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META REPORT

A Search for Deep Energy Savings

NEEA's Study of Existing Building Energy Efficiency Renewals

Final Report

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The buildings highlighted in the nine project profiles herein are owned by the following entities: 200 Market Associates, LP; Alliance for Sustainable Colorado; Brian Runberg; Mutual Building, LLC; Northern Plains Resource Council; JDBG Inc.; Lovejoy Building, LLC; Mercy Corps; and Rose Smart Growth Investment Fund I, LP.

Individuals contributing information to the project profiles are: John Russell, 200 Market Associates; Sheryl Scali, Property Manager, 200 Market Building; Phillip Saieg, Alliance for Sustainable Colorado; Brian Runberg, Runberg Architecture Group; Jonathan Heller and Carmen Cejudo, Ecotope; Gavin Gardi, Sustainability Manager, The Christman Company; Teresa Erickson, Northern Plains Resource Council; Tim Ennis, Western Organization of Resource Councils; Ed Gulick, High Plains Architects; Ron Pecarina, Energy and Sustainable Design Consultants; Steve Allwine, Johnson Braund Design Group; James Meyer, Randall Heeb and Chris Brown, Opsis Architecture LLP; Hugh Donnelly, Manager Administration + Facilities, Mercy Corps; Nathan Taft, Jonathan Rose Companies; Peter Alspach, Arup; and Ralph DiNola, Green Building Services.

Four project profiles were identified through case study research originating from the Urban Land Institute, ASHRAE's *High Performance Buildings* Magazine, and AIA Seattle and the Committee on the Environment - 2008 Top Ten Green Awards. The remaining profiles were identified through individual contacts already listed above.

Cover Photos:

1. *Beardmore Building – Priest River, Idaho. Historic Renovation of a 1922 building completed in 2008. Owner: Brian Runberg, Beardmore Company.*
2. *Home on the Range – Billings, Montana. Renovation of a 1940 building completed in 2006. Owner: Northern Plains Resource Council.*
3. *Joseph Vance Building – Seattle, Washington. Historic Renovation of a 1929 office building completed in 2007. Owner: Rose Smart Growth Investment Fund.*
4. *200 Market Building – Portland, Oregon. Efficiency improvements of 1973 office building from 1989-present. Owner: 200 Market Associates.*
5. *Johnson Braund Design Group – Seattle, Washington. Ongoing efficiency improvements of 1984 office building. Owner: JBDG Inc.*

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EXECUTIVE SUMMARY

This report describes nine existing buildings that underwent deep efficiency projects, including building characteristics, efficiency measures, motivations, money, measured energy performance, market and tenant outcomes, and barriers and innovations. These buildings are all low-energy compared to other buildings of their kind; seven of the nine save 50% more energy than the national average (CBECS[1]) and have an average energy use intensity (EUI[2]) of just 39 kBtu/square foot (sf)/yr.

This work is part of the Northwest Energy Efficiency Alliance (NEEA) regional Existing Building Renewal (EBR) initiative to accelerate commercial market adoption of deep, integrated energy-efficient retrofits. This report builds on New Buildings Institute's (NBI's) Phase 1 work, which developed an initial list of 50 existing building projects showing improvement of 30%+ energy savings from two or more efficiency measures in the past 10 years.

From those 50 examples, NEEA and NBI identified buildings (primarily in the Northwest) with the best opportunities for a deeper look. Nine projects fit the scope and were available for more extensive research and for interviews with owner representatives. The goal was to get the "story" behind each project, including data on measured energy use and financial information. A detailed Project Portfolio of each building is included in the Appendix.

The Buildings. In the past 10 years each of these existing buildings was significantly "renewed" to create an improved working environment or a change of use prioritizing, and accomplishing, lower energy use. The projects in this study are all offices, including three designated as "historic" buildings, with occupied floor space from 8,000 – 394,000 square feet (sf). Seven of the buildings are in the Northwest, one in Denver, Colorado and the other in Lansing, Michigan; all nine are located in Department of Energy (DOE) Climate Zones 3-5, which are the three Climate Zones in the Northwest region. Building ownership and occupancy falls evenly into three categories: 1) private investor-leased property, 2) nonprofit and 3) firms in architecture or construction focused on "green" business.

Eight of the nine projects included energy efficiency as part of a renovation when significant changes to the structure and/or use involved major construction. This optimized the opportunity for deeper savings. Building representatives most frequently cited high-efficiency lighting, daylighting, lighting and ventilation controls,[3] and high-efficiency heating, ventilation and air-conditioning equipment, with several of the projects using forms of radiant heating and cooling and one using evaporative cooling. Projects commonly included daylight features such as light shelves, skylights, interior and exterior shades, and specialty glass, as well as increased shell insulation and operable windows. Several owners mentioned the value of commissioning and ongoing monitoring, which proved critical in one case.

All the buildings participated in U.S. Green Building Council (USGBC) Leadership in Energy & Environmental Design (LEED) and together achieved a total of 13 LEED certifications in four certification categories - all but one at the gold or platinum level. Other independent entities also awarded ratings and recognition in some cases.

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[1] CBECS – The Energy Information Agency's Commercial Buildings Energy Consumption Survey 2003

[2] An Energy Use Intensity (EUI) is the total annual energy (gas and electric) used expressed in thousands (k) of British thermal units (Btus) divided by the square feet (sf) of the space – resulting in a commonly-used metric of energy use in kBtu/sf/yr

[3] Daylighting Controls: Automated dimming in response to daylight. Lighting Controls: Occupancy sensors and timers. Ventilation Controls: CO2 monitors in low-occupancy spaces.

The Business. Motivations for pursuing deep energy-efficiency renewals varied among the nine owners, but the "green" of money linked with "green" environmental and societal motivations factored significantly into both the rationale for low-energy buildings and the outcome to all owners. For firms involved in design, engineering or consulting, showing leadership and experience in areas of effective green approaches and emerging technologies is a necessary part of doing business. In economic terms, the nonprofits gained funding based on being exemplary in their missions; the firms gained clients or expanded the scope of client projects based on demonstrating best practices. The investor property owners stated that tenant volume, rates and terms are improved, and costs reduced, through their efficiency investments. Positive public exposure, strong building ratings and labels, and increased consumer awareness and interests in better buildings are also noted by the investor-owned properties as economic drivers in their decisions and improved their asset valuation.

In most projects the cost of the efficiency portion was not distinguishable due to the renovation nature of the work. However, one nonprofit carefully documented energy efficiency measures as $3/sf, and two projects represented smaller tenant upgrades with efficiency incorporated at $26 and $31/sf. Total renovation costs ranged from $100 to $176/sf for seven of the projects – very much in the standard range for such work. The methods used to access capital were also diverse; only one project identified capital as a barrier.

Based upon the results of this study, NBI identified five common owner attributes in developing a low-energy building:

1) "Green Link" Recognition – they considered and valued the economic and environmental benefits and market expectations that made pursuing energy efficiency essential.
2) Vision – they are goal-driven, pursue targets via LEED, have leadership mentalities, and the willingness and desire to be ahead of the curve in many aspects of their businesses.
3) Money Leverage – they maximize government, utility and organizational incentives and tax credits.
4) Measurement – they track energy results and conduct continuous commissioning to maintain and improve performance.
5) Market Profile – NBI "found" these buildings because publicizing their energy-efficiency renewal results, including the use of public-relations opportunities, is a part of the owners' strategies for increasing their buildings' values.

Some owners provided information from the original plans or from ongoing monitoring regarding the impacts of efficiency on operating costs. The deeper energy renovations led to cost reductions of 50% or more in energy expenses, while the equipment retrofit project earned an estimated 25% cost savings from the efficiency measures.

Energy Outcomes. The EUIs of all nine buildings are from measured data and are compared to the two benchmarks of 1) CBECS' office EUI and 2) EnergyStar Portfolio Manager (PM) calculated EUI[4]. The EnergyStar score is also provided in the summary of building energy metrics. Overall, actual energy use is well below these benchmark references, with EUIs ranging from 32–66 kBtu/sf/yr and five of the

[4] Comparable office average energy use from the Energy Star Portfolio Manager program based on like type, size, occupancy, hours, and climate – determined from statistical analysis of the EIA's CBECS dataset

buildings having EUIs of 40 or less. Average savings are 52% greater than CBECS and 46% better than the PM-calculated EUI for a similar building. The EnergyStar scores provide another metric to indicate strong energy performance, with an average score of 92, placing all of them in the top 10% of office building energy performance in the U.S.

Market Outcomes. Market outcomes are based on owner and design firm testimonials but clearly draw attention to the business benefits attributed to these buildings. One location stated that rents average about 35% higher than other local properties; another owner has increased occupancy from 68% to 96% and has seen increased rents, tenant retention and net operating income, thus enhancing long-term value for his investment property. Several noted they have no problem finding tenants, or that the space has been continuously occupied.

Building owners' comments included: *"People rave about the building" "…tenants are willing to pay a premium for a building that is demonstrably better"* and the building *"added organization legitimacy and credibility, recognition to organization name."* A building manager conducted a tenant satisfaction survey and found most tenants were "satisfied" or "very satisfied" with their renovated work environment and that daylighting stood out as receiving the greatest positive response.

With EnergyStar scores as the basis for the majority of energy disclosure requirements being adopted by U.S. cities and states – including Northwest locations – the scores will become a new visible metric required during real estate transactions and, in some cases, tenant lease negotiations. Their high scores and LEED ratings constituted another positive feature recognized by the market.

Barriers. Owners faced barriers and challenges similar to those seen in most construction projects, frequently citing costs and historical constraints. In one case, high costs drove the team to seek more "simplified" approaches; others missed some efficiency opportunities due to the need to retain historic features but maintained a focus on integration to optimize other areas. Just one building was occupied during renovation, which presented the challenge of implementing strategies while working around existing tenants. Those behind one smaller project found it challenging to get the architect, engineers and contractors on board and transition them into "believers" in low-energy buildings. Another found that contractor competency was missing in the first commissioning team, resulting in unreasonable energy use in the first year of occupancy. A re-commissioning effort reduced energy use by 44 percent.

Innovations. Owners identified unique and innovative aspects of their process and/or project. For the purposes of this study, innovation was interpreted not as being on the fringe of practice, but rather reaching for the ideas that pull the project to the top of its potential. Areas these owners considered innovative included transforming historic buildings; incorporating radiant heating and cooling; applying simplicity as a strategy; using tenant guidelines and gross leases to encourage behavioral change; natural exhausting air through clerestories; and continuous monitoring and building management systems. One firm invoked the business rule *"You can't improve what you don't measure"* regarding its monitoring and continuous improvement strategies.

Next steps for this work are to: 1) develop and widely distribute more market-ready Case Studies from the Project Profiles and the report findings; 2) review the results in specific sections to assess applications to energy programs and the EBR initiative; and 3) conduct Phase 3 – a "deep-dollar dive" with those projects that offered more financial and business information including, from Phase 1, an extensive list of project results with energy and cost data in need of review and analysis.

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1 INTRODUCTION

This work is part of the Northwest Energy Efficiency Alliance (NEEA) regional Existing Building Renewal (EBR) initiative to accelerate commercial market adoption of deep, integrated energy-efficient retrofits. This report builds on New Buildings Institute's (NBI's) Phase 1 work which developed a list of 50 existing building projects showing improvement of 30%+ energy savings from two or more efficiency measures in the past 10 years.

The Phase 2 scope, represented in this report, was to develop project profiles on 8 to 10 buildings. From the 50 initial examples, NEEA and NBI identified buildings with the best opportunities for a deeper look into the measured energy performance, characteristics and motivations of existing building efficiency projects, primarily in the Northwest. These examples will assist NEEA in identifying common technologies and practices to support its EBR initiative, in addition to addressing barriers to deep retrofits, such as skepticism about performance and market outcomes; lack of knowledge on best practice strategies; and business rationale for pursuing energy efficiency.

This report includes a summary of the findings from the nine final project profiles including search methodology, building characteristics, efficiency measures, business and financial motivations, energy performance, market and tenant impact, and barriers and innovations. These buildings are all low-energy compared to others of their kind. Seven of the nine saved 50% more energy than the Commercial Buildings Energy Consumption Survey (CBECS) national average,[5] and have an average Energy Use Intensity (EUI[6]) of just 39 kBtu/sf/yr.

Five of the nine profiles were identified through personal contacts by NBI and Preservation Green Lab (PGL) staff, with the balance coming from follow up on existing case studies or award documentation. Owner representatives were all willing to share with NBI and PGL staff the "stories" behind their projects, including energy data and financial information. In many cases they spent a fair amount of time answering questions and following up with details.

Note: A statistical sampling approach was not used to gather project information, and the data is not necessarily representative of the larger market. Energy data was provided by third parties and reviewed by NBI staff; no on-site monitoring was performed as a part of this scope.

[5] CBECS – The Energy Information Agency's Commercial Buildings Energy Consumption Survey 2003

[6] An Energy Use Intensity (EUI) is the total annual energy (gas and electric) used expressed in thousands (k) of British thermal units (Btus) divided by the square feet (sf) of the space – resulting in a commonly-used metric of energy use in kBtu/sf/yr

2 THE SEARCH

In Phase 1, New Buildings Institute conducted an extensive search for project information, performance data and case studies on existing buildings that have made energy efficiency improvements self-identified as 30% or better than a comparable baseline. A broad outreach using multiple methods resulted in a list of 50 buildings - 49 in North America and 1 in Australia – that exceeded their referenced baseline by an average of 40 percent. From that initial list, the nine projects in this Phase 2 work were selected for a deeper look.

The search methods and resources used to find the initial set of projects are outlined below (excerpted from the Phase 1 report). This information will be helpful for future projects and will provide insight into the amount of work necessary to find even a handful of projects with reasonable data. The full Phase 1 report can be found at http://www.betterbricks.com/design-construction/existing-building-renewal-initiative with extracts in the Appendix. The methods of pursuing and collecting project examples were:

1. Broad Industry E-Communication. NBI initiated the search with a project introduction sent via broadcast emails and E-newsletter announcements through industry allies and utilities. It was also sent to publications such as *Building Energy Performance Assessment News*, *Sustainable Buildings Journal*, *BuildingGreen* and allies such as EcoMotion, Energy Center of Wisconsin and American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
2. Organizations. NBI directly contacted, via email and phone, 47 organizations involved in the design, construction, green building and energy efficiency industries. NBI experience and referrals from professional colleagues led to identification of these firms; they included organizations known to be active in efficiency and green building projects and entities found through outreach. Persistent direct contacts resulted in the identification of 18 projects. Collecting project information was challenging given that it takes time for respondents to gather and is not an immediate priority. Each resource required repeated contacts and a great deal of follow-up.
3. Table 1 shows the organizations contacted for this research.

Table 1: Organizations & Firms Contacted

Organization/Firm	Organization/Firm	Organization/Firm
Ecotope	**CNT Energy**	**Paladino and Associates**
Opsis Architects	**Integrated Design Associates, Inc**	**AIA, Federal Regulatory Relations**
Green Buildings Services	**Sustainable Systems LLC**	**Tom Bassett-Dilley Architects**
Johnson Braund Design Group, Inc	**Powermand**	**City of Charleston, South Carolina**
Tamastslikt Cultural Institute	**Slaterpaull Architects**	**North Atlantic Energy Advisors**
Integrated Design Lab-Boise	**Sustainable Colorado**	**Solarc**
Optimum Energy	**Rocky Mountain Institute**	**Flack & Kurtz**
Seattle Daylighting Lab – Puget Sound	**Preservation Green Lab**	**Warwick Energy Committee, MA**
National Grid	**PAE Consulting Engineers, Inc.**	**NEEP**

Organization/Firm	Organization/Firm	Organization/Firm
General Administration State of WA	New Brunswick Power	Integrated Deign Lab – Inland Northwest
Spokane Daylighting Lab	Efficiency Vermont	Integrated Design Lab – Puget Sound
Energy Studies Building Lab - Eugene	Sidel Systems USA	Lighting Design Lab - Seattle
Pacific Energy Center	Moshier Studio	Center for Energy Research/Education
Integrated Design Lab – Spokane & Boise	Energy Resource Solutions	DeScipio Architecture
SERA Architects	ZGF Architects	NBBJ

4. Website Search. NBI identified and reviewed 29 websites with various levels of information on building energy efficiency improvements, energy use, case studies and awards. Staff reviewed over 500 projects with varying depths and quality of information, resulting in 32 project examples.
5. Table 2, while not intended to represent all possible sites, lists those found in the Phase 1 research.

Table 2: Sites with Commercial Building Case Studies

Website	Website
Source sites for some of the 50 initial project examples:	
HPB Magazine	High Performance Buildings Database
Cascadia Region Green Building Council	The Renewable Energy Trust Projects
Building Green NW Case Studies	US DOE Buildings Database
Midwest Regional Green Building Data	Resource Media
AIA COTE – Seattle Top 10 Awards	Urban Land Institute
USGBC Database – LEED Listings	New Buildings Institute Getting to 50
Other Sites reviewed:	
e-Bids	AIA COTE - National
NEEP Schools Case Study Database	Green Star
CoStar	Green Building Assoc. of Central PA.
City Of Portland	Building Performance Evaluation - Rutgers
City of Seattle	USGBC Case Studies
NEEA/Better Bricks	Architectural Lighting
BOMA 360 Buildings	California Green Building Directory
Wisconsin Green Building Alliance	Climate Works Foundation
Northern California Chapter USGBC	

From the broad information gathered on the 50 buildings in Phase 1, the NEEA Phase 2 scope allowed for deeper research into eight to ten. To determine those with the most promise, selection was based on a combination of objective and subjective information from the initial search, as follows:

1. **Willingness to participate -** a responsive contact(s) with sufficient knowledge of the project (this is the most critical factor).
2. **Northwest projects –** or representative building types in equivalent climates.
3. **Low energy use –** access to the measured results of energy performance after retrofit.
4. **Relevant example –** transferable information and lessons to other commercial building owners in the Northwest.
5. **Building type -** medium and large offices topped NEEA's list, followed by box retail, hospitals and lodging. The initial search was predominantly offices with some mixed use.
6. **Technical details –** on measures, design practices, operations and energy data.
7. **Business information –** information and perspective on the project's business rationale and financial factors.

The team selected 10 projects meeting the above criteria and concluded with a set of nine full Project Profiles.

3 THE BUILDINGS

The projects in this study are all offices but offer a range of sizes, locations, uses, owner types and scope. Common to all is that during the past 10 years they significantly "renewed" an existing building to create an improved working environment prioritizing and accomplishing lower energy use.

Table 3 provides an overview of the nine projects.

Table 3: Overview of Buildings

Building Name	Location	Building Type	Owner Type	Renewal Description	Size 000's SF	Project Completed	Year Built
Vance & Sterling Bldgs	Seattle, WA	Large Office	Private Investor - Tenant Occupied	Renovation	134.0	2007	1929
200 Market Building	Portland, OR	Large Office	Private Investor - Tenant Occupied	Renovation / ongoing retrofits	389.0	2009	1973
Beardmore	Priest River, ID	Medium Office + Multi-use	Private Investor - Tenant Occupied	Historic Renovation	28.8	2008	1922
Mercy Corps Headquarters	Portland, OR	Medium Office	Owner Occupied - Non Profit	Renovation + Addition	80.0	2009	1892
The Christman Building	Lansing, MI	Medium Office	Owner Occupied - Green Firm	Historic Renovation	64.2	2008	1928
Alliance Center	Denver, CO	Medium Office	Owner Occupied - Non-Profit + 50% tenants	Historic Renovation	38.0	2006	1908
Lovejoy Building	Portland, OR	Medium Office	Owner Occupied - Green Firm + 1 tenant	Renovation	12.9	2004	1910
Home on the Range	Billings, MT	Small Office	Owner Occupied - Non Profit	Renovation	8.5	2006	1941
Johnson Braund Design Group	Seattle, WA	Small Office	Owner Occupied - Green Firm	Equip. Upgrade/ Retrofit	8.0	Ongoing	1984

3.1 Ratings and Awards

All nine buildings participated in a range of USGBC LEED programs covering four certifications: New Construction (NC); Existing Buildings, Operations and Management (EBOM); Core and Shell (CS); and Commercial Interiors (CI). Table 4 summarizes these ratings. Existing buildings often cross into several LEED categories depending on the extent of the retrofits or renovations. USGBC is encouraging ongoing certification in EBOM to reflect continuous improvement and energy tracking. Together the buildings achieved a total of 13 LEED certifications - all but one at the gold or platinum level. One building is rated triple-platinum, achieving the highest rating in three certification areas.

Although LEED certification was not a criterion for inclusion in this research (many of the initial set of 50 were not LEED-certified), each project in this subset pursued and obtained a LEED rating. Some possible reasons for this are:

- LEED provided a set of target criteria on a variety of environmental areas.
- In most cases, the building renewals were a one-time occurrence for the owner. With LEED providing a pre-made framework, there was no incentive to explore or establish independent criteria.
- The owners perceived a strong value to the third-party certification and market recognition of the label.
- NBI's search more easily found projects that accomplish LEED or other green/energy ratings due to their higher public and industry news profiles.
- Building owners, operators and design professionals more readily respond to requests for information because they have LEED submittal reports and are interested in the exposure for their work.

Table 4: Summary of LEED Certifications

LEED Certification	Qty.	Level
LEED-NC	4	Gold/Platinum
LEED-EBOM	6	Gold/Platinum
LEED-CS	1	Platinum
LEED-CI	2	Platinum/Silver

Acknowledgment through both ratings and recognition from independent entities remained a theme for most of the buildings. Other awards earned by one or more of the buildings included:

- AIA Top 10 Green Awards
- AIA Regional Top Ten Awards
- EPA Small Business Innovation Award

- Energy Star Award
- American Association for State and Local History – National Award of Merit for Restoration
- Pacific Coast Builders Conference – Grand Award for Best Adaptive Re-Use
- Idaho Historic Preservation Council – Orchid Award: Excellence in Historic Preservation

3.2 Characteristics

This section provides information on common real estate descriptors (location, type, size) and their ownership types, followed by a section focused on the energy efficiency measures used in the buildings.

3.2.1 Retrofit Description

Terminology and definitions are a challenging aspect of research and reporting. The terms used by the energy industry are rarely those used by the market, despite the potential benefits of having common names and definitions for building improvements. According to many in the commercial real estate sector the term "retrofit" is widely applied to any energy efficiency improvement, regardless of other changes in the building. Also, "renovation" denotes a whole or partial building change involving major interior and often structural improvements. A renovation is often associated with a change in use and will typically trigger code due to the extensive nature of the improvements.

This research differentiates three types of projects that in turn can affect the extent of energy efficiency opportunities. Here the term "Equipment Upgrades or Retrofits" indicates that efficiency improvements were made in the absence of other major construction projects or building changes. "Tenant Improvement" helps to identify a change driven by a vacant space or a new tenant, and may be coupled with the other terms. "Renovation" indicates much larger changes involving major construction that open more comprehensive efficiency opportunities than might a simple "retrofit." NBI provided these definitions, summarized in Table 5 to the owner representatives to facilitate defining the types of improvements for this research.

NBI had already established a threshold of two or more system changes and 30% minimum savings for the projects to be considered; the scale of the improvement was addressed through that screening.

Table 5: Definition Guideline for Project Improvement

1)	Equipment Upgrades / Retrofits	Projects that involve non-structural improvements to an existing s**pace and primarily target the building's efficiency systems**. For this research, this must include two or more system improvements such as the upgrade of lighting, HVAC, controls, kitchen and laundry equipment.
2)	Tenant Improvement	An interior build-out for a new tenant of a commercial space that includes **efficiency upgrades or redesign** for systems such as lighting, HVAC, controls, kitchen and laundry equipment.
3)	Renovation or Addition	Major **construction projects** that include **replacement of 50% or more** of lighting, HVAC and controls equipment or projects that increase a building's total square footage and include efficiency upgrades such as lighting, HVAC, controls, kitchen and laundry equipment.

Screening for projects for sufficient documentation and deep savings resulted in eight of nine projects labeled as "Renovations" (Table 6), or about 90% -- the same ratio of renovations from the initial list of 50 buildings identified for consideration in this phase. Retrofitting equipment is constrained only by building structure, wiring and often tenant occupancy; it serves as an important intermediary step for procuring energy savings, and provides cost savings and usually improved work spaces. Many of the projects have ongoing "retrofit" activities to ensure new technologies or practices can be rolled into their buildings to further drive down energy use.

A targeted search for equipment-only improvements would be valuable to inform the existing building market potential, since the majority of commercial buildings are in a fixed state and upgrades can yield high savings on a measured basis. For example, retrofitting the lighting in a building or space with high-performance lamps and ballasts, including daylight dimming and controls, could drop lighting energy use by 50% or more. However, this research focused on "deep savings," defined as 30% or greater whole-building or whole-space improvements using an integration of two or more measures.

Table 6: Improvement Types

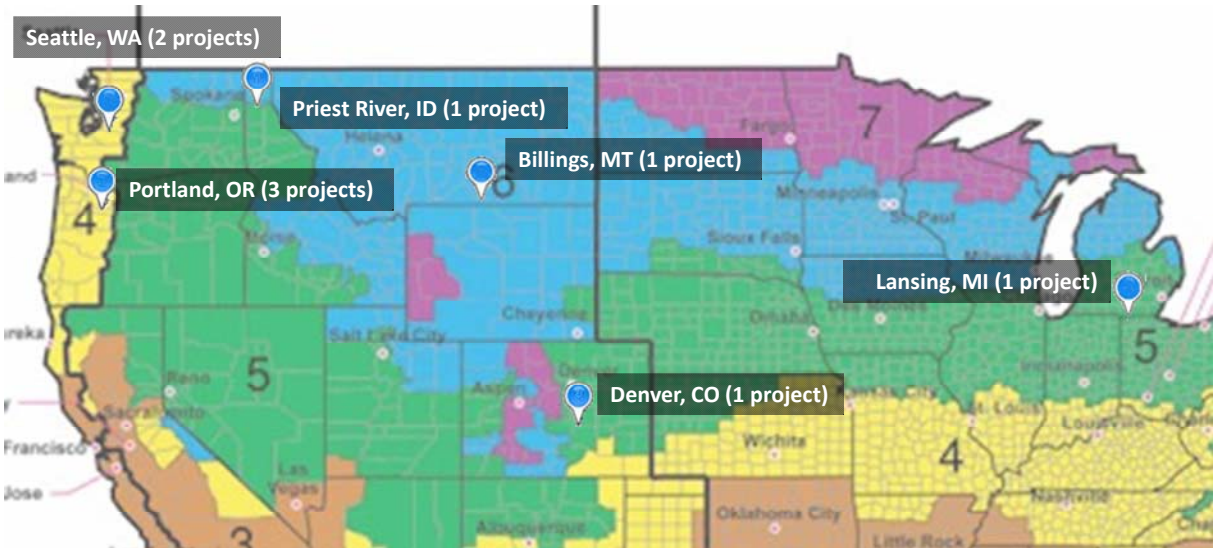
Improvement Type	Size (000s sf)
Equip. Upgrade/ Retrofit	8
Renovation / Historic	29
Renovation / Historic	38
Renovation / Historic	64
Renovation	134
Renovation	13
Renovation	9
Renovation / ongoing retrofits	389
Renovation + Addition	80

Renovations represent a repositioning or "renewal" of buildings in a slumping new-construction market. Renovating existing buildings can be a better investment than building new, as was found by some of the project owners and described in the Business section of this report. Energy efficiency was not the primary driver of renovations, but once the door was opened to major construction changes, owners considered energy efficiency an integral part of improving and updating their buildings.

3.2.2 Locations

The projects described in this report are located in six cities. Seven of the nine are in the three Pacific Northwest states and Montana, all of which are in Department of Energy (DOE) Climate Zones 3 and 4, as shown in Figure 1. The projects in Colorado and Michigan are both located in DOE Climate Zone 5. The building set therefore provides an excellent cross-section of the three Northwest climate zones while exhibiting regional diversity.

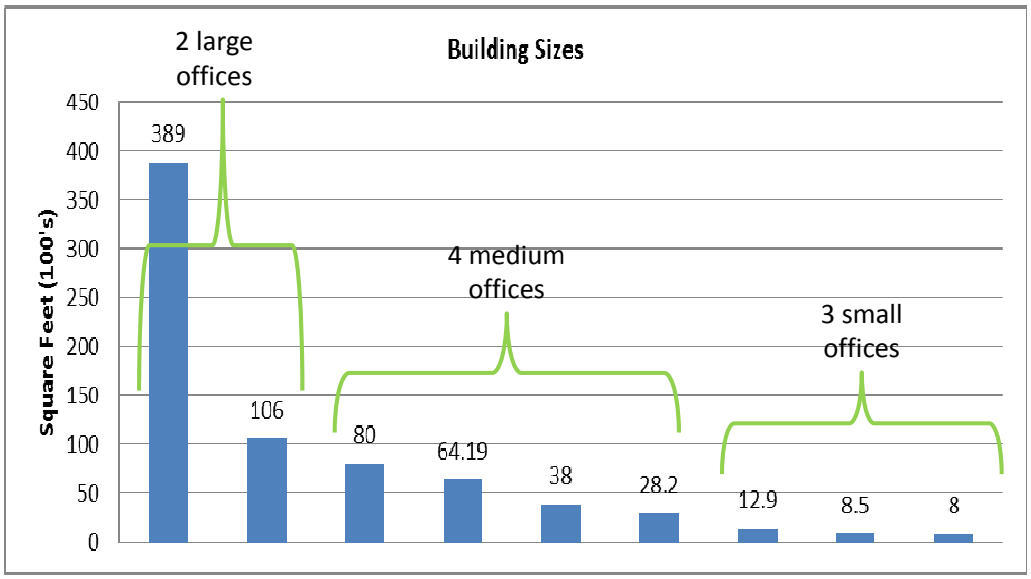
Figure 1: Project Locations and DOE Climate Zones



3.2.3 Building Type and Size

All nine of the buildings are offices. Two buildings have some mixed use, with an unused theater, a spa area and retail as small parts of the floor space. For the purpose of consistency with the energy review, the represented floor space areas are occupied office areas only. The buildings comprise a good mix of square feet (sf) of floor space, ranging from 8,000 sf to almost 390,000 sf (Figure 2). The building set includes three small (< 20,000 square feet), four medium (20,001 – 100,000 sf) and two large office buildings (>100,000 sf).

Figure 2: Type and Size of Buildings



3.2.4 Ownership

The initial Phase 1 search and this deeper-dive research both made clear that the majority of the buildings are owned by mission-driven organizations, firms or individuals. Six of the nine buildings are

owned by nonprofits or firms in the business of demonstrating and recommending green design practices; their buildings serve as extensions of their core missions. For the nonprofits, the buildings function as part of a larger environmental objective. The green firms' buildings serve as demonstration sites and labs on technologies and design that help to convey their green messages to clients.

Both nonprofits and green firms have strong self-interest in promoting the results of their building improvements. As a result, they comprise a high percentage of buildings with documented low energy use. Due to their longer-than-average ownership and broader mandates, nonprofits and mission-driven organizations, are able to take longer-term financial views and consider broader criteria when assessing upgrade options. These types of owners are typically the first out of the gate to help prove the concepts.

At this stage in moving toward deeper energy efficiency the private real estate sector is an increasingly active player. One third of these projects are owned by investors, as shown in Table 7. Of the three buildings, one is owned by an individual investor with a direct interest in the history of the building, and two are owned by large private investor funds – both of which are strongly engaged in being leaders in high performance buildings to the benefit of their business objectives.

Table 7: Owner Categories

Owner Categories	
Owner Occupied: Private Green Firm	3
Owner Occupied: Non profit	2
Owner Occupied: Non-profit + 50% tenants	1
Private Investor: Tenant Occupied	3
Total Projects:	9

The business motivations section of this report further discusses the rationale for these nine owners and the inseparable intertie of green and greenbacks.

3.3 Energy Efficiency Measures

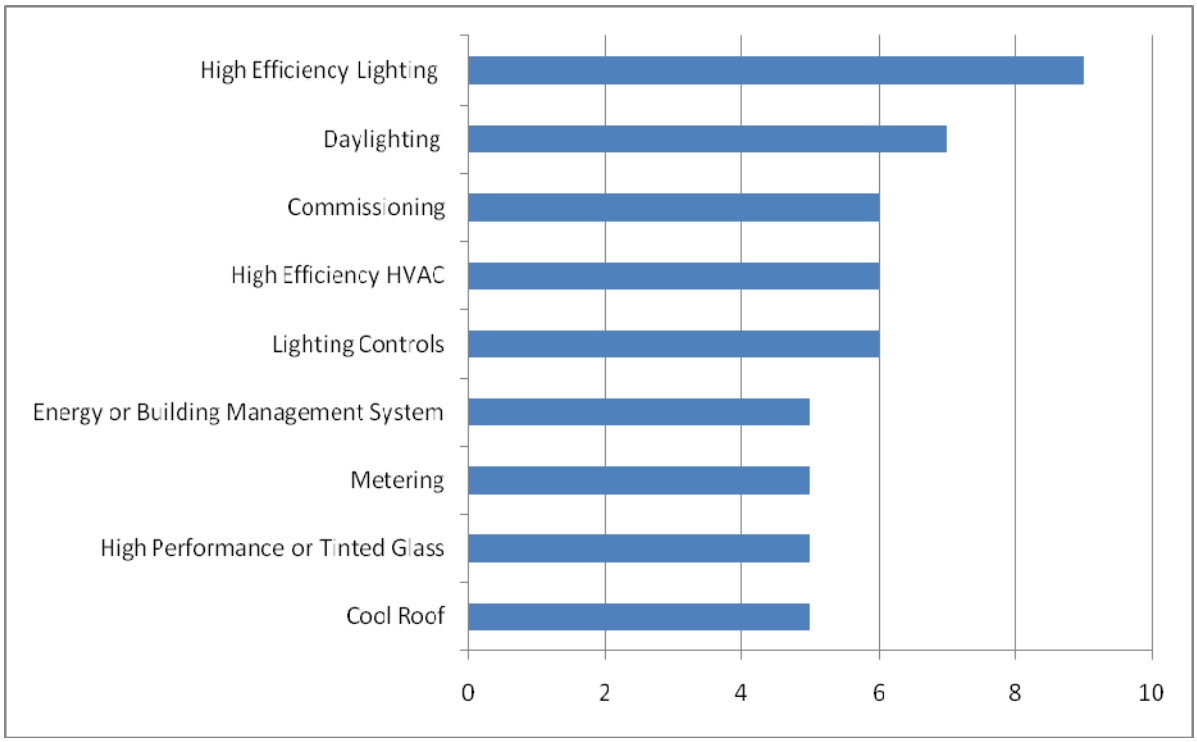
The efficiency measures incorporated in these projects are more comprehensive than could be undertaken by a typical existing building absent a renovation, thus the larger energy savings results associated with these projects. High-efficiency lighting (lamps and ballasts) were a part of each project's upgrade; seven out of nine incorporated daylight dimming controls within the lighting system for their buildings.

Table 8 shows the most frequent measures applied[7], with lighting related measures as three of the top five – high-efficiency lighting, daylighting and lighting controls[8]. High-efficiency Heating Ventilation and Air-Conditioning (HVAC) equipment was included in more than half of the buildings, as was commissioning.

[7] These are ordered by frequency applied rather than in relation to savings per measure. Savings per measure cannot be discerned from this research.

[8] Daylighting Controls: Automated dimming in response to daylight. Lighting Controls: Occupancy sensors and timers.

Table 8: Number of Buildings with Various Efficiency Measures



An overview of some of the key measures in this high performance building set:

Lighting

- 100% of the buildings have high-efficiency lighting
- Integrated daylighting controls (automated dimming of electric lighting) were applied in whole or in part in 78% of the buildings
- Lighting Controls (occupancy sensors / timers) were included in 66% of the buildings

HVAC

- 66% of the buildings upgraded to high-efficiency HVAC systems
    - Two buildings used radiant heating systems, an emerging trend for HVAC, selected (per owners) for energy efficiency and improved tenant comfort
    - Direct evaporative cooling was used in one building
    - HVAC controlled through an Energy (or Building) Management System in five of the buildings
    - Heat recovery or energy recovery was installed in three of the buildings

Daylighting

- Integrated daylighting controls (automated dimming of electric lighting) were applied in whole or in part in six of the buildings
- Architectural features to enhance daylight availability for improved indoor environment and/or to increase the potential for electric lighting reduction, or to control daylighting for glare or heat reduction, included exterior shades, motorized clerestory, automated interior shades, specialty glass and skylights with automated dampers

Whole-Building Controls, Monitoring and Commissioning

- Tenant-level sub-metering was used by two of the investor properties
- Whole-building metering and monitoring via an Energy (or Building) Management System is in place on five of the buildings
- Commissioning was identified as a measure by six of the buildings

Envelope and General Building

- Existing windows were restored for historic preservation on three buildings
- Renovations allowed for improved envelope insulation in most projects
- Operable windows were included as a ventilation and tenant comfort factor on at least two projects
- CO2 sensors provided some savings on ventilation in response to occupancy of spaces in four of the buildings
- Six of the buildings have or are designed for solar electric photovoltaics

The four tables below provide greater detail on the measures, grouped by lighting, HVAC, envelope and monitoring/measurement and commissioning measures.

Table 9: Count of Lighting Measures

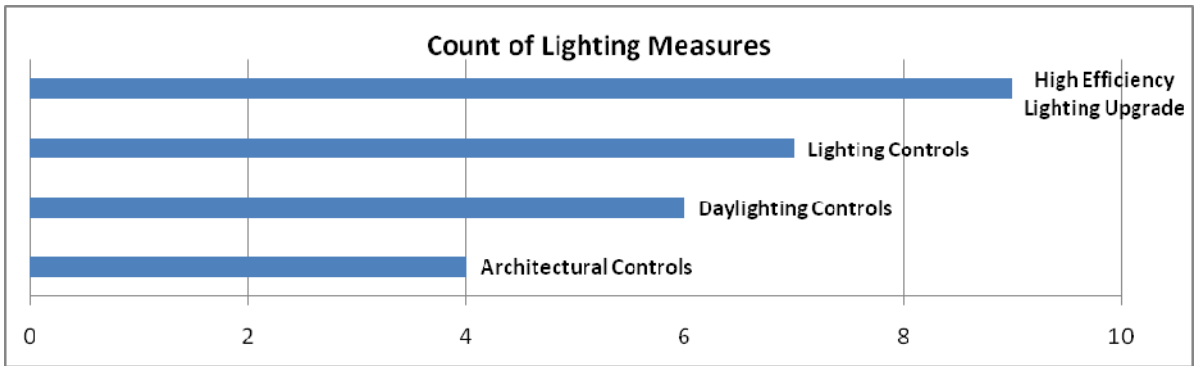


Table 10: Count of HVAC Measures

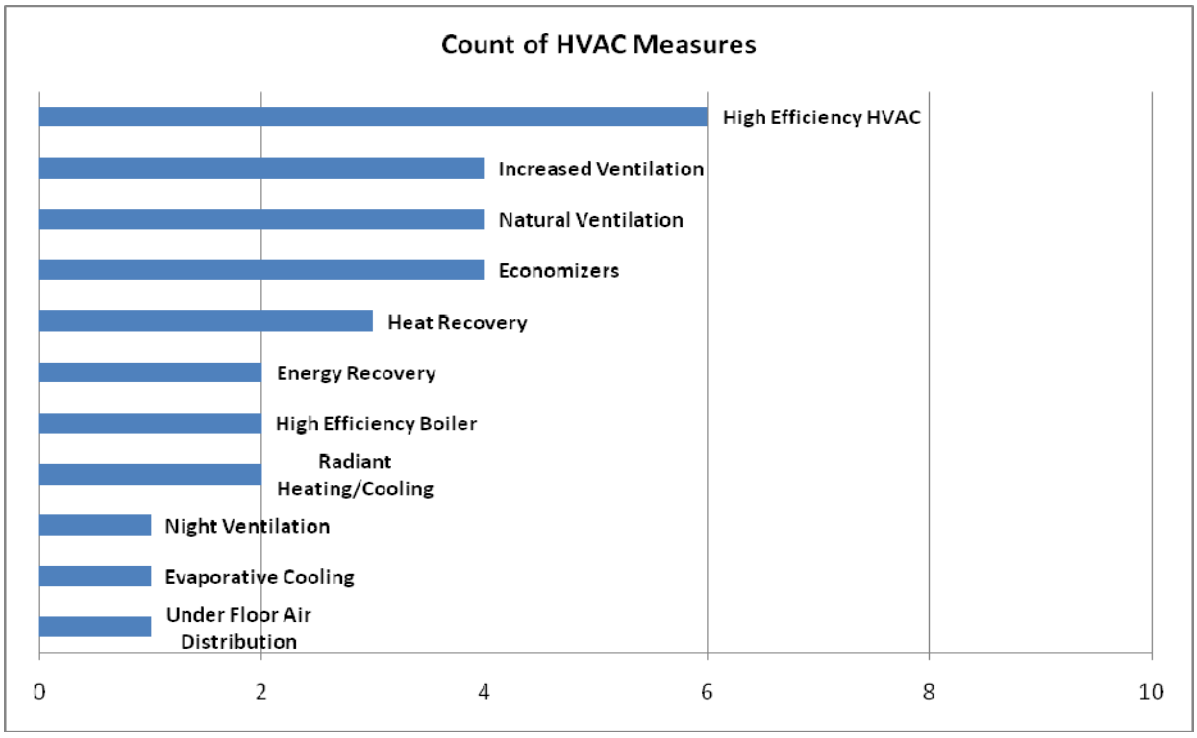


Table 11: Count of Envelope Measures

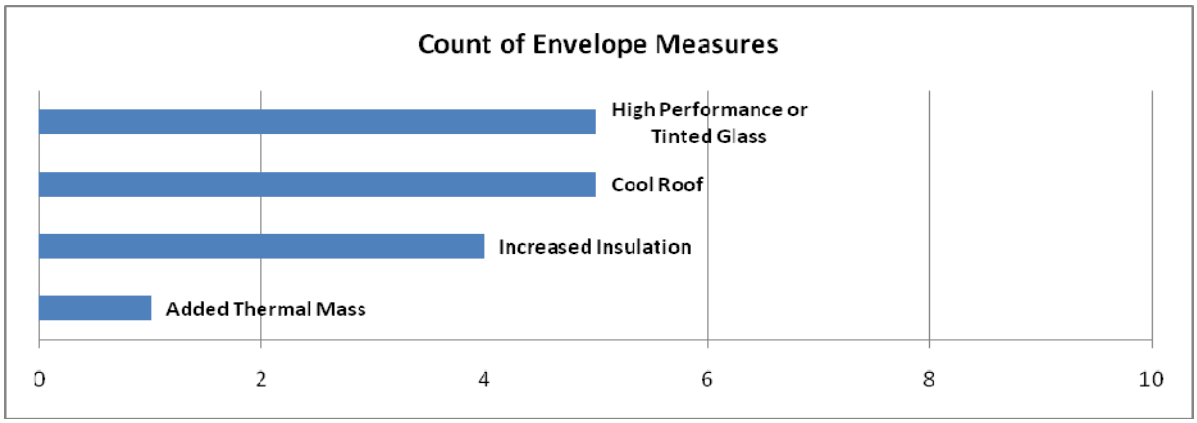
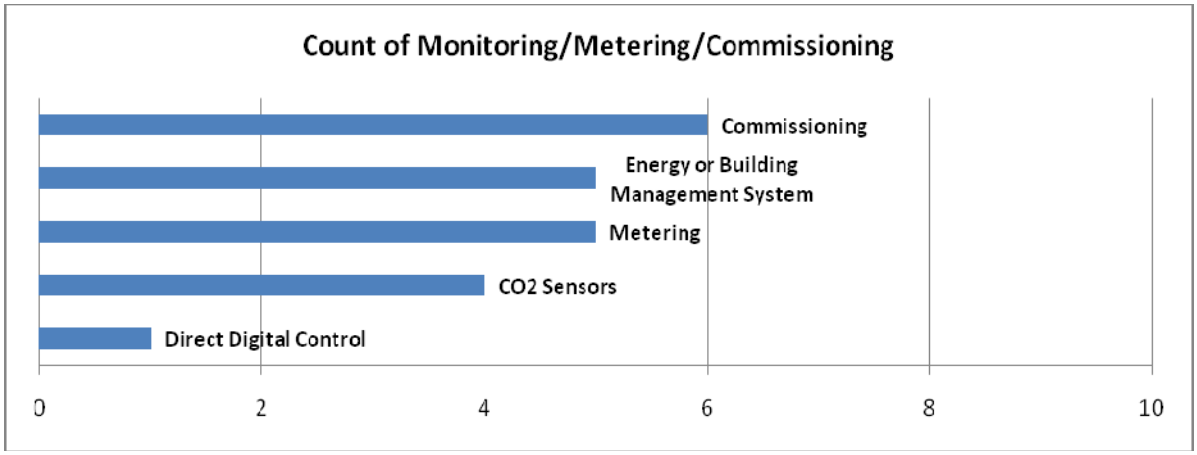


Table 12: Count of Monitoring / Metering and Commissioning Measures



4 THE BUSINESS

While creating low-energy buildings is not the primary business of most of these firms, the business rationale and financial information these projects provide may inform and motivate others. This section addresses the motivations (as provided by the owners) and money aspects related to the existing building improvements and energy efficiency choices.

4.1 Motivations

This set of projects largely represents owners with motivations partly driven by missions to "green" the built environment or to showcase their green businesses as a step toward carbon reduction or other environmental values. However, this statement alone is shortsighted and incomplete. The past 10 years have seen a market trend that blurs the lines between altruistic and societal benefits and purely economic motivations. The "green" of money and "green" environmental and social motivations are primary and inseparable factors for the rationales for both low-energy buildings and the outcome to the owner.

In economic terms, the nonprofits gain funding based on being exemplary in their missions; the architecture firms gain clients or expand the scope of client projects based on demonstrating best practices; the investor property owners stated that tenant volume, rates and terms are improved, and costs reduced, through their efficiency investments. Positive public exposure, strong building ratings and labels, and increased consumer awareness and interest in better buildings are other economic drivers in the decisions of investor-owned property managers.

For example, Beardmore, Lovejoy, Christman and Johnson Braund Design Group (JBDG) are all architectural design and construction firms that wanted to incorporate energy efficiency into their own buildings to influence clients. Home on the Range (HOTR), Mercy Corps and Alliance wanted to be able to "walk their talk" as advocates for conservation, humanitarianism and sustainability. Vance, 200 Market and Beardmore have all found improved tenant draws and enhanced public profiles from the energy/green features of their buildings.

The following section provides some owner perspectives gained through interviews and some direct quotes from the projects.

4.1.1 Green Leadership

For firms involved in building design, landscaping, engineering or consulting, showing leadership and experience in green approaches and emerging technologies is becoming a necessary part of doing business. These firms chose to use their buildings to demonstrate the technologies and practices they promote with clients; as they become models for green building, their abilities to influence other buildings and owners improves. Summaries of their energy efficiency renewal measures follow.

[Beardmore] The owners restored the building using the sustainable and energy-efficient design principles that the owner incorporates into his own architectural practice. It also played an important part in revitalizing the Priest River community and economy by restoring the building to its former grandeur.

[Lovejoy] Designed their space to formulate a living laboratory to showcase and experience the various energy-efficient and sustainable design features it incorporates into its work.

[Christman] Christman's quest is to provide the best possible tools and expertise to customers in achieving its own green building and operations goals. *"What better way to learn how to do that than by taking ourselves through the process, and experiencing it first-hand from an owner's perspective?"*

[Alliance] Striving to meet its mission of achieving sustainability through collaboration, the Alliance converted a warehouse to a multi-tenant nonprofit center that would provide multiple organizations a "healthy, efficient, quality, mission-enhancing workspace." Pursuing energy efficiency supports its mission of sustainability and increases its access to a new tenant base of green-minded organizations and companies.

4.1.2 Money and Market

No owners or organizations approached the energy efficiency upgrades with unlimited funds – all had to consider the options, costs and trade-offs with other capital demands. Below are some of the motivations of these owners associated with money and the market for their buildings or services.

[Mercy Corps] Mercy Corps needed to be fiscally responsible with donor contributions throughout the construction process. After paying more than $34,324 in monthly rent at its previous location, Mercy Corps determined that owning a building was more cost-effective than renting. Lowering its operating costs through energy efficiency allows Mercy Corps to spend more money on humanitarian projects throughout the world. The organization was particularly interested in natural ventilation, so operable windows and motorized clerestory windows were included in the design.

[JBDG] JBDG established goals to reduce electrical and water grid consumption by 50%; receive a reasonable financial payback on all improvements; and improve occupant comfort.

[Vance] Rose Development was motivated to keep costs down by simplifying the energy system approach and to increase tenant draw by renewing the building's most attractive historical features. Peter Alspach, Arup Project Engineer, stated the company wanted to "*take the building back to its roots – architecturally by strategies such as exposing the terrazzo floor, and the same principle for building systems, such as restoring natural ventilation. Pull back to the original systems, and then analyze how we could incrementally apply modern technologies to get best performance. Simplification was the general philosophy.*" Architect firm Zimmer Gunsul Frasca (ZGF) approached interior renovations with a focus on simplicity, which extended to the firm's creation of tenant improvement guidelines.

[200 Market] Keeping the occupancy rate high is a primary driver for improving energy efficiency and increasing this building's "green" profile. Working closely with the building management team, the owner has implemented a program of continuous improvement that not only serves to benefit the current tenants, but also attracts tenants that place a high value on environmental responsibility and a healthy work environment.

This motivation was reflected in 2006 when 200 Market became the first multi-tenant building in the nation to obtain its LEED for Existing Buildings 2.0 Gold certification. Russell Development will only consider projects with payback periods of seven years or less; all improvements to date are well below that threshold. Russell's goal is to incorporate low energy use as a core part of a building's business management.

[Home on the Range] This organization consistently looked at costs and eliminated inefficiencies, but it incorporated most energy efficiency measures into the project. The highest-priority measures of daylighting and radiant floors improved tenant comfort.

[Beardmore] A cost-benefit analysis determined the economic impact of green building practices in terms of design, documentation, material salvage and construction.

[Christman] Using an integrated approach, Christman was able to incorporate energy efficiency into the project and proved it could be accomplished within a tight budget.

In all nine cases, the business views of the individuals or teams responsible for determining the building's energy efficiency aspects shared five key elements:

1) "Green Link" Recognition – they considered and valued the economic and environmental benefits (the "two greens") that make energy efficiency a wise investment.
2) Vision – they are goal-driven, pursue targets via LEED, have leadership mentalities, and the willingness and desire to be ahead of the curve in many aspects of their businesses.
3) Money Leverage – they maximize government, utility and organizational incentives and tax credits.
4) Measurement – they track energy results and conduct continuous commissioning to maintain and improve performance.
5) Market Profile – NBI "found" these buildings because publicizing their energy-efficiency renewal results, including the use of public-relations opportunities, is a part of the owners' strategies for increasing their buildings' values.

4.2 Money

The financial information gathered from owners, design teams and property managers varied widely. Building owners currently have no reason to isolate costs of specific efficiency measures within larger projects. In addition, the effort would be time-consuming and most likely futile due to the near-impossibility of separating labor time associated with, for example, wiring an office from that of wiring an extra connection to a specific control feature that improves efficiency; contractors bill for the full project. Even direct costs associated with efficiency features are rolled into broader invoices from distributors.

Only specific retrofits of efficiency measures can yield accurate cost information. Even then the relevance is highly dependent on the physical constraints faced by the contractor, other building attributes, and the pricing and competitiveness of the locale.

This research experience highlights the fact that finding credible and transferable financial information on single projects is rare. Yet the level of openness with the data these owners did make available is also rare and worth presenting below.

4.2.1 Funding and Costs

Information on costs and financial details is aggregated below.

- The whole-project costs for eight of the full-building renovations ranged from $100 to $176/sf, with one building with an addition and the most extensive building de-and re-construction running $445/sf
- Energy efficiency measures were carefully documented by one nonprofit as $3/sf

- The tenant improvement costs, including the efficiency measures, at the large Seattle office building were stated as $26/sf
- The costs from the one project that consisted primarily of energy efficiency upgrades with some smaller interior improvements was $31/sf
- Specific efficiency measure costs disclosed by 200 Market to benefit others pursuing improved energy performance:
    - $25,000,000 (1989) for boiler upgrade, variable-speed drives added to all pumps and fans and asbestos removal, reconfiguring of the ground floor and upgrading of the life-safety systems
    - $11,000 (2000) for pressurized water tank/pressure sensor replacement of water pumps
    - $6,000,000 (2004) for elevator upgrade including conversion to alternating current drives and new controls
    - $180,000 (2008) for garage lighting upgrade
- Renovating yielded better economics for two of the buildings than did building or renting. For the HOTR building, the owners' cost analysis determined that demolishing the existing structure and building a new office building the same size to the model energy code would have cost approximately $325,000 more than the cost of renovating to LEED Platinum status (Figure 3).
- Financing. The methods used to access capital were also diverse, but only one project identified them as a barrier. In that instance the owner had to expend private funds due to a bank loan limit resulting from the national lending crisis. Here are the overview points:
    - No owners mentioned access to low-interest funds
    - Conventional construction loans, private investor funds, public/private partnerships and sponsor donations constituted the sources of money for these projects
    - Owners took advantage of incentives and tax credits – historic, federal, state and utility. All costs/sf shown above are after these incentives.

[Lovejoy] The owners decided against registering the building as an historic landmark, thus giving up the associated tax credits, in order to retain the flexibility to enlarge the exterior windows and add sunshades. Opsis also chose to not move beyond LEED-NC Gold because of cost. According to James Meyers: *"We took everything as far as we could within a tight budget, and were able to prove that if you are smart with the design, you can achieve LEED-Gold cost-effectively."*

Figure 3: Comparison of New Construction versus Retrofit (HOTR Building)

Conventional Approach (Estimates*)		Green Building Approach (Actual)	
Property	$ 182,500	$ 182,500	Property
Professional Services (10%)	$ 127,290	$ 122,000	Professional Services
Demolition	$ 70,500	$ 15,000	Deconstruction (partial)
New Construction	$ 1,156,700	$ 839,200	Renovation
		$ 66,200	Alternative Energy Systems
Site	$ 191,200	$ 165,700	Site Improvements
		$ 12,800	LEED related costs & fees
Total Capital Costs	**$ 1,728,190**	**$ 1,403,400**	**Total Capital Costs**
First Cost Savings - compared to building new:		$ 324,790	
Capital + 10 years of Operational Costs**	**$ 1,855,683**	**$ 1,429,813**	**Capital + 10 years of Operational Costs**
10 Yr Cost Savings - compared to building new:		$ 425,870	

***Estimates from 2006 RS Means Building Construction Cost Data based on 8,300 SF**
**** Baseline Office Building meeting Model Energy Code Ashrae 90.1-99**
Operational Costs assume an annual 3% energy escalation rate

4.2.2 Savings Estimates

Some owners were able to provide information from the original plans or from ongoing monitoring regarding the impact of efficiency on operating costs. The savings cited for the deeper energy renovations were near or beyond a 50% cost reduction in energy expenses, while the equipment retrofit project estimated 25% savings from the efficiency measures.

[Home on the Range] Northern Plains realized an up-front cost savings of almost 20% in creating a building with operating costs estimated to be 23% lower over a 10-year period. The payback period was determined to be negative.

[Beardmore] The LEED modeling analysis estimated an annual cost savings at full occupancy of $23,370 (~$1/sf), a reduction of more than 50% compared to the national average.

[Christman] The energy efficiency upgrades incorporated into the project result in an estimated annual savings of $45,659 ($0.83/sf). Implementation costs for the energy efficiency upgrades were $22,693, with a payback period of six months.

[JBDG] Improvements to this building reduced annual operating costs by $3,840, or $.48/sf. *(note: typical energy costs are $1.50 - $2.00/sf, so this represents a ~25 - 30% cost savings; however, this project was less deep than the approach available in the full renovations)*

5 OUTCOMES

Identifying the performance outcomes of these buildings has been a unique and exciting part of this deep-dive research, on a broad whole-building level. Measured energy performance data is surprisingly hard to obtain, even in the simple form of monthly utility bills, so these projects provide helpful references. Educating the market on the value of benchmarking and tracking performance, together with the trend toward requiring energy performance disclosure and ratings in real estate transactions, will increase owners' abilities to understand and improve the current building stock. Determining performance following a retrofit or renovation is equally as important for market metrics as for energy efficiency. As with energy efficiency, a market benchmark to compare changes in typical industry metrics such as tenant attraction, retention, lease rates and occupant satisfaction would be valuable in reviewing the project outcomes.

This section presents standard energy benchmarks as a basis for comparing the energy use of these nine buildings, and summarizes the owners' responses regarding the market impact (anticipated or actual) of their buildings.

5.1 Energy Performance

All energy performance information on these buildings is based on measured data. Their actual energy use is well below other benchmark references, with EUIs ranging from 32–66 kBtu/sf/yr; five of the buildings have EUIs of 40 or less.

NBI reviewed a variety of data sources, in some cases multiple types for a single project, for reasonableness and consistency. Sources of energy performance information included:

- EnergyStar Portfolio Manager (PM)
- LEED Energy and Atmosphere (EA1) Report
- Utility billing data
- Contractor Analysis
- USGBC Building Performance Partnership submittal
- Data and analysis by other researchers
- Review of data with NBI's *First View* tool

For this research, measured energy use is presented in three ways:

1) Energy Use Intensity (EUI) – an absolute number of kBtus/sf/yr
2) A percentage improvement relative to a benchmark
    a. CBECS
    b. EnergyStar Portfolio Manager EUI[9]

[9] Comparable office average energy use from the Energy Star Portfolio Manager program based on like type, size, occupancy, hours, and climate – determined from statistical analysis of the EIA's CBECS dataset

3) EnergyStar score

The CBECS database is the primary benchmark source for commercial building energy use in the U.S. is. NBI also had owner permission to access existing Portfolio Manager accounts, or was provided those results, for six of the buildings. NBI directly ran the energy data in Portfolio Manager for the remaining three. This provided an additional consistent benchmark EUI per building and also provided the third source of comparison by establishing an EnergyStar score for all nine buildings.

Pre-existing[10] energy use data is applicable only if the building use, size, occupancy and hours remain reasonably consistent between pre- and post-retrofit. Since these buildings were primarily renovations, this was relevant or available in only two cases. Those cases provide benchmarks of the greatest relevance to the market: the outcome compared to the building before retrofit. Code comparisons are not done due to the variety of time periods and locations, the end-uses such as plug loads not addressed through codes, and the lack of consistent modeled results to generate a code baseline estimate.

These multiple methods of reviewing and comparing data are, understandably, confusing to all but the most serious of energy geeks. Since many in the efficiency industry embrace that label, this information offers sufficient variables from real field findings to benefit their work in the program area. For others seeking a more general overview of accomplishments, arrows in the following charts indicate the direction of "better," to provide at-a-glance understanding when the metrics change, for example, from a goal of low energy to achievement of a high score.

Code comparisons are not done due to the variety of time periods and locations applicable to the projects upgrades as well as the amount of end-uses not addressed through codes (unregulated areas such as plug loads).

5.1.1 Energy Comparisons

Table 13 shows the buildings' energy use intensity compared to the two benchmarks of CBECS and PM; the EnergyStar score is provided as a summary of the building energy metrics. The table also shows activity type, ownership type and size.

Table 13: Summary of Building Energy Metrics

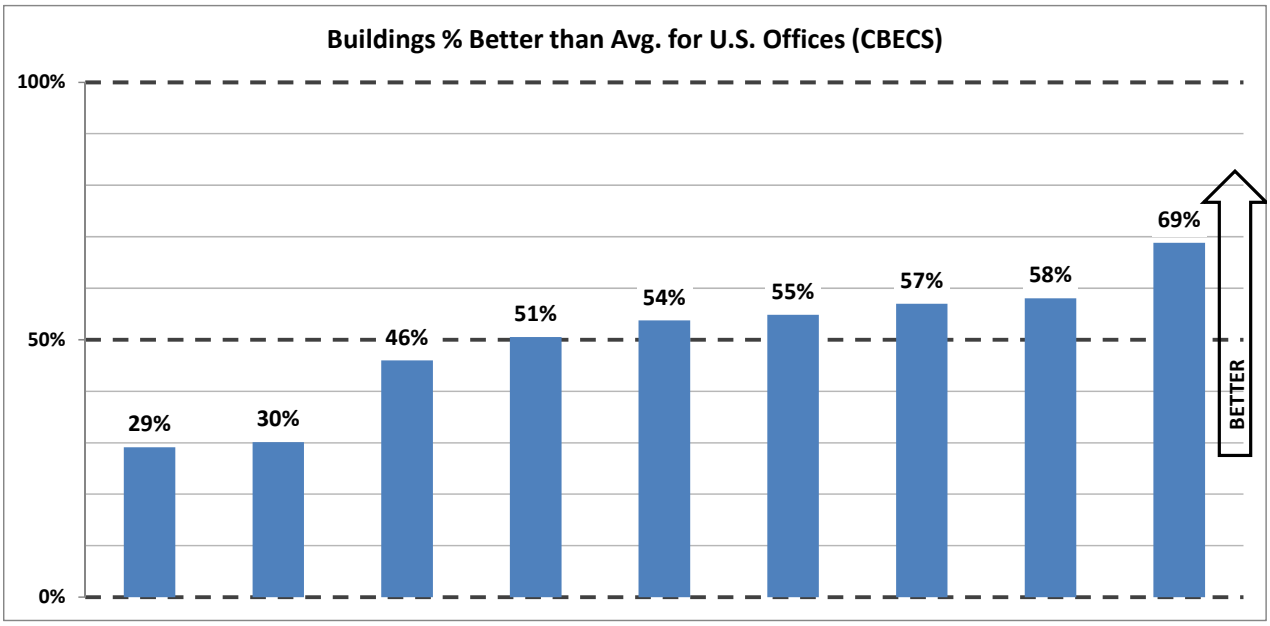
Activity Type	Owner Type	Size 000's SF	Building Measured EUI	% Better than CBECS EUI	% Better than PM EUI	Energy Star Score
Multi-use	Private Investor - Tenant Occupied	28.8	32	66%	47%	90
Medium Office	Owner Occupied - Non Profit	80.0	36	61%	50%	93
Small Office	Owner Occupied - Green Firm	8.0	36	61%	35%	94

[10] Before the retrofit or renovation

Activity Type	Owner Type	Size 000's SF	Building Measured EUI	% Better than CBECS EUI	% Better than PM EUI	Energy Star Score
Large Office	Private Investor - Tenant Occupied	134.0	39	58%	64%	98
Medium Office	Owner Occupied - Green Firm + 1 tenant	12.9	40	57%	38%	92
Medium Office	Owner Occupied - Non-Profit + 50% tenants	38.0	42	55%	39%	85
Small Office	Owner Occupied - Non Profit	8.5	46	51%	72%	99
Large Office	Private Investor - Tenant Occupied	389.0	65	30%	30%	98
Medium Office	Owner Occupied - Green Firm	64.2	66	29%	35%	81

Energy performance in the hundreds of case studies, articles and information sources reviewed for this research is most commonly referenced as "percentage better" and "percentage saved." Most instances included no "compared to. . ." references; percentages "better" or "saved" are very popular and easily-understood bases for presenting performance. Figure 4 shows building energy use as percentages better than the CBECS national average for offices, with an average savings of 52% better than CBECS.

Figure 4: Buildings Percent Better than CBECS

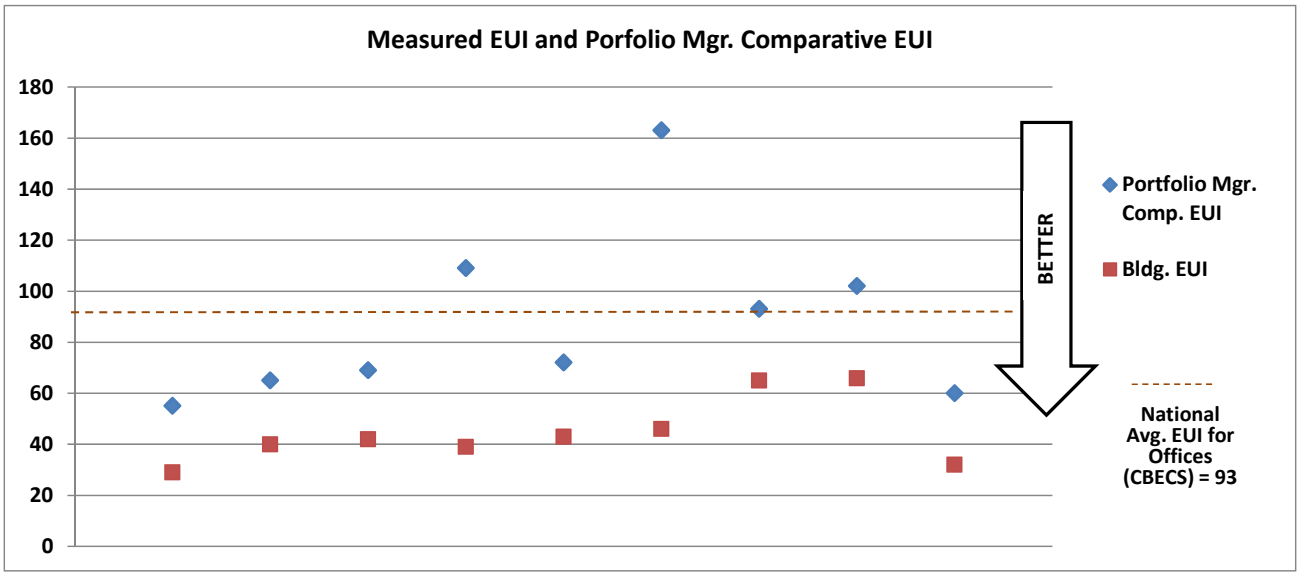


The EnergyStar Portfolio Manager program allows a more specific comparison which determines the energy use of a building of like type, size, hours of use and climate - determined from statistical analysis of the CBECS dataset.

Figure 5 shows all buildings in this report that use less energy than the predicted comparable building. The building's EUIs (indicated by the squares in

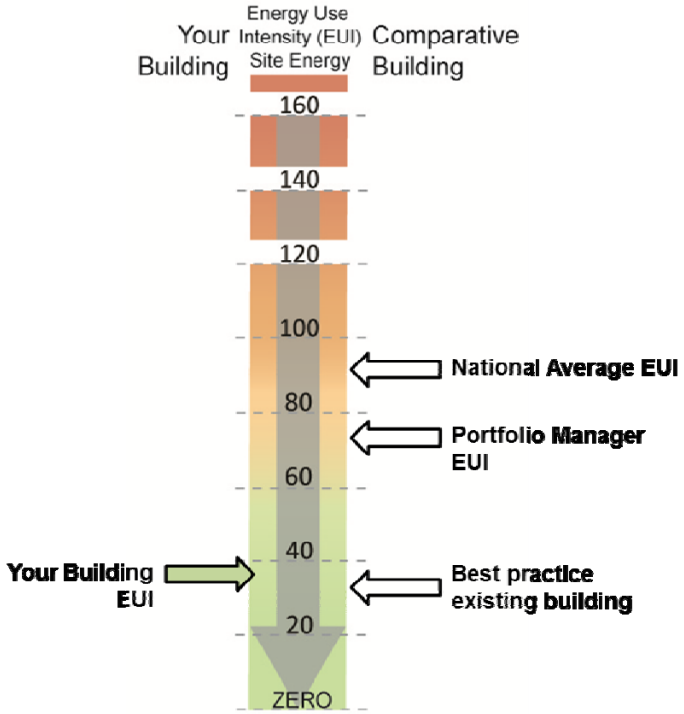
Figure 5) range from 32 – 66 kBtu/sf/yr, and, as shown in Table 13, are 30% - 72% "better than" the PM benchmark, with an average savings of 46% better than the Portfolio Manager-calculated EUI.

Figure 5: Building EUI Comparison to Portfolio Manager EUI



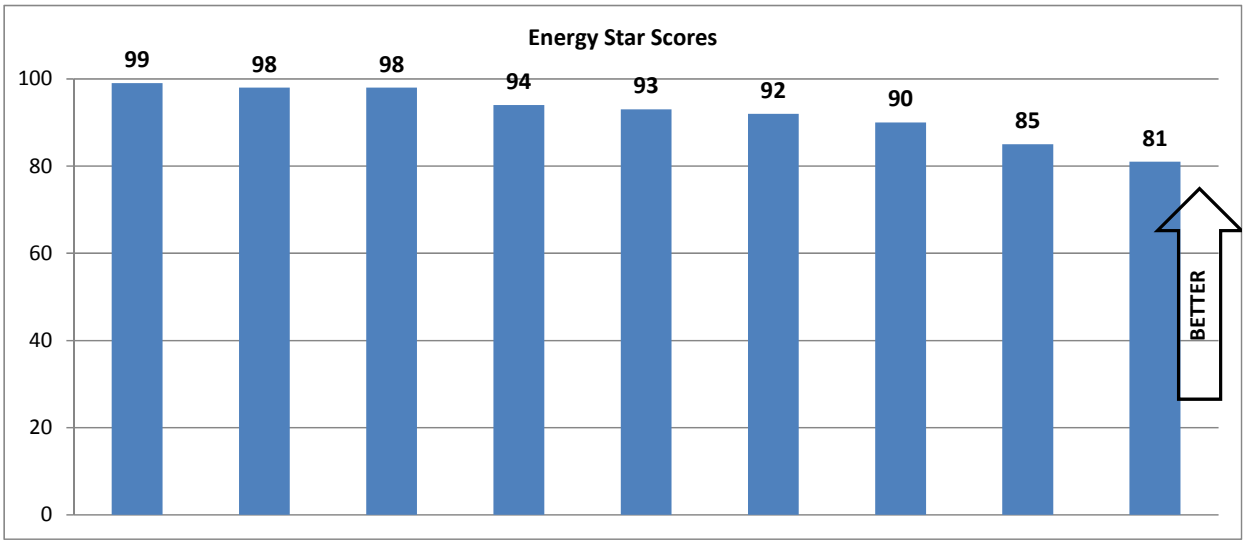
The metrics discussed above are represented in Figure 6 as an example of comparing a building's actual performance on the left side of the scale to other benchmarks on the right side of the scale. This scale helps direct energy use levels toward a "lower is better" vernacular based on ultimately striving for net-zero-energy buildings.

Figure 6: Example Graphic of EUIs based on a Zero Energy Performance Index (zEPI) Scale



The EnergyStar label is a widely-recognized performance rating available to any building through use of the Portfolio Manager tool. Scores range from 0-100, but the EnergyStar label is for buildings in the top 25th percentile of their class compared to others in the U.S. (a score of 75 or higher). The EnergyStar scores of these buildings are shown in Figure 7 as another metric to indicate the strong energy performance outcome achieved; all buildings scored above 80, and the majority scored 90 or above, placing them in the top 10% of office building energy performance in the U.S.

Figure 7: Building EnergyStar Scores



In addition to indicating building performance, EnergyStar scores are also the basis for the majority of energy disclosure requirements currently adopted by U.S. cities and states. Washington and Seattle already have these requirements and Oregon is in the process of adoption. EnergyStar scores will be a new visible metric required during real estate transactions and, in some cases, tenant lease negotiations. The high scores of the buildings in this set give these owners another positive feature recognized by the market.

A new partnership between the Department of Energy and The Appraisal Foundation will further influence labels as a means to higher value and is intended to encourage upfront investment in energy efficiency upgrades. The partnership will work to ensure that appraisers nationwide have the information, practical guidelines and professional resources they need to evaluate energy performance when conducting commercial building appraisals. This will enable investors, building owners and operators and others to accurately assess the value of energy efficiency as part of the building's overall appraisal.

5.2 Market and Tenant Impacts

Market outcomes – predicted and actual – are based on owner and design firm interviews. Despite the wide range of variables involved in the economics of commercial real estate, all of these owners believe their buildings have positive impacts on business opportunities.

5.2.1 Market results

[Beardmore] Brian Runberg, owner, believes the building has "*sparked new economic life into the community, giving it a renewed sense of pride and entrepreneurial spirit. Tenants saw the potential of what could happen in the building and came with business ideas.*" Due to the Beardmore's energy efficiencies and overall historic qualities, according to Runberg, rents average about 35% higher than other local properties.

[Vance] The Rose Development Fund believes the proof of concept is self-evident: Since completion of the renovation, the owner has increased occupancy from 68% to 96% and has seen increased rents, tenant retention and net operating income, thus enhancing long-term value.

[Lovejoy] Because the building is LEED-Gold, Opsis feels it is able to attract tenants committed to sustainability. This does not necessarily mean it has been able to charge more rent, but it has had no problem finding tenants, and the space has been continually occupied.

[Christman] Sustainability manager Gavin Gardi believes the building differentiates its company from others: *"Tenants enjoy working here, the air feels fresh and is good for people with allergies; operating costs are low. People rave about the building."*

[200 Market] *"In my observation, tenants are willing to pay a premium for a building that is demonstrably better."*- John Russell, owner representative. Much of this success has been credited to the owner's efficiency and sustainability investments. It has maintained a high level of occupancy (16 office tenants and 11 retail tenants) despite the economic downturn.

[Alliance] When asked to describe the direct benefits of association with the Alliance Center, owner responses included: *"Added organization legitimacy and credibility, recognition to organization name, a sense of unification and prestige, added recognition for dedication to the environment, built-in fundraising and networking opportunities, an enhanced organization profile as a sustainability leader."*

5.2.2 Involving the Tenant

Guidelines for tenants establish building-wide standards for new tenant improvements that align with the owner's energy and green targets. They can also require tenant-level metering or operational procedures that help reduce energy use. Occupant satisfaction surveys, while still rare, are gaining ground as a means of validating satisfaction with the indoor work environment and identifying areas of improvement that will help retain tenants.

[Vance] The owner and engineer worked with architect ZGF to create guidelines for tenant retrofits to guide design decisions for daylighting, ventilation and finishes. Tenant strategies include light shelves, MechoShades and high-level transom vents where interior, enclosed offices are required.

[Lovejoy] A post-occupancy survey found the majority of employees in the building were "satisfied" or "very satisfied" with their renovated work environments. Daylighting received the greatest positive response from users.

[Vance] A 2010 Occupant Survey Report showed that 77% of building occupants were satisfied with lighting levels, and 85% of occupants indicated general satisfaction with the overall building and individual work spaces.

[200 Market] A quarterly electronic newsletter is published by the building's management team to update tenants on ongoing green efforts and to provide tips on energy conservation measures.

6 BARRIERS AND INNOVATIONS

6.1 Barriers and Resolutions

These nine owners faced barriers and challenges similar to most construction projects with costs and maintaining historical attributes most often cited. As historic renovations, Beardmore, Christman and Mercy Corps offered additional challenges to aligning efficiency measures with historic preservation requirements, but some costs were offset with tax credits. An additional project chose not to pursue historic register status because its owners wanted flexibility to increase window heights.

[Vance] The design team began with an intention to apply higher-end retrofit measures, but the proposed design exceeded the project budget. The team had to rethink options and started focusing efforts on simplified approaches.

[Alliance] Some of the Energy and Atmosphere Credits for which the Alliance Center qualified constituted "significant cost actions," but the Alliance was able to find funds and maintain its high level of commitment to promoting sustainable design approaches.

[Alliance] Because preserving the historic integrity of the building was a priority, only the more contemporary lobby windows received any kind of design treatment; the focus was shifted to improving the mechanical and electrical systems within the building.

[Home on the Range] The challenge was to get the architect, engineers and contractors on board and transform them into "believers" in a low-energy building (they succeeded).

[Beardmore] Ground-floor retail glass transom windows provided almost no insulating properties; initial redesign concepts were rejected by the state historic preservation office. The approved solution allowed installation of a separate insulated glazing unit to the interior of the windows, retaining the exterior character. The historic nature of the building did not allow for addition of a vestibule at the front doors, so ground-floor heat loss in the winter months is an issue.

[Lovejoy] The owners were willing to pay more for lighting controls, operable windows and night flush than they would have for other standard efficiency improvements.

[Christman] The owners wanted to use a daylighting approach with controls and dimmable ballasts, but found the cost at the time was too high (estimated to add one-third to the price of the light fixtures). (*note: dimmable ballast cost is dropping significantly).*

[Vance] The building was occupied during renovation, presenting the challenge of implementing strategies while working around existing tenants, balancing the costs and benefits of green investments.

6.2 Innovations

Owners identified unique and innovative aspects of their processes and/or projects. All the items cited are readily available today and fit within project budgets as well as contributing to their successful outcomes. Innovation is not defined here as on the fringe of practice, but rather reaching for ideas that pull the project to the top of its potential.

[Home on the Range] The owner representative believes the most innovative aspects of the project are the light shelves and the pulverized glass parking lot. *"The fact that we were able to 'walk our talk' has given us an advantage point as an organization."*

[Lovejoy] The architects at Opsis believe the most innovative aspect of their building is the in-floor hydronic heating and cooling, as it is not common practice to incorporate both. Although they agree that the daylighting strategy was not entirely high-tech, they consider it a very successful and most enjoyable aspect of the project.

[Vance] Architect ZGF approached interior renovations with a focus on simplicity, which extended to the firm's creation of tenant improvement guidelines, and the owner's retrofit strategies go beyond building envelope and systems to include operations and maintenance. The project team continues to examine and fine-tune building performance through energy monitoring, post-occupancy surveys and a re-greening effort.

[Alliance] This building provides tenant space for 38 sustainably-focused nonprofits, fosters communication and collaboration and serves as a demonstration project of advanced design strategies in a rehabilitated historic building. In 2006 the Alliance Center was the recipient of a $25,000 grant from the Colorado Governor's Office of Energy Management and Conservation for installing informational and educational signs throughout the building and developing a self-guided tour and brochure. In an interview, Alliance Center director Phillip Saieg cited the direct digital controls installation as especially innovative. This system has allowed the building operators to continue to fine-tune the heating and cooling requirements in this historic structure.

[Christman] The owner representative describes the most innovative aspect of the project as *"taking a historic building and transforming it into a high-quality, high-performance building at no additional cost within a tight budget."*

[Mercy Corps] The owner representative believes the most innovative aspects of the building are the Building Management System and the method by which the clerestory windows exhaust air naturally.

[200 Market] 200 Market utilizes a gross lease structure in which savings in operational expenses such as electrical and water usage go directly to net operating income. This approach encourages owners to incorporate efficiency measures into existing buildings, ultimately improving the bottom line. The firm also believes improvements do not have to be massive capital investment-type projects; success can be found through targeting small issues and implementing appropriate solutions. The owner representative and chief engineer found particularly innovative the use of existing smoke evacuation shafts to increase the building's ventilation rate, especially when it exceeded their initial expectations by improving occupant comfort and reducing fan energy.

7 CONCLUSIONS AND NEXT STEPS

Although each of the nine projects is unique, they share commonalities and offer insights at the individual level. These conclusions are drawn from the findings in Phase 1 – the initial search resulting in the 50 buildings serving as the foundation for this work – followed by the current Phase 2 research.

Conclusions Phase 1: from *The Search for Examples:* (excerpts attached in Appendix)

A more centralized or dominant resource for the collection of information on building performance is needed to improve efficiency programs and policies and inform owners and financers about outcomes.

- The variety of sources for case studies **rarely provides measured energy information or details** on efficiency measures or business rationale.
- Flexibility in the format and level of information is essential to **achieving greater participation**. Direct outreach and offers to complete data forms help. Emphasizing the visibility of the results is also a draw.
- Inconsistent **terminology and definitions** on the measures, baselines and percentage of energy savings results in more time spent and difficulties drawing comparisons among projects.
- **Percentage savings** is the most common market description used to represent an accomplishment; the specifics (baseline, measured versus estimated, absolute savings, etc.) are less detailed and less important in the eyes of the market.
- **Offices** constituted the predominant building type, aligning with the most active building type in many green and efficiency programs.
- **Most projects (88%)** of the initial 50 (and the final nine) self-identified as "**Renovations** or Major Additions," indicating that a) deeper energy savings can be maximized during renovations and b) energy efficiency is seen as a part of the re-positioning or renewing of commercial property.

Conclusions Phase 2 (Nine Project Profiles):

Buildings

- **Offices** and **renovations** offered the most accessible information; this is likely due to their higher frequency of participation in green or utility efficiency programs and the more active nature of this sector in upgrades and building changes.
- Targeting projects looking to **upgrade or renovate** their buildings or spaces is a key market opportunity for deeper more comprehensive efficiency opportunities in existing buildings.
- Deep efficiency retrofits are **not limited to a specific size** of building, but larger buildings are more likely investor-owned versus the small and medium buildings traditionally owned and occupied by nonprofits or private firms.
- Deeper energy efficiency projects were found in all the Northwest states and in large and small cities. Although the numbers are low and information is difficult to find, the presence of these projects indicates some **knowledge and skills are distributed throughout the region**.

Measures

- **Readily available technologies** can be applied to accomplish deep energy savings.
- **Integrated design, multiple measures and monitoring** are more critical to low-energy buildings than any given technology.
- Consistent inclusion of **controls** (lighting, HVAC, CO_2 and whole-building) is an important element of the move to greater savings.
- Other **progressive measures** such as radiant heating and cooling, evaporative cooling, motorized shading and operable windows extend the potential for maximum savings and improve work conditions.
- **Behavioral measures** are increasingly recognized as valuable in creating energy-efficient, green buildings, with tenant-level metering and/or tenant guidelines in use by three projects.
- Building owners consistently mentioned **commissioning, measurement and tracking**, and ongoing improvement as keys to low energy usage.

Energy

- **Energy and cost savings of 50%** are clearly achievable and fit within the business parameters and motivations of these owners. Average savings among these buildings are 52% better than CBECS and 46% better than the PM- calculated EUI for a similar building. The average EnergyStar score of 92 puts them in the top 10% of office building energy performance in the U.S.
- Existing buildings can achieve **zero-energy-capable** energy use, currently considered 20 to 35 EUI. The actual energy usage of these nine ranges from 32–66 kBtu/sf/yr; five of the buildings have **EUIs of 40 or less**.
- Owners considered **innovative areas** as transforming historic buildings; incorporating radiant heating and cooling; applying simplicity as a strategy; using tenant guidelines and gross leases to encourage behavioral change; natural exhaust through clerestories; and continuous monitoring of building management systems.

Business

- A link between the **"two greens"** drove motivations: a) **greenbacks** – recognition and calculations of improved asset value, greater lease rates and tenant occupancy, future-proofing for trends toward greener buildings and disclosure requirements, and operational cost savings, and b) **green leadership** – exemplifying mission work, client interests, or owner values in green building and environmental benefits.
- **Ratings, labels and recognition** appear to be valuable motivators for energy-efficient renewals. Projects seeking deeper energy efficiency tend to be involved and interested in third-party ratings and recognitions. The nine projects have earned a total of 13 LEED certifications and several other awards.
- **EnergyStar scores** are becoming a more **visible metric** required during real estate transactions and, in some cases, tenant lease negotiations. The high scores of the nine buildings in this set give these owners another positive feature recognized by the market.

- **Access to capital** was cited as a barrier by only one project, but several projects have donation-based funding or substantial internal private funding through investors. If the set had included more medium-size projects seeking conventional capital loans, this barrier **may have been greater**.
- **Renovating** provided **better economics** in two instances than would have building or renting.
- Renovations were completed within **standard budget ranges** for this level of work. One project documented the efficiency-only portion as just $3/sf.
- Good **business results are important to these owners** as seen in the forms of **higher rents** (average about 35% higher than other local properties); **increased occupancy** from 68% to 96% post-renovation; better **tenant retention and net operating income**; ease in **finding tenants**; and continuous **occupancy**. These results enhance the long-term values for investment properties.
- Alternative **lease structures** (gross) and **tenant guidelines** were important business approaches for the private investors, distributing the responsibility for savings.
- Costs and the historic natures of three of the buildings impeded pursuit of some energy efficiency; **creativity** and **project champions** were integral to overcoming these barriers. When it comes to costs, a champion must defend efficiency as an embedded project cost inseparable from the renovation; in one case the champion had to "transform" the design and construction team into believing in the outcomes. Creative team members for a large building also found more simplified approaches to efficiency at less cost.
- The **owners or managers** of these buildings share **five** important **characteristics** that are keys to their success:
    - **"Green Link" Recognition** – they considered and valued the economic and environmental benefits (the "two greens") that make energy efficiency a wise investment.
    - **Vision** – they are goal-driven, pursue targets via LEED, have leadership mentalities, and the willingness and desire to be ahead of the curve in many aspects of their businesses.
    - **Money Leverage** – they maximize government, utility and organizational incentives and tax credits.
    - **Measurement** – they track energy results and conduct continuous commissioning to maintain and improve performance.
    - **Market Profile** – NBI "found" these buildings because publicizing their energy-efficiency renewal results, including the use of public-relations opportunities, is a part of the owners' strategies for increasing their buildings' values.

Next Steps

1) Adapt Project Profiles information into various formats for different audiences (more Case Study formatted). Initiate a wide distribution through a variety of outreach methods.
2) Review the results in specific sections to assess applications to programs and the EBR initiative.
3) Investigate the projects financial and business information to determine if there is additional benefit from further research on measure costs and dollar savings.

8 APPENDICES

8.1 Project Profiles

A companion document with the full set of profiles is located on the BetterBricks site at:
http://www.betterbricks.com/design-construction/existing-building-renewal-initiative

Each Profile is also located in the NBI Getting to 50 database – search by project name from the main site via the High Performance Buildings database

http://newbuildings.org/advanced-design/getting-50-beyond

or locate each profile in the GT50 database via the links below within each Project Name:

8.2 Phase 1 Research Report

Initial Search for Examples of Commercial Building Energy Efficiency Retrofits, Renovations and Upgrades

The following are the key portions of the Phase I Research Report. The methodology is described at the front of this full report so not repeated here in the Appendix. The full version is available at http://www.betterbricks.com/design-construction/existing-building-renewal-initiative

NOTE: All table and figure labels are left as represented in the full report.

Executive Summary

This work was performed by New Buildings Institute (NBI) on behalf of the Northwest Energy Efficiency Alliance (NEEA) Existing Building Renewal Initiative, which aims to accelerate market adoption of deep, integrated energy efficient retrofits. The report documents retrofit, renovation and upgrade projects of 50 commercial buildings with demonstrated or predicted performance of 30% or better than the average for comparable buildings.

NBI conducted a broad outreach and research effort resulting in a list of 50 buildings - 49 in North America and 1 in Australia – that exceeded referenced baselines by an average of 40%. The search entailed direct contacts, via email and phone, with 47 organizations involved in the design, construction, green building and energy efficiency industries. Persistent follow-up with these sources resulted in 18 of projects identified. In addition the research team reviewed 29 websites and reviewed over 500 projects with varied depth and quality of information, resulting in an additional 32 project examples.

The focus was on obtaining general project information including multiple efficiency measures, with a preferred emphasis on measured documentation of energy savings. Projects with estimated savings were also considered during this first phase in order to maximize the number available for review. While NEEA's focus was on medium and large offices, box retail, hospitals, lodging and multi-family, the majority of buildings found (88%) were offices. Occupied floor space ranged from 2,300 to 950,000 square feet.

The energy savings identified in the report fall into two categories: measured and estimated. Measured savings was identified through the use of metered data, utility bills, or Energy Star Portfolio Manager. Estimated savings was based on modeled data or in some instances designated when the source was not specified. In both cases savings are compared to a baseline of specific code or energy use under pre-existing conditions. Baselines vary based on age of project, program requirements and location. Average savings exceed 40%, with individual projects ranging from 27-85%.

Energy Conservation Measures (ECMs) associated with each project fall under the following categories: HVAC, Lighting, Daylighting, Controls and Envelope. The majority of projects applied more than two ECMs, with almost half selecting all five in order to achieve a significant level of savings. Projects most frequently applied HVAC measures and lighting measures; of

those citing lighting measures, 50% specifically included daylighting and controls as part of their lighting retrofit packages.

Major insights from this data search included the finding that deep energy savings (>30-40%) can be mined from existing buildings, but documented examples are elusive, and inconsistent terminology and definitions on scope, measures, baseline definitions and percentage of energy savings make drawing comparisons among projects difficult. The fact that more-than-anticipated measured performance references were found is encouraging for ongoing efforts to increase data on actual energy use. There remains a strong need for some centralized or dominant resource for collection of information on building performance.

Phase 2 of this effort will focus on the selection of eight to ten study projects for further investigation. The purpose of the next phase is to do a 'deep dive' into these projects and create detailed profiles to be later developed as case studies for NEEA's Existing Building Renewal initiative. These profiles will provide insights on the integration of commonly found measures, approaches to deep savings and energy performance, owner motivation and areas of innovation.

Findings

While the stated preference throughout the data gathering process was to obtain measured documentation of energy savings, NBI specified in both the email solicitation and *Project Overview Form* that the primary focus was on project information, multiple efficiency measures and readily available data. Projects with estimated, rather than measured, savings were considered at this first phase in order to maximize the number available for review.

50 projects have been identified to date and are summarized in Table 3 below. More levels of information are available through the Project Data Matrix.xls, including the measure descriptions. *Note* in Tables 3 and 4 that the percentage savings are not directly comparable because the projects have varying baselines and newer codes have more aggressive efficiency requirements. "Pre-data" means measured energy use prior to the efficiency upgrades.

Table 3: Northwest Project Summary Table

	Name	Location	Building Type	Size (Sq. ft.)	% Over Baseline	Baseline	Measured or Estimated	Project Completion
1	Home on the Range	Billings, MT	Office	8,300	79%	ASHRAE 90.1-1999	Measured	2006
2	Pringle Creek Painter's Hall	Salem, OR	Office, Assembly	3,600	68%	Other	Measured	2009
3	Jefferson Place	Boise, ID	Office, Retail	75,000	60%	Pre data	Estimated	Still in Design
4	King Street Station	Seattle, WA	Transportatio n	60,000	56%	ASHRAE 90.1-2007	Estimated	2010
5	St. Als RMC South Tower	Boise, ID	Health Care	412,000	56%	CBECS	Estimated	Still in Design
6	Johnson Braund Design Group	Seattle, WA	Office	8,000	51%	Other	Measured	Ongoing
7	Beardmore Building	Priest River, ID	Office, Retail	22,000	46%	Pre data	Estimated	2008
8	Monterey Lofts Chief Seattle Club	Seattle, WA	Multi-unit Residential, Retail	28,000	46%	ASHRAE 90.1-2004	Estimated	2007
9	AIA Center for Architecture	Portland, OR	Office	10,000	44%	ASHRAE 90.1-2004	Estimated	2007
10	Tamastslikt Cultural Institute	Pendleton, OR	Interpretive Center, Office	45,000	42%	Pre data	Measured	2006
11	Gerding Theatre at the Armory	Portland, OR	Assembly, Office	55,000	40%	Pre data	Estimated	2006
12	Mercy Corps HQ	Portland, OR	Office	80,000	40%	ASHRAE 90.1-2004	Estimated	2009
13	Telus William Farrell Building	Vancouver, BC	Office	130,000	39%	Other	Estimated	2000
14	Klos Building	Billings, MT	Office	2,300	38%	ASHRAE 90.1-2004	Estimated	2008
15	Omicron AEC	Vancouver, BC	Office	15,400	38%	ASHRAE 90.1-1999	Estimated	2004
16	MacDonald – Miller Lower Building	Seattle, WA	Office	12,900	33%	Pre data	Measured	2008
17	Lovejoy Building	Portland, OR	Office	20,000	28%	ASHRAE 90.1-2004	Measured	2004
18	200 Market Building	Portland, OR	Office, Retail	389,000	28%	Pre data	Measured	2009
Total Northwest Projects Identified: 18								

Table 14: Non-Northwest Project Summary Table

	Name	Location	Building Type	Size (Sq. ft.)	% Over Baseline	Baseline	Measured or Estimated	Project Completion
19	Gilman Ordway	Falmouth, MA	Office, Laboratory	19,200	83%	ASHRAE 90.1-1999	Measured	2003
20	The Szencorp Building	Melbourne, Australia	Office	12,900	65%	Pre data	Measured	2005
21	Conservation Consultants Inc.	Pittsburgh, PA	Office	11,500	57%	ASHRAE 90.1-1999	Measured	2003
22	CNT	Chicago, IL	Office	14,900	56%	ASHRAE 90.1-1999	Measured	2003
23	Alliance Center	Denver, CO	Office	39,400	55%	CBECS	Measured	2006
24	Navy Building 850	Port Hueneme, CA	Military Base, Industrial, Office	17,000	55%	CA Title 24	Estimated	2001
25	NRDC Office	San Francisco, CA	Office	19,800	55%	CA Title 24	Estimated	2004
26	NRDC Office	Santa Monica, CA	Office	15,000	55%	CA Title 24	Estimated	2003
27	GUND Partnership Studio	Cambridge, MA	Office	12,300	53%	Pre data	Estimated	2008
28	Epping Town Hall	Epping, NH	Assembly, Office	10,000	50%	Pre data	Measured	2007
29	Viking Terrace Apartments	Worthington, MN	Multi-unit Residential	58,000	45%	Pre data	Measured	2007
30	Aventine	La Jolla, CA	Office	210,000	45%	Pre data	Measured	2008
31	The Christman Building	Lansing, MI	Office	64,200	44%	ASHRAE 90.1-1999	Estimated	2008
32	Skanska USA, NY HQ	New York, NY	Office	16,600	43%	Pre data	Estimated	2008
33	Block 225 Education Building	Sacramento, CA	Office, Retail	394,000	43%	ASHRAE 90.1-2004	Measured	2006
34	Exelon HQ	Chicago, IL	Office	220,000	43%	Pre data	Estimated	2007
35	Stop Waste HQ	Oakland, CA	Office	14,000	40%	CA Title 24	Measured	2007
36	IDeAz Z^2 Design Facility	San Jose, CA	Office	7,000	40%	CA Title 24	Measured	2007
37	Engine House No. 5	Denver, CO	Office	13,200	40%	ASHRAE 90.1-2007	Estimated	2010
38	Chicago Center for Green Tech.	Chicago, IL	Industrial, Assembly, Office	40,000	40%	ASHRAE 90.1-1999	Estimated	2003
39	L.L. Bean	Mansfield, MA	Retail	25,000	40%	Pre data	Measured	2008
40	The Barn at	Mill Run,	Office, Interpretive	13,000	38%	ASHRAE	Estimated	2004

	Name	Location	Building Type	Size (Sq. ft.)	% Over Baseline	Baseline	Measured or Estimated	Project Completion
	Fallingwater	PA	Center			90.1-1999		
41	The Green Building	Louisville, KY	Office, Interpretive Center	10,000	37%	ASHRAE 90.1-2004	Estimated	2008
42	Owens Corning	Toledo, OH	Office	391,000	36%	CBECS	Estimated	2006
43	Bazzani Assoc. HQ	Grand Rapids, MI	Office, Multi-unit Residential	9,500	35%	ASHRAE 90.1-1999	Measured	2003
44	Four Seasons Produce	Ephrata, PA	Industrial, Office	226,800	35%	Other	Measured	2009
45	Joe Serna Jr CA EPA HQ	Sacramento, CA	Office	950,000	34%	CA Title 24	Estimated	2003
46	Academy Square	Montclair, NJ	Office	20,000	32%	Pre data	Estimated	2010
47	Herman Miller	Zeeland, MI	Office	19,100	30%	ASHRAE 90.1-1999	Estimated	2002
48	ORNL Office Building 3156	Oak Ridge, TN	Office, Campus	6,900	30%	Pre data	Measured	2009
49	Cambridge City Hall Annex	Cambridge, MA	Assembly, Office	33,200	28%	ASHRAE 90.1-1999	Estimated	2004
50	Russ Building	San Francisco, CA	Office	500,000	27%	Pre data	Measured	Ongoing
Total Non-Northwest Projects: 32								
Total Projects Identified: 50								

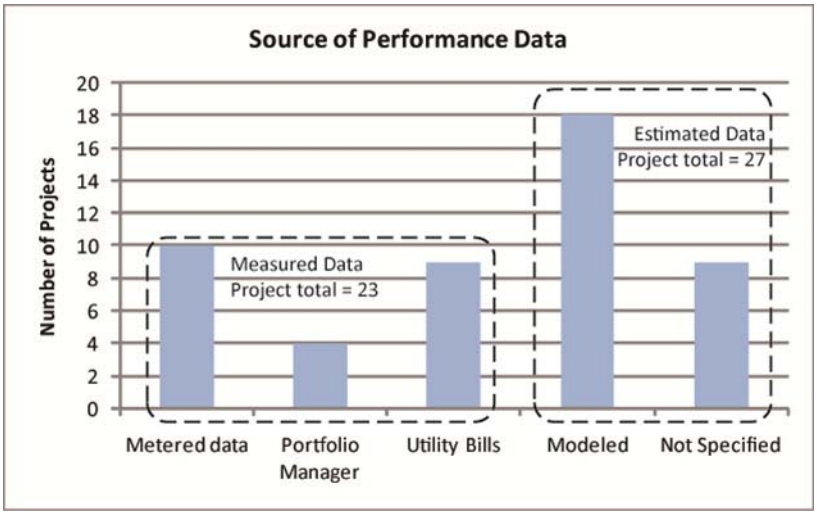
Performance

The per-project energy savings identified in this report fall into two categories: measured and estimated. Only one source was available per project, so the types below are mutually exclusive and represent the totals for the data set. Figure 8 identifies measured, i.e. *actual* performance results, and estimated savings. The percentage of energy savings associated with each project was determined in one of two ways:

- Measured savings: these included projects reporting the use of metered data (whole building or at a subsystem level); utility bills alone; or utility bills run through Energy Star's Portfolio Manager to calculate the project energy savings.
- Estimated savings: these included projects reporting the use of modeled data (the specific program used is cited when known in the full Project Data Matrix.xls) to determine their savings, or projects where the source was not specified.

In all cases, NBI determined savings compared to either a baseline of a specific code or to energy use under pre-existing conditions.

Figure 8: Source of Performance Data



Projects used a number of means of determining levels of performance.

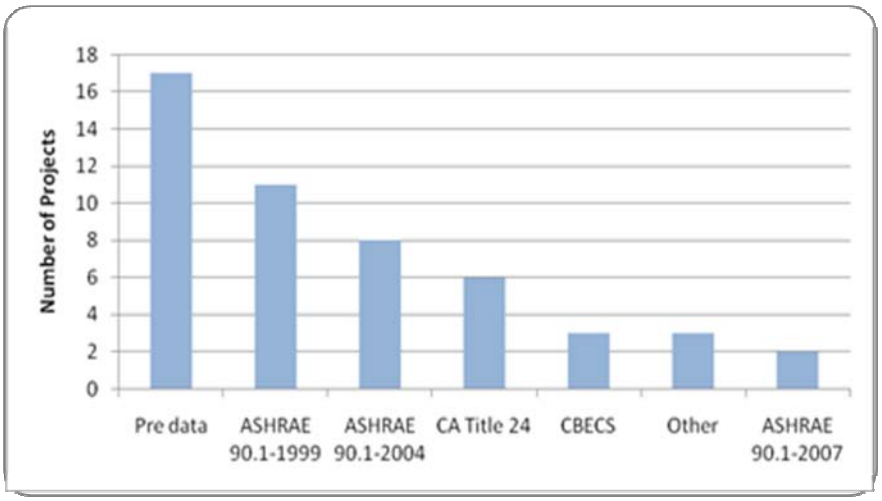
Figure 8 represents the source of performance data used to arrive at the percentage of energy savings identified by each project.

The source of performance data and determined energy savings is described in a variety of ways. In cases where NBI staff entered data on specific projects from case studies and other project profiles, and the percentage of savings was interpreted as a result of energy modeling (unless it was stated explicitly that the savings were measured). The projects listed in Figure 1 as "Not Specified" came from case studies or databases that did not list the source of performance data; they are therefore included as "estimated" savings in Figure 9.

Characterizing the energy savings in this study was difficult due to the lack of a common baseline. Baselines vary due to age of the projects, program requirements and location. Figure 2 displays the different baselines used by projects as well as the average savings using each baseline. Average baseline savings exceeded 40% in all cases, with individual projects ranging from 27 to 85 percent.

Although the newer baselines represent incremental improvements over time, variations in building types and measures make it impossible to directly compare this set of projects by baseline. In general, this dataset provides a list of projects with seemingly high savings which can be further investigated, as planned, in Phase 2 of this research.

Figure 9: Baselines and Average Savings



Average **pre data** savings = 43%

Average **ASHRAE 90.1 1999** savings = 48%

Average **ASHRAE 90.1 2004** savings = 40%

Average **CA Title 24** savings = 47%

Average **CBECS** savings = 49%

Average **ASHRAE 90.1 2007** savings = 48%

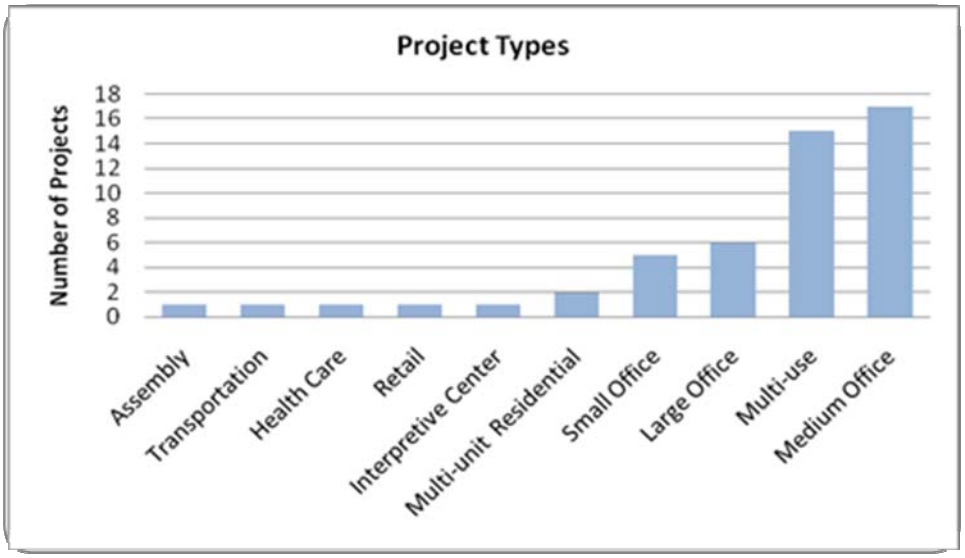
Type

The Project Data Matrix.xls contains all the pertinent information gathered, including percentage of energy savings, comparative baseline and energy conservation measures (ECMs). The majority of projects (82%) are offices or a combination that includes offices. Of the six projects identified as retail, only one is "box" type retail (LL Bean); the others are combined with office or multi-unit. The Health Care project is a hospital rather than a clinic (as evidenced by its size), but NBI used the Department of Energy (DOE) building type label of Health Care in the matrix. For this search, NBI included a few projects not identified as priority types because the extent of savings or the information provided may be useful to NEEA.

The result of project search is:

- 50 projects are included in the Project Data Matrix.xls.
- 18 of these are located in the Northwest.
- 10 different project types are represented, as indicated in Figure 3.

Figure 10: Project Types



Small, medium and large office projects are distinguished separately per the AIA 2030 Challenge[11]:

Small: ≤ 10,000 sq. ft.

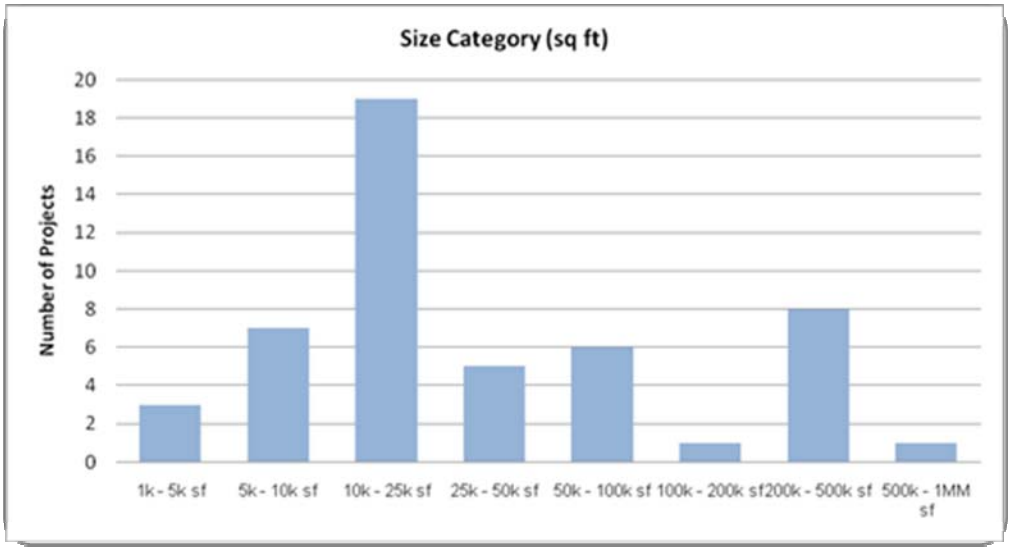
Medium: 10,001 sq. ft. - 100,000 sq. ft.

Large: >100,000 sq. ft.

Size

Projects ranged in size from 2,300 – 950,000 sq. ft., with the 38% (19) in the 10,000 - 25,000 sq. ft. range; 68% are less than 50,000 sq. ft.

Figure 11: Number of Projects by Size

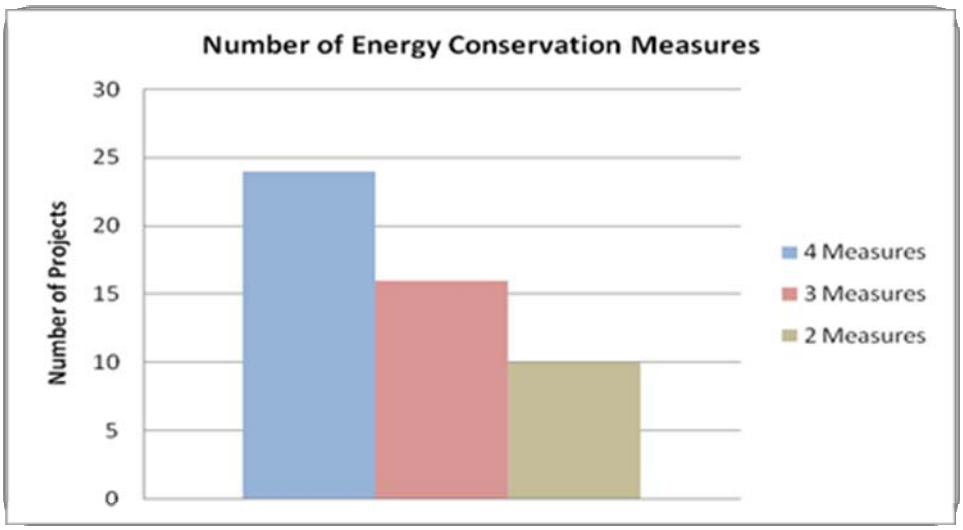


[11] AIA 2030 Commitment Reporting Tool, Version 1.1; Revised December 9, 2010.

Energy Conservation Measures

A list of Energy Conservation Measures (ECMs) associated with each project is documented in the Project Data Matrix.xls and is included below. Projects had to apply at least two ECMs. As Figure 12 indicates, the majority of projects (80%) applied more than two ECMs, with almost half selecting all four ECMs in order to achieve a significant level of savings.

Figure 12: Number of Energy Conservation Measures

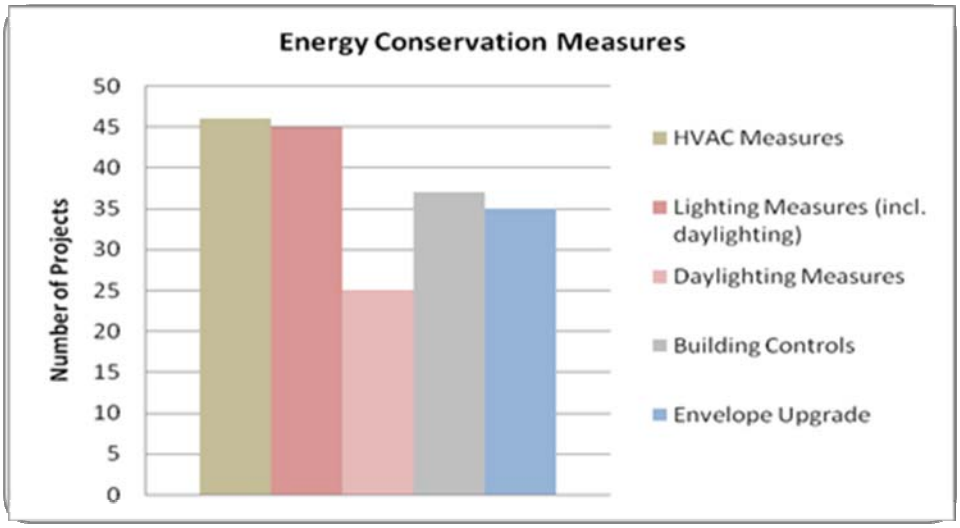


The energy conservation measures are identified as follows:

- **HVAC**: Replacement or alteration to mechanical equipment. Includes active and passive heating and cooling methods.
- **Lighting**: Replacement and/or alteration to the lighting system, including the incorporation of task lighting, lighting controls and daylighting.
  - **Daylighting**: A sub-set of lighting defined as an energy feature rather than a view or aesthetic feature. Acceptable daylighting measures incorporated exterior and interior shading and/or light sensors.
- **Controls**: Includes the addition of an Energy Monitoring System (EMS), Building Automation System (BAS), Building Management System (BMS) and/or lighting/occupancy controls.
- **Envelope**: Upgrade in insulation, including cool roof, addition of high-efficiency windows, including the use of tinting.

The projects most frequently applied HVAC measures and lighting measures (92% and 90% of projects respectively). Of those citing lighting measures, 50% specifically included daylighting as part of their lighting retrofit packages.

Figure 13: Energy Conservation Measures



Search Insights/Conclusions

Insights from this search for data on existing buildings are provided from the perspective and experience of the NBI research team. Many of these insights come not only from this project, but are based on other efforts of the research team and reported by others in the efficiency industry when pursuing information for building case studies. As is said: "If it were easy, it would already be done." Experience gained from this study will provide guidance on strategies to increase the availability of performance information.

- No centralized or dominant resource exists for the collection of information on building performance. This creates a major challenge to obtaining detailed, consistent and reliable building characteristics, measure descriptions, and energy use and savings data.
- Case studies provide the most readily available information, but the formats and depths of information varied widely.
    - Out of over 500 web-based case studies reviewed, only 6% (n=32) met the base criteria of an existing building retrofit since 2000 with multiple efficiency measures and with available baseline and energy savings (either estimated or measured) information.
    - Case study sites with a strong focus on energy information (High Performance Buildings [HPB] database, U.S. Green Building Council (USGBC), DOE and ASHRAE *High Performance Buildings*) were the most helpful, while others that focus on the architectural or construction story (American Institute of Architects [AIA], Urban Land Institute) offer less-accessible energy data (or lack it altogether).
- Even the NBI "Overview" form overwhelmed and was seldom used by most participants.

    - Flexibility in format and information required was important.
    - NBI's direct outreach and offer to complete the data form aided participation.
    - Inconsistency required greater interpretation of the submitted information.
- Providing an incentive for submitting information would increase participation by busy individuals.
    - Incentives could be either a stipend for time spent, or an opportunity for the respondent's project to be showcased or awarded in some manner.
    - Even when the project team offered a small stipend as an incentive, project and energy information within most firms was not readily available or consistently maintained.
    - Seeking firms or contractors that are active in green building committees, have served as project advisors, or have other industry affiliations would increase the likelihood they share a public-purpose interest in increasing knowledge on building performance.
    - Creating and maintaining some form of "open gate" for the submission of basic project performance information would be valuable.
- Inconsistent terminology and definitions on the scopes, measure, baseline definitions, and percentage of energy savings resulted in difficulties drawing comparisons among projects.
- Percentage savings is used to represent an accomplishment; the specifics (baseline, measured vs. estimated, etc.) are less detailed and less important in the eyes of the market.
- The fact that more measured performance references (nearly half of all projects) were found than anticipated (team estimated that maybe 10-25% of projects would have measured results) is encouraging for further efforts to increase data on actual energy use. .
- NBI was most successful in identifying projects implemented in offices, which are the most active building type in many green and efficiency programs. Collecting information from box retail, hospitals and lodging might require more direct inquiries via industry or trade connections.