DEEP ENERGY RETROFITS:
AN EMERGING OPPORTUNITY

An Architect's Guide to the Energy Retrofit Market

THE AMERICAN INSTITUTE OF ARCHITECTS

Rocky Mountain Institute®

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Introduction_

Over the past five years the energy efficiency of the existing US building stock has gained more and more attention. A growing body of research discussing the substantial economic and environmental benefits of energy efficiency has led US policymakers, investors, building owners, environmental groups, and design and construction professionals to seek ways to scale up the energy efficiency retrofit market.

The American Institute of Architects and Rocky Mountain Institute believe that as the energy efficiency retrofit market develops, architects can position themselves to seize a robust business opportunity by offering deep energy retrofits—retrofits that aim to deliver greater energy savings by taking a whole-building approach to energy efficiency—as a new line of service. The purpose of this AIA and RMI co-publication is to introduce architects to the concept of deep energy retrofits, inform them of the significant business opportunity deep energy retrofits represent, educate them on the deep energy retrofit process and the architect's role in it, and familiarize them with the financial tools and incentives needed to participate in this promising market sector. This guide is not meant to serve as a technical design guide. There is little discussion of specific energy efficiency measures or technical design solutions; however, throughout the guide, the reader will find links to resources that can deliver more detailed discussion of different aspects of high-performance design. After reading the guide, the authors hope that architects will be motivated to align their business strategies to compete in this promising and fast-developing sector of the design and construction industry.

CHAPTER 1_ THE ENERGY EFFICIENCY MARKET: GROWTH OPPORTUNITY FOR ARCHITECTS

Chapter 1_

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In the last decade, the United States' energy use and energy sources have gained prominence in policy and economic debates. In 2012, the United States imported $397 Billion in energy-related petroleum products, frequently trading with nations universally recognized as unfriendly to the United States.[1] Spurred by both political and economic calculations, investors increasingly see energy sources of nearly all kinds as growth opportunities—from conventional sources like oil, natural gas, and nuclear power to maturing markets like wind, solar, biomass, and geothermal. While most investors and policymakers have focused on energy sources, lately more and more attention has been given to reducing inefficient use of energy, especially in buildings.

For years, the largest source of energy demand in the United States has been for the operation of buildings. In 2011, 43% of all energy consumed in the United States was dedicated to the heating, cooling, and powering of buildings, outpacing demand for both industry and transportation. When analyzing demand for electricity only, building operations account for more than 75% of all electric use. As a whole, buildings are responsible for more than 40% of all U.S. carbon emissions.[2] The domestic energy and climate challenge cannot be addressed without changing the way our buildings are designed, constructed, and operated.

The architecture community has responded with multiple efforts to help reduce U.S. energy demand through more energy efficient building design and construction. The U.S. Green Building Council's LEED rating system led the way throughout the past decade, with a particular focus on new building design. The Architecture 2030 Challenge and the 2012 International Green Construction Code, along with a steadily increasing consumer demand for environmentally responsible buildings and products show that high-performing building design will be a lasting shift in the construction industry.

For architects, the majority of high-performing design efforts have focused on producing highly-efficient new buildings, largely due to easier adoption of new technologies in new construction. Energy efficient design in the existing building stock, however, is a less mature practice area for architects, despite the fact that each year another 5 billion square feet of existing buildings are renovated—equal to the yearly total square footage of new construction.[3] If architects mean to truly improve the energy efficiency of the nation's building stock, they must apply themselves to reducing energy use in existing buildings as well as new ones. Further, the renovation and upgrade of existing building performance is a very large and untapped market opportunity for architects.

Chapter 1_

THE ENERGY EFFICIENCY MARKET: GROWTH OPPORTUNITY FOR ARCHITECTS

Currently, energy efficiency in existing buildings is most often addressed by upgrading outdated engineering systems, such as lighting and HVAC systems, with better-performing technologies. This sort of standard retrofit saves energy and addresses some of the large energy inefficiencies in existing buildings; however, this limited scope prevents a building from realizing much greater savings. A design-centered, holistic approach to a retrofit, in which all the interactions in a building's systems are considered can yield substantially higher energy savings. Retrofits of this type, called *deep energy retrofits*, aim for energy savings upwards of 50%. Deep energy retrofits are not only more effective in cutting energy use and saving building owners money, they also have the potential to be a new and robust source of business for architects.

This guide makes the case for architect-led deep energy retrofits and offers guidance on how architects can increase their participation in the energy efficiency retrofit market. After reading this guide, architects should have a better understanding of:

+ the market opportunity in deep energy retrofits
+ the deep energy retrofit project delivery process and the architect's potential roles in it
+ the challenges and tools required to finance energy efficiency projects in existing buildings

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1.1 MARKET OPPORTUNITY

The promise of the energy retrofit market lies in the sheer number of buildings in the United States. Most of the buildings erected in the second half of the 20th century were built with little regard to energy use or impact on climate. At a time of low-cost energy and little, if any, awareness of the impacts of carbon emissions and other pollution, energy and environmental performance considerations were largely absent in building design. Our current building stock is dominated by these older, inefficient buildings—as many as 72% of U.S. buildings are over 20 years old.[4]

In the context of a largely older building stock, serious attention to energy performance is still relatively new to the design and construction industry. Until recent years the great majority of buildings were designed merely to meet energy codes, if such codes existed at all, not to optimize energy efficiency. As a result, buildings waste billions of dollars in energy costs due to inefficient design, programming, and equipment. By improving building performance through smart design and improved technologies, building owners can unlock value currently trapped in their buildings. Savvy owners, design and construction professionals, investors, and government officials are beginning to understand that energy efficiency is not only about preserving the environment; it also represents hundreds of billions of dollars in reduced waste - and potential profit.

Recent market analyses have confirmed the scale and scope of the building energy efficiency market. In their March 2012 joint report, the **Rockefeller Foundation and Deutsche Bank Climate Change Advisors** found that improving efficiency by 30% in the nation's pre-1980 building stock would result in $1 trillion dollars of energy savings over 10 years, requiring an upfront investment of just $279 billion dollars, a simple return on investment of 358% over a decade.[5] One key market segment for architects—the commercial building market—represents a $72 billion investment opportunity. A 2010 **McKinsey & Company** analysis found a very similar potential value of commercial building retrofits, at about $73 billion dollars.[6] Studies by **Rocky Mountain Institute**[7] and the **American Council for an Energy Efficient Economy**[8] have reached similar conclusions.

Upgrading the nation's buildings could be a boon to an industry facing more than 5 years of depressed activity in new building design and construction. And with deep energy retrofits, architects have a chance to establish themselves alongside engineers and contractors as energy efficiency experts whose skills are needed to deliver optimal energy savings.

RESOURCES:

NEEA. **Examples of Deep Energy Savings in Existing Buildings**

As an architect you possess skills that equip you to maximize retrofit energy savings. Successful deep energy retrofits require creativity, problem solving skills, knowledge of building design from a whole-building perspective, and the ability to coordinate the activities of many people. Furthermore, as the leading professionals in charge of the design of buildings, architects have a responsibility to act as stewards of the built environment. In this sense, for architects, improving the performance of the existing built environment is as much a professional obligation as it is an opportunity for new business.

1.2 MARKET DRIVERS

The strong market potential for energy retrofits in existing buildings will not be realized without fully engaging building owners. For most of the 20th century, property owners focused on merely providing the minimal operating conditions for building occupants: heating, cooling, power, water, and sewer service. Lately, building owners are becoming increasingly aware of the substantial benefits of improving the performance of their buildings while at the same time improving operating conditions. McGraw Hill Construction's 2011 survey of American businesses showed that 78% of surveyed respondents planned energy efficiency upgrades in their building portfolios.[9] Though many of these improvements may be moderate or incremental in scope, such as replacing incandescent lights with CFLs or upgrading inefficient HVAC equipment, the desire to make them signifies a general recognition among commercial building owners of the benefits of energy efficiency. While this is encouraging information, many building owners do not yet see energy efficiency as a core business priority. This is due to a variety of factors, among them competing demands for owners' limited capital and the split incentive (addressed later in this chapter) where tenants pay the utility bills but the building owner pays for capital improvements to the building.

One important development that is changing energy efficiency as a priority is the wider adoption of **energy disclosure policies**, which require building owners to publicly report their buildings' energy use.[10] This makes owners more aware of their buildings' energy consumption and allows the real estate market to value energy efficiency by informing prospective buyers and renters of a building's energy performance. As more jurisdictions adopt these policies, demand for energy efficient buildings will likely grow, in turn fueling the demand for deep energy retrofits of owners' existing properties.

In addition to growing demand from building owners and tenants, the financial community has devoted substantial capital and attention to creating investment opportunities in energy efficiency. Bank of America launched its $20 billion clean energy investment strategy with $150 million in energy efficiency projects in its own buildings across the country; they've reached their $20 billion target a full four years earlier than projected.[11] Barclays Capital has committed a **$650 million line of credit** to the Carbon War Room's PACE Commercial Consortium for building retrofits in California, Florida and elsewhere.[12] Wells Fargo **provided or raised about $2 billion** for energy efficiency retrofits in 2011.[13] Other major financial institutions from conventional investment banks like Citi to private equity funds like CleanFund have moved from interest to seeing real "deal flow" in projects.

1.3 THE ENERGY EFFICIENCY RETROFIT MARKET TODAY

In 2010, a number of institutional investors and energy efficiency allies partnered with Capital-E, a private equity financing group, to more clearly understand the current landscape for building retrofits and to identify the barriers to capturing the full potential of the energy efficiency market. The Capital-E report identified three main challenges to financing energy efficiency retrofits:[14]

1. Split incentives, where tenants pay the utility bills but the building owner is required to fund the upfront capital costs for building upgrades;
2. Insufficient credit, due to commercial real estate business models and legal structures, discussed below in more detail; and
3. Limited data on long-term energy performance for individual buildings and aggregated building types.

Because of these challenges, most retrofit activity has been isolated to the one segment of the building market that inherently avoids these barriers to financing, publicly owned buildings. Governmental entities, from the smallest villages to the federally-owned General Services Administration (GSA), are very well structured for long-term energy efficiency investments.

Public building owners generally:

1. Pay their own utility bills, so building owners can directly capture the energy and cost savings from a building upgrade;
2. Have sufficient credit to engage in contracts ranging from 5 to 20 years; and
3. Have tracked their own energy consumption for two or more decades, helping identify the most attractive and cost-effective energy efficiency projects within their building stock.

Consequently, energy efficiency contractors and other service providers have focused on serving the MUSH market:

+ **M**unicipal (city, township, state and other local governments)
+ **U**niversities and colleges
+ **S**chools (K-12) and
+ **H**ospitals

MUSH market energy efficiency is currently dominated by Energy Services Companies, or ESCOs, which brought in aggregate revenues of about $5.1 billion in 2011.[15] The **National Association of Energy Service Companies** defines an ESCO as a "business that develops, installs, and arranges financing for projects designed to improve the energy efficiency and maintenance costs for facilities over a seven to twenty year time period. ESCOs generally act as project developers for a variety of equipment replacement tasks and assume the technical and performance risk associated with the project." MUSH market and federal buildings account for almost 85% of all ESCO revenues in large part due to the security and long-term certainty of contracting with government at the local, state, and federal levels.[16]

ESCOs generally operate under Performance Contracting authority, wherein the ESCO guarantees that the building owners will see reduced operating costs due to the energy savings project. In exchange for assuming the technical and performance risk, ESCOs are able to secure margins in excess of 10%. With long-term contracts often stretching to 20 years, ESCOs can absorb any unexpected equipment costs or reduced performance because most years result in energy savings far in excess of the contract costs to both ESCOs and owners.

These "Shared Savings" or Performance Contract projects require long-term contracts to help ESCOs reduce their risk under guaranteed savings contracts. As a result, guaranteed savings projects have traditionally relied on well-understood and predictable energy efficiency measures. These services tend to focus on technology solutions (energy efficient technologies accounted for 75% of ESCO revenues in 2008) and deliver median energy savings of about 15-20% of the utility bill baseline.[17] The most common technologies are lighting which is installed in 80-90% of ESCO projects and HVAC controls which are installed in about 80% of projects.[18]

The major difference between a standard retrofit and a deep energy retrofit is in the approach. In a standard retrofit the energy services provider, often an ESCO, audits a building, evaluates it for obvious inefficiencies and replaces the equipment or systems that cause them. For example, the provider might enter a school and find that it can save energy by replacing its lighting with more efficient bulbs and a lighting control system. After installing the new bulbs and lighting controls, the school enjoys moderately lower lighting costs. In a deep energy retrofit the provider recognizes the inefficient lighting system but instead of immediately replacing it, considers multiple factors in evaluating the optimal solution. Determining the appropriate level of illuminance for the space is the first step. Depending on what the space is used for, it might require less illuminance, and thus fewer light fixtures than it currently has. The provider might be able to reduce the number of light fixtures further by introducing controlled daylighting. With fewer fixtures requiring power and with the installation of a more efficient lighting system, the school will save a far greater amount of energy than if it merely replaced the current system with better performing bulbs and fixtures.

As the ESCO industry has developed, retrofit projects that consist of groupings of different energy upgrades have become more common, but these measures are still mostly equipment-focused. Energy conservation measures that address the building envelope are rare, appearing in only 17% of ESCO-led retrofits in the MUSH market.[19] A deep energy retrofit, which employs a mixture of plug-load reduction, passive design strategies and mechanical energy efficiency measures implemented within a holistic design framework can deliver greater, more cost-effective energy savings. Architects can learn from the turnkey solutions with guaranteed results that ESCOs have provided to the MUSH market, but also improve on this model by incorporating holistic design thinking. Further, the MUSH market has been the primary target sector for ESCOs, leaving the vast majority of the traditional commercial market without an equivalent energy efficiency upgrade solution. This presents a significant opportunity for architects to develop solutions that integrate holistic energy efficiency design with financial tools that support the business objectives of the commercial property owner.

RESOURCES:

ICF International. **Introduction to Energy Performance Contracting**

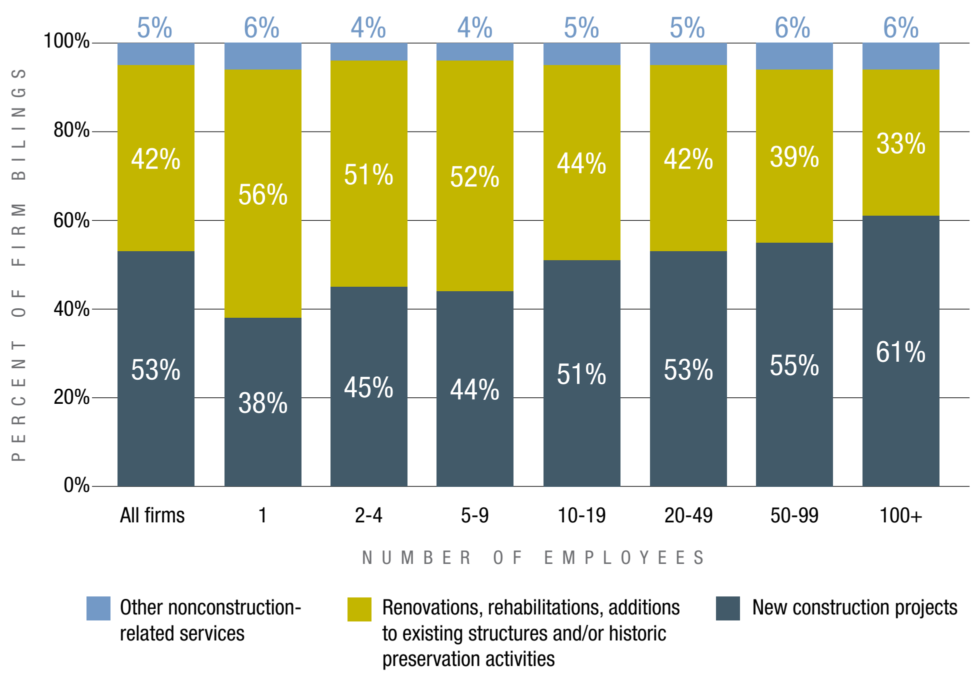
LBNL. **Review of U.S. ESCO Industry Market Trends: An Empirical Analysis of Project Data.**

1.4 ARCHITECTS AND DEEP ENERGY RETROFITS

It is no secret that the architecture profession, like the rest of the design and construction industry, is struggling. The recession has devastated architectural practices across the country, and employment among architects has declined precipitously. As of March 2013, employment in architectural services is 28% lower than its 2008 high.[20]

The slowdown in new construction appears to have caused firms to increase their focus on renovation projects (data was not available to make a direct comparison to renovation billings from 2009). The **2012 AIA Firm Survey** shows that architecture firms received 42% of their billings from renovation projects. For small firms, renovation projects made up the majority of billings. Since projects on existing buildings already make up such a large part of architecture firms' business, architects have an opportunity to expand this part of their practice by engaging in deep energy retrofits.

Renovation Projects Account for a Significant Portion of Firm Billings



While the U.S. economy has started to show signs of a moderate recovery, it may take many years for the architectural profession to regain pre-recession employment levels. The largely untapped energy efficiency retrofit market is one of the most promising opportunities in the design and construction industry, and one that architects should be prepared to capture. As energy costs rise across the nation and as energy codes become more stringent, more building owners are seeking out energy savings opportunities. As the energy efficiency market matures, if the prevailing retrofit model is a standard retrofit which focuses on upgrades to equipment to achieve modest energy savings, not only will architects have lost a profitable business opportunity, but owners will have missed the chance to capture considerably more value from their buildings.

Architects who are able to connect design innovation and technical expertise to the traditional standard energy retrofit process and who can encourage building owners to understand and capitalize on the potential savings and added value will find opportunities to substantially grow their practices. This will require new kinds of technical skillsets and/or partnerships with other professionals to design and fully realize deep energy retrofit potential. Architects who are able to better align their practices to address this new market opportunity and acquire the skills and experience to lead deep energy retrofits will stand to gain immensely.

1.5. FINANCING DEEP ENERGY RETROFITS

To gain an edge in the energy efficiency retrofit market, architects will be well-served by gaining a basic knowledge of energy efficiency retrofit financing. By building in-house basic financing literacy, or by partnering with outside experts in energy efficiency financing, architects will be well-positioned to articulate the value of deep energy retrofits to clients. Chapter 3 focuses on ways for architects to make a strong business case for a building retrofit, including a discussion on specific financing tools. Here, Chapter 1 concludes with an overview of key factors considered by large capital providers before making a large investment in deep energy retrofits:

a. The total **SCALE** of market opportunity. With the potential for as much as $100 billion energy savings annually and less than $20 billion of current activity, energy efficiency retrofits represent a substantial growth opportunity for institutional investors. Any new asset class such as energy retrofits will require a substantial amount of legal, accounting, and regulatory work, and the total market opportunity must be worth the effort. Energy efficiency has gained a lot of attention from large investors over the past four years, with growing "deal flow" each year.

b. Clear identification of the individual borrower—**WHO WILL PAY** the debt service payments? The building sector involves specific challenges for investors, as identified in Chapter 3. While tenants may be the legal borrower when financing the build-out or energy improvements for leased spaces, the building owner is usually the necessary borrower for deep energy improvements to the entire building. Because architects are frequently hired by building owners themselves for deeper building improvements and renovation projects, architects are well-positioned to facilitate agreements between building owners and project financers.

c. **REVENUE** for repayment. Energy and operational savings create greater revenue for the borrower to make required repayments. Because architecture-driven improvement projects are likely to achieve much deeper energy savings as compared with projects that are driven by equipment replacement, borrowers will be better positioned to repay lenders from the captured revenue.

d. **RATE OF RETURN** on the investment must be substantial enough to meet the internal criteria requirements for the investors' and lenders' capital sources. While deep energy retrofits might involve an incremental increase of upfront project costs, the substantially increased energy savings will result in a higher rate of return for investors or lenders, thus positioning architect-driven projects as potentially preferred investments for capital providers.

e. **RISK** of default or nonpayment by the borrower is the greatest challenge to large-scale financing in the building sector. Nearly all of the privately-held building stock in the United States is legally owned by stand-alone Limited Liability Companies (LLCs). These LLCs are often owned, as 100% owners and members of the LLC, by larger holding companies like life insurance companies, Real Estate Investment Trusts, or other holding companies. These holding companies use the LLC structure to insulate themselves from potential losses incurred by an individual building. Should a building face steep losses, the individual LLC can declare bankruptcy, in which case the LLC is able to avoid paying creditors the full amount(s) due. This ownership structure has made lending directly to private building owners for energy improvements difficult; however several financing tools, discussed in Chapter 3, have been developed to address this challenge.

f. **LIMITING TRANSACTION COSTS** is critical for investors and lenders participating in building retrofit projects. Though Wall Street and Main Street lenders and investors are beginning to craft new and more efficient credit structures for financing building-scale energy improvements, individual energy efficiency projects require nearly as much legal and accounting effort as an entirely new building development, but the total transaction value is substantially lower with a building retrofit project. Success in the building retrofit market requires maximizing the energy savings gained in each project to maximize the potential return compared to the relatively standard transaction costs for each project.

Because architect-driven projects achieve stronger revenues from deeper energy savings in each individual transaction, investors are more likely to see these deep retrofits as prime investment or lending opportunities.

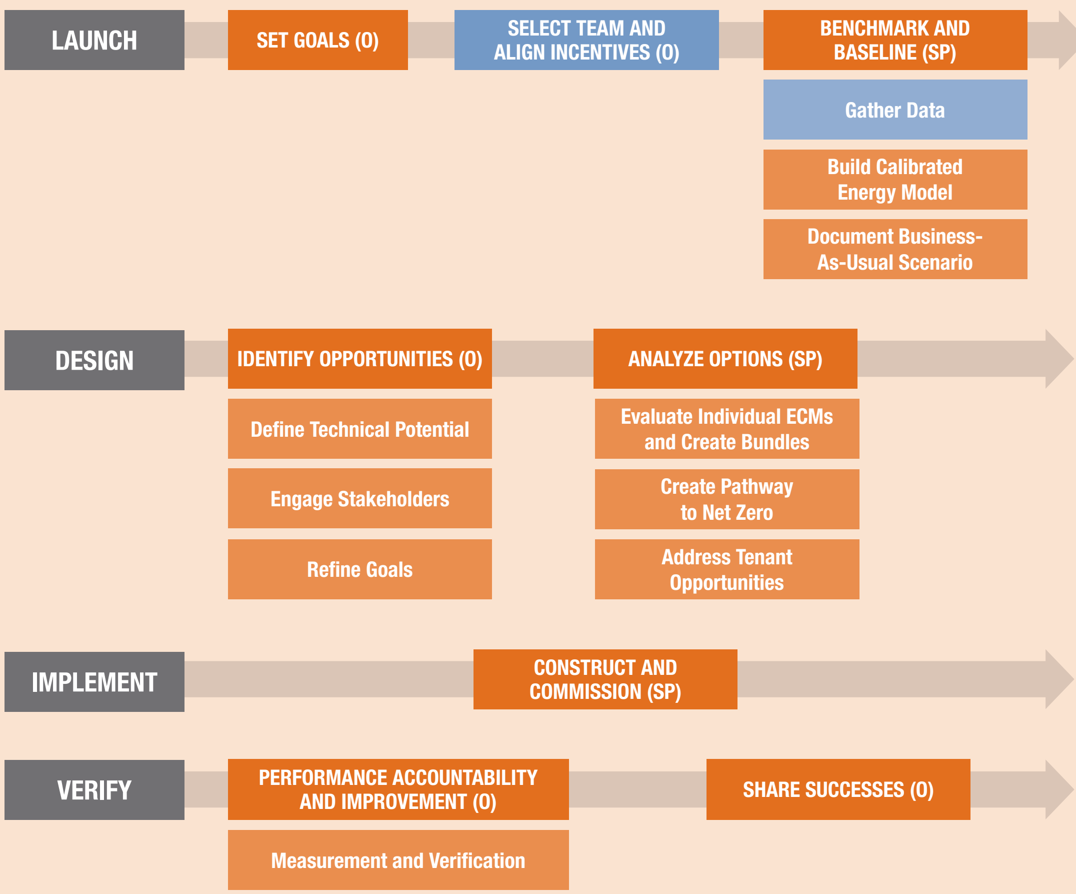
CHAPTER 2_ THE DEEP ENERGY RETROFIT PROCESS AND THE ARCHITECT'S ROLE

Chapter 2_

THE DEEP ENERGY RETROFIT PROCESS AND THE ARCHITECT'S ROLE

This chapter is not intended to function as a step by step guide to delivering a deep energy retrofit project, nor does it discuss specific energy efficiency measures or design solutions. There are already several very good guides available that cover the technical and design elements of the deep energy retrofit process in detail. For example, Rocky Mountain Institute's Retrofit Depot, a website containing information covering nearly every aspect of the deep energy retrofit process and the Department of Energy Office of Energy Efficiency and Renewable Energy's Advanced Energy Retrofit Guides are excellent resources and required reading for architects interested in deep energy retrofits. This chapter will, however, point out the technical and process skills architects will need to acquire to be successful in the energy efficiency market.

Rocky Mountain Institute's Deep Energy Retrofit Process



The goal of a deep energy retrofit is not just to upgrade the building's mechanical and electrical systems and equipment, but to minimize the energy loads that necessitate those energy intensive systems and equipment in the first place. This requires addressing the impact of the building's architecture, including the space planning and envelope.

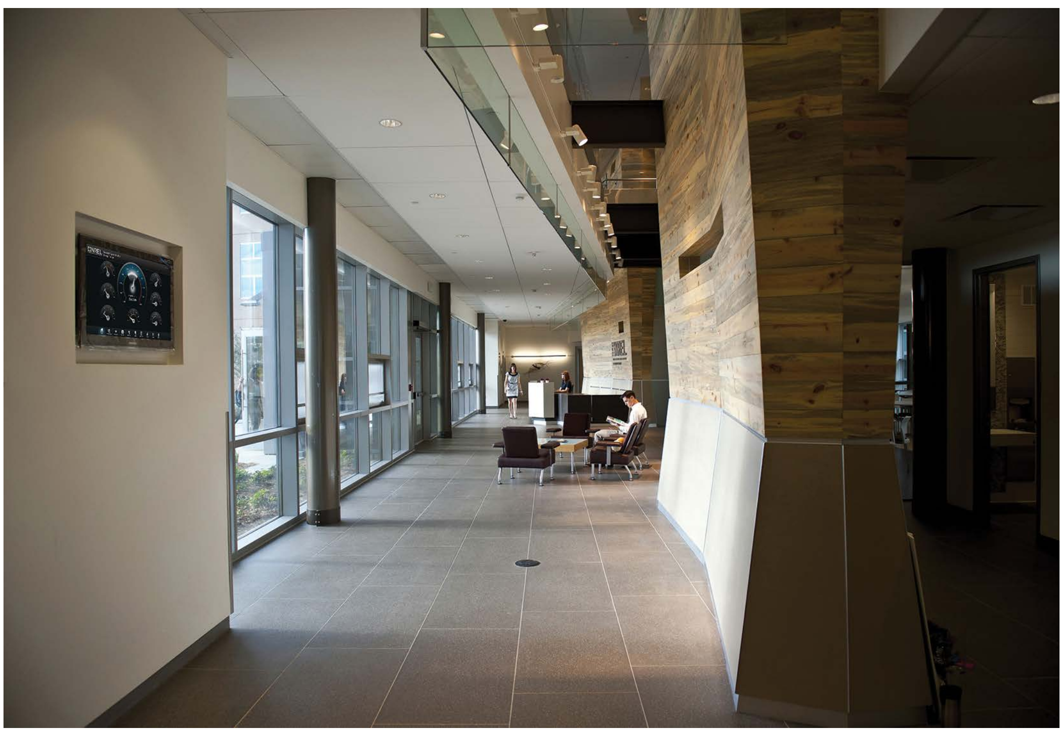
2.1 HOLISTIC DESIGN FOR EFFICIENCY

The key difference between a deep energy retrofit and a standard retrofit is a commitment to holistic design. Looking at a project holistically for potential energy savings invariably means using an integrated design process. By integrated design *process*, we mean a design process which explores the *interdependency* that different building systems, such as the envelope and perimeter-zone mechanical and lighting, have on the potential for optimal energy reduction. This process is also customarily iterative, meaning that the design team is open to considering many ideas in order to find the optimal solution. This can yield discovery of beneficial synergies between systems that afford energy savings greater than would be achieved with optimization of each system individually.

Every retrofit project is different, and every client's goals and priorities for their retrofit project(s) will be different. For each project, the team needs to set specific goals and all team members must agree on how achievement of these goals will be measured and verified. This guide defines a deep energy retrofit as a project that reduces a building's energy use upwards of 50%. Ideally, when retrofitting a building, the energy savings goal will be calculated as a reduction from current energy use, as determined through utility bills.

2.2 PRE-PROJECT

Before a project team can be assembled, the Owner's Project Requirements (OPR) must be developed so that a Request For Qualifications (RFQ) can be issued. While some owners will have a clear idea of what they want a deep energy retrofit project to accomplish, others will require the help of a knowledgeable design professional to help them write the OPR and RFQ for this type of project. The architect is the design professional best equipped to help the owner develop a realistic but ambitious project goal that best complements the building's programming. Additionally, having worked with and coordinated other, more specialized design professionals, the architect is a good candidate to help the owner select a team with the right skills for delivering a successful project, particularly a highly specialized and technical deep energy retrofit project.



2.3 PROJECT TEAM AND AGREEMENTS

While it is common in today's building design industry for architects and engineers to work more or less separately from each other (with the architect tasking engineers with creating systems to fit a fixed architectural design concept), such an approach is insufficient to achieve a deep energy retrofit's ambitious goal of 50% energy savings. A collaborative, integrated *team* is therefore often the best way for team members to take full advantage of each other's ideas and expertise, so that potential holistic, interdependent design solutions can be evaluated by their effect on the building as a whole.

Although deep energy retrofits require a collaborative project team, there must still be a strong and knowledgeable project leader to direct and coordinate the process of achieving the project vision and goals. The architect is well-suited by training and experience to fill this role, because:

- Architects have experience coordinating an array of professionals to ensure that their work conforms to the overall design and performance goals of the project.
- Architects are well-practiced in translating the owner's project goals into programming and design.
- Architects have experience expressing technical ideas back to the owner. This is an especially important skill for deep energy retrofits, because only the most sophisticated building owners will have a strong understanding of energy performance.
- Many architects include construction administration services in their practices and so are familiar with overseeing the implementation of system upgrades and replacements that will ultimately be required to achieve the performance goals.

Ideally, a deep energy retrofit project team should consist of the design professionals (architect, engineers, and equipment specialists), the project owner or owner's representative, and the project's facility manager. It is also often helpful, particularly when component/equipment cost and installation strategies are key to the value decision-making process, to include the general-contractor and specialty sub-contractors, or a cost-estimator depending on contractual requirements. Ideally, all members of the design team will be involved early on in the life of the project, though this is not an absolute necessity to complete a successful deep energy retrofit.

The collaborative nature of deep energy retrofit projects proffers a need for a deeper upfront understanding of the risks and rewards associated with this type of project. Thoughtful review of goals, conversations with liability insurance carriers, and well-written agreements can give team members a better upfront understanding of any potential liability concerns that may arise. This approach fosters a more trusting relationship between project stakeholders, which should allow designers to abandon their focus on the building's individual systems and focus instead on designing a better performing building.

RESOURCES:

Rocky Mountain Institute's **Integrated Design Checklist** is a useful tool for understanding how an integrated design team should approach investigating different design solutions in a deep energy retrofit.

2.4 PRE-DESIGN AND GOALS

Before considering design solutions, the deep energy retrofit project leader needs to have a detailed discussion with the owner about the nature of the project and the desired outcomes. It is important to set specific goals and agree on how achievement will be measured and verified. The owner and project leader also need to agree on business and energy baseline scenarios against which they will assess their project.

Typically, to decide the business baseline in an energy retrofit, the project team compares the costs and benefits of the project against the "cost of doing nothing" or the cost of "business-as-usual". All buildings require periodic maintenance, and many buildings, especially those built in the latter half of the 20th century and later, are to the point of needing replacement of major systems and the envelope. The "business-as-usual" baseline scenario should reflect the costs of these necessary capital investments. Collecting accurate information about the condition of the building and anticipated future maintenance and scheduled replacements will allow the team to calculate the true marginal cost of the project's combined energy efficiency retrofit measures.

Once a business baseline has been agreed upon, the team needs to select a baseline for energy consumption. Most commonly, when retrofitting a building, the energy savings goal is calculated as a reduction from the minimum energy performance as required by code for the project type. This is required for both code compliance and most sustainability rating systems, such as LEED. However, this comparison between the building's anticipated post-retrofit performance and code minimum typically seriously underestimates the actual energy savings the project-client will see compared to pre-retrofit utility bills, since the building's envelope and mechanical and lighting systems were likely designed to meet the lower minimum requirements of older codes. To understand the actual potential energy savings of the retrofit project the energy savings goal should also be compared to the current energy use, as determined through utility bills. In this case, a calibrated energy model that shows the project's pre-retrofit energy use must be developed to compare alongside the "baseline building" energy model. Unfortunately information on current energy use is often difficult to acquire, though the **widening adoption of energy disclosure requirements** in cities and counties across the country may change this.

As an alternative or supplemental energy baseline, the project team might want to see how the building compares to other, similar buildings. The team can use the **ENERGY STAR Portfolio Manager** database to see energy use data for a variety of building types. Similar information can be found through **DOE Buildings Energy Data Book,** the **Buildings Performance Database,** and the multiuse calculator in the AIA's **2030 Challenge documentation spreadsheets**. These can be helpful in assessing potential Energy Use Intensity (pEUI), particularly for new use allocation in an adaptive reuse project. Many deep energy retrofit projects track energy savings potential against multiple baselines.

After agreeing on the business and energy baselines, it is time to set the actual performance goals of the project. While the team might be able to form a general idea of an achievable energy savings goal based on initial inspections, a much more rigorous discovery process is likely necessary to determine an appropriate goal. Early energy/performance modeling of different design strategy alternatives can help tremendously with this.

During the goal setting phase of a deep energy retrofit, there is a natural role for a member of the project team to act as a kind of knowledge manager. This person needs to ensure that the business baseline contains all relevant information needed to make an accurate estimate of the cost of the business-as-usual case. The architect is probably the best prepared to help the owner articulate their capital project's plans and future business desires as well as new planning and design requests in terms that can translate to performance-based goals.

2.5 INITIAL DESIGN

Once the team has settled on the project goals, the design phase of the project begins. The key to designing the best project possible is a rigorous investigation of the building, its systems, internal planning layout, and operations and maintenance procedures. In short, the team should try to learn about every characteristic or process that affects the building's energy consumption.

Interviews with building users including tenants, facilities managers, and maintenance personnel are also important in helping identify opportunities to reduce energy loads. Sometimes this leads to large energy savings that would have been missed in the standard retrofit approach.

The deep energy retrofit of **Indianapolis' City-County Building** is a good example of how an initial design charrette can lead to energy saving opportunities that might have been missed otherwise. During a charrette, the design team learned that because of a high water table, the building had been pumping 225 gallons of groundwater per minute from the lower parking deck. They realized that what appeared to be a large energy liability could actually be turned into an asset. By using the water flow as a heat exchanger, the team could lower the costs of heating and cooling the building. This discovery was a major factor in the project's achievement of 46% energy savings.

After engaging stakeholders, the team will

1. collect detailed information about the building's energy consumption if available,
2. evaluate for space-use and program efficiencies,
3. embark on some forensic investigation into the materials and components that currently exist in most of the systems on the project (for deep energy retrofits, forensic analysis of the components and materials in the envelope has a direct impact on energy use, but performance potential may also hinge on the structural load capacity),
4. perform or commission an energy audit of the existing project.

The Stanford Medicine Outpatient Center case study is an illustrative example of the potential need to assess both an overall building's structural capacity to carry additional mechanical equipment weight on the roof and the structural slab-edge's capacity to carry the weight of additional cladding upgrades needed to improve envelope thermal performance.

SEE THE CASE STUDY

A combination of a rigorous energy audit, forensics and detailed energy modeling will give the team the information it needs to assess the building's energy use and determine the retrofit's optimal performance potential.

ENERGY AUDITING

There are three levels of ASHRAE energy audits. Architects may want to learn to perform an ASHRAE Level I energy audit on a building. An ASHRAE Level I audit is a basic survey audit in which the auditor gains a rough idea of the building's energy performance through brief interviews with operations staff, a review of utility bills, and a "walk-through" to spot obvious inefficiencies. ASHRAE Level I audits can be done for a relatively low cost ($0.02 -$0.06 / sq. ft.), and, though they are not sophisticated enough to account for interactions between the building's systems, they can help determine the general feasibility for capturing deep energy savings. An ASHRAE Level I audit is not in itself necessarily sufficient to inform the project team's design choices, but it could be useful for architects who want to scout out new projects.

There are now several tools available to perform "touch-less audits". These tools use utility bills to estimate building loads and recommend energy efficiency measures. The level of detail offered is roughly similar to a level one audit.

ASHRAE Level II and III audits are much more comprehensive than Level I audits, allowing the auditor to measure energy consumption throughout the building's systems; however, in addition to being much more expensive than Level I, Level II ($0.05 -$0.15 / sq. ft.), and Level III ($0.10 -$0.50 / sq. ft.), audits are also much more technically demanding and should be carried out by qualified engineers. While few architects will be able to lead Level II and III audits, any architect working on a deep energy retrofit should be familiar enough with the audit process to understand the data and be able to judge its general quality.

RESOURCES:

DOE. **Advanced Energy Retrofit Guides**

ASHRAE. **"Procedures for Commercial Building Energy Audits"**

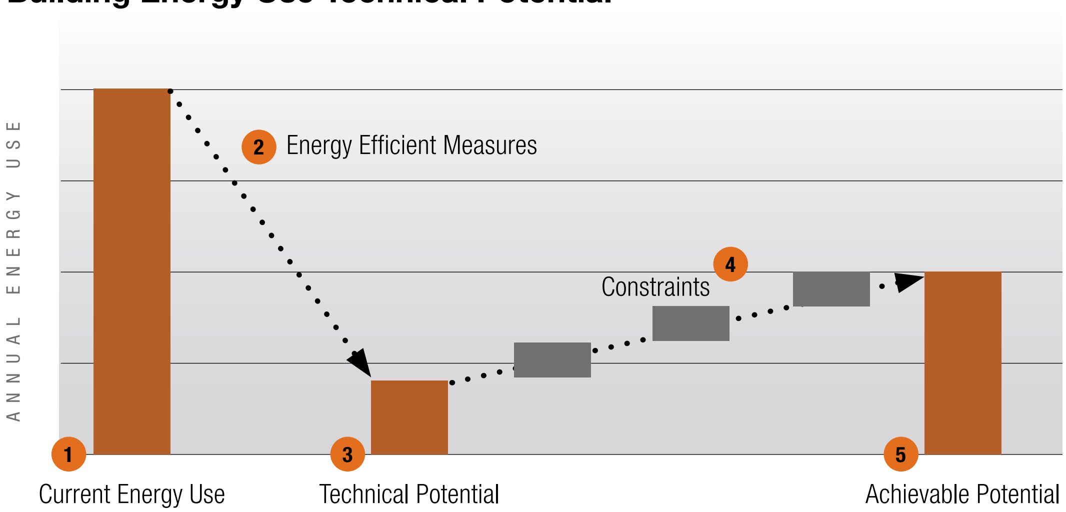
ENERGY MODELING

Like energy auditing, energy modeling comes in gradations of complexity, and like energy auditing, some parts of the energy modeling process may require some sophisticated simulation to render information comprehensive and detailed enough to be useful in a deep energy retrofit. Any architect working on a deep energy retrofit should know enough about energy modeling to know hot to judge when a particular energy model makes sense and how to develop the model to yield the information needed to make informed design choices. The AIA's **An Architect's Guide to Integrating Energy Modeling in the Design Process** will give architects a basic familiarity with energy modeling.

One method of defining the optimal performance potential with which the deep energy retrofit project will proceed is to first assess the Maximum Performance Potential (MPP) for the project. The MPP is the highest amount of energy that could be saved by applying all of the most advanced energy efficiency measures available to the project. There are many system, component, and material options as well as any *mutually reinforcing combinations* (often termed 'bundles') that should be explored, not all of them obvious.

Establishing the MPP allows the team to view what is technically possible before introducing constraints. This prevents the team from rejecting any measures out of hand for fear that they may be cost-prohibitive. In this way, the team will be less likely to allow false assumptions about cost, schedule, or other constraints to prevent them from discovering less-obvious design ideas that can actually deliver a more cost-effective and performance-enhanced project. Once the maximum *technical* performance potential has been established, constraints such as cost, schedule, etc. can be overlaid, allowing the team to determine the project's *optimal achievable potential.*

Building Energy Use Technical Potential



One way of finding the MPP is to host an initial design charrette with all major project stakeholders. The open, workshop-like atmosphere of a charrette allows the design team to get a comprehensive perspective on the available design opportunities and to earn support from the owner-client. If owners are vested in the process and understand the fundamental integrative design principle of interactive efficiency measures, the bundle of measures the team ultimately selects will be less likely to be stripped apart later.

However, the above approach can be frustratingly time consuming for an architect experienced with designing to cost and schedule constraints. Therefore, it can often be more time/cost effective to explore the application of a number of bundled energy efficiency measures that include design/construction strategies already determined to meet cost, schedule, or other project constraints. It is worth noting that these bundled energy efficiency strategies very often provide an even higher energy-saving potential than applying individual energy efficiency measures.

Using whole-systems thinking to capture synergies between each energy efficiency measure is at the core of delivering successful deep energy retrofit projects. Before considering technological upgrades, the team should start by looking for simple solutions. How can you optimize opportunities to reduce loads? Are there opportunities to increase access to daylighting? Can the habits of building users be changed to lower energy demand? Understanding how occupants use the building is key to understanding the building's energy demand profile and designing a system that efficiently meets their needs.

2.6 DESIGN MEASURES

Once the maximum or optimum technical energy saving potential of the project has been determined, it is time to begin evaluating different energy efficiency measures for optimal **value**.

Ideally, alongside the project team's assessment of individual measures for energy savings, each measure would also be evaluated for its estimated capital cost. As the team creates bundled measures, it can model the cumulative effect of the measures and estimate the bundle's life-cycle cost, including maintenance and replacement costs over the chosen life-cycle, as well as first cost and energy cost savings.

For example, the California DMV case study illustrates how relocation and accommodation of staff during construction can be a massive factor in the cost of a retrofit. This element alone can make or break the go/no-go decision for a client with respect to the total capital cost outlay for the retrofit project.

SEE THE CASE STUDY

Additionally, the UCLA Center for the Health Sciences case study illustrates how important construction access can be for the cost to retrofit of an existing building. Many older 3-10 story existing buildings, built to older codes, may not have rooftop maintenance access that would facilitate envelope upgrade installation and built-up surrounding sites may limit the ability to put up scaffolding. Thus creative and sometimes more expensive installation design and access strategies need to be accounted for in costing alternatives.

SEE THE CASE STUDY

This is when having a good cost-estimator or the contractor and sub-contractors as part of the team becomes essential, as it is fundamental to a retrofit project that the Life Cycle Cost Analysis (LCCA) also includes accurate comparisons of the impacts of all of the construction *process* as well as material and installation costs.

When time and cost constraints prevent the team from modeling each possible measure, design teams will have to rely on their knowledge and experience to come up with bundles that they believe have a better chance than others of providing deep energy savings. While not as thorough as the approach above, this method, when employed by a strong design team, can deliver impressive energy savings.

After evaluating the bundles, the team should formulate several different bundles to present to the owner. For example, the team might create one bundle that optimizes energy savings, one that optimizes net present value of the investment, and one that addresses an alternative client goal such as increasing worker satisfaction. For each option, the project team should also create a plan for implementing it. A smart implementation strategy can result in significant cost savings. For instance, one way to reduce project costs is to install equipment when the current systems are scheduled to be replaced. Because deep energy retrofits occur on an existing building, the team should also address how to minimize disruption of building business operations while implementing the energy efficiency measures, as this can provide significant savings over the cost of renting alternative space to temporarily house employees for the duration of construction. Though it is sometimes possible to time implementation with a change in occupancy, many times the project team will need to be more creative in scheduling construction around the activity in the building and finding technical design and construction solutions that won't interfere with maintaining business operations.

2.7 PRE-IMPLEMENTATION

Once the final deep energy retrofit strategy is agreed upon, a detailed, calibrated (if the building's metered energy use data is available) energy model of the agreed upon solution should be developed. This is the model that will be used to determine if the building's post-retrofit measured energy use provides the expected performance. This is not only important from a final validation perspective. Comparing a well-structured final calibrated model to early installation energy use data can also help with the first 1-2 year commissioning effort. This information can help the facility manager identify glitches in new component startup and optimization that need to be addressed. The comparison can also illuminate building maintenance or occupancy issues that may need to be addressed to achieve the modeled, predicted energy performance.

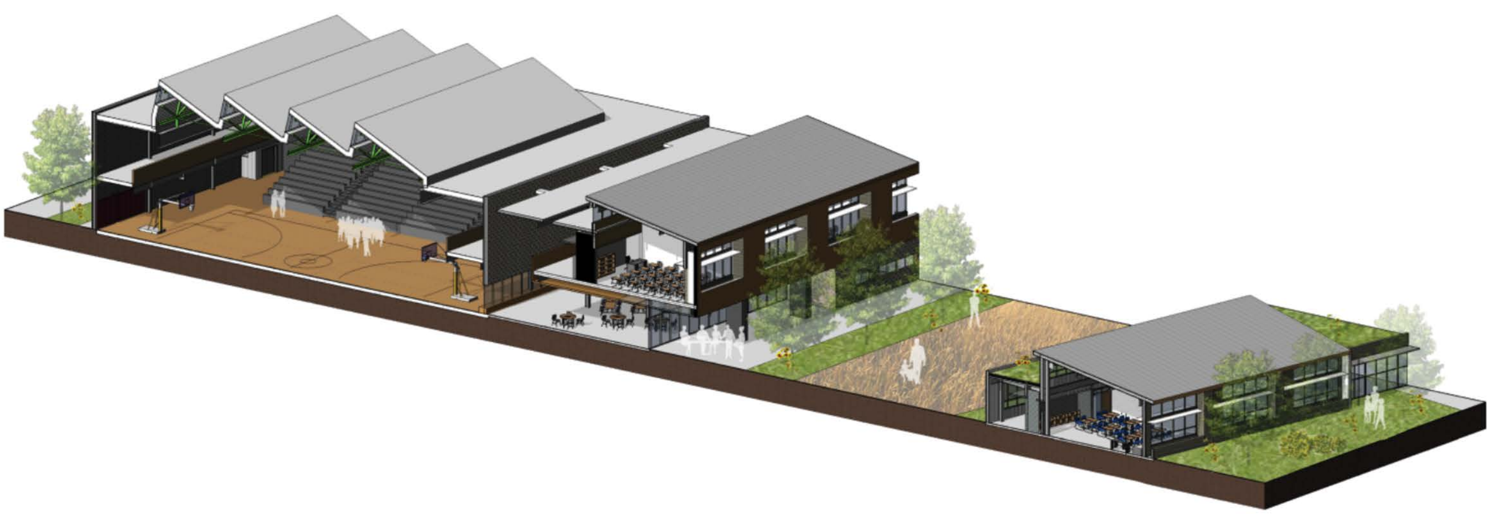


Photo credit: ©BNIM

Architects with experience in the Design-Build and Construction Manager At-Risk project delivery methods know how to supply contractors with the pre-construction information they need to accurately implement the design. This kind of coordination between the design team and the builder is all the more important in a deep energy retrofit, since poor construction can render the benefits of many energy efficiency measures moot.

2.8 IMPLEMENTATION AND COMMISSIONING

Once the project team has settled on the energy efficiency measures it will make, planning for the construction and commissioning of the project begins.

ASHRAE defines the commissioning process as "a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meets defined objectives and criteria."

Commissioning in deep energy retrofits is intended to verify the interactions of systems toward meeting or exceeding the project's energy efficiency objectives. There are generally two phases to the commissioning process. In the pre-occupancy phase of the work, a commissioning agent (CxA) may consult in design review, may provide input on the feasibility of implementing energy efficiency measures, and works to observe and verify that the envelope, systems, and controls are installed correctly.

In the post-occupancy phase of the commissioning work the building systems are reviewed against the design criteria, assumptions, and objectives to ascertain they are working properly. This is an important phase for adjustments and fine-tuning the building under load (while occupied) and to establish on-going and long-term operational parameters toward continued efficient operation throughout the life-cycle of the building and its systems.

Since many deep energy retrofits occur while the building is occupied, a construction plan is generally developed to accommodate the building's users by minimizing the disruption of normal operations. The plan generally takes into account building operations, occupant use and comfort, critical data operations, and heating and cooling load parameters among others.

A collaborative commissioning process that engages the owner, contractor, and design professionals throughout the design and construction process is an effective method of delivering an efficient building with a deep energy retrofit. Without a collaborative process there is no way to make adjustments to installed systems or evaluate control set points and occupant use of new systems to work toward delivering a building that performs as designed. A robust commissioning process is the only method the design and construction team has of demonstrating to the owner that the delivered, retrofitted building performs to the level of the owner's expectations.

No matter how effective the design solutions, if they are not implemented correctly the project will risk missing its performance goals. Keeping the builder and commissioning agents involved in the design process from its earliest phases will cut down on the risk of construction or commissioning mistakes that can add cost to the project and cause underperformance.

RESOURCES:

National Institute of Building Sciences. **Whole Building Design Guide Building Commissioning**

Most of the literature on commissioning currently recommends that the commissioning agent (CxA) be an independent consultant working under a separate contract with the owner. However, as most current commissioning agents are mechanical engineers by training, architects with strong technical knowledge of building envelope performance may find opportunities to offer commissioning services for both new construction and retrofits.

2.9 MEASUREMENT AND VERIFICATION (M&V)

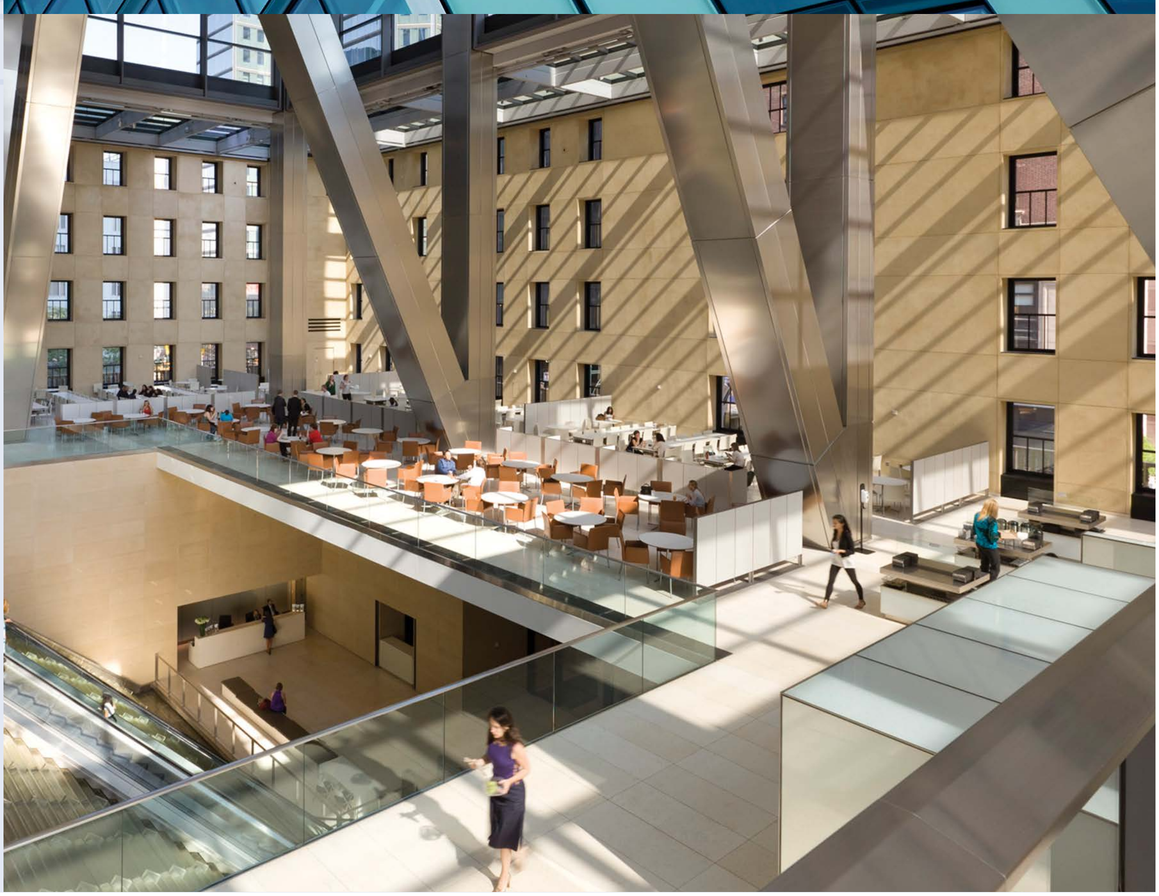
After the project has been designed, built, and commissioned, its energy consumption needs to be measured. The measurement and verification plan should be developed early in the deep energy retrofit process. It should lay out how and where energy consumption data is to be collected, as this will often inform where and how many meters need to be installed as part of the retrofit work. The M&V plan should also spell out who will take on the M&V responsibility, and how and when they will determine if the project's goals are being met.

M&V should take place at least a year after the building has returned to normal operations, but monitoring should typically be checked against the calibrated energy model throughout the first year to make sure that the building is being used and operated according to the design assumptions inherent in the model that was used to set the performance target. If any of these assumptions change during implementation or occupancy, the energy model must be re-calibrated and any resulting modifications to the goals must be discussed before continuing to verify performance.

RESOURCES:

Efficiency Valuation Organization

CHAPTER 3_ UNDERSTANDING THE BUSINESS CASE



Chapter 3_

UNDERSTANDING THE BUSINESS CASE

Most of the market opportunity studies cited in Chapter 1 recognized the technical, social, and general financial feasibility of building energy upgrades when calculating the total potential energy savings achievable in the U.S. building market. If every building owner could access unlimited amounts of affordable upfront capital, the retrofit market would likely exceed even $150 Billion a year.

However, both publicly owned and privately owned energy retrofit activity currently totals less than $20 Billion a year.[21] Three core challenges limit building owners from capturing the energy and operational savings opportunities:

1. Complexity
2. Cost
3. Internal competition for capital

Commercial, privately-held building owners face one additional challenge—the unique ownership structure of commercial real estate. Because commercial building ownership is structured as single-building LLCs, longer-term building investments require financing structures specifically aligned to this idiosyncratic business model.

Further, in all building sectors all or a large majority of a building's energy and operational costs are often not borne by the building owner but are instead tenants' responsibilities. Even though owners are becoming more aware of the benefits of energy efficiency and green buildings, because energy savings are not necessarily directly realized by the owner, a deep energy retrofit or other green construction is still frequently first perceived as an additional cost rather than an investment with a strong return. Because most property owners do not see energy management as part of their core business, as a general rule they are reluctant to commit large sums of capital to a major project outside their main priorities, especially if they do not expect to recoup their investment quickly.

Architects wishing to capture the deep energy retrofit market opportunity need to engage building owners in communicating a strong business case for upgrading their buildings. It will not be enough to wait for owners to come to this realization on their own. As experts on building design and performance, it is up to architects to help potential clients understand both the cost of accepting a building's current inefficiencies and the benefits of investing in their property's performance. The benefits of deep energy retrofits should be framed in ways that address owners' key business concerns which may include increased rents, renter turnover, resale value, maintenance, and branding/image.

3.1 COST ANALYSIS: SIMPLE PAYBACK VS. LIFE CYCLE

The most often used financial analysis method for energy retrofits is “simple payback.” Simple payback gives a basic assessment of how long an energy investment will take to pay for itself by dividing the capital cost by the projected annual energy costs savings.[22] For instance, a $1,000,000 lighting upgrade that saves $250,000 a year in reduced electric bills will result in a simple payback of 4.0 years.

Simple payback analysis is used so often because it is a relatively simple and easily understood way to determine whether a certain energy efficiency measure gives an acceptable return on investment; however, a simple payback calculation may omit other significant benefits associated with the project that are more difficult to quantify. For this reason, the cost of deep energy retrofits should be evaluated using a life cycle cost analysis, which allows the team to view a more realistic estimate of the project’s economic costs. Architects are in a unique position, as the professionals with the most integrated knowledge of the technical building systems as well as occupancy and maintenance patterns, to identify and quantify savings beyond the off-the-label savings easily calculated during standard equipment upgrades.

The most effective way to communicate savings to commercial building owners is through the Return on Investment (ROI, sometimes referred to as Internal Rate of Return [IRR]) of a project. This is the standard method used in the business world to compare capital investments. It allows the design team to compare different packages of energy efficiency measures and evaluate them against each other and a baseline, “business-as-usual” scenario in a way that aligns with the building owner’s decision making process. A simple payback analysis does not fully account for the business-as-usual capital costs that are inherent in maintaining a building. It compares the investment cost of the energy efficiency measures with a zero-cost baseline scenario, even though such a zero-cost baseline is an abstract concept and not a real number routinely used by owners. Existing equipment must be regularly maintained and replaced and those costs should be considered. As an example, suppose a building owner was considering replacing a chiller with a new, energy efficient model. That owner shouldn’t compare the cost of the new, efficient chiller against a zero-cost baseline. At some point, the current chiller would reach the end of its life-cycle and need to be replaced by a standard code-compliant unit. The true cost of installing the energy efficient chiller is not actually its full cost, but the margin between its total cost and the cost of the business-as-usual replacement. This margin is what the energy savings must recoup.

Simple Payback Considerations	Life Cycle Cost Analysis Considerations
• Cost of Measures • Incentives • Energy Savings	• Cost of Planned Expenditures • Incremental Cost of Measures • Credit for Downsized Equipment • Values Beyond Energy Cost Savings • Inflation • Incentives • Energy Cost Savings

RESOURCES:

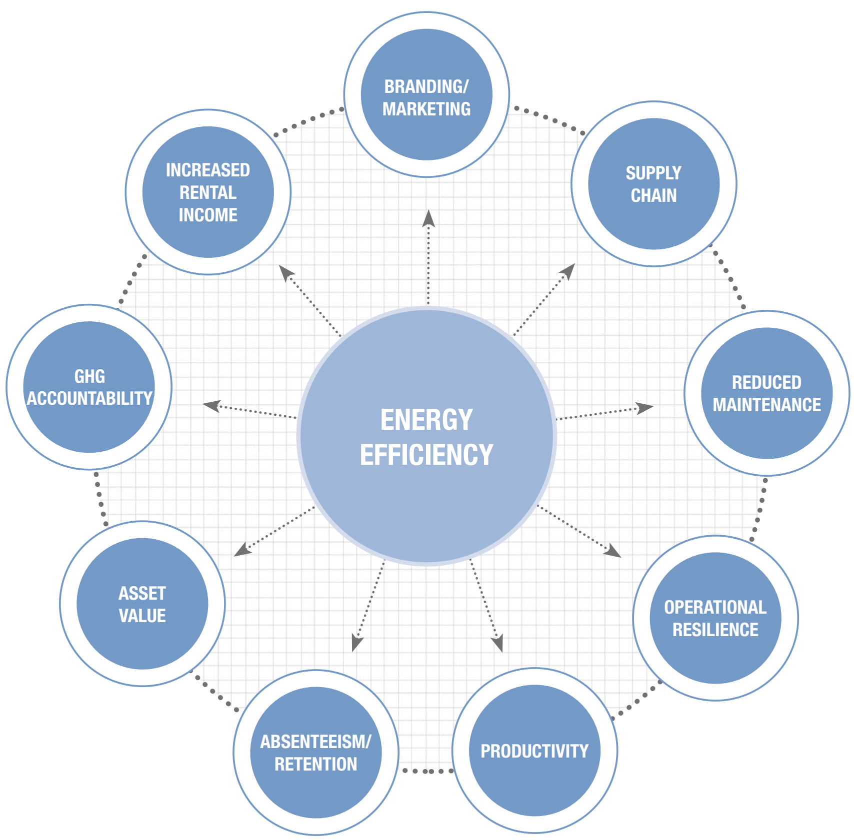
DOE. **Life Cycle Cost Analysis for Sustainable Buildings.**

Rocky Mountain Institute. **LCCAid Free Software.**

3.2 VALUE BEYOND ENERGY COST SAVINGS

Most people think of operational cost savings as the only benefit of upgrading a building's performance, but deep energy retrofits often yield other economic benefits that should be considered when evaluating a project's economic viability. Evidence shows that high-performing buildings are associated with improved employee satisfaction and retention, higher occupancy rates, and a rental and sale price premium.[23] While these additional benefits are difficult to quantify and cannot be included in a life cycle cost analysis, they deserve attention nonetheless and can be included in a life cycle *value* discussion with the owner. In instances where the life cycle cost analysis makes a marginal economic case for a deep energy retrofit, these additional benefits could be the deciding factor. The study of how high-performing buildings affect variables such as property value, worker productivity, and lease rates is still in its infancy, and as such, reliable methods of estimating these benefits are still being developed. Still, early evidence suggests that ultimately these factors and the competitive advantage of brand differentiation may actually outweigh the benefit of energy cost savings and could ultimately become the driving force in the existing building retrofit market.

Value Beyond Energy Cost Savings



Property Value

The demand for sustainability has increased rapidly in the design and construction industry, and so it should come as no surprise that sustainable, high-performing buildings command a premium in the market. A summary of studies of the value of green building by Rocky Mountain Institute shows that Energy Star Certification is associated with a range of benefits, including:

+ a 5.8 – 26% increase in property value
+ a 1.3 – 11% increase in occupancy rate
+ a 3 – 15% increase in lease rates[24]

In response to the economy-wide recession beginning in 2008, commercial property owners have struggled to retain and attract tenants to fill large vacancies in many key markets across the country. Energy efficient buildings result in lower operating costs for owners and for tenants. In 2010, C.B. Richard Ellis found that LEED-certified or Energy Star-labeled buildings have a 4% higher occupancy rate than market average, and LEED-certified buildings gain a 7.4% higher rental rate than the market average.[25]

While the wide range in data can make it hard to pinpoint the exact increase in value afforded by a green building, there can be little doubt that the effect is real and that owners of poorly performing buildings are at a disadvantage in the marketplace as sustainability continues to integrate with mainstream expectations in the real estate market.

Rent Rates and Tenant Turnover

For commercial buildings that are occupied by tenants, a major concern of building owners is the amount of rent they can charge as well as how to retain renters in a competitive market. Especially in buildings where tenants pay their own utilities, an efficient, healthy building will bring higher rents and retain more tenants. Though this can be a difficult benefit to quantify, it is a real benefit that a deep energy retrofit can enhance.

Employee Benefits

Most businesses spend far more on labor costs than they do on operational costs. According to a report by Rocky Mountain Institute, salary costs are generally ten times higher than energy costs in U.S. office buildings.[26] This means that even a small increase in employee productivity can have a much larger positive financial impact than the savings from lower operational costs. Energy efficient, high-performance buildings are often biophilic, meaning they provide their inhabitants with access to daylight, comfortable temperatures, and better air quality. These qualities are correlated with lower absenteeism and higher productivity; daylighting can save up to $2,000 per employee in office costs.[27] Architects can help business and building owners realize significant productivity and personnel retention benefits with thoughtful, efficient space planning. Taken together with the significant energy and operational cost savings of a deep energy retrofit, these additional benefits can radically improve a business' competitive performance. Currently the benefits of productivity and reduced absenteeism are difficult to monetize for a single building with a great degree of accuracy, as research is still relatively new in this area. As more deep energy retrofits are completed, and as information becomes more available, it may become possible to compare your project to similar ones to estimate a range of reasonable employee benefits

Utility Rebates, Tax Incentives and Other Tax Benefits

Utility rebates and state and federal tax incentives for energy efficiency can have a significant impact on the economics of a project. Architects should have a good working knowledge of the federal, state, local and utility energy efficiency incentives available to them. Most electric utilities offer significant rebates for high-performing equipment, and some even offer financial assistance to offset the increased labor costs of high-performing building design (**Xcel Energy's Design Assistance Program** is just one example). In some areas of the United States, upfront utility rebates can offset as much as 10-15% of a total project's costs.

Further, multiple tax incentives are available to property owners investing in deep energy improvements. The **Energy Efficient Commercial Buildings Tax Deduction**, also known as the 179D tax deduction, allows an owner whose building reduces its energy costs by at least 50% relative to a theoretical reference building compliant with ASHRAE 90.1 to deduct up to $1.80 per square foot from their federal income tax. In addition, many energy efficiency technologies allow owners to depreciate owners' investments within as little as 3 years. The total tax benefits of a project can reach as much as 40% of a project's cost for private commercial property owners.

Because utility rebates and tax incentives are always subject to change by regulators and policymakers as well as market forces, architects would be wise to stay current on any changes. The **Database of State Incentives for Renewables & Efficiency** is a trusted repository of many of the rebates, tax credits, and grants available for energy efficiency improvements. The AIA works hard to stay up to date on federal tax policy, and architects should ask their local AIA chapter to do the same on local utility rebates and any state or local tax incentives available in addition to federal incentives.

Energy Efficient Mortgages

For commercial property owners, the two driving factors in their business model are: 1) positive cash flow from year-to-year, resulting from the subtracting of operating costs from the overall lease payments from tenants; and 2) capital gains, resulting from subtracting the original purchase price and any other capital improvements, including energy improvements, from the price paid by the new buyer. Reduced operating costs and increased occupancy and lease rates are attractive to commercial property buyers, but the purchase price for high-performance buildings is likely higher than conventional buildings. Lower mortgage and insurance rates offered for purchasers of high-performance buildings can substantially reduce any perceived barriers for new buyers; an energy-efficient mortgage could even be structured such that the lower interest payments outweigh any increase in purchase price.

Increasing volumes of data are showing a higher return on investment and lower risk of default and value-erosion for energy efficient buildings, particularly in the commercial building sector. One study, "Greening Our Built World: Costs and Benefits" by Capital E in 2010 demonstrated that though greening a building costs $4 to $5 per square foot in additional costs, the return on that incremental investment is more than 300% over a 20 year time horizon. Real estate mortgages are deliberately structured over longer terms than other loans—frequently 20 years or longer—and are thus well-suited to capture the increased operating income and lower operating costs, particularly when compared to conventional buildings operating just at the minimum performance required by code; in the case of older buildings, the return can be even greater than 300%.

The Capital Markets Partnership is just one consortium of lenders, investors, building owners and municipalities advancing specific tools to capture this added value and decreased risk to mortgage lenders for energy efficient properties. The Capital Markets Partnership released the National Consensus Green Building Investment Underwriting Standards for Commercial Buildings in September 2008, as a "straightforward, easy-to-implement tool allowing lenders, private equity investors, developers, and real estate owners the ability to rate an asset's 'greenness' at the time of financing or acquisition… as an underwriting overlay… to serve as an indicator of investment risk and long-term asset value."

The Green Building Investment Underwriting Standards and other tools are important because they can assist building owners in articulating the long-term value of improving their buildings' energy performance. Of particular importance is the ability for owners to translate that perceived value into a hard number—the appraised value of the building in preparation for sale.

Avoided Capital Costs and Value Creating Triggers

One of the most important but often overlooked elements in the business case for deep energy retrofits is the savings from avoided capital costs. When analyzing the business case, the owner or design team should account for how the project will affect planned capital improvements. Often, the equipment replaced in a deep energy retrofit would have needed to be replaced anyway within the owner's project payback timeframe. Moreover, in many cases, load reduction from the retrofit's energy efficiency measures allow the design team to downsize the mechanical equipment, which can save the owner significant capital. Because avoided capital costs are found in nearly every deep energy retrofit and because they can have such a large impact on a potential project's economics, architects should be aware of situations in which they can maximize the value of a deep energy retrofit for the building owner.

Rocky Mountain Institute identifies eight "value creating triggers"—special situations that improve the cost-effectiveness of a deep energy retrofit. Value creating triggers are often, but not always, planned capital improvement projects which present an opportunity to include comprehensive energy efficiency strategies at a relatively low-incremental cost. By timing deep energy retrofits to occur simultaneously with capital improvement projects, you can upgrade a building's energy performance without causing additional disruption and often for cheaper than if you implemented the retrofit at another time. Some of the triggers create an opportunity to perform a deep energy retrofit all at once, while others create the chance to implement incremental steps toward a complete deep energy retrofit over time.

VALUE CREATING TRIGGERS: WHEN TO DO A DEEP ENERGY RETROFIT

1. **Adaptive Reuse, Market Repositioning, or Modernization:** Repositioning an existing building will require significant capital expense to which the cost of a deep retrofit would be incremental and likely small in comparison.
2. **Roof, Window, or Other Major Envelope Replacement:** Planned roof, window, and other major envelope replacements provide opportunities for significant improvements in daylighting and efficiency at minor incremental cost, providing the leverage for a deep retrofit that reduces loads and potentially the cost of replacing major equipment such as HVAC and lighting.
3. **HVAC, Lighting, or Other Major Equipment Replacement:** Major equipment replacements provide opportunities to address envelope and other building systems as part of a deep energy retrofit. After reducing thermal and electrical loads, the marginal cost of replacing the major equipment with much smaller equipment (or no equipment at all) can be negative.
4. **Upgrades to Meet Code:** Life safety upgrades may require substantial disruption and cost, enough that the incremental investment and effort to radically improve the building efficiency becomes not only feasible but also profitable.
5. **New Acquisition or Refinancing:** New acquisition or refinancing at historically low interest rates can put in place attractively financed building upgrades as part of the transaction, upgrades that may not have been possible at other times.
6. **Fixing an "Energy Hog":** There are buildings, often unnoticed, with such high energy-use or high energy-prices (perhaps after a major rate increase) that deep retrofits have compelling economics without leveraging any of the factors above.
7. **Major Occupancy Change:** A company or tenant moving a significant number of people or product into a building or major turnover in square footage presents a prime opportunity for a deep retrofit, for three reasons. First, a deep retrofit can generate interior layouts that improve energy and space efficiency, and can create more leasable space through downsizing mechanical equipment. Second, ownership can leverage tenant investment in the fit-out. Third, tenant disruption can be minimized.
8. **Energy Management Planning:** As part of an ongoing energy management plan for a group of buildings, the owner may desire a set of replicable efficiency measures. These measures can be developed from the deep retrofit of an archetypical building and applied to a larger set of similar buildings.

RESOURCES:

Rocky Mountain Institute. **"Retrofit Depot: Guide to Building the Case for Deep Energy Retrofits"**

Muldavin, Scott. **Value Beyond Cost Savings: How to Underwrite Sustainable Properties**, 2010.

Terrapin Bright-Green. **"The Economics of Biophilia: Why Designing with Nature in Mind Makes Financial Sense"**

CoStar Group. **LEED Buildings Outperform Peers**

Fuerst and McAllister. **New Evidence on the Green Building Rent and Price Premium**

Deloitte. **The Dollars and Sense of Green Retrofits**

Conlon and Davis. **The Relationship Between Corporate Sustainability and Firm Financial Performance**

Empire State Building

A good example of how to time a deep energy retrofit to take advantage of a planned capital improvement is the 2009 retrofit of the **Empire State Building**. In this project, Rocky Mountain Institute architects worked with the ESCO Johnson Controls, the Clinton Climate Initiative, and Jones Lang Lasalle which acted as the owner's representative. The Empire State Building's energy efficiency measures (EEMs) were part of a $500 million planned capital improvement program. This allowed the design team to consider multiple EEMs which could be implemented simultaneously to create synergies in energy and cost savings. Some of the EEMs the design team chose were an upgrade of every window in the building, daylighting and light fixture upgrades, radiator insulation to direct more heat into the building, and upgrades to ventilation controls. The impact of these EEMs is not limited to the energy they save. Together, they reduced the building's peak cooling load enough that the design team was able to avoid replacing the building's chiller with a bigger one. This resulted in avoided capital cost of approximately $17 million. In all, the Empire State Building retrofit is expected to cut energy use by approximately 38% and save about $4.4 million a year. To learn more about the Empire State Building retrofit, please read Rocky Mountain Institute's summary of the project **here**.

3.3 SPECIFIC FINANCING TOOLS FOR DEEP ENERGY RETROFITS

Distinguishing the Commerical Market from the "MUSH" Market

For reasons identified earlier, financing building-scale energy improvements for commercial property owners has been challenging due to the deliberate ownership structure of commercial real estate. In the United States, most private property ownership is structured as limited liability companies (LLCs) to allow building owners facing poor cash flows to declare bankruptcy. The LLC typically does not survive, legally, and is thus able to avoid any long-term obligation to the buildings' creditors. Despite these difficult circumstances, several financing tools have been developed to address the structural barriers in the commercial retrofit market.

In the MUSH market sector, financing building-scale energy improvements is much easier. Financial investors or lenders know that they can rely on public borrowers' long-term survival. Though the specific credit ratings and financial health of an individual city, county, state, or school district can range from AAA credit to B- credit, these risks are manageable and easily calculated by lenders or investors.

Architects who wish to offer deep energy retrofit services should have at least a basic understanding of the financing tools for both the MUSH and commercial retrofit markets, summarized below.

Retrofit Financing Tools

1. **Energy Savings Performance Contracting—the "ESCO model"**

   Energy Service Companies develop, implement and finance energy-savings projects, ranging from low-cost measures like lighting and updated building controls to more intensive energy savings measures like mechanical system replacements. These "ESCOs" are authorized by state law to provide guaranteed savings to the building owner year-over-year, ensuring that the building owner will see both reduced energy costs and reduced risk of underperformance or maintenance issues over the life of the contract. In exchange for assuming this risk, ESCOs frequently earn double-digit returns on these projects, and require longer-term contracts, frequently for 15-20 years.

Best Suited For	MUSH market, with almost no current use in the commercial market.
Geographic Application	All 50 states.

2. **Revolving Loan Funds a/k/a State and Municipal Loan Programs**

The 2009 American Recovery and Reinvestment Act (ARRA) directed more than $3.1 billion into state energy programs and an additional $3.2 billion in conservation block grants to cities and counties. Most states, and dozens of cities, used these stimulus funds to establish Revolving Loan Funds (RLFs) devoted to both public and private building energy efficiency projects. The state or local governments provide loans at below-market interest rates to both commercial and MUSH market building owners after reviewing proposed energy improvements. The credit review and underwriting process is straightforward compared to market-oriented loans, since the federal and state/local governments have established the energy savings as a public good.

In most cases, the Revolving Loan Funds continue past the ARRA stimulus funding timeline. As loans are repaid, the RLF pool is recapitalized, allowing for state and local governments to fund more energy efficiency projects. ARRA funds were applied to both the commercial and MUSH markets, building on the success of smaller-scale RLFs dedicated to governments' own stocks of lower-performing buildings. Many of these local loan programs continue today, even as other stimulus funds have been exhausted.

Best Suited For	Both COMMERCIAL and MUSH markets.
Geographic Application	Based on individual state and local programs.

3. **Sustainable Energy Utilities**

A Sustainable Energy Utility (SEU) serves as a one-stop shop for financing, technical assistance, and financial incentives such as conventional utility rebates. These state-established entities help take the burden off of conventional electric and natural gas utility providers in delivering and financing energy efficiency programs and create enough certainty for private investors and lenders to participate in commercial energy savings projects. Delaware and the District of Columbia have established SEUs with more than $100 million in activity thus far. Efficiency Vermont has a long track record of deep success as well, facilitating a total of $27.7 million in commercial building energy improvements just in 2011, in the small, rural state of Vermont.

Best Suited For	Both COMMERCIAL and MUSH markets.
Geographic Application	Currently limited to Delaware, Washington, D.C., and Vermont.

4. **Mortgage-Backed Financing**

Energy-efficiency-based mortgages create a relatively secure lending structure, because the mortgage provides substantial security for lenders. However, the total project size must be significant in order to justify the substantial transactional costs involved in issuing a mortgage. Further, an energy efficiency-based mortgage is likely to be structured as a second mortgage; in a default or foreclosure, the lender faces far more risk of not receiving the entire principle remaining on the mortgage. As a result, the energy efficiency mortgage is likely to require that borrowers pay interest rates of at least 5%, and likely up to 8%. The mortgage lending industry is increasingly interested in this market, given the substantial revenue produced by energy efficiency improvements to buildings. In some cases, lenders seek out energy efficiency projects for buildings targeted for refinancing or for purchase. When included in a first mortgage, these energy projects can be funded for 2-4% interest rates, given the historically low lending rates today.

Best Suited For	COMMERCIAL market.
Geographic Application	All 50 states, but with limited market penetration thus far.

5. **Utility-Backed On Bill Financing**

Utility On Bill Financing (OBF) allows electric and natural gas utilities to finance the upfront cost of energy improvements for their customers. The customer then pays the principal and interest as an added charge on their utility bill. The utility serves as a conduit for investors or lenders to reach a volume of borrowers through an investment-grade utility partner. By providing funds first to the utility and then relying on the utility to serve as the direct lender to borrowers, investors rely on the utility's credit should any borrowers fail to repay their loan. The utility is able to substantially minimize nonpayment by lending only to customers with perfect bill payment histories, along with other factors showing financial health, and the utility can threaten to shut off service in the case of late payments. While some state and local policies are pushing utilities to offer OBF to help their customers and ratepayers reduce their energy consumption, most utilities are resisting the push to become both utility provider and energy loan provider.

Best Suited For	COMMERCIAL market.
Geographic Application	Though growing, currently limited to participating New York and California utilities.

6. **Property Assessed Clean Energy (PACE)**

Property Assessed Clean Energy (PACE) is a conduit financing tool similar to On Bill Financing. PACE loans are paid back via an additional property tax assessment to local or state governments. For at least 70 years, cities have served as the conduit for commercial property owners to upgrade their properties for such measures as sewer and water services, tree planting or trimming, and even for downtown skyways in colder climates. In 30 states, cities and other jurisdictions are able to provide relatively low-cost financing for commercial property owners to implement energy efficiency and renewable energy projects. The local government sells a PACE bond to private investors and then uses the bond proceeds to lend to qualified commercial borrowers. The borrower repays the loan via a special assessment added to their property taxes. This primary lien ensures that the local government is repaid before any mortgage is repaid in the case of a foreclosure or other default. The property tax assessment is assigned to the property, not the building owner, allowing loan terms to extend anywhere from 5 to 20 years, depending on the project size and energy savings. In the case of a property sale, the buyer either assumes the property tax payments or folds the additional special assessment into the new mortgage. PACE loans are being provided at rates between 2.5% and 7.5%, depending on the size and location of the project.

Best Suited For	COMMERCIAL market.
Geographic Application	PACE is now legal in 30 states and Washington, D.C., with active programs in California, Michigan, Minnesota, Ohio, Connecticut, Florida, and a few other states.

RETROFIT FINANCING TOOLS	PUBLIC "MUSH" MARKET	COMMERICAL MARKET
Energy Savings Performance Contracting	X	
Publicly-funded Revolving Loan Fund	X	X
Sustainable Energy Utility	X	X
Mortgage-backed Efficiency Financing		X
Utility-based On Bill Financing		X
Property Assessed Clean Energy		X

Appendix_

CASE STUDIES

Below are three case studies of architecture-driven deep energy retrofits. These three projects took place in California, where the Title 24 energy requirements are the strictest in the nation. Each project uses Title 24 as its energy baseline, causing energy savings to appear to be more modest than they actually are, since merely meeting Title 24 would be a significant energy upgrade. To read more deep energy retrofit case studies, see the project profiles in "A Search for Deep Energy Savings" prepared by New Buildings Institute for the Northwest Energy Efficiency Alliance.

A. CALIFORNIA DEPARTMENT OF MOTOR VEHICLES

In the mid-1990s, the state of California hired the architecture and engineering firm Lionakis to analyze the California Department of Motor Vehicles (DMV) building for seismic performance. Lionakis found structural deficiencies and was hired to retrofit the building after it was determined that retrofitting the existing structure would have less of an environmental and financial impact than replacing it. In addition to addressing the structural deficiencies, Lionakis made improving the building's overall energy performance one of the primary goals of the project. The California DMV retrofit demonstrates how a major capital improvement can create an opportunity for a deep energy retrofit that is driven by architecture, not equipment replacement.

Façade

Because the DMV is a critical government agency, Lionakis had to come up with a way of implementing the retrofit incrementally so that the agency's operations were minimally disturbed. This precluded the use of traditional, prescriptive solutions for structural upgrades that would disrupt DMV operations by reducing usable floor area. After modeling the building, Lionakis determined that they could achieve the desired level of structural integrity by applying a thin carbon fiber wrap to the outside of the building, particularly to areas with seismic vulnerability. This method was less expensive, less invasive, and required less material than introducing new structural elements.

The carbon fiber wrap necessitated a re-skinning of the building's façade which was badly in need of improvement, both in its energy performance and its aesthetics. The building's original skin alternated between brick-clad structural concrete pilasters and small 3' x 3' single pane windows separated by un-insulated spandrel panels. Lionakis found that the façade's existing thermal insulation was significantly out of compliance with California's Title 24 energy requirements. In addition to poor thermal performance, the existing façade gave the building an unattractive, squat appearance. In response, Lionakis removed the spandrel panels and enlarged the windows to increase daylight and views. The brick pilasters could not be removed because they had structural integrity and they were to be covered in places by the carbon fiber wrap. To conceal the wrap, Lionakis devised a system of curtain wall and insulated metal panels to surround the outside of the building, each elevation responding to conditions regarding exposure and adjacent neighborhoods. The new façade made the building's exterior more visually appealing while reducing energy loads by increasing daylighting and improving thermal insulation.

Noting that the building's south and west sides were exposed to intense heat during the summer months, Lionakis designed a dual skin for portions of those elevations. The dual skin created a pocket of air to act as a buffer between the interior of the building and the exterior. Operable vents at the top and bottom of the dual skin façade allow natural ventilation to occur in summer. As the air in the chamber created by the dual skin façade heats up, it rises to escape out of the top vent, lowering the building's surface temperature. In the winter, when the vents are closed, the air in the chamber is warmed in a greenhouse effect. This passive ventilation system improves employee comfort and reduces the building's heating and cooling loads.

Lighting

In addition to installing more energy efficient lighting fixtures, Lionakis introduced task lighting at individual work stations so that workers could be effective at lower ambient lighting levels. Occupancy and daylight sensors were connected to a building energy management system, allowing the facilities staff to turn off half of the building's interior lighting without a loss of uniformity of illumination during peak energy use.

Building Systems

Before the Lionakis retrofit, the DMV used a vertical, constant volume HVAC system in which a central plant in the basement provided chilled water for cooling and steam for heating to two air handlers located in the penthouse. In order to minimize disruption of the DMV's workflow, Lionakis designed a horizontal HVAC replacement system that allowed for the floor by floor renovation of the building. This system includes two air handlers per floor, fed from a new remote central plant. The new HVAC system was designed to be more responsive to demand. Instead of constant volume, the new system provides variable air volume and is connected to the building's energy management system. The new remote central plant is much more efficient than the previous plant, not only because it employs state-of-the-art technology, but also because the improved façade significantly reduces loads. This benefits the plant's overall efficiency and provides capacity for future growth at the DMV campus. Finally, the switch to a horizontal HVAC system had an added benefit: it cleared the roof for the installation of a 495 kW photovoltaic system.

Energy Savings & Performance

With a building that was designed well before energy standards were formalized, and metering separate systems was unheard of, there is no realistic way to compare the before and after energy use of the DMV project. Added to this challenge is the explosion in the use of technology over the course of the fifteen year renovation period and an exponential increase in day to day plug loads. Couple these obstacles with constantly increasing utility rates, and it is virtually impossible to quantify the savings that are being realized when compared to pre-renovation usages.

With this in mind, it is critical to provide a baseline and measure against it. When compared to the 2005 California Title 24 Energy Code, all of the project's combined improvements are projected to provide an energy use saving of 3,712 MBtu/year, which is a 12.5% savings when compared to the baseline. Using today's energy rates, this equates to $126,000 in annual energy cost savings, which equals a 16.4% saving in today's dollars.

+ **Exceeds 2005 Title 24 Energy Code by 12.5%**
+ **Energy Savings per Year: 3,712 MBtu**
+ **Annual Energy Cost Savings: $126,00**

B. STANFORD MEDICINE OUTPATIENT CENTER

The conversion of three open-plan office buildings into the Stanford Medicine Outpatient Center serves as an excellent demonstration of how adaptive reuse projects can lead to an opportunity for a simultaneous deep energy retrofit that is driven by architecture and space planning rather than mechanical equipment replacement. In fact, in this case the size of the proposed upgrades to the mechanical system was reduced substantially.

In 1996 Stanford University purchased three open-plan office buildings in the South San Francisco Bay Area with the intention of transforming them into a new outpatient clinic facility for skin diagnostics and treatment including outpatient surgery. To meet the programming requirements of the medical facility, architectural firm Anshen + Allen was hired to devise new internal space plans for the buildings. Because many dermatology-related conditions require access to natural daylight to diagnose properly, the advising doctors and nurses required the team to plan cellular examination rooms and physicians' offices along the majority of the perimeter of each building. This change from an open-plan office to a cellular healthcare perimeter substantially increased the conditioning needed to locally offset the thermal loads now confined in perimeter rooms and provide the infection control required by the local health authorities for this type of facility.

As in many spec-development projects, the project team found that the existing buildings' structure and mechanical systems were designed to meet the minimum limits of early 1990s code requirements. This introduced a number of architectural problems that needed to be considered in order to locate the additional mechanical conditioning equipment needed to provide the required performance:

+ The buildings' overall structural capacity couldn't accommodate the weight of the additional rooftop mechanical system needed to offset the perimeter loads in a confined space.
+ The buildings' rooftops did not have enough space to hold the additional mechanical system components needed for the upgraded performance.

This meant that either the expected performance needed to be reduced (not acceptable for a healthcare facility), some additional space needed to be found elsewhere on the site to locate the mechanical equipment (either in part, with long runs between that severely reduced efficiency, or in total, requiring excessive expense), or the perimeter loads needed to be reduced to the point that the necessary mechanical upgrades could be accommodated on the existing rooftops (both spatially and structurally.) Again, however, the minimal construction of the existing building imposed additional constraints:

+ The project team could not replace the existing, single-glazed storefront enclosure with a high-performance, insulated glass curtain wall (which could provide the external thermal load control) because the building's slab-edge construction could not support the added load.

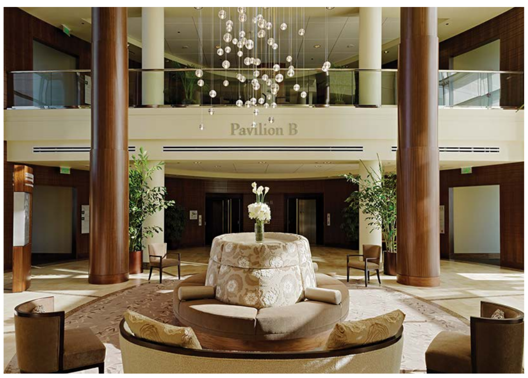
Additionally, while improving energy performance was not one of the primary goals of the project, the scope of changes needed to make the three office buildings into healthcare facilities was large enough to trigger compliance with the newer, more restrictive, California Title 24 energy code; further necessitating that the design team improve enclosure performance as well as upgrade the buildings' mechanical systems.

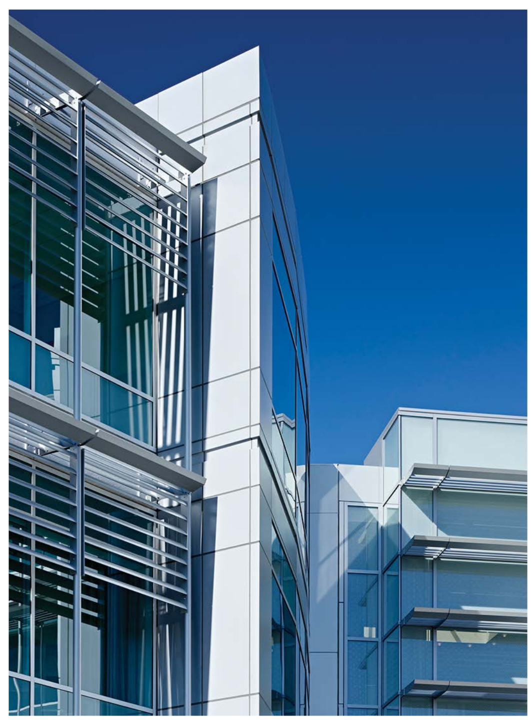
Using early-design energy modeling, the team (including Guttemann Blaevoet, mechanical engineers and Maurya McClintock, façade engineer) decided to keep the existing, single-glazed storefront which allowed for the unaltered daylight critical for clinical diagnoses, despite its poor thermal performance. They then added lightweight external sunshades to the buildings (that the slab edges could support) to boost the envelope performance without adding excessive structural load. Again using energy modeling, the sunshades were designed to provide the solar control needed for each of the different orientations of the three buildings' facades, and to reduce the perimeter load to exactly that which could be accommodated by mechanical systems upgrades that would fit on the rooftops. All of the sunshades employed a "kit-of-parts" design strategy that afforded a consistent aesthetic for the three buildings (as well as economical fabrication and installation) despite the different configurations needed to optimize solar control on the different orientations.

And, while the expense of adding the sunshades was more than the capital savings on the reduced mechanical system upgrades, the reduced thermal load provided ongoing energy and maintenance cost savings while still meeting the requirements of California's Office of Statewide Health Planning and Development Code and the newer Title 24 energy code requirements. More importantly, the increased envelope efficiency from the sunshades substantially reduced the need to upgrade the mechanical system, such that the upgrades could be accommodated both spatially and structurally on the existing buildings' rooftops, without which Stanford would have likely been forced to purchase another property for this project.

Design-phase energy analysis indicated the following estimates for the Stanford Medicine Outpatient Center:

+ **Exceeds 2005 California Title 24 Energy Code by 22%**
+ **Energy Savings per Year: 89 kW—654,500 kWh**
+ **Greenhouse Gases Mitigated: 1162 tons per year**
+ **Annual Energy Cost Savings: $188,060.00**





C. UCLA CENTER FOR THE HEALTH SCIENCES

The 12-story, 443,387 GSF South Tower (a former Medical Center Tower) is part of the 2.4 million GSF UCLA Center for the Health Sciences complex on the UCLA campus. After the 1994 Northridge earthquake, damage assessment and engineering studies funded by FEMA determined that the South Tower's structure was weakened. In response, UCLA developed a comprehensive strategy to create a replacement hospital on the campus and to perform a seismic upgrade and renovation of the South Tower to house state-of-the-art research wet labs in support of the School of Medicine's research and educational programs.

The university hired architecture firm ZGF to upgrade the building's seismic performance and then re-plan and renovate it to accommodate a new research-lab and associated office functions. As the extent of the adaptive reuse and seismic upgrade triggered the requirement to meet newer code requirements, ZGF and the UCLA campus architect agreed that the scope of the renovation afforded them an opportunity to address the building's energy efficiency as well as compliance with current seismic and high-rise building codes, and upgrade core and life safety infrastructure. The resulting project is a good example of how adaptive reuse interior planning overlaid on a planned capital improvement project can create an opportunity for a deep energy retrofit that is driven by architecture and design rather than replacement of mechanical equipment.

The open lab spaces are being programmed to be generic and highly flexible environments that can function as wet bench, lab support, or dry lab space with quick and minimal build-outs. This approach allows the University to develop the building without the need to identify specific user groups and research programs that will be accommodated in the building. The revamped South Tower will be a key component in the restructuring of School of Medicine research programs along thematic lines rather than by department.

This planning strategy also provided the opportunity for each wing to be supplied by a small air handler with a centralized exhaust. While the centralized exhaust system is to be installed up front, the air supply system will be installed as users and programs move into the tower. This will allow the University to:

+ postpone the cost of fitting out the lab wings until a specific user or program has been identified for it
+ eliminate the complexity and cost of fitting a conventional centralized HVAC design into the tower (with its low, 13’-6” floor to floor heights) requiring the exhaust shafts to be relocated onto the exterior
+ reduce the high initial cost for air handlers and ducts to service the entire tower

The building’s façade of single-glazed ribbon windows with tinted glass and heavily-louvered external shading and wall areas of un-insulated brick-clad concrete was out of compliance with the newer California Title 24 energy requirements.

The brick walls and ribbon windows aesthetic is prevalent on the UCLA campus, so to preserve it, ZGF had to find a way to improve the façade’s thermal performance while increasing daylight availability for its new inhabitants. To do this, ZGF hired McClintock Façade Consulting to run early-design energy models of different configurations of glass types and shading strategies. From these iterations, they chose newer high-performance ultra-clear glazing and a horizontal shading configuration. Coordinating with IBE mechanical/electrical engineers, whole-building energy modeling indicated that this approach, along with providing R15 batt insulation behind the masonry-clad brick, addressed compliance with California’s 2008 Title 24 energy requirements and improved daylight performance dramatically. With daylight dimming lighting, energy modeling indicated the potential for associated energy reduction savings of approximately 40% in energy for the daylight zone (window area). When extrapolated out to the whole building, this showed to be a savings of approximately 33KW (out of 100KW total for the lighting) or a savings of approximately 33% working out to about $ 6,177 per year (based on the current lighting design as a baseline, which is already 45% under Title 24 requirements.)

As with many renovation projects, added construction complications, in this case stemming from site access constraints, had to be factored into the window replacement design.

+ All of the courtyards directly adjacent to the building were required to be available for use during construction
+ What limited surrounding landscaping and courtyards existed on the tight site had been built over an underground parking garage that had limited additional support capacity.

Both of these eliminated the possibility to scaffold the building for window replacement. And,

+ Typical of much low and midrise developments of that era, the building had no external maintenance access support system on the roof.

This meant that a window system that included the external shading, had to be designed to be completely installed (and have the ability to replace glazing in the future) from the interior of the building. A unitized internal re-glaze window system (based on a unitized curtain-wall construction approach was developed to meet these installation constraints.

Additionally, the prerequisite to meet new code requirements meant that the building's seven 8-10 story open-air access stairs needed to be enclosed, which could have required the addition of yet more energy-intensive mechanical equipment to condition each of these stair-towers. Instead, ZGF enclosed the open-air stair towers with a new glazed curtain wall that included external shading, louvered intakes at ground-level soffits, and operable louvers above roof-level; the combination of which facilitated the use of natural ventilation-driven cooling to condition these spaces. Again, energy/air-flow modeling coordinated between IBE and McClintock Façades indicated that the stack effect between the low and high-level openings encouraged natural air flow through the towers and reduced not only annual energy costs but also the capital costs of the mechanical equipment that would otherwise have been needed. As such, stair-tower active-mechanical was then needed only to provide pressurization required for emergency evacuation of occupants, significantly reducing the size and cost of this equipment.

In conclusion, the seemingly disadvantageous physical characteristics of the former hospital tower such as narrow floor-plates, low floor heights, continuous strip windows and a structural grid designed to accommodate patient rooms, have been turned into advantages in designing an efficient, high-performance, sustainable research building. By retrofitting the existing structure and shell, UCLA was able to save $78 million. Additionally, according to design-phase energy analysis, the reduced need for conditioning provided through right-sizing HVAC equipment, use of chilled beams, daylighting controls, and exterior skin upgrades will provide ongoing energy cost savings of $63,860 per year.

+ **Exceeds 2008 California Title 24 Energy Code by 22.4%**
+ **Energy Savings per Year: 199 kW—457,353 kWh**
+ **Greenhouse Gases Mitigated: 566,747 lbs per year**
+ **Annual Energy Cost Savings: $63,860**

BEFORE

AFTER

ENDNOTES

1 Congressional Research Service. "U.S. Trade Deficit and the Impact of Changing Oil Prices." Report No. RS22204. 2013. Web. Retrieved Apr 2013 at **http://www.fas.org/sgp/crs/misc/RS22204.pdf**.

2 US Energy Information Administration. "Annual Energy review 2011." Web. Retrieved Apr 2013 at **http://www.eia.gov/totalenergy/data/annual/pdf/aer.pdf**.

3 Architecture 2030. "A Historic Opportunity." Web. Retrieved Apr 2013 at **http://architecture2030.org/the_solution/buildings_solution_how**.

4 Empire State Building. "Empire State Building Case Study: Cost-Effective Greenhouse Gas Reductions via Whole-Building Retrofits: Process, Outcomes, and What is Needed Next." Microsoft PowerPoint File. Web. Accessed Feb 2013 at **http://www.esbnyc.com/documents/sustainability/ESBOverviewDeck.pdf**.

5 Deutsche Bank Climate Change Advisors & The Rockefeller Foundation. "United State Building Energy Efficiency Retrofits: Market Sizing and Financing Models." 2012. Retrieved Jan 2013 at **http://www.rockefellerfoundation.org/news/publications/united-states-building-energy-efficiency**.

6 McKinsey & Company. "Unlocking Energy Efficiency in the U.S. Economy." 2010. Retrieved Mar 2013 at **http://www.eia.gov/conference/2010/session9/granade.pdf**.

7 Rocky Mountain Institute. "Value of U.S. Buildings' Energy Efficiency, 2010-2050." 2011. Retrieved Mar 2013 at **http://www.rmi.org/RFGraph-Value_US_buildings_energy_efficiency**.

8 Laitner, John A., Steven Nadel, R. Neal Elliott, Harvey Sachs, and A. Siddiq Khan. American Council for an Energy Efficient Economy. "The Long-Term Energy Efficiency Potential: What the Evidence Suggests." 2012. Retrieved Mar 2013 at **http://aceee.org/research-report/e121**.

9 McGraw Hill Construction. "Business Case for Energy Efficient Retrofit and Renovation." 2011. Web. Retrieved Jan 2013 at **http://apps1.eere.energy.gov/buildings/publications/pdfs/alliances/business_case_for_energy_efficiency_retrofit_renovation_smr_2011.pdf**.

10 BuildingRating.org. "U.S. Policy Comparison." Web. Retrieved Apr 2013 at **http://www.buildingrating.org/content/policy-comparison**.

11 Bank of America. "Bank of America Exceeds $20 Billion Environmental Business Initiative." 2013. Web. Retrieved Apr 2013 at **http://newsroom.bankofamerica.com/press-release/environment/bank-america-exceeds-20-billion-environmental-business-initiative**.

12 Carbon War Room. "Carbon War Room-Brokered Consortium Set to Unlock Multi-Billion Dollar Global Commercial Property Retrofit Market." 2011. Web. Retrieved Jan 2013 at **http://www.carbonwarroom.com/news/2011/09/19/carbon-war-room-brokered-consortium-set-unlock-multi-billion-dollar-global**.

13 Wells Fargo. "Wells Fargo Environmental Finance Report." 2012. Web. Retrieved Feb 2013 at **https://www.wellsfargo.com/downloads/pdf/about/csr/reports/environmental_finance_report.pdf**.

14 Kats, Greg, Aaron Menkin, Jeremy Dommu, and Matthew DeBold. "Energy Efficiency Financing—Models and Strategies." Prepared by Capital E for the Energy Foundation. 2011. Web. Retrieved Jan 2013 at **http://www.cleanenergyfinancecenter.org/wp-content/uploads/EE-Financing-Models-and-Strategies-Oct.-2011.pdf**.

15 Navigant Research. "The U.S. Energy Service Company Market." 2012. Web. Retrieved Feb 2013 at **http://www.navigantresearch.com/research/the-u-s-energy-service-company-market**.

16 Satchwell, Andrew, Charles Goldman, Peter Larsen, Donald Gilligan, and Terry Singer. Lawrence Berkeley National Laboratory. "A Survey of the U.S. ESCO Industry: Market Growth and Development from 2008 to 2011." 2010. Web. Retrieved Feb 2013 from **http://www.escholarship.org/uc/item/2114b1bx#page-1**.

17 Hopper, Nicole, Charles Goldman, Jennifer McWilliams, Dave Birr, and Kate McMordie Stoughton. Lawrence Berkeley National Laboratory. "Public and Institutional Markets for ESCO Services: Comparing Programs, Practices and Performance." 2005. Web. Retrieved Jan 2013 from **http://emp.lbl.gov/sites/all/files/REPORT%20lbnl%20-%2055002.pdf**.

18 Hopper, et al. Lawrence Berkeley National Laboratory. "Public and Institutional Markets for ESCO Services: Comparing Programs, Practices and Performance."

19 Hopper, et al. Lawrence Berkeley National Laboratory. "Public and Institutional Markets for ESCO Services: Comparing Programs, Practices and Performance."

20 Bureau of Labor Statistics.

21 Kats, Greg, Aaron Menkin, Jeremy Dommu, and Matthew DeBold. "Energy Efficiency Financing—Models and Strategies." Prepared by Capital E for the Energy Foundation. 2011.

22 Buys, Aaaron, Michael Bendewald, and Kendra Tupper. "Life Cycle Cost Analysis: Is it Worth the Effort?" Rocky Mountain Institute. 2010. Web. Retrieved Feb 2013 at **http://www.rmi.org/Knowledge-Center/Library/2010-24_LCCA**.

23 Fuerst, Franz and Patrick M. McAllister. "New Evidence on the Green Building Rent and Price Premium." 2009. Web. Retrieved Mar 2013 at **http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1372440**. and Eicholtz, Piet, Nils Kok, and John M. Quigley. "The Economics of Green Building." Program on Housing and Urban Policy. University of California, Berkeley. 2011. Web. Retrieved Mar 2013 at **http://urbanpolicy.berkeley.edu/pdf/EKQ_041511_to_REStat_wcover.pdf**.

24 Rocky Mountain Institute. "RetroFit Depot: Guide to Building the Case for Deep Energy Retrofits." 2012. Web. Retrieved Jan 2013 at **http://www.rmi.org/Content/Files/RMI_Retrofit_Guide_BuildingTheCase_1.1.pdf**.

25 McGraw Hill Construction. "Business Case for Energy Efficient Retrofit and Renovation."

26 Rocky Mountain Institute. "RetroFit Depot: Guide to Building the Case for Deep Energy Retrofits."

28 Terrapin Bright Green. "The Economics of Biophilia: Why Designing with Nature in Mind Makes Financial Sense." 2012. Web. Retrieved Feb 2013 at **http://www.terrapinbrightgreen.com/downloads/The%20Economics%20of%20Biophilia_Terrapin%20Bright%20Green%202012e.pdf**.

28 Kats, Greg, Aaron Menkin, Jeremy Dommu, and Matthew DeBold. "Energy Efficiency Financing—Models and Strategies." Prepared by Capital E for the Energy Foundation. 2011.

29 Efficiency Vermont Annual Report 2011. 2012. Web. Retrieved Apr 2013 at **http://www.efficiencyvermont.com/docs/about_efficiency_vermont/annual_reports/2011-Annual-Report.pdf**.

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