- DOE
- National laboratories
- National standards organizations
- Utilities including conservation, long range planning, customer billing, and information systems departments
- Government lenders including Small Business Administration, Federal National Mortgage Association (Fannie Mae), and Federal Housing Administration
- Industry champions including private sector organizations (for-profit, non-profit, and foundations) conducting research, development, funding, and public affairs to advance national and local energy conservation
- Real estate associations including brokers, appraisers, lenders, investors, building owners, property managers, and non-profit organizations
- Business associations including small business and franchise owners
- Technology providers
- Energy service providers.

## What are key actions to support the strategy?

I. *Recognize the full value of energy efficient buildings:* Establish a national standard for building energy labeling that is based on actual use and is tuned to the characteristics of small buildings. Implement Small Business Administration, Federal National Mortgage Association (Fannie Mae), and Federal Housing Administration underwriting guidelines that require energy use disclosure on appraisals. Add criteria for energy evaluation to the professional guidelines and standards for tax assessors, appraisers and brokers.

II. *Make energy opportunities transparent between owners and occupants:* Collaborate with real estate professional associations to create standardized contract amendments for owners and tenants in small buildings that define the responsibilities, benefits, and costs of energy planning between landlords and tenants. Estimate the capital needed from different sources to deliver the maximum, cost-effective energy conservation measures at different points in the life cycle for each small building type.

III. *Create partnerships that support the needs of small businesses and building owners.* Leverage business districts and associations to convene energy planning workshops that include building owners, businesses, contractors, manufacturers, and utility advisors.

## 3. ALIGN NEW BUSINESS MODELS BEHIND SOLUTIONS THAT SCALE

To capture energy savings from the millions of diverse businesses in small buildings, new business models for energy efficiency must respond to compatible regulations, motivated and organized customers, and products whose time has come. *Utilities and local energy regulators must collaborate with industry champions in pilot projects to demonstrate research and development and to validate technology and financial solutions in different building types and regions.*

### Why is the strategy needed?

There is a major, unrealized opportunity for capturing energy efficiency from a customer-centric approach that provides a turnkey energy service to the business, which has a direct relationship with the utility. Utility conservation incentives predominantly place the responsibility for decision-making, project management, and financing on these customers, yet surveys suggest that these firms do not have the human or financial resources to accept this responsibility. [35]

To overcome this barrier, technical and financial resources must be tailored to enhance the performance and profitability of the businesses that occupy small buildings, aligning with these firms' needs and business motivations. Only when technical solutions and financial tools are **convenient and profitable** for these businesses will savings be unlocked at a scale to match the opportunity in the SBSP sector.

Utility-managed "direct install" programs have successfully reached the small building market, but their scalability is limited. Because utilities pay the high share of program costs, and because these funds are typically structured as incentives, they cannot be recovered and recapitalized. Limited by a pool of conservation funding, these programs achieve only the energy savings that this mandated funding provides for and that the program can cost effectively deliver.

### How will the strategy achieve the desired result?

A fundamentally different set of business models is needed to overcome the highly fragmented nature of the small buildings market and bring energy conservation to scale.

***Technology***

Small business markets can be accessed and transformed by digital applications; for example, scalable technologies such as electronic payroll, digital voicemail, and corporate smart phones. Internet-based, open platforms for collecting energy data, similar to what have been deployed in residential customer engagement programs by innovators such as OPower and Tendril, are key to optimizing the energy performance of the small buildings sector at national scale. Supported by emerging standards, these third-party providers must work both within and outside the constraints of energy regulators to provide benefits to — or align the interests of — utilities and customers. Economies of scale are possible with accurate data collection and ongoing measurement and verification.

***Turnkey Solutions***

Firms like Solar City and Sungevity have transformed the consumer market for residential and small business solar installation, using innovative leasing solutions that reduce the financial burden on customers. [36, 37] Similarly, energy conservation providers must deliver evaluation, estimating, implementation, and financial solutions that match customer cash flow and investment needs. The small building marketplace has more in common with the small residential sector than with the large commercial sector. Simplicity is essential to owners, and scale is essential to service providers and investors. As with the solar sector, turnkey financial solutions alone can support a highly fragmented pool of installing contractors, particularly in smaller communities.

***Financial Alignment***

No business model at scale is possible without cash flow, customers, and institutional financial backing. By altering how energy savings are measured and valued, Strategy 1 changes the pool of capital for conservation from a limited annual supply of mandated incentives to a replenishing supply of loans and equity that seek stable long-term cash flow. National-scale programs and pilots that work across the jurisdictions of utility regulators can open this new market, providing access to larger quantities of lower cost capital in the form of loans, leases, and equity investments for conservation measures that deliver measurable savings.

***New Partnerships***

Google, LinkedIn, and Facebook demonstrate that millions of customers are willing to share data in exchange for valuable services. To achieve scalable energy savings and unlock the potential of the small buildings market, utilities must forge new partnerships with the trusted provider networks of their business customers: business alliances, information services companies, and economic development advocates. National programs for the commercial sector will require new business models that bundle high value, low-cost services to customers and acquire data in return.

### What stakeholders are needed to sustain the strategy to its end?

- DOE and national laboratories
- U.S. Department of Commerce — National Institute of Standards and Technology
- State and local energy regulators
- Utilities
- Local jurisdictions
- Industry champions including private sector organizations (for-profit, non-profit, and foundations) conducting research, development, funding, and public affairs to advance national and local energy conservation
- Technology providers including developers of data, energy management systems, communications networks, and devices
- Energy service providers including small general contractors, HVAC contractors and electrical contractors
- Government lenders
- National real estate associations including private lenders, investors, building owners and managers
- National business associations including business districts, small businesses and franchise owners.

### What is the action plan to support the strategy?

I. *Support private and public sector research and development that implements information gathering at scale across utility jurisdictions.* Encourage development of large data sets, essential to developing statistically significant models that can analyze energy use in small commercial buildings. Create open data platforms that share aggregated building characteristics across multiple utilities to encourage private investment in research, development, and commercialization that relies on analysis of aggregated building characteristics. Continue support of standards for customer-specific data platforms that may remain closed and proprietary to encourage private investments in research, development, and commercialization.

II. *Create technical guidance for turnkey solutions for small buildings,* considering the energy saving attributes of older buildings and the unique needs of small business owners. Recommend packages of 1) low- and no-cost operating strategies for businesses and building owners, 2) retrofit measures that produce stable, long-term rates of return that could be funded with long-term, external capital, and 3) maintenance strategies for small businesses. Tailor the content of the packages to smaller general contractors, HVAC contractors, and electricians.

III. *Encourage nationally coordinated programs and business models,* emphasizing partnerships across jurisdictional boundaries to achieve scale. Support national pilot programs that integrate data collection, evaluation, implementation, measurement and verification. Create innovative partnerships to deliver new sources of capital to energy conservation projects, including conventional and tax credit equity, as well as on- and off-balance sheet financing.

## FIGURE 21 - Key Actions for Stakeholders

| STAKEHOLDER (Primary / Supporting) | DOE | National Labs | National Standards | Energy Regulators | Jurisdictions | Utilities | Industry Champions* | Technology Providers | Energy Service Providers | Government Lenders | Real Estate Associations | Business Associations | Small Businesses | Building Owners | Property Managers |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **STRATEGY 1: Identify Waste, Measure Results** | | | | | | | | | | | | | | | |
| ***1. Quantify the national impact of conservation investments:*** | | | | | | | | | | | | | | | |
| a. Analyze the aggregate impacts on U.S. and state employment, GDP, mineral reserves, and carbon emissions of gradually replacing existing generation and distribution resources with energy savings generated through conservation investments. | Primary | Supporting | | | | | | | | | | | | | |
| ***2. Create the data network necessary to measure energy savings:*** | | | | | | | | | | | | | | | |
| a. Promote the ongoing development of a strong national standard that makes business-level energy data seamlessly available to utility customers, regulators, jurisdictions, financiers, and service providers. | Supporting | Supporting | Primary | Supporting | Supporting | Supporting | Supporting | | | | | | | | |
| b. Invest in the further research and development of technologies that measure energy savings in new and existing buildings and that are compliant with the International Performance Measurement and Verification Protocol for establishing whole building energy performance. | Primary | Supporting | | | | Supporting | Supporting | Supporting | | | | | | | |
| c. Assure customer data privacy and security compliance with Fair Information Practice Principles. | | | Primary | Supporting | Supporting | Supporting | Supporting | Supporting | | | | | | | |
| ***3. Communicate the economic value of eliminating energy waste:*** | | | | | | | | | | | | | | | |
| a. Provide guidance to local energy regulators, utilities and jurisdictions that defines the benefits and costs of measuring the energy used by buildings and paying for realized energy savings. | Primary | Supporting | | | | | Supporting | | | | | | Supporting | Supporting | Supporting |
| ***4. Tie energy standards to measured performance:*** | | | | | | | | | | | | | | | |
| a. Promote solutions to measured energy use in the development of international model codes that are acceptable and cost effective for small building owners and businesses. | Primary | Supporting | Supporting | Supporting | Supporting | | Supporting | | | | Supporting | Supporting | | | |
| b. Develop energy use targets for currently regulated and unregulated loads in both new construction and existing buildings, recognizing the distinct physical and market characteristics of existing buildings to save energy. | Primary | Supporting | Supporting | Supporting | Supporting | | | | | | | | | | |
| ***5. Transform the market through demonstration projects:*** | | | | | | | | | | | | | | | |
| a. Support the implementation of federal, state, and local pilot projects that utilize utility Power Purchase Agreements (PPA) to pay for measured energy savings and that encourage the aggregation of savings across portfolios or districts of small buildings. | Primary | Supporting | Supporting | | | Supporting | | | Supporting | | | | | | |
| b. Support a private market for energy conservation financing that is secured by utility PPAs for measured energy savings. | Supporting | Supporting | | Primary | | Supporting | Supporting | Supporting | Supporting | Supporting | Supporting | Supporting | | | |

## FIGURE 21: Key Actions for Stakeholders (continued)

STAKEHOLDER: ★ (orange) Primary; ★ (blue) Supporting

| | DOE | National Labs | National Standards | Energy Regulators | Jurisdictions | Utilities | Industry Champions* | Technology Providers | Energy Service Providers | Government Lenders | Real Estate Associations | Business Associations | Small Businesses | Building Owners | Property Managers |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **STRATEGY 2: Plan for Improvement** | | | | | | | | | | | | | | | |
| ***1. Recognize the full value of energy efficient buildings:*** | | | | | | | | | | | | | | | |
| a. Establish a national standard for building energy labeling that is based on actual use and is tuned to the characteristics of small buildings. | Primary | | Supporting | | | Supporting | Supporting | Supporting | | Supporting | Supporting | Supporting | Supporting | Supporting | Supporting |
| b. Implement Small Business Administration, Federal National Mortgage Association (Fannie Mae), and Federal Housing Administration underwriting guidelines that require energy use disclosure on appraisals. | Supporting | | | | | Supporting | Supporting | Supporting | | Primary | Supporting | | | | |
| c. Add criteria for energy evaluation to the professional guidelines and standards for tax assessors, appraisers and real estate brokers. | | | Primary | | | Supporting | Supporting | Supporting | | Supporting | Supporting | | | | |
| ***2. Make energy opportunities transparent between owners and occupants:*** | | | | | | | | | | | | | | | |
| a. Collaborate with real estate professional associations to create standardized contract amendments for owners and tenants in small buildings that define the responsibilities, benefits, and costs of energy planning between landlords and tenants. | Primary | | Supporting | | | | Supporting | | | | Supporting | Supporting | | | Supporting |
| b. Estimate the capital needed from different sources to deliver the maximum, cost-effective energy conservation at different points in the building life cycle for each of the different types of small buildings. | | Primary | | | | Supporting | | Supporting | Supporting | | Supporting | Supporting | Supporting | Supporting | Supporting |
| ***3. Create partnerships that support small business and building owners:*** | | | | | | | | | | | | | | | |
| a. Leverage business districts and associations to convene energy planning workshops that include building owners, businesses, contractors, manufacturers, and utility advisors. | | | | | | Primary | Supporting | Supporting | Supporting | | Supporting | Supporting | Supporting | Supporting | Supporting |
| **STRATEGY 3: Align New Business Models Behind Solutions that Scale** | | | | | | | | | | | | | | | |
| ***1. Support R&D that implements information gathering at national scale:*** | | | | | | | | | | | | | | | |
| a. Encourage development of large data sets, essential to statistically significant models that can analyze energy use in small commercial buildings. | Primary | Supporting | Supporting | | | Supporting | | Supporting | | | | | | | |
| b. Create open data platforms that share aggregated building characteristics across multiple utilities to encourage private investment in research, development, and commercialization. | Primary | Supporting | Supporting | Supporting | Supporting | Supporting | Supporting | Supporting | Supporting | | Supporting | | | | |
| c. Continue support of standards for customer-specific data platforms that may remain closed and proprietary to encourage private investments in research, development, and commercialization. | Primary | Supporting | Supporting | | | Supporting | Supporting | Supporting | Supporting | | Supporting | Supporting | Supporting | Supporting | Supporting |
| ***2. Create turnkey solutions for small buildings and businesses:*** | | | | | | | | | | | | | | | |
| a. Recommend packages of 1) low and no cost operating strategies for businesses and for building owners, 2) retrofit measures that produce stable, long-term rates of return within small buildings that could be funded with long-term, external capital, and 3) maintenance strategies for small businesses. | Supporting | Supporting | | | | Primary | Supporting | Supporting | Supporting | | Supporting | Supporting | | | Supporting |
| b. Tailor the content of the packages to smaller general contractors, HVAC contractors, and electricians. | | | | | | Primary | Supporting | Supporting | Supporting | | Supporting | Supporting | Supporting | | |
| ***3. Encourage nationally coordinated programs and business models:*** | | | | | | | | | | | | | | | |
| a. Support national pilot programs that integrate data collection, evaluation, implementation, and measurement and verification. | Primary | Supporting | | Supporting | Supporting | Supporting | Supporting | Supporting | Supporting | | Supporting | Supporting | | | |
| b. Create innovative partnerships to deliver new sources of capital to energy conservation projects, including conventional and tax credit equity, as well as on- and off-balance sheet financing. | | | | Supporting | Supporting | Primary | Supporting | Supporting | Supporting | Supporting | Supporting | Supporting | | | |

*Industry champions: Private sector organizations conducting research, development, funding and public affairs to advance national and local energy conservation.

# OPPORTUNITIES FOR FUTURE RESEARCH

The building characterization research conducted by PGL is part of a larger initiative to deliver tools and resources to small commercial buildings, in partnership with NBI. The ongoing research agenda of this partnership is based on data collected from the CBECS database, the market analysis performed on the sector, and the PGL's past analysis of small commercial buildings. The planned research and development of this team includes:

### ENERGY USE PATTERN ANALYSIS OF SMALL COMMERCIAL BUILDINGS

Using the physical characteristics collected by PGL in the national survey of small commercial buildings, NBI is modeling the typical energy use patterns and characteristics of the SBSP building stock to identify retrofit opportunities and to prioritize the most promising energy efficiency strategies.

### RETROFIT STRATEGIES FOR SMALL COMMERCIAL BUILDINGS

An increased understanding of the relationship between the physical characteristics of existing buildings and energy performance for the types of small commercial buildings identified in this report will enable the development of simplified tools and guidelines for retrofits that drive significant energy savings in this sector.

The analysis conducted for this report also uncovered a number of future research opportunities that could provide a more comprehensive understanding of the potential for energy savings from the SBSP sector. These include:

### JOINING BUILDING CHARACTERIZATION TO SITE ENERGY DATA

The building characterization research presented in this report was limited to physical building characteristics that were publicly available and did not include the actual energy use data from each site, but instead utilized aggregate energy use data from the CBECS database for each building type. Both open and private data sets enable research and development that analyzes the potential for energy conservation based upon the unique physical characteristics of actual buildings or districts. Future research is needed to quantify the energy savings that may result from joining these data sets.

### CHARACTERIZATION OF COMMON BUSINESS DISTRICTS

The Preservation Green Lab national survey focused primarily on existing, urban business districts and historic districts where the Main Street building type is typically found. That survey identified trends toward the clustering of specific building types and suggested approaches to working with business associations to increase the adoption rate of energy conservation. More research is needed to understand the characteristics of other business clusters such as urban and suburban arterial corridors, highway corridors, and neighborhood or regional commercial centers.

## CONCLUSION

The findings of the Preservation Green Lab's past characterization research of existing commercial buildings of less than 50,000 square feet shows the potential of this sector to save over 1,000 TBtu of energy nationally, leading to the improved energy performance and profitability for approximately 4.4 Million businesses. Several key recommendations were made in this report that will help eliminate energy waste from small buildings, requiring little time, technical expertise, or direct financial investment on the part of the businesses that own and occupy them. Three central strategic thrusts are necessary to accomplish this vision:

I. Identify waste and measure results.
II. Plan for improvement.
III. Align new business models behind solutions that scale.

These strategies require leadership from the private, non-profit, and public sectors and support from many diverse stakeholders for critical actions that will realize this great potential for both conservation and profitability. Pilot projects that are coordinated nationally are needed to demonstrate the potential of these strategies working together to reduce energy use and in turn lower the cost of energy to small businesses.

**A VISION FOR SMALL BUILDINGS:** ENERGY WASTE IS ELIMINATED FROM SMALL BUILDINGS WITH LITTLE TIME, TECHNICAL EXPERTISE, OR DIRECT FINANCIAL INVESTMENT REQUIRED ON THE PART OF THE BUSINESSES THAT OWN AND OCCUPY THEM.

# ENDNOTES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# APPENDIX

## APPENDIX A: CHARACTERIZATION BUILDING TYPES

PGL's CBECS cluster analysis resulted in 26 building types, as shown below:


1

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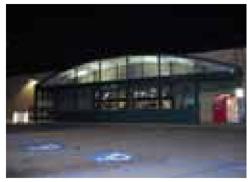

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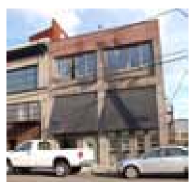

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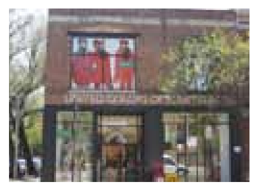

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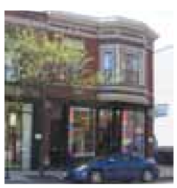

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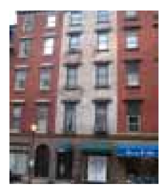

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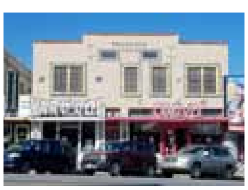

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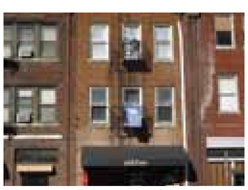

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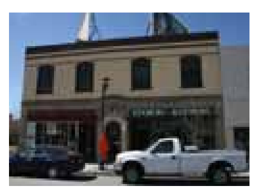

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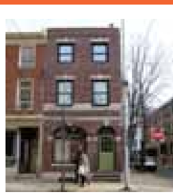

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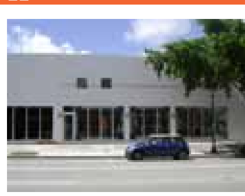


26

The original 26 building types were consolidated to seven types based predominantly on use and market opportunity.

| # | Original Characterization Types | Final Types |
|---|---|---|
| 1 | 1 story; freestanding; post-WWII; restaurant | Food service & food sales; freestanding; single use |
| 2 | 1 story; freestanding; pre-WWII; restaurant | |
| 3 | 1 story; freestanding; post-WWII; grocery store | |
| 4 | 1 story; freestanding; pre-WWII; office | Office; freestanding; single use; |
| 5 | 1 story; freestanding; post-WWII; office | |
| 6 | 2+ story; freestanding; post-WWII; office | |
| 7 | Freestanding; pre-WWII; school; primary and secondary | Schools |
| 8 | Freestanding; pre-WWII; school; conversion to retail, offices, multi-family, etc. | |
| 9 | Freestanding; post-WWII; school | |
| 10 | 1 story; attached; post-WWII; strip mall | Strip Mall |
| 11 | 1 story; freestanding; pre-WWII; retail | Retail; freestanding; single use; |
| 12 | 1 story; freestanding; post-WWII; retail | |
| 13 | Freestanding; post-WWII; lodging; external circulation | Lodging |
| 14 | Attached or freestanding; pre-WWII; lodging; boutique hotel | |
| 15 | 2+ Story; attached; converted warehouse/showroom; pre-WWII; office over office | Main Street |
| 16 | 2+ Story; attached; converted warehouse/showroom; pre-WWII; office over retail | |
| 17 | 2+ story; attached; converted warehouse/showroom; pre-WWII; office over restaurant | |
| 18 | 2+ story; attached; converted warehouse/showroom; pre-WWII; multi-family over office | |
| 19 | 2+ story; attached; converted warehouse/showroom; pre-WWII; multi-family over office | |
| 20 | 2+ story; attached; pre-WWII; Main Street; office over office | |
| 21 | 2+ story; attached; pre-WWII; Main Street; office over retail | |
| 22 | 2+ story; attached; pre-WWII; Main Street; office over restaurant | |
| 23 | 2+ story; attached; pre-WWII; Main Street; multi-family over restaurant | |
| 24 | 2+ story; attached; pre-WWII; Main Street; multi-family over retail | |
| 25 | 2+ story; attached; pre-WWII; Main Street; multi-family over office | |
| 26 | 1 story; attached; pre-WWII; neighborhood storefront rows | |

# APPENDIX B: MARKET ANALYSIS

## DEEP SCORE DEFINITION

The DEEP score is an index that assembles four components onto a single scale of 0 to 100. The index ranks building types by their potential for achieving broad market acceptance for deep energy efficiency retrofits.

DEEP Score = (Energy Density) x 22.25% + (EUI Ratio) x 27.25% + (Market Factor) x 26% + (Scale Factor) x 25%

### Energy Density

Energy density is an index component with an average value of 0.89 and a range of 1.06. The underlying values are determined from CBECS micro-data for each building type. The index compares the energy consumed per building for each building type to indicate the relative potential for energy savings from each building in the market segment.

Energy Density = Total Annual Energy/# of Buildings
Weight = 22.25%

### EUI Ratio

EUI is an index component with an average value of 1.09 and a range of 2.20. The index compares the EUI calculated for the specific building type, using CBECS micro-data averages, as a percentage of the national EUI average for all building types. Building types with highest variation of relative EUI will carry the most weight, due to the averaging calculation.

EUI Ratio = % of National EUI Average
Weight = 27.25%

### Market Factor

The market factor is an index component with an average value of 1.04 and a range of 0.50. The index uses the results of the market analysis approach and building type evaluation process to create a market analysis for each building type. The market factor adjusts the rating for each building type by setting a neutral position of neither positive nor negative impacts as a value of 3.0 of 5.0.

Market Factor = Market Analysis Rating (0.0 to 5.0)/3.0
Weight = 26%

### Scale Factor

The scale factor is an index component with an average value of 1.00 and a range of 1.61. The index compares the relative market share of each building type against the average market share of all building types to calculate the relative potential of the building type for broad energy savings impact at scale.

Scale Factor = Market Share/Average Market Share
Weight = 25%

All Configurations — Single use — Retail, Food Service

**FUNCTION** Market Analysis

## Overall Impacts of Market Forces on Adoption of Energy Efficiency Measures

Most Negative 1 —— 2 —— 3 ⊕—— 4 —— 5 Most Positive

## Owners and Occupants

Influence of ownership structures, management structures and occupant types.

| | | | |
|---|---|---|---|
| **Owners:** | Highly Decentralized | 1------2------3-----(4)-----5 | Highly Centralized |
| **Operators:** | Most Operated by Manager | 1------2------3-----(4)-----5 | Most Operated by Owner |
| **Occupants:** | Highly Fragmented | 1------2------3-----(4)-----5 | Highly Consolidated |

IMPACTS OF OWNERS AND OCCUPANTS

Most Negative 1 —— 2 —— 3 —— (4) —— 5 Most Positive

## Energy and Operations

Influence of energy management practices, operator skill level and approach toward renovations and maintenance.

| | | | |
|---|---|---|---|
| **Savings by Owner:** | Not Important | 1------2-----(3)-----4------5 | Extremely Important |
| **Operator Skill:** | Very Low Sophistication | 1------2-----(3)-----4------5 | Very High Sophistication |
| **Renovation Frequency:** | Very Infrequent | 1------2-----(3)-----4------5 | Very Frequent |
| **Maintenance:** | Highly Deferred | 1------2-----(3)-----4------5 | Highly Planned |

IMPACTS OF ENERGY AND OPERATIONS

Most Negative 1 —— 2 —— (3) —— 4 —— 5 Most Positive

## Market Differentiators

Impact of real estate market fundamentals, regulations and the dynamics of the specific building use segment.

| | | | |
|---|---|---|---|
| **Occupant Turnover:** | Very Low Turnover | 1-----(2)-----3------4------5 | Very High Turnover |
| **Energy Regulations:** | Highly Unregulated | 1-----(2)-----3------4------5 | Highly Regulated |
| **Segment Dynamics:** | Very Volatile Market | 1------2------3-----(4)-----5 | Very Stable Market |

IMPACTS OF MARKET DIFFERENTIATORS

Most Negative 1 —— 2 ——⊕ 3 —— 4 —— 5 Most Positive

## Financial Pressures

Impact of energy costs, financial motivations, availability of capital and alignment of utility incentives with market.

| | | | |
|---|---|---|---|
| **Energy Savings:** | Insignificant to Payer | 1-----(2)-----3------4------5 | Extremely Significant to Payer |
| **Owner Motivation:** | Highly Unmotivated | 1------2------3-----(4)-----5 | Highly Motivated |
| **Capital Availability:** | Very Low Availability | 1------2-----(3)-----4------5 | Very High Availability |
| **Incentive Alignment:** | Very Misaligned | 1------2------3-----(4)-----5 | Very Aligned |

IMPACTS OF FINANCIAL PRESSURES

Most Negative 1 —— 2 —— 3 ——⊕ 4 —— 5 Most Positive

Attached | Multiple use | Retail/strip mall

**FUNCTION** Market Analysis

## Overall Impacts of Market Forces on Adoption of Energy Efficiency Measures

Most Negative 1 —— 2 —⊕— 3 —— 4 —— 5 Most Positive

## Owners and Occupants

Influence of ownership structures, management structures and occupant types.

| | | | |
|---|---|---|---|
| **Owners:** | Highly Decentralized | 1-----(2)-----3------4------5 | Highly Centralized |
| **Operators:** | Most Operated by Manager | 1-----(2)-----3------4------5 | Most Operated by Owner |
| **Occupants:** | Highly Fragmented | 1-----(2)-----3------4------5 | Highly Consolidated |

IMPACTS OF OWNERS AND OCCUPANTS

Most Negative 1 —— (2) —— 3 —— 4 —— 5 Most Positive

## Energy and Operations

Influence of energy management practices, operator skill level and approach toward renovations and maintenance.

| | | | |
|---|---|---|---|
| **Savings by Owner:** | Not Important | 1------2-----(3)------4------5 | Extremely Important |
| **Operator Skill:** | Very Low Sophistication | 1-----(2)-----3------4------5 | Very High Sophistication |
| **Renovation Frequency:** | Very Infrequent | 1------2------3-----(4)-----5 | Very Frequent |
| **Maintenance:** | Highly Deferred | 1-----(2)-----3------4------5 | Highly Planned |

IMPACTS OF ENERGY AND OPERATIONS

Most Negative 1 —— 2 ——⊕ 3 —— 4 —— 5 Most Positive

## Market Differentiators

Impact of real estate market fundamentals, regulations and the dynamics of the specific building use segment.

| | | | |
|---|---|---|---|
| **Occupant Turnover:** | Very Low Turnover | 1------2------3-----(4)-----5 | Very High Turnover |
| **Energy Regulations:** | Highly Unregulated | 1-----(2)-----3------4------5 | Highly Regulated |
| **Segment Dynamics:** | Very Volatile Market | 1-----(2)-----3------4------5 | Very Stable Market |

IMPACTS OF MARKET DIFFERENTIATORS

Most Negative 1 —— 2 ——⊕ 3 —— 4 —— 5 Most Positive

## Financial Pressures

Impact of energy costs, financial motivations, availability of capital and alignment of utility incentives with market.

| | | | |
|---|---|---|---|
| **Energy Savings:** | Insignificant to Payer | 1-----(2)-----3------4------5 | Extremely Significant to Payer |
| **Owner Motivation:** | Highly Unmotivated | 1-----(2)-----3------4------5 | Highly Motivated |
| **Capital Availability:** | Very Low Availability | 1-----(2)-----3------4------5 | Very High Availability |
| **Incentive Alignment:** | Very Misaligned | 1------2------3-----(4)-----5 | Very Aligned |

IMPACTS OF FINANCIAL PRESSURES

Most Negative 1 —— 2 ⊕—— 3 —— 4 —— 5 Most Positive

All Configurations | Single use | Office

# FUNCTION Market Analysis

## Overall Impacts of Market Forces on Adoption of Energy Efficiency Measures

Most Negative


Most Positive

## Owners and Occupants

Influence of ownership structures, management structures and occupant types.

**Owners:** Highly Decentralized 1------2------3-----(4)-----5 Highly Centralized
**Operators:** Most Operated by Manager 1-----(2)-----3------4------5 Most Operated by Owner
**Occupants:** Highly Fragmented 1------2-----(3)-----4------5 Highly Consolidated

IMPACTS OF OWNERS AND OCCUPANTS

Most Negative

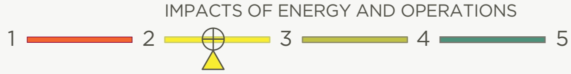

Most Positive

## Energy and Operations

Influence of energy management practices, operator skill level and approach toward renovations and maintenance.

**Savings by Owner:** Not Important 1------2-----(3)-----4------5 Extremely Important
**Operator Skill:** Very Low Sophistication 1-----(2)-----3------4------5 Very High Sophistication
**Renovation Frequency:** Very Infrequent 1------2-----(3)-----4------5 Very Frequent
**Maintenance:** Highly Deferred 1-----(2)-----3------4------5 Highly Planned

IMPACTS OF ENERGY AND OPERATIONS

Most Negative


Most Positive

## Market Differentiators

Impact of real estate market fundamentals, regulations and the dynamics of the specific building use segment.

**Occupant Turnover:** Very Low Turnover 1------2-----(3)-----4------5 Very High Turnover
**Energy Regulations:** Highly Unregulated 1------2------3-----(4)-----5 Highly Regulated
**Segment Dynamics:** Very Volatile Market 1------2------3-----(4)-----5 Very Stable Market

IMPACTS OF MARKET DIFFERENTIATORS

Most Negative


Most Positive

## Financial Pressures

Impact of energy costs, financial motivations, availability of capital and alignment of utility incentives with market.

**Energy Savings:** Insignificant to Payer 1------2-----(3)-----4------5 Extremely Significant to Payer
**Owner Motivation:** Highly Unmotivated 1------2-----(3)-----4------5 Highly Motivated
**Capital Availability:** Very Low Availability 1------2-----(3)-----4------5 Very High Availability
**Incentive Alignment:** Very Misaligned 1------2------3-----(4)-----5 Very Aligned

IMPACTS OF FINANCIAL PRESSURES

Most Negative


Most Positive

**FUNCTION** Market Analysis

## Overall Impacts of Market Forces on Adoption of Energy Efficiency Measures

Most Negative 1 — 2 — 3 — 4 — 5 Most Positive

## Owners and Occupants

Influence of ownership structures, management structures and occupant types.

| | | | |
|---|---|---|---|
| **Owners:** | Highly Decentralized | 1-----(2)-----3------4------5 | Highly Centralized |
| **Operators:** | Most Operated by Manager | 1------2------3-----(4)-----5 | Most Operated by Owner |
| **Occupants:** | Highly Fragmented | (1)-----2------3------4------5 | Highly Consolidated |

IMPACTS OF OWNERS AND OCCUPANTS

Most Negative 1 — 2 — 3 — 4 — 5 Most Positive

## Energy and Operations

Influence of energy management practices, operator skill level and approach toward renovations and maintenance.

| | | | |
|---|---|---|---|
| **Savings by Owner:** | Not Important | 1------2-----(3)-----4------5 | Extremely Important |
| **Operator Skill:** | Very Low Sophistication | (1)-----2------3------4------5 | Very High Sophistication |
| **Renovation Frequency:** | Very Infrequent | 1-----(2)-----3------4------5 | Very Frequent |
| **Maintenance:** | Highly Deferred | 1-----(2)-----3------4------5 | Highly Planned |

IMPACTS OF ENERGY AND OPERATIONS

Most Negative 1 — (2) — 3 — 4 — 5 Most Positive

## Market Differentiators

Impact of real estate market fundamentals, regulations and the dynamics of the specific building use segment.

| | | | |
|---|---|---|---|
| **Occupant Turnover:** | Very Low Turnover | 1------2------3-----(4)-----5 | Very High Turnover |
| **Energy Regulations:** | Highly Unregulated | 1-----(2)-----3------4------5 | Highly Regulated |
| **Segment Dynamics:** | Very Volatile Market | 1-----(2)-----3------4------5 | Very Stable Market |

IMPACTS OF MARKET DIFFERENTIATORS

Most Negative 1 — 2 — 3 — 4 — 5 Most Positive

## Financial Pressures

Impact of energy costs, financial motivations, availability of capital and alignment of utility incentives with market.

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|---|---|---|---|
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| **Owner Motivation:** | Highly Unmotivated | 1-----(2)-----3------4------5 | Highly Motivated |
| **Capital Availability:** | Very Low Availability | 1-----(2)-----3------4------5 | Very High Availability |
| **Incentive Alignment:** | Very Misaligned | 1------2------3-----(4)-----5 | Very Aligned |

IMPACTS OF FINANCIAL PRESSURES

Most Negative 1 — 2 — (3) — 4 — 5 Most Positive

**FUNCTION** Market Analysis

## Overall Impacts of Market Forces on Adoption of Energy Efficiency Measures

Most Negative 1 2 3 4 5 Most Positive

## Owners and Occupants

Influence of ownership structures, management structures and occupant types.

| | | | |
|---|---|---|---|
| **Owners:** | Highly Decentralized | 1-----(2)-----3------4------5 | Highly Centralized |
| **Operators:** | Most Operated by Manager | 1------2------3-----(4)-----5 | Most Operated by Owner |
| **Occupants:** | Highly Fragmented | (1)-----2------3------4------5 | Highly Consolidated |

IMPACTS OF OWNERS AND OCCUPANTS

Most Negative 1 2 3 4 5 Most Positive

## Energy and Operations

Influence of energy management practices, operator skill level and approach toward renovations and maintenance.

| | | | |
|---|---|---|---|
| **Savings by Owner:** | Not Important | (1)-----2------3------4------5 | Extremely Important |
| **Operator Skill:** | Very Low Sophistication | 1------2------3-----(4)-----5 | Very High Sophistication |
| **Renovation Frequency:** | Very Infrequent | 1------2------3-----(4)-----5 | Very Frequent |
| **Maintenance:** | Highly Deferred | 1------2-----(3)-----4------5 | Highly Planned |

IMPACTS OF ENERGY AND OPERATIONS

Most Negative 1 2 (3) 4 5 Most Positive

## Market Differentiators

Impact of real estate market fundamentals, regulations and the dynamics of the specific building use segment.

| | | | |
|---|---|---|---|
| **Occupant Turnover:** | Very Low Turnover | 1------2------3------4-----(5) | Very High Turnover |
| **Energy Regulations:** | Highly Unregulated | 1------2------3-----(4)-----5 | Highly Regulated |
| **Segment Dynamics:** | Very Volatile Market | 1-----(2)-----3------4------5 | Very Stable Market |

IMPACTS OF MARKET DIFFERENTIATORS

Most Negative 1 2 3 (4) 5 Most Positive

## Financial Pressures

Impact of energy costs, financial motivations, availability of capital and alignment of utility incentives with market.

| | | | |
|---|---|---|---|
| **Energy Savings:** | Insignificant to Payer | 1------2------3-----(4)-----5 | Extremely Significant to Payer |
| **Owner Motivation:** | Highly Unmotivated | 1------2------3-----(4)-----5 | Highly Motivated |
| **Capital Availability:** | Very Low Availability | 1------2-----(3)-----4------5 | Very High Availability |
| **Incentive Alignment:** | Very Misaligned | 1------2------3-----(4)-----5 | Very Aligned |

IMPACTS OF FINANCIAL PRESSURES

Most Negative 1 2 3 4 5 Most Positive

FUNCTION Market Analysis

## Overall Impacts of Market Forces on Adoption of Energy Efficiency Measures

Most Negative 1 —— 2 —— 3 —— (4) —— 5 Most Positive

## Owners and Occupants

Influence of ownership structures, management structures and occupant types.

| | | | |
|---|---|---|---|
| **Owners:** | Highly Decentralized | 1------2------3------4-----(5) | Highly Centralized |
| **Operators:** | Most Operated by Manager | 1------2------3------4-----(5) | Most Operated by Owner |
| **Occupants:** | Highly Fragmented | 1------2------3------4-----(5) | Highly Consolidated |

IMPACTS OF OWNERS AND OCCUPANTS

Most Negative 1 —— 2 —— 3 —— 4 —— (5) Most Positive

## Energy and Operations

Influence of energy management practices, operator skill level and approach toward renovations and maintenance.

| | | | |
|---|---|---|---|
| **Savings by Owner:** | Not Important | 1------2------3------4-----(5) | Extremely Important |
| **Operator Skill:** | Very Low Sophistication | 1------2------3-----(4)-----5 | Very High Sophistication |
| **Renovation Frequency:** | Very Infrequent | (1)-----2------3------4------5 | Very Frequent |
| **Maintenance:** | Highly Deferred | (1)-----2------3------4------5 | Highly Planned |

IMPACTS OF ENERGY AND OPERATIONS

Most Negative 1 —— 2 —— (●) 3 —— 4 —— 5 Most Positive

## Market Differentiators

Impact of real estate market fundamentals, regulations and the dynamics of the specific building use segment.

| | | | |
|---|---|---|---|
| **Occupant Turnover:** | Very Low Turnover | (1)-----2------3------4------5 | Very High Turnover |
| **Energy Regulations:** | Highly Unregulated | 1------2------3------4-----(5) | Highly Regulated |
| **Segment Dynamics:** | Very Volatile Market | 1------2------3------4-----(5) | Very Stable Market |

IMPACTS OF MARKET DIFFERENTIATORS

Most Negative 1 —— 2 —— 3 —— (4) —— 5 Most Positive

## Financial Pressures

Impact of energy costs, financial motivations, availability of capital and alignment of utility incentives with market.

| | | | |
|---|---|---|---|
| **Energy Savings:** | Insignificant to Payer | 1------2------3------4-----(5) | Extremely Significant to Payer |
| **Owner Motivation:** | Highly Unmotivated | 1------2------3------4-----(5) | Highly Motivated |
| **Capital Availability:** | Very Low Availability | 1------2-----(3)-----4------5 | Very High Availability |
| **Incentive Alignment:** | Very Misaligned | 1------2------3-----(4)-----5 | Very Aligned |

IMPACTS OF FINANCIAL PRESSURES

Most Negative 1 —— 2 —— 3 —— (4) —— 5 Most Positive

## APPENDIX C: SURVEY RESPONSE VARIABLES

National Survey Data Categories, Prioritized According to Impact on Energy Retrofit Potential

| MODELING VARIABLES (PRIORITY A) | MODELING VARIABLES (PRIORITY B) |
|---|---|
| Current use | Net SF |
| Year of construction | Basement? |
| Gross SF | Apartment units? |
| Ownership: Occupation Status | Condo units? |
| Ownership: Type of Legal Entity | Original use |
| Height | Roof shape |
| 1st floor height | Roof material |
| 2nd floor and up height | # of gas meters |
| Footprint shape | Ventilation system |
| 1st floor SF | Majority frame material |
| Structural system | Majority frame material |
| Relationship to other buildings | Mechanical permits (3): date + work completed |
| Number of attached sides (if applicable) | Changes of use permits (3): date + work completed |
| Glazing % | Building envelope permits (3): date + work completed |
| Majority operability | Number of residential units |
| Majority window system | Net SF |
| Majority glazing/window height | Is there combustion equipment? |
| Majority glazing thickness | Is there a District Energy system feeding the building? |
| Majority head height | Are there water pipes providing heating and/or cooling? |
| Window consistency between floors | Date of last primary equipment replacement |
| Majority operability | |
| Majority window system | **MODELING VARIABLES (PRIORITY C)** |
| Majority glazing/window height | |
| Majority glazing thickness | Building name |
| Majority head height | Street address |
| North orientation window exterior shading devices | Parcel ID |
| South orientation window exterior shading devices | Current owner |
| East orientation window exterior shading devices | Neighborhood |
| West orientation window exterior shading devices | Original/historic name |
| Exterior shading device consistency between floors | Cladding material |
| Vertical exterior shading devices | Front door faces ___ |
| Horizontal exterior shading devices | Secondary Equipment + Distribution |
| Exterior shading device extent | Date of last secondary equipment replacement |
| Exterior shading device movability | DHW fuel type |
| Are there air distribution ducts in the building system? | DHW equipment |
| Does the building have A/C? | Date of last DHW equipment replacement |
| Primary Fuel Type (for this building section) | |
| Primary equipment + distribution | |
| Secondary Fuel Source (for this building section) | |
| Source of HVAC information | |

Survey variables were collected by Preservation Green Lab under a contract with the New Buildings Institute during 2011 and 2012 and are copyright protected. Variables are intended to inform the development of low-cost energy analysis tools and scalable energy conservation strategies for small commercial buildings. Results for each of the Priority A variables were further analyzed under the same contract to determine appropriate default values for the energy modeling of typical building types.