U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Energy Efficiency in Separate Tenant Spaces – A Feasibility Study

APRIL 2016

ENERGY.GOV

Table of Contents

1. Executive Summary 1
2. Introduction, Definition of Scope and Existing Efforts 3
   2.1 Introduction and Legislative Mandate 3
   2.2 Definition of Scope 3
3. Benefits of Achieving Energy Efficiency in Tenant Spaces 4
   3.1 Energy and Emissions in Tenant Spaces 4
   3.2 Potential Benefits 5
   3.3 Effects of Energy Efficiency on Employment 5
4. Feasibility of Achieving Energy Efficiency in Tenant Spaces 6
   4.1 Challenges 6
      4.1.1 Timing & Process 6
      4.1.2 Education, Awareness, and the Role of the Broker 11
      4.1.3 Tenant Market Demographics 13
      4.1.4 Cost Structures 14
      4.1.5 Data Availability 16
   4.2 Technical Opportunities to Improve Energy Efficiency in Tenant Spaces 18
      4.2.1 Analysis of High Efficiency Technologies 23
   4.3 Market Opportunities to Improve Energy Efficiency in Tenant Spaces 23
      4.3.1 Processes 23
      4.3.2 Programs 28
   4.4 Measurement & Verification 43
      4.4.1 Current Application of Feasibility of M&V in Tenant Spaces 43
      4.4.2 M&V Gaps & Needs 44
5. Acknowledgements 45
6. Appendix 46
   6.1 Energy Efficiency Employment Impact Multipliers 46
      6.1.1 Modeled Energy Efficiency Scenarios 46
      6.1.2 Further Sources 47
   6.2 Analysis of High Efficiency Technologies Continued 48
      6.2.1 High Efficiency Lighting 48
      6.2.2 Lighting control technologies 48
      6.2.3 Daylighting 49
      6.2.4 ENERGY STAR® Certified Appliances and Office Equipment 50
      6.2.5 Plug and Process load (PPL) inventory and reduction strategies 51
      6.2.6 Point-of-use domestic water heating 52
      6.2.7 Energy management and information systems (EMIS) 53
      6.2.8 Optimization of outside air volumes according to tenant occupancy 54
      6.2.9 Data centers and IT server room best practices 55
      6.2.10 Improving Building Envelope Performance 55
      6.2.11 HVAC zoning 57
      6.2.12 Window attachments 58
      6.2.13 Utility Metering and Submetering 59

1. Executive Summary

Commercial buildings account for 20% of energy used in the United States economy,[1] with leased spaces representing approximately 50% of all commercial building energy use.[2] Increasingly, market pressures such as rising energy costs, new requirements to publicly disclose energy usage, and increased attention on energy efficiency as a means to combat climate change are motivating tenants, building owners, and other commercial building stakeholders to explore new ways to reduce energy consumption.

Traditionally, efforts to encourage energy efficiency in commercial buildings have focused on building owners rather than tenants. While building owners generally have control over building systems and operations, tenants play a critical role in achieving lasting reductions in energy intensity. In recognition of this collaborative role, the Energy Efficiency Improvement Act of 2015 mandated the development of a voluntary tenant space recognition system similar to the successful ENERGY STAR® buildings program. Additionally, the legislation mandated a feasibility analysis, presented here, regarding the implementation of tenant-specific energy efficiency measures. In response, this paper presents best practices, resources, and policies that could serve as the backbone for future tenant energy efficiency programs.

The energy consumption at a representative large, multi-tenant building can be partitioned into energy attributable to common areas (such as atriums, lobbies and garages), shared mechanical systems (such as central heating, fans, and cooling towers), and tenant spaces. In a typical arrangement, certain segments are clearly controlled by the owner, such as the garage lighting. Other segments are clearly controlled by the tenant, such as plug loads in tenant spaces. However, ultimate responsibility for managing the energy consumed in a multi-tenant space is often balanced between tenants and owners. Circumstances differ based on lease structure, but in a typical arrangement, neither owner nor tenant has complete control.[3] Instead, the energy usage and associated emissions are under the joint control of the owner and tenant, and the significant reductions in energy consumption require collaboration between the two parties.

Achieving greater levels of energy efficiency in tenant spaces is feasible through the use of technologies that exist in the market today. However, historic challenges have prevented wide-spread adoption of separate space efficiency measures. First, the timing and process of leasing - characterized by infrequent design windows, multiple stakeholders, design and budget constraints, and the dynamics of fluctuating negotiating leverage between owners and tenants - have largely prevented rapid advancement of energy efficiency in separate tenant spaces. Second, many owners, tenants, and brokers remain unaware or uninterested in the financial benefits and opportunities afforded by energy efficiency within leased spaces. Third, the majority of tenants in the market are small, disparate, and hard to reach with overarching energy efficiency strategies. Fourth, owners and tenants are hesitant to invest in tenant space energy efficiency measures due to the "split-incentive" problem. This "split-incentive" refers to the financial disconnect of investments in energy efficiency that can result from how costs and benefits of energy efficiency are allocated to different parties. And fifth, the inability to collect tenant-specific energy data from whole building consumption, in order to validate the benefits of energy efficiency investments, limits owners and tenant insight into the value of energy efficiency, further dampening interest.

1 U.S. Energy Information Administration. (2006). 2003 CBECS Detailed Tables – Table C4A: Expenditures for Sum of Major Fuels for All Buildings. https://www.eia.gov/consumption/commercial/data/archive/cbecs/cbecs2003/detailed_tables_2003/2003set14/2003html/c4a.html

2 NRDC. (2013). High Performance Tenant Demonstration Project. http://www.josre.org/wp-content/uploads/2013/02/CMI-PPT-on-Tenant-Energy-Performance.pdf

3 As an example, while the owner may select and maintain the central heating system, the tenant may have control over the thermostat controlling the leased space and the adjoining common corridor. Together, the choices made by the owner and tenant determine the energy consumption at the building.

Increased education and awareness materials, collection of tenant-specific energy consumption data, and a re-alignment of leasing cost structures targeted toward building owners, tenants, and brokers, may help overcome these challenges and encourage widespread uptake of tenant space energy efficiency measures. This paper highlights a variety of potential ways to address these needs including:

Submetering of tenant spaces – Metering tenant-specific energy use offers the ability to separate out individual tenant-level energy usage from common area usage. This "submetering" helps ensure that each tenant pays for their own energy consumption, and receives the full benefit of energy cost reductions on their part.

Easy comparison of energy efficient technologies – Technologies exist to increase the energy efficiency of tenant spaces. However, understanding the costs and benefits of utilizing such technologies is often complicated and time consuming, requiring tenants to understand not only the energy saving attributes of individual products, but also interactive effects between technologies. Improving the ability to readily compare packages of technologies through interactive tools or build-out guidance checklists is one potential way to increase the uptake of energy efficient technology in tenant spaces.

Recognizing the business case for energy efficiency – Many businesses recognize the ways in which energy efficiency can improve their bottom line. There are opportunities to help even more businesses see these benefits, including the role of energy efficiency in reducing total cost of occupancy, making spaces more comfortable and attractive, contributing to improved worker performance, and increasing asset value at time of sale. Even in lease structures with a split incentive for energy efficiency, building owners can benefit from increased energy efficiency through market differentiation – and in certain markets command higher rents and longer tenures. A growing body of research has shown that energy efficient buildings rent for an average premium of 2-6%,[4] can sell for a premium of as much as 16%,[5] attract high-quality tenants,[6] and have lower default rates for commercial mortgages.[7]

Low-cost energy simulation models for tenant spaces – Tenants can compare different energy efficiency measures through energy simulations and decide which options are most appropriate for the individual space. Energy modeling is most often used today in large spaces (greater than 20,000 square feet) where the return on investment from energy efficiency measures more than covers the upfront costs of modeling. Continued investments in both guidance and software to make advanced modeling more accessible and targeted at tenant spaces will help smaller tenant applications (less than 20,000 square feet) to use designs that benefit from energy modeling.

Improving leasing language and broker engagement – energy efficiency-aligned language can be added to traditional building leases to create "green leases" that mitigate the landlord-tenant split-incentive problem. To increase the use of green leases, which in turn can help tenants realize financial benefits, industry trade organizations can continue to highlight examples of successful green leases, collect and publish best practices, and create case studies that illustrate the benefits and market opportunity for green leasing strategies. Education that increases energy efficiency literacy among real estate brokers will help them to better respond to tenant requests for energy efficient spaces and leases.

4 Eichholtz, P., Kok, N., & Yonder, E. (2012). Portfolio greenness and the financial performance of REITs. Journal of International Money and Finance, 31(7), 1911-1929. http://www.fir-pri-awards.org/wp-content/uploads/Article-Eichhiltz-Kok-Yonder.pdf

5 Eichholtz, P., Kok, N., & Yonder, E . (2010). Doing Well by Doing Good? American Economic Review. http://urbanpolicy.berkeley.edu/pdf/AER_Revised_Proof_101910.pdf

6 Eichholtz, P., Kok, N., & Quigley, J. M. (2009). Why do companies rent green? Real property and corporate social responsibility. Real Property and Corporate Social Responsibility (August 20, 2009). Program on Housing and Urban Policy Working Paper, (W09-004). http://www.ucei.berkeley.edu/PDF/EPE_024.pdf.

7 An, X., & Pivo, G. Default Risk of Securitized Commercial Mortgages: Do Sustainability Property Features Matter? (2015). http://capla.arizona.edu/sites/default/files/faculty_papers/Default%20Risk%20of%20Securitized%20Commercial%20Mortgages%20and%20Sustainability%20Features%2C%202015.pdf

Creation of a federal tenant space recognition system – By allowing for direct peer-to-peer comparison of buildings based on energy or sustainability performance, recognition systems provide the market with greater insight to evaluate building performance. This can help owners, tenants, and brokers to broadcast the value of energy efficiency measures, and distinguish high-performance buildings from the rest of the market. Simplifying efficiency to an accessible metric can give market participants a "scorecard" to measure higher levels of performance, and often drives activity across the industry as a whole through competitive forces and peer comparison. There will be several possible ways to design a recognition program for leased spaces. Options range from recognition based on outcome-focused gross metrics like those used by the Australian government (energy use intensity), to detailed metrics focused on design and operational inputs like the government in Singapore (lighting level, temperature ranges) to energy simulation-based approaches or simpler checklist-based approaches. Further research is warranted to assess the metrics, structure, and market viability of a potential system to best support the U.S. market.

2. Introduction, Definition of Scope and Existing Efforts

2.1 Introduction and Legislative Mandate

Over the past 20 years, many of the energy efficiency gains in commercial buildings in the United States have occurred as a result of a focus on improved technologies and owner-oriented tactics, while tenants have so far received relatively little pressure or support to improve energy efficiency measures within their spaces. As such, congress passed the Energy Efficiency Improvement Act of 2015 on April 23, 2015 to foster greater attention and collaboration on tenant space energy management.

The Energy Efficiency Improvement Act requires completion of this study to determine the feasibility of: (1) significantly improving energy efficiency in commercial buildings through the design and construction of separate spaces with high-performance energy efficiency measures, and (2) encouraging owners and tenants to implement such measures in separate spaces. The legislation also requires the Secretary to publish this study on the website of the Department of Energy (DOE).

2.2 Definition of Scope

This study investigates the feasibility of significantly improving energy efficiency in commercial buildings through the design and construction, by owners and tenants, of separate spaces with high-performance energy efficiency measures. For the purposes of this study: "significant improvement" is defined as an excess of 20% improvement, "separate spaces" are spaces that tenants are leasing, and "high-performance energy efficiency measures" are combinations of tools, practices, and technologies that when applied drive energy efficiency improvements in excess of 20%, either separately or in combination.

In addition, this study investigates the feasibility of encouraging owners and tenants to implement high-performance energy efficiency measures in separate spaces. For the purposes of this study: "encouraging" is the development, distribution, and adoption of tools, resources and policies that enable owners and tenants to implement energy efficiency measures.

3. Benefits of Achieving Energy Efficiency in Tenant Spaces

Reducing the energy used in tenant spaces would provide significant benefits to the economy and environment of the United States. Fundamentally, both owners and tenants affect the energy consumed and resulting emissions from leased spaces, and as a result, this section discusses the energy and emissions of the commercial real estate sector accordingly.

3.1 Energy and Emissions in Tenant Spaces

The energy consumption at a representative large, multi-tenant building can be partitioned into energy attributable to common areas (such as atriums, lobbies and garages), shared mechanical systems (such as central heating, fans, and cooling towers), and tenant spaces. In a typical arrangement, certain of these segments are clearly controlled by the owner, such as the garage lighting. Other segments are clearly controlled by the tenant, such as plug loads in tenant spaces. However, ultimate responsibility for managing the energy consumed in a multi-tenant space is often balanced between tenants and owners. Circumstances differ based on lease structure, but in a typical arrangement, neither owner nor tenant has complete control.[8] Instead, the energy and associated emissions are under the joint control of the owner and tenants, and significant reductions in energy costs can best be captured through their collaboration.

For purposes of scale, this section quantifies the total energy consumed by office, retail, and flex (a mix of office, warehouse, and light industrial) spaces. While multifamily spaces are also leased, they typically are not designed and constructed for each new tenant, and have a different set of considerations that are outside the scope of this report.

As a whole, commercial buildings account for 20% of the energy used in the United States Economy.[9] Of this number, office, warehouse, and retail spaces in the United States occupy 26.5 billion square feet of space, consume 4,700 trillion Btu of energy (major fuels and electricity), and spend $25 billion annually on energy costs. The office, retail, and warehouse sectors produce over 970 million metric tons (MMT) of carbon dioxide equivalent emissions (CO2e).[10] While these estimates encompass all office and retail space, leased space accounts for more than 50% of an office building's total energy use.[11] Making a conservative assumption that energy use associated with retail and warehouse leased space is also 50% of total building energy use, leased spaces account for more than 490 MMT of emissions, and 2,350 trillion Btu of energy consumption annually.

8 As an example, while the owner may select and maintain the central heating system, the tenant may have control over the thermostat controlling the leased space and the adjoining common corridor. Together, the choices made by the owner and tenants determine the energy consumption at the building.

9 U.S. Energy Information Administration. (2006). 2003 CBECS Detailed Tables – Table C4A: Expenditures for Sum of Major Fuels for All Buildings. https://www.eia.gov/consumption/commercial/data/archive/cbecs/cbecs2003/detailed_tables_2003/2003set14/2003html/c4a.html

10 EIA. (2003). Commercial Buildings Energy Consumption Survey (CBECS) – 2003 CBECS Survey Data. CBECS website http://www.eia.gov/consumption/commercial/data/2003/

11 NRDC. (n.d.). High Performance Tenant Demonstration Project. http://www.josre.org/wp-content/uploads/2013/02/CMI-PPT-on-Tenant-Energy-Performance.pdf

3.2 Potential Benefits

There are quantifiable financial and environmental benefits associated with increasing energy efficiency. As a quick estimate of benefits, if current energy use in retail, warehouse, and office space was reduced by 20%, the country could save:

- 940 trillion Btu of energy, roughly the quantity of electricity consumed by Mexico.[12]
- $5 billion in annual expenditures.
- 190 MMT of CO_2e, or the emissions from 370 billion miles of automobile travel.

3.3 Effects of Energy Efficiency on Employment

A recent literature review and analysis by the Pacific Northwest National Laboratory (PNNL) evaluates the impact of improved energy efficiency on employment and the economy.[13] [14] The study evaluated two primary vectors of energy efficiency job creation:

1. Long-run, economy-wide job creation due to energy efficiency freeing up money that would otherwise have been spent on energy. The study concluded that spending money made available by reducing energy expenditures for alternative goods and services generates a net gain of about 8 jobs per million dollars of consumer bill savings.
2. Immediate, sector-specific job creation due to investments in energy efficiency. The study concluded that initial investments in energy efficiency generate about 11 jobs per million dollars of investment. These activities include the purchasing and installing of measures for retrofit or for new construction and also jobs in other sectors "induced" by this economic activity.

Common Types of Lease Structures

While there are many lease structures, a few of the most common are briefly described below, in order to illustrate the ranges of responsibility:

- In a triple-net lease, the costs of maintenance, insurance, taxes, and utilities are borne by the tenant. In this case, the owner has little control or financial interest in the energy consumption of the leased area.
- In a gross lease, the costs of maintenance, insurance, taxes, and sometimes utilities are paid by the owner. The tenant pays a flat fee covering these expenses. In this case, the owner has more control and financial interest in the energy consumption of the leased area.
- In a pro rata share scenario, tenants are responsible for a percentage of total utility bills proportional to the percentage of the building's area which they occupy, and are billed through a monthly recovery fee.
- The vast majority of lease structures resemble one of these three models, with tenants directly or indirectly covering energy usage costs associated with their use (such as plug loads), and paying proportionally for the use of shared systems or energy costs for common area spaces, lobbies, etc.

12 EIA. (2014). Total Petroleum and Other Liquids Production – 2014. http://www.eia.gov/beta/international/

13 Anderson, D. M., Belzer, D. B., Livingston, O. V., & Scott, M. J. (2014). Assessing National Employment Impacts of Investment in Residential and Commercial Sector Energy Efficiency: Review and Example Analysis (No. PNNL-23402). PNNL, Richland, WA (US). http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-23402.pdf

14 Further explanation of the PNNL study methodologies and results are referenced in section 5.1 of the appendix.

4. Feasibility of Achieving Energy Efficiency in Tenant Spaces

The technologies exist to improve energy performance in separate spaces; however, historic challenges have prevented wide-spread adoption of separate space efficiency measures. While challenges do exist, there are a variety of opportunities that mitigate these barriers and encourage the uptake of energy efficiency in tenant spaces. The following discussion summarizes current research and strategies to improve tenant spaces energy efficiency.

4.1 Challenges

While the potential benefits of energy efficiency in separate tenant spaces were described in Section 3, several challenges have historically prevented large-scale adoption of such measures. These systemic barriers discourage the implementation of energy efficient technologies during design and construction. Broadly speaking, these challenges can be categorized as issues of Timing and Process, Education and Awareness, Tenant Market Demographics, Cost Structures, and Data Availability.

4.1.1 *Timing & Process*

As background, the energy efficiency of a tenant space is determined primarily during two time windows:

- Design and fit-out, or the time leading up to and including construction of the tenant space.
- Occupancy, or the time in which tenants occupy the space.

Major tenant improvements are relatively infrequent – tied to the lease cycle, the time in-between can typically be 3-7 years or more – and as such the opportunity to influence the design and selection of major systems and technologies in the space are limited to these intermittent windows.[15] While some energy efficiency strategies are available during occupancy, the largest-scale gains are typically achievable in the infrequent design window, with moderate additional energy savings obtainable during occupancy. Generally speaking, these gains apply to office, retail and warehouse buildings, whereas other space types such as data centers and manufacturing have an entirely different relationship where the operational energy in the space is much greater than that of the building. Figure 1 below provides a generalized overview of the leasing and tenant improvement process, noting the sequence of these "windows" in a typical project:

15 The greatest opportunity to implement energy efficiency in separate tenant spaces is during the new construction process and in particular, during a build-to-suit development. During new construction, the greatest systemic changes can be implemented, including customized design of the HVAC system, metering schema, and building envelope. While the opportunities are greater during this stage, the considerations are highly similar to those discussed in this section.

FIGURE 2 – THE TENANT IMPROVEMENT PROCESS

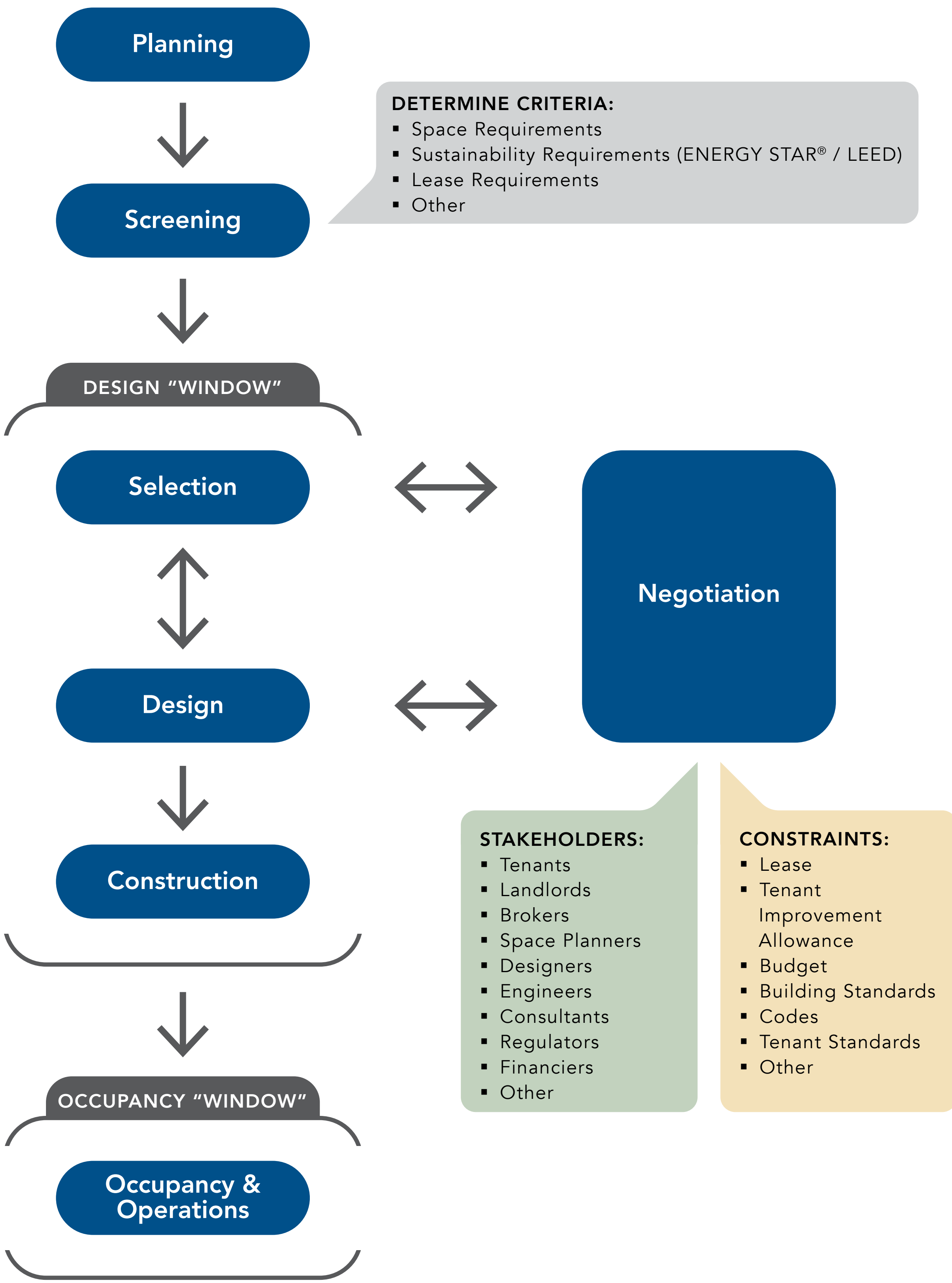


Table 1 details each of the steps shown in Figure 1, noting key activities and processes that can influence the implementation of energy efficiency initiatives throughout the tenant improvement process:

TABLE 1 – THE KEY PHASES OF THE TENANT IMPROVEMENT PROCESS

PHASE:	DESCRIPTION AND ACTIVITIES:
Planning	■ Decision that new space is needed ■ Criteria development ■ Office search and design team formation, can include: tenant representative (broker), designer, architects, and space planners
Screening	■ Initial review of candidate properties ■ Preliminary matching against space criteria ■ Development of a "short list" of properties for initial negotiations
Selection	■ Final decision on property, depending on outcome of negotiations and design
Negotiations	■ Finalizing lease terms, conditions, rental rates, tenant improvement allowances, length, and other considerations
Design	■ Space planning ■ Aesthetic and functional design of tenant suite
Construction	■ Build-out, furnishing, and commissioning of infrastructure, systems, and equipment
Occupancy & Operations	■ Building operations and maintenance ■ Tenant business operations

The energy performance of tenant spaces is influenced in multiple ways across each of the above phases. Factors including owner attitudes, financial situation, and negotiating position can foster or inhibit energy performance considerations in decision-making. For example, in the planning phase, tenants can establish environmental and energy performance targets for their space, guiding which buildings become eligible through the screening process. As a result, tenants may screen building ownership for their sustainability practices and attitudes, or limit their searches to LEED or ENERGY STAR® certified spaces in an effort to find a collaborative partner for saving energy. These, and other decisions at earlier stages of the tenant improvement process, can have significant influence on the ultimate efficiency of the space.

The Design Window

The design window consists of three phases (2): selection, negotiation, and design. Depending on the market, the size of the leased space, the sophistication of the parties, and the specifics of the project, these phases can occur simultaneously or sequentially.[16] Through the three stages parties iteratively negotiate, examining proposals and counter-proposals, evaluating competing bids, and revising financial projections. Timing pressure and budget constraints are intense components of this process, as owners and tenants both wish to avoid lost revenues or unnecessary costs due to a long leasing process. As such, energy efficiency measures may be rushed or dropped altogether, as the parties often perceive that they have more pressing considerations.

While the three phase design window is the process used by many tenants, other tenants may go through a simpler process. In its simplest form the process may involve identifying a nearby space (avoiding the selection phase), negotiating terms directly with the owner (avoiding the broker), and moving in with little fit-out. Again, energy efficiency may be de-prioritized as tangential in this process.

Throughout this entire design window, multiple stakeholders (and motivations) come into play, each with varying levels of influence depending on the situation:

- Brokers, motivated by commissions, often leave out energy efficiency topics in negotiations as they often seek quick and simple deal closure, and try to eliminate any extraneous factors from complicating negotiations.
- Tenants, often facing "sticker shock" at the expenses involved in leasing space or dealing with day-to-day business requirements, are faced with adding additional up front expenses of incorporating energy efficiency measures into their operations.
- Designers, consultants, and engineers all must keep abreast of negotiations and budgets in addition to client energy efficiency demands, and translate tenant criteria and space constraints into a workable plan.[17] Energy efficiency can be pushed aside relative to other client priorities.

The Deep-Retrofit "Window"

In addition to the design and occupancy windows described here, a major opportunity to improve energy performance arises through a "Deep Retrofit." Defined as an integrated, whole-building modernization program, Deep Retrofits can reduce energy consumption by 40% or more by enacting a holistic set of energy efficiency strategies across both common areas and tenant spaces.

Deep Retrofits often make sense when real estate owners, developers, and investors seek to "reposition" an older, dated property to be more competitive in the market, when significant tenant turnover is expected, or when large centralized systems such as a chiller or window glazing need to be replaced. By acting on this Deep Retrofit window - and integrating energy performance strategies throughout tenant spaces and building common areas - building owners can achieve a multiplier effect in terms of energy savings potential. However, these windows are infrequent, often 20-50 years apart.

16 Critically, tenants often will enter into negotiations with multiple building owners at the same time, attempting to achieve pricing leverage or to examine multiple options or locations. Designers often must look at the available space and produce a "test fit" preliminary design to ensure that the tenant requirements could be met by a particular property, and to check the impacts to the tenant improvement budget. Building owners put forward an initial proposal at this stage including rental rates, terms, and tenant improvement allowances.

17 Constraints also guide the ultimate space design. Large, national tenants or chains and franchisees may have brand standards and design criteria, specifying lighting technologies, illumination levels, or other aesthetic requirements that may compete with energy efficiency strategies. Building codes, project budgets, or unique leasing terms regarding maintenance practices may all combine to limit designers. Further, building ownership may have tenant improvement guidelines or building standards that specify systems, technologies, or operational constraints that impact energy performance opportunities. Each of these options needs to be evaluated by the parties in the transaction, and resolved through negotiations and by designers.

- Building owners, in a highly competitive market, have a valuable product and may suspend complex negotiations involving energy efficiency when a more attractive tenant - with simpler demands - appears.

Once design of a tenant space begins in earnest, timing considerations add pressure to decision making. At this juncture, both tenants and owners likely have financial and other resources committed to the deal, and any delays can result in additional costs:

- Tenants and owners often forego energy efficiency analyses - such as engineering studies, energy modeling, or technical pilots –so as to not disrupt the project's timing.
- Tenants may not be able to justify the financial and time costs of analysis by consultants, engineers, or other design professionals in comparison to the amount of energy costs that may be saved, particularly in smaller spaces.
- Owners often avoid perceived risks of "new" or "different" requirements are included, as this adds further complexity and uncertainty to the deal.
- In many cases, the initial costs of more efficient lighting, HVAC, or other equipment exceed that of standard technologies, further burden project financing and strain negotiations.

Ultimately, what gets installed and built in a tenant improvement project can depend on negotiating leverage. In a high-vacancy, tenant friendly market, a national credit-worthy tenant can demand and often receive significant concessions from property owners. Alternatively, in a low-vacancy, owner friendly market, building owners may provide minimal tenant improvement allowances (if any) or charge rent premiums. Such a market discourages the inclusion of energy efficient measures due to the ability of owners to easily identify alternative, less-demanding tenants.

Given these process related aspects – the phases of the design window, the multiple stakeholders and design constraints, and the dynamics of fluctuating negotiating leverage – significant advancements in achieving energy efficiency in separate tenant spaces has been slow to materialize.

When energy efficient technologies are implemented in the tenant improvement process, the most common improvements are items localized to the separate space, such as interior lighting upgrades and/or enhancements, efficient power supplies, efficient data center power and cooling systems, and tenant-specific HVAC systems that may or may not interact with central building systems. In larger leases, where a tenant has leverage through potential occupancy of a significant portion of a building, tenant improvements and leasing requirements may also include envelope enhancements, specify operating hours and practices by building management, set expectations on sustainability certifications such as LEED or ENERGY STAR®, or control other operational aspects.

The Occupancy Window

Once a tenant begins occupancy, some potential for significant energy savings diminishes. Tenants have limited control over central systems and in-suite equipment to improve efficiency, and only control limited building operations, if any. Owners, having secured the tenant for the life of the lease and having financed all or part of the cost of the tenant improvement, are hesitant to consider additional upgrades while mid-stream in the lease. Likewise, tenants in a shorter lease or mid-stream in their lease will resist spending resources on energy efficiency projects as they will not be able to fully benefit from the generated cost savings by the time their lease is up. At this point, the utility costs are paid by either the tenant or the owner as designated in the lease, and any cost savings achieved through energy efficiency may not be realized by the party that is making the investment. Further, the business needs and requirements of a tenant may preclude changes in technology or system operations for the purposes of energy efficiency – for example, while one might typically try to restrict operating system use during traditional business hours, tenant operations might require extended operations of HVAC equipment.[18] Owners are also reluctant to conduct large-scale energy efficiency upgrades that may disrupt tenants due to construction activities. As a result, both the owner and tenants may have limited appetite to pursue major energy savings projects during occupancy.

During occupancy, owners are generally operating and maintaining shared building systems, such as HVAC, exterior lighting, elevators, and building amenities. Depending on the leasing arrangements, the owner may also be maintaining select equipment within tenant spaces, such as replacing lights, or operating dedicated HVAC systems. Yet doing so still requires significant coordination between building ownership and tenants. The ultimate result is that during occupancy, most owners focus energy efficiency efforts on shared building systems under their purview, while tenants implement plug-load and behavior change strategies within their own spaces, if they act at all.

4.1.2 *Education, Awareness, and the Role of the Broker*

While timing pressures during the lease negotiation process decrease the prioritization of energy efficiency, the challenge is compounded by the fact that for many in the industry, energy efficiency in tenant spaces is not yet a common topic of discussion. While leading property owners and managers have become increasingly aware of the financial and competitive benefits of energy-efficient buildings, the owner has historically been the main driver of energy efficiency in commercial real estate. As discussed earlier in this section, the leasing terms have typically allowed the owner to dictate energy efficiency measures.

As a result, a vast number of potential tenants remain unaware or uninterested in the financial benefits and opportunities afforded by energy efficiency within leased spaces. Market inertia, competing priorities, information overload, and financial concerns can crowd out the "mindspace" of a potential tenant, leaving little time to investigate energy efficiency opportunities. For example, when examining a new space for lease, most tenants are primarily focused on location, rent, space suitability, and amenities. Energy efficiency is a distant fifth or lower on the list of priorities. This is reinforced by the relative costs of energy and rent. At a typical major city office building, energy will cost between $2 and $4 per SF. By contrast, rent may be as much as:

18 An example of necessary extended operating system hours could be an accounting firm requesting HVAC services for after hours during tax season.

TABLE 2 – RENT IN MAJOR MARKETS

CITY:	AVERAGE CLASS A OFFICE ANNUAL RENT ($/SF)
Manhattan, NY	$77 [A]
New York, NY (City Average)	$49 [B]
Washington, DC	$45 [C]
Austin, TX	$43 [D]
Denver, CO	$34 [E]
Tulsa, OK	$16 [F]

A Mashayekhi, R. (2015). Manhattan office vacancy rate hits six-year low. The Real Deal. http://therealdeal.com/2015/07/21/manhattan-office-vacancy-rate-hits-six-year-low/

B LoopNet. (2015). New York, NY Market Trends. http://www.loopnet.com/New-York_New-York_Market-Trends/?Trends=AskingRentsFL,NumberOfListingsFL,ProfileViewsFL,TotalSFAvailableFL,DaysOnMarketFL&PropertyTypes=Multifamily,Office,Industrial,Retail

C LoopNet. (2015). Washington, DC Market Trends. http://www.loopnet.com/Washington_District-of-Columbia_Market-Trends?Trends=AskingRentsFL,NumberOfListingsFL,ProfileViewsFL,TotalSFAvailableFL,DaysOnMarketFL&PropertyTypes=Multifamily,Office,Industrial,Retail

D Davidson, C. (2015). Austin Office Market Report – Q1 2015. The Tenant Advisor. http://www.coydavidson.com/office/austin-office-market-report-q1-2015/

E API Global. (2015). High Lease Rates and Low Vacancies a Hard Pill to Swallow for Tenants. Denver Metropolitan Commercial Real Estate Update. http://sg-realty.com/wp-content/uploads/2010/03/news-mid-year-20155.pdf

F CBRE. (2015). Tulsa Office MarketView H1 2015. Market Reports USA Tulsa/Oklahoma. http://www.cbre.us/o/tulsa/Pages/market-reports.aspx

One potential barrier to raising awareness is the role of the real estate advisor or brokerage community. Brokers "…hold the keys to what gets negotiated in the lease and what interests are being represented."[19] Working primarily for a commission based on the total rent and length of the lease, brokers facilitate negotiations covering terms, conditions, cost structures, tenant improvement allowances, and other logistical details.[20] When and if energy cost arrangements are discussed, they often constitute a minor element of negotiations, given the scale of energy costs in comparison to rent and other considerations. These same advisors are typically compensated when a deal is completed and have little incentive to complicate the transaction with discussions of sustainability. Thus, many tenants remain unaware of the relative efficiency of the tenant spaces they are considering.

Various real estate advisors – brokers, designers, property managers – play a particularly prominent role because the average tenant improvement project is driven by a non-real estate professional. The typical small to medium business owner who is seeking new space will designate a member of the staff to manage the process. Often, a human resources manager, business executive, or the owner themselves will act as project champion. Their leasing experience may represent the only time they engage in this type of transaction, resulting in a heavy reliance on their leasing representative and prospective owners for information and guidance.

It then falls to the real estate advisors to inform prospective tenants on the value of energy efficiency improvements. Brokers in particular play a critical role in interpreting, explaining, and advising their clients on the lease terms. But many real estate advisors will not take the time to educate tenants unless energy efficiency or sustainability is a goal expressed in preliminary discussions by the prospective tenant. Likewise, many tenants simply do not know what questions to ask related to energy efficiency. Unless an active effort is made by the tenant or owner sides to introduce energy efficiency and sustainability into leasing discussions, many projects will continue to move ahead without capitalizing on the opportunities.

4.1.3 *Tenant Market Demographics*

The tenant space market is comprised of a minority of national tenants with the ability to implement portfolio-wide energy efficiency changes. Conversely, the majority of tenants in the market are small, disparate, and hard to reach with overarching energy efficiency strategies. The National Association of Realtors and CoStar Group provide visualization of these market demographics:

- "In terms of inventory, commercial real estate markets are bifurcated, with the majority of buildings (81%) being relatively small, while the bulk of commercial space (71%) is concentrated in larger buildings."[21]
- Tenant demand is strongest for small leased properties of 5,000 square feet (SF) or less - these properties represent 75% of all leased properties in the United States. While demand for large spaces of 50,000 SF and above represent less than 15% of leased properties (Figure 2).[21]
- The average office lease for class A, B and C office buildings are about 8,000 sf, 3,500 sf, and 1,600 sf, respectively.[22]

19 Regulations.gov. (2015). Comment response to the published Request for Information (RFI). Shorenstein Realty Services. http://www.regulations.gov/#!documentDetail;D=EERE-2015-BT-BLDG-0012-0005

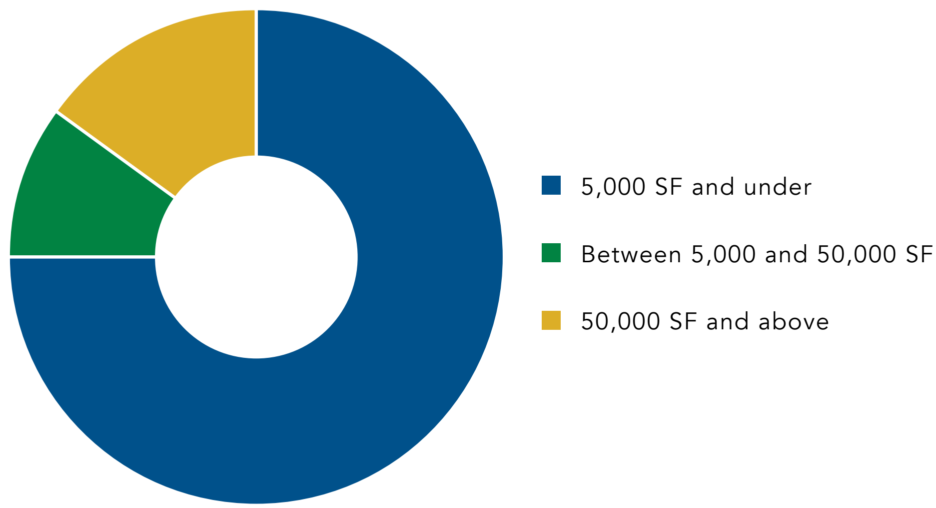
20 Brokers may also cover energy related items such as sustainability certifications, special HVAC cooling needs due to data centers or other unique equipment, operating hours, or energy and power source requirements due to intensive plug loads.

21 This number includes retail, office, and multifamily, and industrial space data. National Association of Realtors® Research Division. (2016). Commercial Real Estate Market Trends: Q4.2015. http://www.realtor.org/reports/2015-q4-commercial-real-estate-market-survey

22 Ponsen, A. (2015). Trends in Square Feet per Office Employee. Commercial Real Estate Development Association. http://www.naiop.org/en/Magazine/2015/Spring-2015/Business-Trends/Trends-in-Square-Feet-per-Office-Employee.aspx

- Lease terms of 36 and 60-months are most predominant in the market (59%).[21]
- Average lease prices vary with class A offices, class B and C offices, class A retail spaces, and class B and C retail spaces averaging $129/SF, $98/SF, $124/SF, and $91/Sf, respectively.[21]

FIGURE 2 – TENANT DEMAND FOR LEASED PROPERTIES REPRESENTED AS A PERCENTAGE OF THE U.S. MARKET.[21]



Efforts or programs targeting tenants will have an uphill battle due to the fragmented and diverse nature of the tenant population. These trends necessitate the creation, production, and distribution of resources and tools that can be effectively disseminated and communicated to tenants despite such variabilities.

4.1.4 *Cost Structures*

One of the most commonly cited barriers to the adoption of energy efficiency strategies in shared spaces remains the "split-incentive" problem. In a commercial building lease, all operational and maintenance costs associated with a building are paid by the owner, the tenant, or some combination thereof. These costs may include utilities, property taxes, security, insurance, janitorial services and more, and the lease legally defines who is responsible for these costs and any methodologies for cost-sharing or reimbursements.

In this context, the "split-incentive" refers to the accrual of costs and benefits of energy efficiency to different parties based on the separation of responsibilities for capital improvements and paying energy bills, or other bills associated with benefit streams such as operations and maintenance and worker salaries. In one typical scenario, capital costs are the responsibility of the owner, but operational costs are borne by the tenant. As an example, if a building owner invests in a more efficient lighting technology, the financial benefits of reduced energy consumption will flow partially or in whole to the tenant, depending on the lease structure. Likewise, tenants who will only occupy a building for a few years are hesitant to invest in a building system that lasts beyond that time horizon, or that ultimately becomes the building owner's property. Another form of the split-incentive can be found in space that is not submetered, but energy is included in the lease. With this structure, energy saving behavior by one tenant doesn't necessarily benefit that tenant – instead, the bill reduction is split across all tenants.

Numerous scenarios exist that determine to what extent, if any, owners or tenants both have a financial interest in reducing energy consumption. Specific lease types such as gross, net, fixed-base, or various permutations have different mechanisms for allocating energy costs. Gross leases typically specify that owners are responsible for energy costs, while net leases place that responsibility on the tenant. Various other approaches utilize mathematical formulas, cost ratios, common area maintenance (CAM) methodologies, or energy submeters to determine the timing, proportion, and ultimate responsibility for energy costs. Further, different property types traditionally use different methodologies – with industrial or retail properties, the tenant is typically responsible for all utilities, while office properties are typically have terms that reflect local norms.

In many leases, owners have the right to pass-through costs of upgrades to the building, *if that investment will lead to a financial benefit to the tenant.*[23] For example, if a lighting retrofit would cost $2,000, and as a result the tenant would receive energy cost savings of $200 a year, then the owner could approach the tenant and pass the $2,000 through to them, assuming the tenant would be in the space for over 10 years and would "break-even" at a minimum. Of course, both parties would need to agree to this course of action and the specifics of the lighting project, subject to the terms and conditions of the lease. Understandably, many tenants are hesitant to agree to these relatively unplanned costs – effectively a rent increase - as they are trying to manage their total cost of occupancy in the building as part of their business expenses. Likewise, owners may be unwilling or unable to effectively discuss these types of energy efficiency investments with tenants, due to the complexity of the cost allocations, a fear of potentially upsetting or losing the tenant, or simply because the perceived benefits are minimal.

The "split-incentive" market barrier is not new, and has been identified and acted on by a number of organizations, with some limited progress. BOMA released its Green Lease Guide in 2008[24] and has made several updates since

The Distinction between Value and Cost-Savings

The benefits of energy efficiency and sustainability in commercial buildings can take many forms, and an important distinction should be made between cost-savings and value. In the book Value beyond Cost Savings and through numerous other publications, Scott Muldavin, the Rocky Mountain Institute (RMI), and many others have articulated the numerous real estate, business, and corporate enterprise benefits that result from energy efficient, green, or sustainable buildings. These benefits include improved competitiveness, increased asset value, increased worker productivity, reduced risks, improved corporate image and branding, employee attraction and retention – all can directly or indirectly result from improved energy performance, and provide building owners, business enterprises, and tenants with tangible value.

To a large extent, these benefits are not subject to the split-incentive in the same manner as cost-savings, as the owner and tenant each directly benefits from these attributes. For example, an owner will benefit from increased asset value, while a tenant would benefit from increased productivity.

In viewing the larger value considerations beyond basic cost savings, more-compelling business cases and new, opportunities can emerge. As market participants – owners, investors, tenants, and businesses – become aware of and act on the greater value benefits beyond strict cost savings, investments in energy efficiency and sustainability may accelerate, and circumvent many of the market barriers and challenges described herein.

23 This is often referred to as a tenant cost recovery clause.

24 BOMA. (2010). Commercial Lease: Guide to Sustainable and Energy Efficient Leasing for High-Performance Buildings. BOMA website http://store.boma.org/products/commercial-lease-guide-to-sustainable-and-energy-efficent-leasing-for-high-performance-buildings

then. The Green Lease Guide and subsequent publications provide model leasing language and practices for optimizing lease language in a manner that, among other things, aligns owner and tenant interests in energy efficiency and sustainability initiatives. The Natural Resources Defense Council's (NRDC) Center for Market Innovation has also published Energy Efficiency Lease Guidance, and is participating with the City of New York Mayor's Office of Long-Term Planning and Sustainability to disseminate and craft model energy aligned lease language within the New York real estate market. Additionally, a tenant space energy efficiency program managed by the Urban Land Institute (ULI) seeks to deliver a replicable process that integrates energy efficiency into office tenant space design and construction within the tenant improvement cycle window (refer to section 4.2 below for more details on this program).

The Institute of Market Transformation (IMT) has launched several tools, resources, and programs promoting "green leasing" practices, most notably the Green Lease Leaders recognition program.[25] Over the past several years, the Rocky Mountain Institute (RMI), the General Services Administration (GSA), the Northwest Energy Efficiency Alliance (NEEA), the Penn State Consortium for Building Energy Innovation, the California Sustainability Alliance, and numerous other regional and national groups have developed tools and programs targeting leasing and "split-incentive" cost structure barriers in the commercial real estate market.[26] [27] [28] [29] [30]

4.1.5 *Data Availability*

Another major challenge in improving the energy efficiency of separate spaces is segregating the energy consumed by a particular tenant from the whole building's energy consumption. This inability to collect tenant-specific energy data hinders efficiency for two primary reasons:

- As discussed, owners hesitate to invest in energy efficiency improvements of shared systems as only the tenant benefits from reduced utility costs of such endeavors.
- Second, lack of individualized data results in a common-pool resource issue[31] as tenants have no incentive to reduce energy use if they are not held financially accountable for their actions. Changes in their personal energy consumption would be distributed across all tenants.

Metering tenant-specific energy use, a process known as submetering, serves as one potential solution to this data availability problem. Submetering is needed to ensure that each tenant pays for what they use and receives the full benefit of energy they save.

Comments from USGBC are illuminating about the prevalence of tenant space submetering. The 2009 LEED-CI rating system has credit language that rewards the measurement and verification of tenant spaces which includes the installation of submetering equipment to measure and record energy use within tenant spaces. USGBC data show that 54% or 1,900 projects certified under the 2009 LEED-CI rating system have achieved credits dealing with measurement and verification, of which submetering is among several compliance options. This achievement rate demonstrates that submetering is achievable in the tenant space but is not an industry norm.

25 Green Lease Library. (2015). Green Lease Leaders. http://www.greenleaselibrary.com/green-lease-leaders.html

26 Rocky Mountain Institute. (n.d.). Built Environment: Tools and Resources. http://www.rmi.org/tools_and_resources

27 GSA. (n.d.). Green Lease Policies and Procedures. http://www.gsa.gov/portal/category/108551

28 Northwest Energy Efficiency Alliance. (2009). Solving the Energy Efficiency Puzzle: Achieving Bigger Savings in the Pacific Northwest. http://www.nwenergy.org/data/NWEC_Solving-the-EE-Puzzle.pdf

29 Consortium for Building Energy Innovation. (n.d.). http://cbei.psu.edu/

30 California Sustainability Alliance. (n.d.). Green Leases Toolkit. http://sustainca.org/green_leases_toolkit

31 The tragedy of the commons denotes a situation where individuals acting independently and rationally according to each other's self-interest behave contrary to the best interests of the whole group by depleting some common resource.

As a matter of current practice, few buildings and markets in the country measure tenant-level energy use through submetering. Where submetering strategies are employed, meters are most commonly installed for the primary function of lease administration, or the proper billing of tenants for energy use. The vast majority of these installations are typically for the purposes of monitoring spaces characterized by above-average energy use, such as data centers, and separating out this use from total building energy consumption.

Submeters are usually installed as a single entity or as a small group of manually-read meters. Their measurement is typically restricted to electricity use of lighting and plug loads. Energy use from HVAC and other shared systems is not included in these measurements; it is instead billed to the tenant by the owner on a pro rata basis.

Building owners often utilize less sophisticated meters over utility-grade meters. These meters are less expensive and "get the job done" when it comes to simple and consistent measurement of energy use from a single space. These basic meters provide a simple number of kWh used by a separate space over a given period of time. Under this scenario, facilities staff or contractors read the submeter's energy use and apply appropriate multipliers to this number in order to subtract this usage from that of the whole building's demand-charged utility bill.

These same meters can be installed with technical options allowing electricity measurements to tie into systems mimicking utility tariff standards. Such sophisticated options are used for heightened accuracy of tenant energy use billback.

Installing permanent submeters is expensive, with prices often ranging from $700 to almost $5,000 depending on the type and number of meters installed.[32] [33] These costs discourage many owners and tenants from purchasing meters as an energy monitoring tool. While lower-cost wireless meters exist, they currently lack the ability to measure energy use over an extended period of time. Rather, they are most commonly used to temporarily monitor the energy use of a space in order to justify permanent submetering of above-average energy use spaces.

In the absence of nationwide regulation, the presence of submetering is influenced primarily by tenant profile, with large corporate renters, energy-intensive users, sustainability conscious tenants, and tenants vying for LEED-CI certification occasionally requiring submetering during lease negotiations. This disparity can often lead to a varied presence of submetering within markets and buildings, making it difficult to uniformly collect energy use data for individual tenant spaces.

Building owners such as Shorenstein Realty have emphasized the "all or none" problem with billing tenants for energy use.[34] In order to separate out common area usage from tenant usage for billback, owners need to understand the energy consumption of each tenant in the building. Distinguishing common area usage from tenant energy usage can only be accomplished by submetering every tenant in the building. The submetering of just one tenant does not solve this issue as the owner is left with the problem of partitioning the remaining energy use between tenants and common area usage.

32 National Science and Technology Council Committee on Technology. (2011). Submetering of Building Energy and Water Usage. https://www.whitehouse.gov/sites/default/files/microsites/ostp/submetering_of_building_energy_and_water_usage.pdf

33 GSA. (2012). Submetering Business Case: How to calculate cost-effective solutions in the building context. http://www.gsa.gov/portal/mediaId/156791/fileName/Energy_Submetering_Finance_Paper_Knetwork_2012_11_269(508).action

34 Regulations.gov. (2015). Comment response to the published Request for Information (RFI). Shorenstein Realty Services. Regulations.gov website http://www.regulations.gov/#!documentDetail;D=EERE-2015-BT-BLDG-0012-0005

4.2 Technical Opportunities to Improve Energy Efficiency in Tenant Spaces

Despite the variety of challenges to achieving energy efficiency goals in tenant spaces, the technologies exist to significantly improve energy efficiency in these spaces. Case studies and cost benefit analyses of many proven technologies clearly demonstrate the feasibility of improving the energy efficiency in tenant spaces under a variety of different space and use conditions.

Efficient technologies are traditionally considered on an individual basis by which an owner or tenant can choose between simple investment options, such as whether or not to install LED lighting or lighting controls, in order to increase the efficiency of their space. Through this process, the decision maker can draw a straight line from cost of investment to energy savings as only one, or a few, efficiency upgrades are implemented at a time.

It is becoming increasingly important to consider energy efficiency technologies as a package of solutions rather than individual entities during a tenant fit out. This is because high efficiency technologies oftentimes complement the energy reductions of one another (such as HVAC equipment selection and advanced monitoring and controls) and owners often make decisions on more than one type of technology at a time during a fit out. As such, an owner or whole-building tenant may consider their investment holistically during construction.

Choosing between packages of energy efficiency technologies becomes difficult to manage as the number of variables involved increases. In addition, the costs and benefits of technologies can vary significantly depending on the geography, construction, and operations of the building. As a result, owners and tenants sometimes rely on energy modeling and technical consultants to assist with the decision-making process. As such, there is a clear market need for user-friendly, inexpensive tools that allow for decisions to be made without additional burden of technical considerations. Such tools could come in the form of an excel based program, a simple download, or an application that would allow owners and tenants to input specifics about their property (location, size, layout and use), select packages of efficient technologies, and compare results of packages based on financial metrics (incremental cost, payback period, and return on investment).

Several resources which provide broad return on investment (ROI) estimates of recommended energy efficiency packages are available to the public, including the Advanced Energy Retrofit Guide for Office Buildings prepared for the U.S. DOE and case studies produced by the Tenant Energy Analysis and Metrics program. The results of these case studies demonstrate the feasibility of significantly improving the energy efficiency of tenant spaces.

The Advanced Energy Retrofit Guide (AERG) for Office Buildings prepared for the U.S. DOE by PNNL provides several insightful case studies illustrating the implementation of different energy efficiency packages in different locations and the associated financial benefits of the project results.

One AERG case study highlighted the GUND Partnership's 2008 Cambridge, MA office renovation project and attainment of LEED Gold for Commercial Interiors certification (LEED-CI). Specific measures in the selected energy efficiency technology package included: lighting retrofits and the installation of ENERGY STAR® computers, printers, and office equipment. The project's costs totaled $4,400, estimated annual electricity savings were calculated to be $3,000, and the simple payback period was 1.5 years.[35]

An additional AERG case study focused on the 2009 energy efficiency retrofit of the Wilson Blvd. Building in Arlington, VA. Key energy efficiency measures included in the efficiency technology package

35 Thornton, B.A., Wang, W., Lane, M.D., Rosenberg, M.I., and Liu B. (2011). Advanced Energy Retrofit Guides Office Buildings. http://www.pnnl.gov/main/publications/external/technical_reports/pnnl-20761.pdf

included: alternate HVAC rooftop units, upgraded pneumatic HVAC controls and air handler system compressors, the installation of LED downlights, and the promotion of a tenant energy awareness strategy. Project costs totaled $1,140,000, while estimated annual energy savings were calculated to be $250,000, and the simple payback period for the project was 3.9 years.[35]

The Tenant Energy Analysis and Metrics program (referred to as "the program" or "the process") seeks to deliver a replicable process to integrate energy efficiency into office tenant space design and construction within the tenant improvement cycle window.[36] The program, developed in partnership with the NRDC, now resides at and is managed by the Urban Land Institute (ULI). The Tenant Energy Analysis and Metrics approach outlines a 10-step process to guide tenants through the leasing, design, modeling, analysis, execution, and measurement and verification stages of their build-out and occupancy:

- Step 1: select an office space.
- Step 2: select a project team (architects, engineers, and contractors tasked to help with the build-out).
- Step 3: set energy performance goals and create a list of energy efficiency technologies and strategies.
- Step 4: create packages of energy efficiency technologies and model their projected energy performance.
- Step 5: review the incremental costs of the energy efficiency packages and available incentives to specific energy efficiency technologies.
- Step 6: conduct a financial analysis including the calculation of return on investment (ROI) and payback period for each package of energy efficiency measures.
- Step 7: review financial analyses and choose a package of energy efficiency measures.
- Step 8: build out the space with chosen package of energy efficiency measures.
- Step 9: measure and verify the actual energy performance of the space.
- Step 10: share the results on an ongoing basis.

This process is further supported through guidance documents which detail in-depth instructions to complete each of the 10-steps discussed above.

The program documented ten case studies of tenants using the 10-step process to choose between packages of energy efficiency solutions, and the results they observed. These case studies are described in brief below. Energy and cost savings projections detailed in these summaries are based on actual energy performance and delivered savings. Case study participants verified savings numbers by measuring the operational energy use of their space upon completion of the build-out.

Bloomberg LP, a leading provider of global business information, rented space in Manhattan's 120 Park Avenue. Bloomberg partnered with the program for the design and construction of their new office. The company selected the following package of high efficiency measures for their build-out: mechanical duct bridging, high-efficiency lighting, daylight harvesting, and NightWatchman Software (plug load management). Combined, these efficiency measures totaled $3.06/square foot in incremental implementation costs.[37] Over the course of Bloomberg's lease, the project is estimated to reduce electricity use by 10.5% and save more than $173 thousand in electricity costs with a ROI of 140% and a payback period of 2.5 years (Table 3).

36 Information related to the ULI tenant space energy efficiency program and the case study summaries discussed below will be hosted at http://uli.org/.

37 The incremental implementation cost includes deductions from rebates and incentives.

COTY Inc., a global leader in beauty products, designed a tenant space build-out for floors 16 and 17 of their Empire State Building headquarters in Midtown Manhattan. Using the 10-step process, COTY chose the following package of high efficiency technologies for their planned build-out: a LED lighting system, daylight controls, variable air volume (VAV) air handling units, demand control ventilation, elimination of noise traps on air handling units, and plug and process load reduction through the installation of ENERGY STAR® equipment. In total, these efficiency measures amounted to $0.71/square foot in incremental implementation costs.43 Over the course of COTY's 17-year-lease, this project is estimated to reduce electricity use by 30.7% and save more than $716 thousand in electricity costs with a ROI of 328% and a payback period of 2.7 years (Table 3).

Cushman & Wakefield, a global commercial real estate services company, rented space in the newly constructed One World Trade Center in 2015. The company chose to use the program to guide the design and construction of their office. Cushman & Wakefield selected the following efficiency measures for their build-out: LED lighting; daylight harvesting; no humidity control, raising of temperature set points, and allowing independent distribution facility (IDF) room ventilation to cycle off; high-efficiency tenant HVAC and motors; ENERGY STAR® office equipment; server power management; and temperature set points (77° cooling and 70° heating). All in all, incremental implementation costs for these efficiency measures totaled $3.25/square foot.43 Over the course of Cushman & Wakefield's 10-year-lease, this project is estimated to reduce electricity use by 47.5% and save more than $87 thousand43 in electricity costs with a ROI of 359% and a payback period of 1.7 years (Table 3).

The Estee Lauder Companies, a leading manufacturer and marketer of cosmetics, leased 10,000 square feet at 110 East 59th Street in Manhattan. Through their partnership with the program, the company selected a package of energy efficiency measures for their build-out, which included: high efficiency lighting (0.7 and 0.9 Watts/square foot), daylight harvesting, occupancy sensor lighting, ENERGY STAR® equipment, and plug loads shutdown (master shutoff switch). This package of energy efficiency measures totaled $1.29/square foot in incremental implementation costs.43 Over the course of The Estee Lauder Companies' 6-year-lease, this project is estimated to reduce electricity use by 12.1% and save more than $15 thousand in electricity costs with a ROI of 42% and a payback period of 3.7 years (Table 3).

Global Brands Group Holding Ltd. leased 137,000 square feet on Floors 7, 8, and 9 of the Empire State Building in Midtown Manhattan and used the program to guide the design and construction of their new office space. The company selected the following package of energy efficiency measures for their build-out: daylight harvesting lighting controls, high-efficiency lighting, optimized HVAC units, demand-controlled ventilation (CO2 sensors), low-velocity air handler units (AHUs), and plug load management. The project totaled $0.98/square foot in incremental implementation costs.43 Over the course of Global Brands' 15-year-lease, this package of efficiency measures is estimated to reduce electricity use by 11.8% and save more than $438 thousand in electricity costs with a ROI of 126% and a payback period of 4.6 years (Table 3).

LinkedIn Corp, the world's largest online professional network, leased 36,000 square feet on Floor 22 of the Empire State Building in Midtown Manhattan. The company partnered with the program to guide the build-out of their office. LinkedIn chose the following energy efficiency measures to be incorporated into their new space: high-efficiency lighting, advance lighting (daylight harvesting and occupancy sensors), no humidification and increased temperature set points in IDF, optimized air handlers, demand-controlled ventilation, ENERGY STAR® equipment, and occupancy sensor plug strips. The incremental implementation cost for this project totaled $2.63/square foot.43 Over the course of LinkedIn's 10-year-lease, this package of efficiency measures is estimated to reduce electricity use by 31.3% and save more than $153 thousand in electricity costs with a ROI of 23% and a payback period of 6.4 years (Table 3).

The New York State Energy Research and Development Authority (NYSERDA), a state agency that helps New Yorkers increase energy efficiency, leased office space at 1359 Broadway in Manhattan. The agency partnered with the program for their planned build-out. NYSERDA chose the following energy efficiency measures to be included in the design and construction of their new space: high-efficiency lighting, daylight harvesting, ENERGY STAR® equipment, computer shutoff software, energy recovery ventilator, natural ventilation, and a variable refrigerant flow (VRF) system. Project incremental implementation costs totaled $2.43/square foot.43 Over the course of NYSERDA's 14-year-lease, this package of efficiency measures is estimated to reduce electricity use by 39.0% and save more than $188 thousand in electricity costs with a ROI of 179% and a payback period of 3.6 years (Table 3).

Reed Smith, a leading international law firm, moved into their office in Philadelphia's Three Logan Square in 2014. The company utilized the 10-step process and chose the following energy efficiency measures for their new office space: energy efficient lighting design (0.84 Watts/square foot), daylight harvesting controls, bi-level lighting control, dimmable switching controls, ENERGY STAR® equipment, occupancy sensor power strips, manually controlled quad outlets, after-hours outlet control, and high-efficiency motors and variable frequency drives on air handling units (AHUs). Incremental implementation costs for this project totaled $1.31/square foot.43 Over the course of Reed Smith's 16-year-lease, this package of efficiency measures is estimated to reduce electricity use by 44.5% and save more than $1 million in electricity costs with a ROI of 410% and a payback period of 2.2 years (Table 3).

Shutterstock, a global provider of high-quality licensed media, leased approximately 60,000 square feet at the Empire State building in Midtown, Manhattan. The company applied the 10-step process to their office build-out. Shutterstock selected the following energy efficiency measures for their new space: as-designed lighting (0.986 Watts/square foot), daylight harvesting, local occupancy sensors, economization of data center space, demand-controlled ventilation, and a chilled water data center cooling unit. Project incremental implementation costs totaled $2.63/square foot.43 Over the course of Shutterstock's 11-year-lease, this project is estimated to reduce electricity use by 22.9% and save more than $369 thousand in electricity costs with a ROI of 40% and a payback period of 6.1 years (Table 3).

In 2013, TPG Architecture, an architecture and interior design firm, signed a lease for 40,000 square feet of office space in Midtown Manhattan's 31 Penn Plaza. TPG worked with program partners to identify key energy efficiency measures in the design of their office space. The company selected the following energy efficiency package in their tenant space build out: as-designed lighting (1.08 Watts/square foot), daylight harvesting, local lighting occupancy sensors, ENERGY STAR® equipment, demand-controlled ventilation, no humidification in the office data center, computer shut-off software, occupancy sensor plug strips, and high-efficiency lighting (0.8 Watts/square foot). In total, incremental implementation costs for the package were estimated to be $2.01/square foot.43 Over the course of TPG's 11-year-lease, this project is estimated to reduce electricity use by 21.6% and save more than $275 thousand in electricity costs with a ROI of 162% and a payback period of 3.2 years (Table 3).

TABLE 3 – ULI TENANT SPACE ENERGY EFFICIENCY PROGRAM CASE STUDY RESULTS[A]

COMPANY	LOCATION	LEASED AREA	INCREMENTAL IMPLEMENTATION COST ($ / SQ FT)	PHASE*	ENERGY REDUCTION	TOTAL ELECTRICITY SAVINGS OVER LEASE TERM	ROI	PAYBACK PERIOD
Bloomberg LP	120 Park Avenue, Manhattan	20,000 ft²	$3.06 / sq ft	Modeled Savings	10.9%	$182,208	152%	2.4 years
				Verified Savings	10.5%	$173,880	140%	2.5 years
COTY Inc.[B]	350 Fifth Avenue, Manhattan	80,000 ft²	$0.71 / sq ft	Modeled Savings	32.0%	$548,317	227%	3.5 years
				Verified Savings	30.7%	$716,148	328%	2.7 years
Cushman & Wakefield	One World Trade Center, Manhattan	7,500 ft²	$3.25 / sq ft	Modeled Savings	52.6%	$95,663	404%	2.2 years
				Verified Savings	47.5%	$87,862	359%	1.7 years
Estee Lauder Companies[C]	110 E. 59th St., Manhattan	10,000 ft²	$1.29 / sq ft	Modeled Savings	10.8%	$23,069	106%	2.5 years
				Verified Savings	12.1%	$15,862	42%	3.7 years
Global Brands Group	350 Fifth Avenue, Manhattan	137,000 ft²	$0.98 / sq ft	Modeled Savings	25.5%	$546,983	189%	3.7 years
				Verified Savings	11.8%	$438,090	126%	4.6 years
LinkedIn Corp.	350 Fifth Avenue, Manhattan	36,000 ft²	$2.63 / sq ft	Modeled Savings	34.2%	$284,195	129%	3.4 years
				Verified Savings	31.3%	$153,000	23%	6.4 years
NYSERDA	1359 Broadway, Manhattan	15,200 ft²	$2.43 / sq ft	Modeled Savings	34.2%	$180,277	168%	3.8 years
				Verified Savings	39.0%	$188,017	179%	3.6 years
Reed Smith	Three Logan Square, Philadelphia	117,000 ft²	$1.31 / sq ft	Modeled Savings	34.3%	$1,800,986	715%	1.4 years
				Verified Savings	44.5%	$1,126,498	410%	2.2 years
Shutterstock Inc.	350 Fifth Avenue, Manhattan	58,600 ft²	$2.63 / sq ft	Modeled Savings	23.5%	$354,861	34%	6.3 years
				Verified Savings	22.9%	$369,897	40%	6.1 years
TPG Architecture LLP	31 Penn Plaza, Manhattan	40,000 ft²	$2.01 / sq ft	Modeled Savings	20.2%	$188,447	79%	4.7 years
				Verified Savings	21.6%	$275,372	162%	3.2 years

* "Modeled Savings" numbers represent original project savings estimates (step 4 of the 10-step process) while "Verified Savings" numbers represent verified project savings estimates (step 9 of the 10-step process).

A The numbers outlined above are the results of the Tenant Analysis and Metrics program which documented ten case studies of tenants using the 10-step process to choose between packages of energy efficiency solutions.

B Differences in modeled savings and verified savings energy reductions may be attributed to baseline and assumption adjustments and actual energy use documented during the measurement and verification process.

C Differences in modeled electricity savings is usually due to a discovered underestimation or overestimation of energy use in the measurement and verification process.

4.2.1 *Analysis of High Efficiency Technologies*

The technologies, outlined below, and their associated cost benefit analyses clearly demonstrate the feasibility of improving the energy efficiency in tenant spaces under a variety of different space and use conditions. This analysis of high efficiency technologies, discussed in the appendix, provides insight into major energy efficiency opportunities in separate spaces, simple cost-benefit analyses, and links to additional information.[38] This collection of technologies is reflective of the general opportunities and classes of technology that can be used in improving energy efficiency in a separate tenant space, but should not be considered a comprehensive list.

The following technologies are discussed in the appendix:

High Efficiency Lighting 48
Lighting control technologies 48
Daylighting....................49
ENERGY STAR® Certified Appliances and Office Equipment....................50
Plug and Process load (PPL) inventory and reduction strategies 51
High efficiency HVAC units for above-standard operations....................51
Point-of-use domestic water heating 52
Energy management and information systems (EMIS)....................53
Optimization of outside air volumes according to tenant occupancy 54
Data centers and IT server room best practices....................55
Improving Building Envelope Performance 55
HVAC zoning....................57
Window attachments 58
Utility Metering and Submetering....................59

4.3 Market Opportunities to Improve Energy Efficiency in Tenant Spaces

In addition to technology, there are market-based opportunities to increase energy efficiency through processes, programs, and policies oriented to encourage the uptake of energy efficiency in tenant spaces. This section offers a list of high performance energy efficiency market-based opportunities with the intention of illustrating the variety of approaches available. These energy efficiency approaches are broken out into two categories, processes and programs.

4.3.1 *Processes*

This section discusses the market processes that currently influence the level of energy efficiency within a tenant space, explains how a tenant might navigate these processes, and investigates how these processes might be improved to drive additional energy efficiency across the market.

4.3.1.1 *Analyzing Opportunities*

Within the design and construction process, both tenants and owners have a role in determining the efficiency of the tenant space. As discussed, building owners traditionally control the building shell, shared equipment such as HVAC systems, and any global operational controls. By contrast, tenants

38 The High Impact Technology Catalyst: Technology Deployment Strategies paper prepared by Navigant Consulting for the U.S. DOE is one of the primary additional information resources and provides a list of building technologies with large savings potential.

control the installation of efficient equipment (lighting and plug-loads), and more directly manage energy use behavior.

Depending on the size and characteristics of the space, the tenant may choose to use conventional methods and checklist approaches to determine energy efficiency strategy in the build-out of the space, or employ estimates and energy modeling for a more detailed perspective and to maximize return on investment.

Conventional Methods and Checklist Approaches

Under a conventional fit-out process, driven by a tenant, the tenant may work with architects, engineers, and the owner to outfit the space. This team may rely upon guidelines, rules of thumb, or prior experiences in order to select technologies for meeting their pre-determined energy efficiency goals. Choices can be driven at one extreme by the legal codes and standards (minimum applicable requirements), and at the other by certification standards (ratable standards for design and construction such as LEED and Green Globes). Most fit-outs will fall somewhere in the middle, where decisions to incorporate energy efficiency projects above and beyond minimum applicable requirements are made absent of a coherent efficiency plan.

For many owners and tenants in this middle-ground scenario, checklist approaches may be sufficient to determine their energy efficient technology needs. While checklist approaches may not maximize potential energy savings, these methods may provide easy-to-implement guidance applicable to a variety of space types that align with a clearly defined energy efficiency result. This guidance can be incorporated cost-effectively, particularly in the case of smaller projects.

The industry has taken steps towards providing such guidance checklists. However, the current scope of these checklists falls short in accommodating the industry-wide need for a comprehensive set of guidelines that offer specification language customizable to the variety of tenant spaces that exist (such as a large versus small space or a retail versus office space). Additionally, the industry has not widely publicized these materials, leading to a lack of awareness on their existence and proper usage.

The Saving Energy in Leased Spaces (SELS) training and information website, created by the Consortium for Building Energy Innovation,[39] is one example of an existing online toolkit. The SELS website provides three toolkits focusing on saving energy in: existing leases, new leases, and during tenant improvement projects. Each toolkit provides users with: an online course on energy reduction; tools and checklists to track plug loads and calculate estimated energy savings; and a resource library of reference materials.[40] While the SELS website exhibits some best practices, including specification language for several types of tenant space improvements and options for users in different phases of the leasing cycle, it does not provide customization for different purposes (retail versus office) or sizes (small or large) of leased spaces.

The DOE's Technology & System Specifications represents another example of a collection of best practice guidelines. These specifications are designed to guide building owners and tenants through the process of obtaining quotes for energy efficient purchases.[41] While this collection offers a variety of specifications, users are required to determine which specifications apply to their leased space and to further customize chosen specifications to fit their space's attributes.

The Chartered Institution of Building Services Engineers' "Energy Efficient Refurbishment of Retail

39 The Energy Efficient Buildings Hub (EEBHUB) has been rebranded as the Consortium for Building Energy Innovation, however the SELS website still uses EEBHUB branding.

40 Energy Efficient Buildings Hub. (n.d.). Saving Energy in Leased Spaces (SELS) training and information website. http://savingenergyinleasedspace.com/

41 DOE Better Buildings. (n.d.). Technology & Systems Specifications. https://www4.eere.energy.gov/alliance/activities/specifications

Buildings" document provides guidance specific to retail space fit-outs. However, this document does not include specification language.

RMI is currently developing the Commercial Energy+ Initiative, which aims to rapidly increase the scale of building retrofits by providing a platform to provide accessible and inexpensive energy efficiency solutions for commercial buildings with tenant spaces. RMI reports that this initiative will supply a package of efficiency measures and technologies that can be scaled to specific building attributes and directly increase the efficiency of the space.[42]

Estimates and Energy Models

In scenarios where a tenant chooses to go beyond the minimum code requirements, but not pursue a formal guidance checklist, the tenant or service provider can estimate the value of an energy efficiency measure in a tenant space by calculating upfront costs, lifecycle costs, annual savings, and returns on investment. Tenants can also use energy modeling to help determine the energy efficiency opportunities of a space. With modeling, the tenant can compare different energy efficiency measures and decide which options are most appropriate for the individual space.

One example of such modeling programs is the EnergyPlus energy simulation software, DOE's free and open-source, whole building energy modeling engine that allows users to estimate energy consumption from a variety of sources including: plug and process loads, heating, cooling, and lighting.[43] A companion product is OpenStudio, a free and open-source graphical application for model development, parametric analysis and optimization using EnergyPlus. Commercial, proprietary front ends to EnergyPlus offer additional functionality.

While energy models provide the benefit of assessing energy efficiency measures in detail before their implementation, the effort required to use them has historically prevented such tools from wide-spread market uptake. Energy modeling often requires specialized consultants, and some additional time, both of which can strain project budgets. Modeling guidance for tenant space is also lacking – e.g. there may be confusion over whether central HVAC systems need to be modeled, or how to model adjacent tenant spaces. Clear modeling guidelines for tenant space are needed to ensure consistency and avoid confusion.

Organizations are beginning to develop tools to help translate modeling results to be applicable to tenant spaces. As an example, the ULI Tenant Energy Analysis and Metrics program aims to create a process to assist tenants achieve 30 to 50 percent energy savings with a payback period of 3-5 years through a 10-step process that relies on energy modeling.[44] The program's Excel-based Value Analysis Tool that allows for the comparison of energy efficiency measures grouped into "Good," "Better," and "Best" packages in order for the tenant to decide which options are the most appropriate for their goals and budget – an analysis that can also be useful in traditional non-modeling approaches.

Given the current levels of effort required, energy modeling is most beneficial to large spaces where the return on investment from energy efficiency measures covers the additional upfront costs of modeling. In order to make this process financially feasible for small tenant applications, continued investments in both guidance and turnkey wrappers that make modeling and modeling results more accessible are necessary.[45] Specifically, development of a layman's user interface for comparing simple tenant energy efficiency measures could make robust analysis available to a broad set of tenant spaces.

42 DOE. (n.d.). EnergyPlus Energy Simulation Software. http://energyplus.net/

43 2015-09-30 Comment response to the published RFI: High Performance Tenant Optimization Guide. ID #: EERE-2015-BLDG-0012-0011. http://www.regulations.gov/#!documentDetail;D=EERE-2015-BT-BLDG-0012-0011

44 The popularity of the miles per gallon (MPG) comparison tools at FuelEconomy.gov offers a glimpse of potential for such low-cost software.

45 2015-09-30 Comment response to the published RFI: High Performance Tenant Optimization Guide. ID #: EERE-2015-BLDG-0012-0011. http://www.regulations.gov/#!documentDetail;D=EERE-2015-BT-BLDG-0012-0011

4.3.1.2 *Leasing*

Traditional lease language does not typically directly address the energy efficiency of the tenant space. As discussed in section 4.1 above, a conventional lease might allocate utility expenses to tenants proportionally based on leased area and create a split incentive between tenants and owners with regard to energy efficiency measures. As such, neither owners nor tenants may be financially motivated to reduce energy use. However, in recent years the "green lease" has become an option for owners and tenants to re-align energy efficiency incentives through changes to leasing language.

While there are no formal standards for a "green lease", recent initiatives have articulated best practices and provided templates, including the BOMA Green Lease Guide, and the Green Lease library, maintained by the Institute for Market Transformation (IMT). The requirements for the Green Lease Leader recognition program lend a useful set of criteria for defining a green lease, which should contain:

- **A tenant cost recovery clause** that can be used for energy efficiency-related improvements. Tenant cost recovery clauses, which allow the owner to recover the cost of capital on infrastructure investments through a specified amortization schedule, have been included in most commercial leases for the last 10-15 years. That said, these clauses have not typically been used for energy efficiency improvements. When this clause is used for green leasing, owners are incentivized to invest in energy efficiency improvements as they will be able to recoup their costs.[46]
- **Stipulations for best practices in energy management** that can include: installation of submeters for tenants, minimum standards for tenant energy efficiency improvements (such as equipment specifications or available watts per square foot), payment of services to periodically adjust or calibrate equipment to ensure efficiency, and requirements for tenant disclosure of monthly utility data for building benchmarking purposes.53
- **Guidance on sustainable operations and maintenance** that should cover the restriction of individual tenant space heaters, requests for extensions of normal leasing hours such as weekends, and ensuring janitorial services occur during daytime hours.53

As discussed in Section 4.1.1, energy efficiency remains a relatively minor consideration in larger leasing negotiations. However, even in situations where energy efficiency is a priority, several challenges exist to implementing a green lease:

- **Lease diversity.** Tenants in the same building can have leases that look vastly different from one another as their priorities and negotiating power likely differ.
- **Tenant size.** With smaller or less sophisticated tenants, leasing language is often driven by building ownership. In these cases, owners have greater control over leasing language and may not be responsive to a tenant's requests for modification. With large tenants that have greater purchasing power and mandates for green leasing - such as the General Service Administration, Walmart, Target and others - owners may be more willing to incorporate client-specific mandates within leasing language.

46 Green Lease Library. (n.d.). Program Requirements. http://www.greenleaselibrary.com/program-requirements.html

- **Owner size.** Only owners with significant market power can implement aggressive energy efficiency lease clauses. These large owners may have the ability to retain tenant demand for their buildings despite changes in conventional leasing structures, unlike smaller tenants with less market power. As an example, Pyramid Companies (the largest privately owned developer of shopping centers in the Northeast United States), expanded its Carousel Center retail complex to include a 1.3-million-square-foot LEED Gold certified project for Core & Shell Development in the United States. As part of this development, Pyramid modified its standard lease to require that all 100 tenant spaces achieve LEED for LEED-CI certification.[47]
- **Lack of incentive for brokers to advocate for a green lease.** Real estate brokers are motivated by their commission to close deals quickly and often view green leasing stipulations as an added layer of complexity in a deal.

To continue advancing green leases, which in turn will advance high performance spaces, industry organizations can continue to collect and publish best practices, and create case studies to illustrate the benefits and market opportunity for green leasing strategies. However, providing resources is not enough.

First and foremost, brokers need to become actively motivated to implement green leases. Both owners and tenants can accomplish this by directing their brokers to include key green lease features as their default leasing language in leasing negotiations. Brokers will be driven to accommodate these requests in order to close real estate deals.

Additionally, a broker engagement strategy, which would align incentives so that brokers actively facilitate green leases, would also improve the adoption of green leases. A broker engagement strategy might include the following components:

- Developing a coalition of brokers to encourage and educate existing brokers and brokerage firms about green leasing. NAIOP (the Commercial Real Estate Development Association), SIOR (the Society of Industrial and Office Realtors), National Association of Realtors, or other organizations could play a leadership role.
- Working with the coalition of brokers to develop potential updates to the licensure exam, or additional certifications that could be leveraged as a marketing differentiator. This may require a gradual approach since licensing requirements for commercial real estate brokers often differ depending on the state.
- Basing an ongoing green certification for brokers on the completion of a minimum number of green leases per year (meeting the Green Lease Leader criteria).
- Working with Green Lease Leaders and other programs to communicate the benefits of using an efficiency-certified broker.

Similar steps are currently being taken by industry members. As an example, CBRE developed and launched a training platform for its more than 2,900 U.S. brokerage professionals. The platform includes a broker training video and a resource center that helps brokers understand and communicate the sustainable features of commercial properties helping to connect sustainability conscious tenants with high performing space that meets their needs. This training program does not go as far as a certification, but is a large step towards recognizing and responding to current needs.

By engaging brokers, communicating the value of an "efficiency-certified" broker, and requiring on-going completion of green leases to maintain certification, green leases can be more commonly harnessed to drive efficiency.

47 DOE. (n.d.). Pyramid Companies Implements Green Leasing to Promote Energy Efficiency in Tenant Retail Space. Building Technologies Program. http://apps1.eere.energy.gov/buildings/publications/pdfs/alliances/pyramid_case_study_10-15-12.pdf

4.3.2 *Programs*

Improvements in energy efficiency can also be encouraged through programs that target specific market challenges or opportunities unique to tenant spaces, including: expanding the business case for energy efficiency; rating systems; reporting frameworks; leasing language; voluntary initiatives; regulation; and education, awareness, and behavioral change.

4.3.2.1 *Expanding the business case*

One key reason leading to historic under-emphasis on energy efficiency in the design and construction of tenant spaces are the weak financial incentives to each party (brokers, designers, building owners, and tenants, as discussed in section 4.1). As discussed in section 4.1.2, utility costs are typically small in comparison to rent and other costs associated with the transaction, and often fade from prominence during the negotiation of the lease. However, a growing body of research quantifies the financial benefits of increasing energy efficiency of tenants' spaces to owners, tenants, designers, and brokers alike.

Even in lease structures with a split incentive for energy efficiency, building owners can benefit from increased energy efficiency through market differentiation – and attract higher rents and longer tenures. Research shows that energy efficient buildings rent for an average premium of 2-6%,[48] sell for a premium of as much as 16%,[49] attract high-quality tenants,[50] and have lower default rates for commercial mortgages (Figure 3).[51] According to a 2010 study,[52] lease-up rates for green certified spaces can range from average to 20% above average market rates for conventional spaces. A 2012 study examining the San Diego real estate market showed that the overall vacancy rate for green buildings was 4% lower than for non-green properties and LEED-certified buildings routinely commanded the highest rents, and an increased asset value of their buildings.[53] Significantly, more than 62% of buildings nationally over 500,000 square feet were green certified, representing 76% of all area in those buildings.[54] In such a market, not receiving a green certification actually leads to a competitive disadvantage. Additionally, a recent study found that commercial properties with ENERGY STAR® labels were 20% less likely to default on mortgage loans than those without labels;[52] supporting the conception that buildings with energy efficient features are better financial investments.

48 Eichholtz, P., Kok, N., & Yonder, E. (2012). Portfolio greenness and the financial performance of REITs. Journal of International Money and Finance, 31(7), 1911-1929. http://www.fir-pri-awards.org/wp-content/uploads/Article-Eichhiltz-Kok-Yonder.pdf

49 Eichholtz, P., Kok, N., & Yonder, E. (2010). Doing Well by Doing Good? American Economic Review. http://urbanpolicy.berkeley.edu/pdf/AER_Revised_Proof_101910.pdf

50 Eichholtz, P., Kok, N., & Quigley, J. M. (2009). Why do companies rent green? Real property and corporate social responsibility. Real Property and Corporate Social Responsibility. Program on Housing and Urban Policy Working Paper, (W09-004). http://www.ucei.berkeley.edu/PDF/EPE_024.pdf

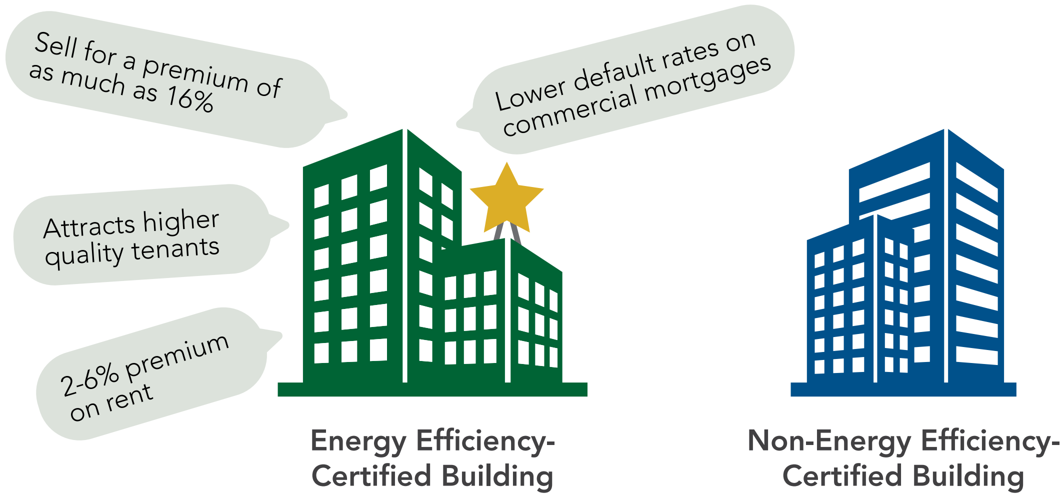
51 An, X. & Pivo, G. (2015). Default Risk of Securitized Commercial Mortgages: Do Sustainability Property Features Matter? http://capla.arizona.edu/sites/default/files/faculty_papers/Default%20Risk%20of%20Securitized%20Commercial%20Mortgages%20and%20Sustainability%20Features%2C%202015.pdf

52 Miller, N. (2010). Does Green Still Pay Off? http://www.normmiller.net/wp-content/uploads/2012/08/Does-Green-Still-Pay-Off.docx

53 CBRE Global Research and Consulting (2012). Global Market View - Q2 2012.

54 CBRE. (2015). Green Adoption Index 2015. http://www.cbre.com/~/media/files/corporate%20responsibility/green-building-adoption-index-2015.pdf?la=en

FIGURE 3 – FINANCIAL BENEFITS OF ENERGY EFFICIENCY-CERTIFIED BUILDINGS



Tenants can realize a wide variety of benefits from the implementation of energy efficiency projects in their leased spaces. The most direct benefit of energy efficiency is the decrease in utility costs. However, a number of other benefits can also be attributed to energy efficient spaces such as increased worker productivity,[55] [56] attracting and retaining employees,[57] and increasing brand value. Changing social norms, recognition of these benefits, and increased awareness of the "brand" value of green space can drive demand for high performing tenant spaces.

Engineers, architects, and interior designers can also profit from energy efficient tenant spaces. Each of these design professionals wants to remain competitive within their respective industries. Potential clients such as GSA,[58] TD Banknorth, and Capital One now require energy efficiency within their lease terms and will only work with designers who can fulfill such requests.[59]

Broker incentives for energy efficiency remain one of the most challenging open issues holding back energy efficient separate spaces. One recent initiative has been the Green Lease Leader program, which recognizes brokers for successfully implementing green lease language into new or existing leases. As discussed earlier, the broker plays a key role in matching owners and tenants. Providing a powerful incentive for brokers to preferentially consider energy efficient spaces would significantly encourage owners and tenants to implement energy efficiency measures. If brokers adopt practices, language, and processes centered on the leasing of efficient buildings, it could result in a competitive advantage. However, brokers remain unaware or unmotivated to adopt such practices, because the market has not demanded such service.

---

55 Delmas, M & Pekovic, S. (2012). Environmental standards and labor productivity: Understanding the mechanisms that sustain sustainability. Journal of Organizational Behavior. Pages 34, 230-252. 2012

56 Allen, J., MacNaughton, P., Satish, U., Santanam, S., Vallarino, J., & Spengler, D. (2015). Associations of Cognitive Function Scores with Carbon Dioxide, Ventilation, and Volatile Organic Compound Exposures in Office Workers: A Controlled Exposure Study of Green and Conventional Office Environments. Environmental Health Perspectives. http://ehp.niehs.nih.gov/15-10037/

57 CBRE. (2015). National Green Building Adoption Index, "Houston", CBRE, Page 16.

58 GSA. (n.d.). Green Lease Policies and Procedures. http://www.gsa.gov/portal/category/108551

59 Green Lease Library. (2015). Green Lease Leaders. http://www.greenleaselibrary.com/2015-awardees.html

Efforts to raise awareness of these financial benefits are necessary to increase emphasis on energy efficiency in the design and construction of tenant spaces. Policy makers, owners, and tenants can all participate in these efforts:

- Policy makers can support programs that illustrate and communicate the quantitative link between increased energy efficiency and increased competitiveness to the commercial real estate market can drive change as industry participants become aware of the business benefits of energy efficiency. In a market where high performing tenant spaces are expected, owners would be inclined to implement energy efficiency measures as a way to preserve and increase the value of their investments.
- Owners can advertise the decreased operational costs and increased employee retention, worker productivity, and brand value associated with the energy-efficient aspects of their building to potential tenants.
- Tenants and owners can articulate their demand to brokers for energy efficient buildings and green leasing structures.
- Tenants and owners can implement requirements that push designers to attain certifications and offer services to meet the demand for energy efficient tenant spaces, thus driving energy efficiency through competition.

4.3.2.2 *Rating systems*

By allowing for direct peer-to-peer comparison of buildings based on energy performance, rating systems provide the market with greater insight to evaluate building performance, broadcast the value of energy efficiency measures, and distinguish high-performance buildings from the rest of the market. Simplifying efficiency to an accessible metric gives market participants a "scorecard" to measure higher levels of performance, and often drives activity across the industry as a whole through competitive forces and peer comparison. Whole building rating systems, such as ENERGY STAR® and LEED have histories spanning decades,[60] and have driven energy efficiency demand by providing owners and tenants with broad information about building performance.

However, there are few applicable rating systems in the U.S. that focus on design and operations at the tenant space level. The additional resolution provided by rating systems focused on separate spaces has the potential to provide substantial value if designed in a way that cost-effectively provides the market with unique information about a space.

60 ENERGY STAR®. (n.d.). The value of the ENERGY STAR® certification. http://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/learn-benefits/value-energy-star-certification

Whole Building Rating Systems

Three prominent examples of whole building energy rating systems include:

ENERGY STAR®, a voluntary program managed by the Environmental Protection Agency (EPA) and DOE, has encouraged building operators to benchmark energy use, implement energy management practices, cut operational costs, and earn recognition for performance. The ENERGY STAR® ranking system provides a 1-100 score for buildings that directly coincides with performance compared to peer buildings of a similar type. Since 1999, over 27 thousand buildings and plants representing 3.9 billion square feet[61] throughout the United States have earned the ENERGY STAR® certification. The EPA reports that the ENERGY STAR® building initiative saves more than 9 billion dollars and prevents nearly 135 MMT of greenhouse gas emissions each year.[62]

"Designed To Earn ENERGY STAR®" is the ENERGY STAR® design designation through which Architects can help their clients reduce their carbon footprints and energy costs by designing buildings to earn the ENERGY STAR®. These buildings are designed to perform in the top 25% of similar buildings nationwide, and are recognized for their design (and predicted ENERGY STAR® score), rather than operational performance. Many buildings go on to receive the ENERGY STAR® certification.[63]

The U.S. DOE's Building Energy Asset Score is a more recent national standardized tool for assessing the physical and structural energy efficiency of commercial and multifamily residential buildings. The Asset Score generates a simple energy efficiency rating that enables comparison among buildings, and identifies opportunities to invest in energy efficiency upgrades. Unlike an ENERGY STAR® score, which enables the comparison of buildings based on their energy consumption, the Asset Score reflects the energy efficiency of a building based on its design, construction, and energy systems.

The Leadership in Energy and Environmental Design (LEED) rating systems, voluntary frameworks developed by the U.S. Green Building Council (USGBC), guides building owners and operators through the process of achieving green building design, construction, operations, and maintenance solutions. While both LEED and ENERGY STAR® focus on energy efficiency, LEED also incorporates a broader set of performance categories focusing on non-energy related items. Buildings can earn points by demonstrating their ability to address environmental impacts and human benefits through six categories: sustainable sites, water efficiency, energy & atmosphere, materials & resources, indoor environmental quality, and innovation in design. Within the United States alone, more than 25 thousand projects representing about 3.2 billion square feet of building space are LEED-certified.[64]

These LEED and ENERGY STAR® systems have driven market change by demonstrating value to owners, managers, and leaseholders. However, while these systems provide significant value, they don't attribute responsibility to individual actors within a multi-tenant space, with the exception of LEED for Commercial Interiors (LEED-CI) which is discussed below.[65]

---

61 ENERGY STAR®. (n.d.). Certified Buildings and Plants. https://www.energystar.gov/index.cfm?fuseaction=labeled_buildings.locator

62 ENERGY STAR®. (n.d.). Buildings & Plants: https://www.energystar.gov/buildings?s=mega

63 ENERGY STAR®. (2015). Projects and architects to achieve Designed to Earn the ENERGY STAR®. https://www.energystar.gov/buildings/service-providers/design/step-step-process/apply-designed-earn-energy-star/architects-and-projects

64 USGBC. (2016). Country Market Brief: United States. http://www.usgbc.org/advocacy/country-market-brief

65 LEED has Core and Shell, New Construction, and Existing Building and Maintenance programs, focused on the whole building –the Commercial Interiors program, which does have a tenant component, is discussed in the next section.

Tenant Space Rating Systems

While a tenant space rating system could lead to a significant increase in the energy efficiency of separate spaces, several barriers, discussed in Section 4.1, have hindered emergence of a widely adopted tenant space rating system in the United States:

- Market research hasn't demonstrated strong demand for an additional set of voluntary building rating systems.
- Lack of submetering for energy used in tenant space has prevented measurement of tenant energy use.
- Tenant space rating systems will likely be implemented in buildings that already participate in whole-building rating systems such as LEED or ENERGY STAR®. Therefore, the costs associated with such tenant space rating systems would likely be additive to the costs associated with existing whole-building rating systems.

The most common tenant space rating system in the United States is LEED for Commercial Interiors, a variant of the voluntary LEED system managed by USGBC. However, participation within this LEED rating system and other similar tenant space rating systems in the United States remains small and inconsistent. For example, there are currently 8,000 certified LEED-CI projects representing about 380 thousand square feet of space,[66] these certified spaces equate to less than 0.01% of U.S. commercial real estate floor space.[67] This lack of market uptake and consistency leads to consumer confusion and, as a result, these rating systems have largely not driven significant market change. By contrast, both Australia and Singapore have implemented universal tenant space rating systems that show the potential of a single dominant rating system to propel industry-wide energy efficiency improvements.

LEED for Commercial Interiors

LEED for Commercial Interiors (LEED-CI) addresses the specifics of tenant spaces primarily in office, retail, and institutional buildings. Tenants who lease their space or do not occupy the entire building are eligible. Over 12,000 projects have certified or have declared intent to certify with the LEED-CI.[68]

A primary barrier to LEED-CI is cost, as the program typically involves consultants to guide the project team through the process of certification and documentation. Regardless of the size of the space, all LEED-CI prospects are required to undergo the same process and documentation. This fixed cost is especially challenging for tenants with smaller spaces. Tenants who do use the LEED-CI process tend to be those with a large rental area for which the cost of certification is not prohibitive, or those with corporate guidelines mandating building performance certifications for rental spaces.

LEED-CI is not a universally prevalent scheme in the United States, and thus does not fulfill the full potential of a tenant space-rating scheme to drive energy efficiency. By contrast, the NABERs system in Australia has become prevalent throughout the market, and as a result is used as a common comparison scheme to drive the adoption of energy efficient technologies.

66 USGBC. (2016). Country Market Brief: United States. http://www.usgbc.org/advocacy/country-market-brief

67 EIA. (2003). Commercial Buildings Energy Consumption Survey (CBECS) – 2003 CBECS Survey Data. CBECS website http://www.eia.gov/consumption/commercial/data/2003/

68 Opitz, M. (2008). From Single Commercial Buildings to Portfolios: Streamlining LEED® Documentation for Volume Customers. USGBC. http://aceee.org/files/proceedings/2008/data/papers/4_199.pdf

International Programs: National Australian Built Environment Rating System (Australia and New Zealand)[69]

The National Australian Built Environment Rating System (NABERS) was originally established as in 1998, by the government of the Australian state of New South Wales. At its founding, three building rating systems were developed: whole building, base building (excluding leasable square footage), and tenant spaces. In a critical move, in 2009, the Council of Australian Governments mandated disclosure of energy efficiency of commercial buildings.[70]

In developing its tenancy energy ratings, NABERS has benefited from the fact that, in the Australian states of New South Wales (NSW) and Victoria, the law forbids owners to pass electricity costs through to their tenants. Thus, unlike in the United States, the law has compelled tenant spaces to be individually metered. The typical metering divisions in Australian buildings allocate heating, air conditioning, elevators, and common area HVAC and lighting to the base building meters. The NABERS tenancy rating thus covers the other loads typically on the tenancy distribution board, including lighting within the tenancy, tenant equipment, and supplementary tenant air conditioning.

As a consequence, the NABERs system benefited from two advantages that are not currently available for tenant space ratings in the U.S.

- In Australia, energy data was readily available for tenant spaces.
- The use of the rating system was mandated.

Critical to driving energy efficiency, tenant space ratings are mandated to occur before the point of the real estate transaction. When the owner or manager intends to advertise the space for let, they must engage a NABERS assessor to conduct an assessment, to result in a star rating (1-6) to be used in promotional literature, advertisements, and on the publically posted signage connected to tenant spaces.

Within the NABERS, a rating of 2.5-3 stars is considered market average building performance, 5 stars is considered excellent building performance, and 6 stars is considered to be market-leading building performance. Originally the ratings only went up to five stars, with the sixth star being added four or five years ago after realization that some buildings were achieving five stars and beyond. When NABERS was first being developed, 4 stars was considered "not easily achievable" and 5 stars achievable only through "exceptional design and operation." This held true for some time, as even in 2006, only 5% to 15% of rated buildings achieved 4 stars or higher. However, in more recent years, those ratings have become more prevalent; out of the 1,422 buildings rated using NABERS Energy in 2012/13, the median result was 4 stars with more than 20% achieving 5 stars or higher.[71] A rating is determined by comparing consumption use of the space against spaces of the same type and is valid for one year.

69 Much of the material in this section is drawn from EPA ENERGY STAR® Task Order 306, Technical Direction #1: Memorandum, Case Studies of Government-Sponsored Tenant Energy Performance Programs Based On Measured Energy Data.

70 At present NABERS is administered by an internal government team of 18 full-time staff, drawing on a network of around 600 accredited NABERS assessors who perform the majority of the work required to determine ratings. Most of the funding for the NABERS program (around 80%) comes from fees associated with ratings, including fees for registering a rating with NABERS, as well as accreditation and training fees for assessors. The remaining 20% of funding comes from state and territory representatives that pay a fee to participate in the national steering committee. NABERS is looking to shift to a full cost recovery model, either by increasing fees or streamlining internal costs.

71 The Office of Environmental Heritage. (2014). The Key Principles and Defining Features of NAMBERS Version 1.0. http://www.nabers.gov.au/public/WebPages/DocumentHandler.ashx?docType=3&id=134&attId=0

International Programs: Green Mark for Office Interiors (Singapore)

Singapore's Building and Construction Authority (BCA) launched the voluntary BCA Green Mark Scheme in January 2005. There are several different "schemes," which apply to different space types, including one for office interiors, whose criteria were first developed in May 2009 and revised in November 2012. The criteria for office interiors can be applied to new offices, existing operating offices, as well as existing offices undergoing renovation.

Singapore's regulations require that all new buildings, building additions, or major retrofits to existing buildings of 2000 square meters (21,530 sf) or greater, achieve a sustainability standard equal to Green Mark Certified level. Tenancy ratings for spaces within existing buildings not undergoing build-out or major renovation are voluntary. Certified buildings are required to be re-assessed every three years in order to maintain their Green Mark status.

Unlike a performance based systems, there are specific operational criteria to Singapore's program. As an example, office interiors pursuing Green Mark certification at any level must meet the prerequisite requiring that the office's temperature setting is no lower than 24 degrees Celsius. Those seeking a Gold^{Plus} rating must have an energy efficiency index (EEI) not exceeding 80 kWh/m^2/year (or 7.43 kWh/ft^2/year) and a lighting power budget of 11 W/m2 (or 1.02 W/ft^2) or lower.

Additionally, the plan puts forward new awards to recognize buildings that have adopted green leases and achieved certification for at least 50% of their tenant spaces.

Opportunities for a U.S. Tenant Recognition Systems to Drive Energy Efficiency

As seen above, rating systems can help achieve improved efficiency in the design and construction of tenant spaces. As shown by the examples in the U.S., Singapore, and Australia, data availability and a critical focus on simple comprehensive metrics are key to designing an effective, equitable, and widely accepted rating system.

With wide acceptance, energy ratings could make their way into more transactional decisions in real estate. Such programs could include the incorporation of building energy performance data within commonly used real estate platforms, serving to match tenants seeking energy efficient spaces with owners who have available efficient space. In Australia and Singapore, where these ratings are near universal, tenants and owners each have the ability to weigh energy efficiency in their leasing and purchasing decisions. In these markets it is clear:

- When the rating system is universal, the information can be more easily included as part of the transaction, regardless of broker incentives.
- The on-going need to renew ratings can drive competitive energy efficiency improvements.
- If market demand for the voluntary rating system is high, it can cause owners to install the metering equipment necessary to participate.

A Federal Tenant Space Recognition System

The U.S. is exploring a government recognized recognition system. The Energy Efficiency Improvement Act of 2015 mandates the establishment of a voluntary tenant space recognition system in the United States. Administered by the EPA, developing this program will require access to several new data sets, and will also need to confront the same challenges regarding participation and information barriers.

In establishing this system, EPA will have the option of many approaches, each with their own inherent challenges. Options range from gross metrics focused on outcomes like those used by Australia (EUI), to detailed metrics focused on design and operational inputs like Singapore (lighting level, temperature ranges). This paper and other efforts will further assess the market viability, metrics, and structure of a potential system to best accommodate the U.S. market.

4.3.2.3 *Reporting Frameworks*

Investors, owners, tenants, regulators and other stakeholders are increasingly asking for greater levels of transparency with respect to environmental issues. This demand for disclosure on the sustainability performance of property companies and fund managers is broadly driving energy efficiency across portfolios. An increasing number of investors now incorporate such information directly into their investment strategies.[72] Consequently, comprehensive reporting frameworks provide market benchmarks, compare peers, force respondents to monitor and act on energy performance, and encourage improvement through competitive public rankings.

Examples of these reporting frameworks include the following:

- **The Global Real Estate Sustainability Benchmark (GRESB)** is a benchmark used by institutional investors to assess sustainability performance of real estate at the portfolio level. As of 2014, the benchmark included 637 survey participants representing 56,000 assets covered, and $5.5 trillion in institutional capital.[73] Annual survey results are analyzed and turned into portfolio benchmarks and rankings across a number of environmental, social, and governance dimensions.
- **The Carbon Disclosure Project (CDP)** works with public companies to improve their disclosure of environmental impacts and risks. Similar to the use of GRESB survey results, CDP survey respondents can use this information to market their environmental performance and advertise to investors that they comply with voluntary environmental performance disclosure standards. As of 2014, over 5,000 companies respond to the CDP survey each year.[74]

Other reporting frameworks include those organized by the Urban Land Institute’s Greenprint Program, the National Council for Real Estate Investment Fiduciaries (NCREIF) collection of sustainability data, and the International Council of Shopping Centers (ICSC) scorecard.

72 GRESB. (2015). 2015 GRESB Report. https://www.gresb.com/results2015/introduction

73 GRESB. (2014). 2014 GRESB Report. http://www.corporate-engagement.com/files/file/2014%20GRESB%20Report.pdf

74 CDP. (2014). Climate Change Program. https://www.cdp.net/respond

These frameworks could be modified and leveraged as a mechanism to encourage owners to implement high performance energy efficiency measures in separate spaces. In particular, frameworks could begin to include tenant specific metrics such as:

- Average tenant space rating (when available).
- Ratio of (sub) meters to leases.
- Cost sharing and how the company handles the split incentive.
- Tenant incentives offered during design and construction or occupancy to encourage energy efficiency.

By expanding these frameworks to recognize those investors who have specifically taken action to significantly improving energy efficiency in commercial buildings through the design and construction of separate spaces, these competitive frameworks can serve as a catalyst to the more rapid adoption of high-performance measures.

4.3.2.4 *Voluntary Initiatives and Professional Certifications*

Voluntary initiatives encourage energy efficiency by fostering peer-to-peer competition and by providing tools and resources to further industry improvement and education. A voluntary initiative specifically focused on tenant spaces would be a powerful mechanism toward driving energy efficiency, by providing a single source for tools, resources, and expertise to drive the market. Voluntary initiatives can range from building-specific, to corporate, to local, to national in scale and they can also take the form of professional certifications.

Better Buildings Initiative and Green Lease Leaders

One successful voluntary initiative, albeit one that focuses on both large institutions and whole-building energy performance, is the DOE's Better Buildings Initiative. As of 2015, more than 250 organizations, representing over 3.5 billion square feet, 650 manufacturing plants, and $5.5 billion in financing investments, have committed to improving their energy efficiency by 20% or more over 10 years[75] through their participation in this voluntary initiative. In addition to an energy savings pledge, organizations also commit to: conduct an energy efficiency assessment of their building portfolio, showcase an energy efficiency project with long-lasting results, and publically report on their progress by sharing their successful methods for energy efficiency.

The Better Buildings Initiative has created: a searchable database for understanding trends in building performance, a dictionary of building characteristics and energy use terms, compiled financing solutions for energy efficiency initiatives, and a building energy asset scoring tool, in addition to a variety of other educational resources. The program has also developed partnerships with large commercial organizations such as Wal-Mart, Best Buy, Macy's, and others, fostering a competition of well-known brands in the public spotlight that will drive further interest and participation in these programs.

Under the Better Building Alliance affiliate program, non-profits, efficiency NGOs, and trade organizations that represent sectors covered by the Alliance, including Commercial Real Estate, Hospitality, Retail, Food Service, Grocery, Healthcare, and Higher Education, are eligible to join the alliance as program affiliates. The affiliates then use their membership resources to advance joint initiatives relating to energy efficiency.

The Green Lease Leaders program provides a number of support pieces that are similar to the Better

75 Better Buildings Solutions Center. (n.d.). About the Better Buildings Challenge. DOE. http://betterbuildingssolutioncenter.energy.gov/about-better-buildings-challenge

Buildings Initiative, including a library of resources, webinars, and a method for contacting an expert. Reflecting the fragmented state of the tenant market, the Green Lease Leaders program does not have the proactive outreach and networking component of the Better Buildings Initiative. The average tenant is seeking turn-key resources when they need to negotiate a lease and fit-out a space, and therefore does not necessarily want to commit to long-term membership in an energy efficiency initiative.

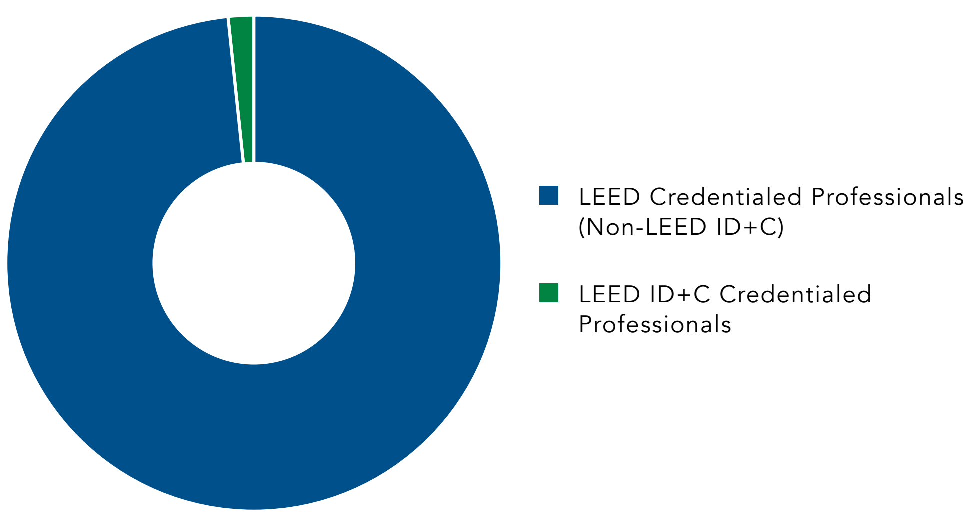
Critically, for many smaller tenants, lease negotiation is an infrequent occurrence, and they only need support at certain discrete points in the business cycle. While the suite of tools and resources produced by the Green Lease Leaders program provides a model to partially replicate for tenant spaces, the on-going support is not necessarily sufficient for the needs of smaller tenants.

Professional Certification Programs

A different tact for creating positive voluntary action is to address personnel, rather than real estate portfolios. While many popular professional certifications exist that relate to energy management, ranging from the certified energy managers (CEM) program to the LEED Accredited Professional (AP), the industry has taken its first steps to extend existing accreditations to explicitly include a curriculum around energy efficient tenant spaces. Ideally, these credentials will begin to improve the ability for designers and other professionals to market their credentials. With such programs, energy-efficiency conscious tenants can begin to choose qualified personnel to assist them in modifying their rental space to fit their needs aesthetically and environmentally.

The USGBC has created such a tenant space certification within their LEED AP Interior Design and Construction (ID+C) specialization. This certification "serves participants in the design, construction and improvement of commercial interiors and tenant spaces that offer a healthy, sustainable and productive work environment."[76] However, LEED ID+C professionals (about 2,500 credential holders) currently represent a small minority, or 1.4%, of LEED credentialed professionals (about 175,000 credential holders) (Figure 4).[77]

FIGURE 4 – LEED ID+C CREDENTIALED PROFESSIONALS AS A PERCENT OF TOTAL LEED CREDENTIALED PROFESSIONALS



76 USGBC. (2016). Distinguish your Expertise. http://www.usgbc.org/credentials#ap

77 USGBC. (2016). County Market Brief: United States. http://www.usgbc.org/advocacy/country-market-brief

Additionally, the Better Buildings Initiative is collaborating with industry practitioners and the National Institute of Building Sciences to maintain voluntary national workforce guidelines that improve the quality and consistency of commercial buildings workforce credentials for energy-related jobs.[78] During 2015, DOE released four Job Task Analyses and Schemes: Energy Manager, Energy Auditor, Building Operator, and Commissioning Professional and announced the corresponding Better Buildings Workforce Guidance (BBWG) recognition program for certification bodies. In late 2015, the Certified Energy Manager certification from the Association of Energy Engineers (AEE) became the first BBWG recognized certification program and others are expected to follow. Building owners and managers can use these guidelines when hiring or procuring services in these four job areas by requesting that individuals hold credentials that are recognized by DOE as aligned with the Better Buildings Workforce Guidelines.

Once these credentials are available, a tenant space focused guideline and certification could be a potential next step in defining and recognizing such skillsets.

While the industry is just beginning to create tenant space professional certification programs, participation and awareness of these programs among energy professionals remains low. As such, there is a market need for the increased support and creation of awareness materials to encourage the further development of, and interest in, such certifications.

4.2.3.5 *Incentives, Policies, and Regulation*

Utility policy, equipment and performance incentives, information disclosure policies, and regulation are additional options to accelerate the adoption of energy efficiency measures in tenant spaces.

Utility Policy and Incentives

The American Council for an Energy-Efficient Economy's State Energy Efficiency Scorecard tracks and evaluates state and local energy efficiency policies, and provides a valuable resource on local utility incentives, as does the DOE's Database of State Incentives for Renewables & Efficiency (DSIRE) program and Energy Incentive Programs listing.[79] [80]

Most states have implemented pre-qualified incentives for existing building energy efficiency initiatives. As an example, under its Existing Facilities Program, the New York State Energy Research and Development Authority (NYSERDA) offers facility owners, management companies, and tenants incentives to help offset the costs of implementing energy efficiency improvements. Applicants can receive up to $30,000 for pre-qualified simple equipment updates including lighting, HVAC, chillers, variable frequency drives, and commercial refrigeration. Larger improvements that save at least 250,000 kWh and/or 2,000 MMBtu per year are eligible for performance-based incentives of up to $500,000.[81]

These types of utility rebates have historically been oriented around pre-qualified (or prescriptive) savings estimates or on engineering studies and modeling estimates to determine the size and nature of the incentive. However, most historical programs have not been designed to tie to measured performance at the meter (kWh reduced below a baseline). Performance based incentives are more complicated to validate, and can be more challenging to implement for applicants who have no guarantee of payment.

78 DOE. (n.d.). Better Buildings. http://energy.gov/eere/better-buildings

79 DOE. (n.d.). Energy Incentive Programs. http://energy.gov/eere/femp/energy-incentive-programs

80 DSIRE. (n.d.). Database of State Incentives for Renewables & Efficiency. http://www.dsireusa.org/

81 Typically, and as a consequence of regulation, utility rebates are awarded for technologies that directly reduce energy usage. As a consequence, rebates are not typically available for submeters. If rebates could be awarded for submeters, this might be a powerful, although expensive, method for increasing the penetration of submeters.

Irrespective of these challenges, the 2015 passage of SB-350 in California "authorize[s] pay for performance programs that link incentives directly to measured energy savings. As part of pay for performance programs authorized by the [State Energy Resources Conservation and Development] commission, customers should be reasonably compensated for developing and implementing an energy efficiency plan, with a portion of their incentive reserved pending post project measurement results." SB 350 later states that "incentive payments shall be based on measured results."

A performance based utility incentive that requires normalized energy consumption to decrease as compared to a baseline could be a technology neutral driver of significant savings. It is notable to mention that this type of incentive can best be captured by tenants if their energy usages are separately metered. Such performance based programs that are explicitly designed for separate spaces and provide concrete energy use data could help to move the market toward greater efficiency. Submetering can be employed to determine accurate energy usage and utility billing of tenant spaces. Clarification of state rules that explicitly allow building owners to submeter tenants would be useful in states where these actions have been in question.

Building Codes and Design Standards

Building codes provide regulated minimum energy efficiency standards at the federal, state, and local level. Most building energy codes are implemented at the local level in the United States.

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) and the International Code Council (ICC) are tasked with the development and administration of the two model commercial building energy codes used in the United States: the ASHRAE 90.1 ("Energy Standard for Buildings Except Low-Rise Residential Buildings") and the International Energy Conservation Code (IECC), respectively. Both codes are updated through a revision process that includes submissions of proposed changes, stakeholder participation, public hearing opportunities, and committee review. New editions of the ASHRAE 90.1 and IECC are published every three years and reflect changes gathered through the revision process. States and local jurisdictions can adopt codes through direct legislative action or through specialized regulatory agencies. Upon approval, the building energy code becomes the law within that state or jurisdiction. Unlike federal laws or regulations, energy codes can be changed relatively frequently, and relatively quickly.

Due to the frequent revisions, energy codes can be an effective way to dictate minimum standards for energy efficiency. In fact, the U.S. DOE estimates the ASHRAE 90.1-2010 standard yields 23% energy savings relative to the 2004 edition.[82] Codes adapted to tenant space needs could yield a similar efficiency effect. Adoption can be accomplished by incorporating tenant space measures into existing codes or creating entirely new codes specific to tenant spaces. Specific measures could include prescriptive policies such as: requiring LED lighting, specifying thermostat settings within given ranges, installing automated lighting control technologies; or, efficiency performance specifications such as requiring specific energy use intensity based on the size and function of a tenant space. Tenant space energy codes could serve to set minimum efficiency requirements and impact every tenant improvement project in the state or locality where it is established.

82 DOE. (2014). Saving Energy and Money with Building Energy Codes in the United States. http://energy.gov/sites/prod/files/2014/05/f15/saving_with_building_energy_codes.pdf

Tax Policies

Federal

Federal tax policies can be used as an effective tool to drive energy efficiency. While requiring an act of congress, they can provide a broad financial incentive for increasing efficiency. Previous actions have generally focused on tax incentives for the purchase of equipment meeting energy efficiency standards. Past examples include the American Recovery and reinvestment Act of 2009, which offered tax credits for homeowners purchasing energy efficient equipment for their properties,[83] and the Energy Policy Act of 2005, which established the 179D tax deduction for energy-efficient equipment in commercial buildings.[84]

Any new policies could consider the following options for tenants:

- Offering tax deductions based on achieved energy use intensity.
- Accelerating the depreciation of systems and equipment installed as part of a tenant fit-out.[85]
- Incentivizing the purchasing of energy efficient equipment.
- Removing sales tax on energy efficient equipment.[86]
- Lowering import duties on energy efficient equipment.[87]
- Reducing real estate tax for spaces that have achieved a targeted energy reduction.

Of these ideas, the most common tax incentives are consumer rebates based on equipment installation. However, more recent federal efforts have focused on providing financial incentives to a small amount of manufacturers rather than a large number of consumers.[88]

While any of these incentives could be targeted toward tenant fit-out, focusing on the performance (achieved EUI) offers the most guaranteed benefit, but also requires metering to demonstrate achieved EUI. Incentives not requiring metering would parallel those that have been previously executed – such as offering direct tax credits for energy efficient equipment, or creating a parallel to the 179D deduction and allowing its use for tenant spaces.

83 DOE. (2012). Success of the Recovery Act. http://www.energy.gov/recovery-act

84 Businesses can take a tax deduction for new or renovated buildings by reducing the energy costs associated with three components—lighting system; building envelope; and heating, cooling and water heating equipment. Buildings must meet the ASHRAE 90.1-2001 standard and be placed in service between January 1, 2006 and December 31, 2013 in order to be eligible.

85 Example: The Tax Relief, Unemployment Insurance Reauthorization and Job Creation Act of 2010 provides businesses with 100 percent bonus depreciation for certain capital investments placed in service between September 8, 2010 and December 31, 2011. As an example, outdoor energy efficient LED lighting qualifies for a 100% deduction under the new bonus depreciation rules. http://www.boston.com/business/personalfinance/managingyourmoney/archives/2011/03/tax_opportuniti.html

86 Example: Tax free weekends on ENERGY STAR® equipment are currently offered by Alabama, Florida, Georgia, Louisiana, Maryland, Missouri, Texas and Virginia. http://www.houselogic.com/blog/taxes-incentives/state-sales-tax-holidays/

87 Example: In 2006 the Thai government introduced tax incentives for energy efficiency projects. The tax incentives include: Exemption of the import duties for energy efficiency / renewable energy equipment, exemption of corporate income tax for 8 years for energy efficiency equipment and renewable energy manufacturers and ESCO companies, reduction of the corporate income tax for companies that improve their energy efficiency or develop renewable energy projects. http://iepd.iipnetwork.org/policy/tax-incentives

88 Doris, E., Cochran, J. & Vorum, M. (2009). Energy Efficiency Policy in the United States: Overview of Trends at Different Levels of Government. National Renewable Energy Laboratory Technical Report. http://www.nrel.gov/docs/fy10osti/46532.pdf

Additionally, good tax policy design would ensure that even entities without tax liabilities can still benefit from the tax incentive for an efficiency fit-out. For example if a Real Estate Investment Trust (REIT) that does not receive tax burden, is eligible for an efficiency fit-out tax incentive, they should be allowed to assign (or trade) it to an entity with tax liability (such as the tenant or the engineering firm doing the work).

State and Local

Many states also provide financial incentives to support energy efficiency. [91] [89] One example is found in Oregon, which has offered a Business Energy Tax Credit (BETC) since 1979, which includes a tax credit of 35% towards the purchase of conservation technologies, and includes a Pass-through Option, which allows entities that do not pay a sufficient amount in taxes to receive a lump-sum payment. The options for designing the tax incentive are similar at the state, local, and federal level – however the path to enacting the tax incentive varies by jurisdiction.

4.3.2.6 *Education, Awareness, and Behavioral Change*

The overarching goal of each of the initiatives discussed above, from financial incentives, to rating systems, reporting frameworks, leasing language, voluntary initiatives, and regulation is to drive behavioral change and give people opportunities and incentives to select more energy efficient choices. One additional opportunity is to explicitly educate occupants in order to change the way they interact with the building. Recent scientific studies have drawn a clear link between energy savings education and awareness and behavioral change resulting in reduced energy consumption. For example, a 2013 meta-analysis of 156 energy conservation field studies found that behavioral strategies yielded an average of a 7.4% improvement in energy conservation.[90] [91] Energy conservation behavioral strategies can include:

- Disclosing information such as a building's current energy demand in the lobby or through other tenant communications.
- Adding educational signs that encourage resource conservation and education, such as "turn off the lights when you leave the room."
- Displaying energy efficiency awards (such as LEED certification and ENERGY STAR® plaques) in building common areas to increase awareness.
- Hosting educational training programs or providing tips and fact sheets that train building occupants on energy conservation strategies.
- Encouraging people toward energy-saving behavior through building aesthetics (making stairwells easy to access, pleasant, etc.).
- Energy conservation competitions and recognition of top performers.

89 The same report has a useful chart of all government incentives (non-research and development) that are targeted toward energy efficiency.

90 Although, the same study noted that conservation decreased with relative study rigor.

91 Delmas, M., Fischlein, M. & Asensio, O. (2013). Information Strategies and Energy Conservation Behavior: A Meta-Analysis of Experimental Studies from 1975 to 2012. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2273850

While most of these initiatives are directly applicable to tenant spaces, there are tools that could be better leveraged to maximize their impact. One option is to maximize the availability of these educational resources through:

- Advertising at public forums that reach general audiences, such as construction trade association meetings, local business associations, chambers of commerce and other events.
- Creating websites with educational toolkits catered specifically to tenants and building owners of separate spaces. ENERGY STAR® "Bring Your Green to Work" is a good example of a current toolkit,[92] as is the Better Buildings Implementation Model for Shorenstein Realty LLC.[93]

One further option is to include such measures as part of the fit-out phase, by incorporating specific requirements (such as educational signs or displays of building energy use). One example might be to install "please shut off the light stickers" next to each switch. Some rating systems, such as LEED, already allocate points within their recognition systems for the inclusion of this type of awareness building.

Stanford University's Precourt Energy Efficiency Center provides several resources on driving energy efficiency through behavioral science. These include a series of foundational readings,[94] as well as a series of tools, such as resources for program design and evaluation, and key behavior and energy questions as identified by sector leaders.

92 ENERGY STAR®. (n.d.). Bring Your Green to Work with ENERGY STAR®. https://www.energystar.gov/buildings/about-us/how-can-we-help-you/communicate/energy-star-communications-toolkit/bring-your-green-work

93 Better Buildings Solutions Center. (n.d.) Implementation Model: "Flip the Switch" Tenant Engagement Program. http://betterbuildingssolutioncenter.energy.gov/implementation-models/%E2%80%9Cflip-switch%E2%80%9D-tenant-engagement-program

94 Precourt Energy Efficiency Center, (n.d.). Stanford University. Foundational Readings. http://peec.stanford.edu/behavior/foundational_readings.php

4.4 Measurement & Verification

4.4.1 *Current Application of Feasibility of M&V in Tenant Spaces*

Measurement and Verification (M&V) is the process for quantifying savings delivered by energy efficiency measures. M&V programs are utilized for a variety of reasons:

- **Tenants and Owners** may have a need to validate a return on their investments. As an example, some tenants and owners invest in efficiency only when they can recover their investment from their reduction in utility costs. In other cases, M&V may be required to demonstrate a return to a rebate issuing third party.
- **Vendors** can use M&V to validate their energy efficiency offerings, and demonstrate the value of their product.
- **Utilities** may require M&V to meet regulatory requirements, to demonstrate savings, or to validate energy rebates.

An M&V platform typically consists of systems to gather, analyze, and manage data. In typical scenarios, an M&V platform can be used to (a) measure actual energy use derived from base consumption and compare it to consumption under energy efficiency measures, and (b) determine whether the implemented measures generate the savings intended in the initial design and construction of the separate spaces.

As M&V platforms differ, decisions can be made as to whether the system will include the whole building or a specific space, incorporate data in real time or at regular intervals, and include shared systems or just local loads. In most cases, data and collection is technically feasible; the main consideration is cost relative to potential return.[95] At the data collection level, there are a number of factors affecting cost:

- While most buildings will have total ("whole-building") utility usage data from a master meter, not all buildings have submeters to isolate separate spaces within a building, nor will all buildings have "smart" meters to support real-time analysis.
- Some M&V projects will require current transformers to apportion energy from shared systems such as cooling towers or shared HVAC.
- In some cases, building management systems can automatically collect energy consumption data via smart meters, data loggers, and network controllers.
- To minimize costs, an M&V system should be designed to work in conjunction with the design of the tenant space, as well as the central systems.

95 In a small space, while feasible, the potential energy savings may not justify significant additional data collection costs. By contrast, in a larger space, M&V can be more easily absorbed in the energy savings.

A major step toward reducing the costs of M&V are the class of technologies considered collectively as, Measurement & Verification (M&V) 2.0. A M&V 2.0 system builds upon energy information technology advancements, such as measurement software, embedded equipment sensors, advanced metering infrastructure and data analytics to calculate energy savings accurately and quickly. Where submetering is in place at the level of a tenant space, these tools can provide a rapid and cost-effective way to track results from energy-saving activities and provide warnings when energy performance begins to degrade.

There are a wide variety of software tools that can be used to construct an M&V program, and which integrate this new technology to varying degrees. These tools track energy usage at greater temporal (daily, hourly, or minute-by-minute) and spatial (space or equipment specific) resolution to match the sub- and smart metering of the building. Based on this data, sophisticated models can be developed to predict and avoid inefficient energy usage.

In addition to tools, guides such as the International Performance Measurement and Verification Protocol, compile best practice techniques for the measurement and verification of energy use data. These resources allow practitioners to use tools consistently and allow for relevant comparisons of energy efficiency data.

The best of the M&V 2.0 tool sets can help eliminate the "night-time walkthrough" or the need to survey the space outside of operating hours to identify equipment that is operating unnecessarily. Instead, the sensors and system can help identify the issues in real time, improve efficiency, and drive down operational costs.

4.4.2 *M&V Gaps & Needs*

Within the M&V 2.0 ecosystem, hardware such as sensors and submeters, analytic software, and the technician time to provide analyses of performance can be expensive.

- While costs are dropping, the most prevalent submetering technologies remain expensive and can be limited in their data collection.
  - A submeter is able to track energy use from plug loads (such as appliances, computers, printers, etc.) but cannot monitor individual use of shared systems such as HVAC units.
  - The installation of submeters and sensors can be complex. If tenants move or reconfigure office space, then submetering systems must be reconfigured accordingly.
- While modern analytic software often simplifies trend analysis, a specialist (consultant) is often required to recommend a course of action.

One major step toward further use of M&V 2.0 is the emerging technology of "smart" devices that can report their own real-time performance to an energy management and information system (EMIS). These devices have the opportunity to transform the M&V process, and are being supported by major industry vendors. Lower costs, easier installation, and high configurability are the keys to future adoption.

5. Acknowledgements

This report was prepared by JDM Associates with contributions from Deborah Cloutier, Jack Davis, Hannah Tillmann, and Kirk Vizzier, under the oversight of Cody Taylor and Jason Hartke at the U.S. Department of Energy. The authors of this report would like to express their gratitude to all report reviewers, especially Michael Zatz and Cindy Jacobs from the U.S. Environmental Protection Agency. We would also like to thank all individuals and organizations who submitted comments to the Department of Energy's public request for information. And, finally we would like to thank the Urban Land Institute and the Natural Resources Defense Council for sharing and discussing their tenant space energy efficiency materials.

6. Appendix

6.1 Energy Efficiency Employment Impact Multipliers[96]

The PNNL paper concludes that energy efficiency results in positive economic impacts including overall levels of employment. Greater energy efficiency means households and businesses are able to maintain or increase the levels of service (e.g., comfortable indoor temperatures, illumination, and hot water) from their buildings or equipment while consuming less energy. Over the lifetime of energy efficiency measures, the money saved on energy becomes available to be spent on other goods and services. Typically, the number of jobs required to produce these other goods and services are greater per dollar of output than the number of jobs needed to produce the same dollars' worth of energy. Based on the results of a number of studies, spending money made available by reducing energy expenditures for these alternative goods and services generates a net gain of about 8 jobs per million dollars of consumer bill savings.

Distinct from the effects of bill savings, the PNNL study concludes that initial investments in energy efficiency generate about 11 jobs per million dollars of investment. These activities include the purchasing and installing of measures for retrofit or for new construction and also jobs in other sectors "induced" by this economic activity. This impact occurs in years when these investments occur. Results using this approach are comparable to typical industry-specific estimates of the job creation from spending targeted at specific sectors.

6.1.1 *Modeled Energy Efficiency Scenarios*

PNNL modeled the 2030 employment impacts of a national initiative to accelerate residential and commercial energy efficiency trends under both 15% and 10% electricity savings cases. In the 15% case, efficiency activities save about 15% of Annual Energy Outlook (AEO) Reference Case commercial and residential electricity consumption by 2030.[97] [98]

The analysis of the 15% case indicates that by 2030 nearly 320,000 new jobs likely would result from energy efficiency. To achieve this level of new jobs in 2030 would require an annual average of more than 60,000 jobs in prior years directly supporting the manufacturing, installation, and maintenance of energy efficiency measures and practices.

These are new energy efficiency jobs resulting initially from the investment associated with the construction of more energy-efficient new buildings or the retrofit of existing buildings, and would be sustained for as long as the investment continues. Based on what is known about the current level

96 This text draws heavily from: Anderson, D. M., Belzer, D. B., Livingston, O. V., & Scott, M. J. (2014). Assessing National Employment Impacts of Investment in Residential and Commercial Sector Energy Efficiency: Review and Example Analysis (No. PNNL-23402). PNNL, Richland, WA (US). http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-23402.pdf

97 Significantly, the PNNL study does not consider the impacts of energy efficiency on all fuels, but focuses on electricity. In 2014, electricity generation consumed 40% of the energy in the United States, while residential and commercial fuel consumption accounted approximately another 12%. As the potential energy efficiency gains in separate spaces would likely also reduce fuel consumption, the PNNL paper likely underestimates the total potential employment gains.

98 The 15% case assumed that the additional energy savings in both the residential and commercial sectors due to the scenario begin in 2015 at zero, then increase in an S-shaped market penetration curve, with the level of savings equaling about 7.0 percent of the AEO 2014 U.S. national residential and commercial electricity consumption saved by 2020, 14.8 percent by 2025 and 15 percent by 2030. The 10% case assumes the additional savings due to the scenario begin at zero in 2015, increase to 3.8 percent in 2020, 9.8 percent by 2025 and, 10 percent of the AEO reference case value by 2030.

of building-sector energy efficiency jobs, this would represent an increase of more than 13% from the current estimated level of over 450,000 such jobs. The more significant and longer-lasting effect comes from redirecting energy bill savings to the purchase of other goods and services in the general economy. This example analysis utilized PNNL's ImSET model, a modeling framework that PNNL has used over the past two decades to assess the economic impacts of DOE's energy efficiency programs in the buildings sector.

The PNNL study focuses principally on the economic effects arising from increased levels of energy efficiency in the buildings (both residential and commercial). As the present discussion focuses solely on commercial real estate (and in fact on the office, retail, and industrial subset of the that sector), we can approximate the impacts from an improvement in commercial building energy efficiency by parsing out the electricity consumption in the residential and commercial sectors – the paper attributes approximately 50% of the electricity usage to the commercial sector. As a consequence, perhaps 160,000 net new jobs could be attributed to a 15% reduction in energy consumption in the commercial sector.

6.1.2 *Further Sources*

The employment analysis presented in this paper is largely in line with other similar studies conducted over the past ten years, including papers presented by the American Council for an Energy Efficient Economy (ACEEE),[99] Cambridge Econometrics,[100] the Economic Policy Institute,[101] as well as many of the dozens of peer-reviewed and white papers reviewed in the PNNL paper excerpted above.[102] Investment in energy efficiency has consistently shown a positive multiplier effect – where investments consistently yield increases in employment.

99 American Council for an Energy-Efficient Economy. (n.d). How Does Energy Efficiency Create Jobs? http://aceee.org/files/pdf/fact-sheet/ee-job-creation.pdf.

100 Cambridge Econometrics. (2015). Assessing the Employment and Social Impact of Energy Efficiency. https://ec.europa.eu/energy/sites/ener/files/documents/CE_EE_Jobs_main%2018Nov2015.pdf.

101 Bivens, JoshJ. (2015). A Comprehensive Analysis of the Employment Impacts of the EPA's Proposed Clean Power Plan. http://www.epi.org/publication/employment-analysis-epa-clean-power-plan/./

102 Anderson, D. M., Belzer, D. B., Livingston, O. V., & Scott, M. J. (2014). Assessing National Employment Impacts of Investment in Residential and Commercial Sector Energy Efficiency: Review and Example Analysis (No. PNNL-23402). PNNL, Richland, WA (US). http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-+-23402.pdf.

6.2 Analysis of High Efficiency Technologies Continued

6.2.1 *High Efficiency Lighting*

Lighting accounts for approximately 30-40% of commercial building energy consumption.[103] Installing high efficiency lighting technologies (e.g., LED, high efficiency linear fluorescent, and compact fluorescent lamps) can reduce tenant space lighting energy consumption by up to 30-60%.[104] For example, LED lamps use at least 75% less energy and last 25 times longer than incandescent lighting,[105] which reduces ongoing maintenance and lamp replacement costs. Additionally, high efficiency T8 linear fluorescent lamps, a standard lighting technology in tenant spaces, use 20-35% less energy than standard efficiency linear fluorescent lamps. Finally, LED technologies incorporated in to the most common commercial lighting fixtures, recessed lighting troffers (representing an estimated 50% of commercial lighting fixtures), can provide energy savings up to 60%.[106]

Cost/Benefit analysis for a typical use or uses

High efficiency lighting technologies can reduce tenant space lighting energy consumption by up to 30-60% with a typical payback ranging from 1-3 years.[107] Costs vary considerably with type of upgrade and project size but the average cost is roughly $5/square foot.[108]

More Information

- Interior Lighting Campaign. US DOE Better Buildings. Link.
- LED lighting. US DOE. Link.
- LED Lighting: The New Low-hanging Fruit in a Lighting (R)evolution. CLEAResult. Link.
- Upgrading Troffer Luminaries to LED. US DOE. Link.
- Certified Products. ENERGY STAR®. Link.

6.2.2 *Lighting control technologies*

A variety of cost-effective lighting control technologies can be employed in tenant spaces to reduce lighting energy consumption including vacancy sensors, bi-level switching, timers, and daylight sensors.

- Vacancy sensors require occupants to manually turn the lighting on and then automatically turn the lighting off when motion is not detected for a period of time.
- Bi-level switching enables the control of a lighting system in groups of fixtures or lamps. For example, bi-level switching allows you to turn off half of the lights in a room off when full illumination is not required.

103 Regulations.gov. (2015). This is a Comment on the Energy Efficiency and Renewable Energy Office (EERE) Notice: 2015-07-31 Request for Information (RFI) for High-Performance Energy Efficiency Measures in Separate Spaces. http://www.regulations.gov/#!documentDetail;D=EERE-2015-BT-BLDG-0012-0010.

104 Nelson, DavidD. (2014). Energy Efficient Lighting. Whole Building Design Guide. https://www.wbdg.org/resources/efficientlighting.php.

105 DOE. LED Lighting. DOE Energy Saver. http://energy.gov/energysaver/led-lighting

106 Navigant Consulting for DOE. (2015). High Impact Technology Catalyst: Technology Deployment Strategies. http://energy.gov/sites/prod/files/2015/09/f26/CBI%20HIT%20Deployment%20Strategy.pdf.

107 Nelson, DavidD. (2014). Energy Efficient Lighting. Whole Building Design Guide. https://www.wbdg.org/resources/efficientlighting.php.

108 Benson et al. (2011). Retrofitting Commercial Real Estate: Current Trends and Challenges in Increasing Building Energy Efficiency. http://www.environment.ucla.edu/media/files/Retrofitting-Commercial-Real-Estate-30-mlg.pdf.

- Timers turn lights on or off at pre-determined periods of the day to ensure lighting is activated only when needed.
- Daylight sensors dim lighting when sufficient daylight is available, saving energy and money.[109]

Proper commissioning of such technologies is needed to ensure that sensors and controls are performing as intended.

Cost/Benefit analysis for a typical use or uses

Lighting controls can reduce tenant space lighting energy consumption by 24-38% with a typical payback of less than 3 years.[110] [111] Costs vary considerably with type of strategy and project size but average costs of roughly $2/square foot have been achieved in the industry.[112] Bundling lighting controls with lamp upgrades can maximize the savings opportunity by lowering purchase costs, as it is less expensive to install lighting controls and lamp upgrades at the same time compared to separate installations, and creating higher returns on investment.

More Information

- ENERGY STAR® Building Upgrade Manual. ENERGY STAR®. Link.
- Energy Savings Tips for Small Businesses: Offices- Owners and Tenants. ENERGY STAR®. Link.

6.2.3 *Daylighting*

Daylighting is the controlled introduction of natural light into an interior space to reduce lighting energy consumption. An effective daylighting strategy is integrated with conventional lighting design strategies and appropriately illuminates the tenant space without subjecting occupants to glare or major variations in light levels, which can impact comfort and productivity.[113] Various design strategies can be employed to maximize daylighting in a tenant space, including exterior shades or light shelves that redirect sunlight deep into the space,[114] window films that reduce solar heat gain and improve lighting distribution, light-colored reflective ceiling and wall finishes, window shades on the lower portions of the windows, low wall partitions or translucent panels to allow deep daylight penetration, locating private offices on the interior of the floor to maintain open space along the perimeter walls, and installing daylighting controls to turn off or dim interior lighting when natural lighting is sufficient. Additionally, improving daylighting in a tenant space can lead to increased employee productivity, improved health, and improved mood and reduced absenteeism.[115]

109 ENERGY STAR®. Energy Savings Tips for Small Businesses: Office – Owners and Tenants. http://www.energystar.gov/sites/default/files/tools/Small_Business_Offices_0.pdf.

110 Williams, Alison;A., Atkinson, Barbara;B., Garbesi, Karina;K., & Rubinstein, FrancisF. (2012). Quantifying National Energy Savings Potential of Lighting Controls in Commercial Buildings. Ernest Orlando Lawrence Berkeley National Laboratory. http://eetd.lbl.gov/sites/all/files/quantifying_national_energy_savings_potential_of_lighting_controls_in_commercial_buildings_lbnl-5895e.pdf

111 Kanellos, MichaelM. (2010). Payback for Lighting Controls: Less than Three Years. GreenTechMedia. http://www.greentechmedia.com/articles/read/payback-for-lighting-controls-less-than-three-years

112 Berkeley Lab Energy Technologies Area (ETA). (2013). Lighting Control Testbeds at the General Services Administration Showing Promise for Lighting Energy Reductions. (2013). http://eetd.lbl.gov/news/article/56664/lighting-control-testbeds-at-th.

113 http://www.gsa.gov/portal/mediaId/211239/fileName/Lighting_and_Daylighting_Two_Pager_508_compliant_2-9-15.action GSA. GSA. (n.d.). Saving Energy through Lighting and Daylighting Strategies. http://www.gsa.gov/portal/mediaId/211239/fileName/Lighting_and_Daylighting_Two_Pager_508_compliant_2-9-15.action

114 http://www.wbdg.org/resources/daylighting.php Ander, Gregg DG. (2014). Whole Building Design Guide. Daylighting. http://www.wbdg.org/resources/daylighting.php

115 https://www.portlandoregon.gov/bps/article/285215 City of Portland Bureau of Planning and Sustainability. (n.d.). Creating a High Performance Workplace. https://www.portlandoregon.gov/bps/article/285215

Cost/Benefit analysis for a typical use or uses

An effective daylighting strategy can reduce tenant space lighting energy consumption by 20-80%[116] and has a cost premium of ≤ $5/square foot.[117]

More Information

- Creating a High Performance Workspace. Portland's Green Tenant Improvement Guide. Link.
- Daylighting. Whole Building Design Guide. Link.
- Saving Energy through Lighting and Daylighting Strategies. GSA. Link.

6.2.4 *ENERGY STAR® Certified Appliances and Office Equipment*

ENERGY STAR® certified appliances and office equipment are highly energy efficient and use 10-40% less energy than standard models. They often include higher quality components that can result in fewer mechanical problems, longer equipment life, and extended warranties. Appliances and office equipment with the ENERGY STAR® certification include refrigerators, freezers, dishwashers, vending machines, coffee makers, computers, external displays, printers, and data center storage units.[118]

Cost/Benefit analysis for a typical use or uses

ENERGY STAR® certified appliances and office equipment use 10-40% less energy than standard efficiency models and although there can be a cost premium in the range of $50 - $200; ENERGY STAR®-certified appliances typically provide a payback period of 1-3 years.[119] [120]

More Information

- Certified Products. ENERGY STAR®. Link.

116 http://news.mit.edu/2007/techtalk51-26.pdf MIT. MIT. (2007). Tech Talk. Daylight device lightens electricity cost. http://news.mit.edu/2007/techtalk51-26.pdf

117 http://energy.gov/sites/prod/files/2014/02/f8/BTO_windows_and_envelope_report_3.pdf DOE. DOE. (2014). Windows and Building Envelope Research and Development: Roadmap for Emerging Technologies. http://energy.gov/sites/prod/files/2014/02/f8/BTO_windows_and_envelope_report_3.pdf

118 https://www.energystar.gov/ia/new_homes/features/Appliances_062906.pdf ENERGY STAR®. ENERGY STAR®. (n.d.). ENERGY STAR® Qualified Appliances. https://www.energystar.gov/ia/new_homes/features/Appliances_062906.pdf

119 ENERGY STAR®. (n.d.). Certified Products. https://www.energystar.gov/products

120 Green Building Advisor. (2010). Are Energy-Efficient Appliances Worth it? http://www.greenbuildingadvisor.com/blogs/dept/green-communities/are-energy-efficient-appliances-worth-it

6.2.5 *Plug and Process load (PPL) inventory and reduction strategies*

"Plug and process loads" (PPLs), or the energy consumed by the equipment connected to electrical outlets, account for 30% of the electricity consumption in office buildings.[121] In a commercial building, PPLs include computers, printers, networking equipment, task lighting, kitchen appliances, etc.[122] Performing a plug load inventory and implementing a load reduction strategy can reduce unnecessary tenant space plug loads by up to 20-50%.[123] Effective strategies for tenant spaces include utilizing wireless devices to control specific receptacles, wiring separate electrical zones to enable occupancy sensor or timer control of the PPLs, and end-user dashboard-based feedback technology and smart sub-metering that prompts end-users to power off equipment.

Cost/Benefit analysis for a typical use or uses

A plug load reduction strategy can reduce unnecessary plug load energy use by up to 20-50%.[124] In a National Renewable Energy Laboratory (NREL) study, a $20 electrical outlet timer was installed on an ENERGY STAR® ice maker and saved $150 per year.[125]

More Information

- Assessing and Reducing Plug and Process Loads in Office Buildings. NREL. Link.
- Plug Load Reduction Checklist. GSA. Link.
- Decision Guides for Plug and Process Load Controls. DOE. Link.

High efficiency HVAC units for above-standard operations

Installing high efficiency, ENERGY STAR® certified, supplemental HVAC equipment for tenant spaces with above standard operating hours or heating and cooling needs (e.g., data centers, server rooms, call centers, etc.) can reduce HVAC energy consumption by 5-20%[126] when compared to standard efficiency units. Specifying ENERGY STAR® certified HVAC units with variable speed compressors, fans, and pumps that are appropriately sized for the heating and cooling loads of the space can lead to significant energy saving over less efficient equipment. Where feasible, water-cooled HVAC equipment should be specified that can be tied into the base building condenser water loop. Water-cooled HVAC equipment is typically 10-20% more efficient than air-cooled equipment. Additionally, energy consumption associated with the supplemental HVAC equipment should be submetered.[127]

121 http://www.gsa.gov/portal/mediaId/178935/fileName/PlugLoad_Checklist_Form_Fields_508 GSA. GSA. (n.d). Plug Load Reduction Checklist. http://www.gsa.gov/portal/mediaId/178935/fileName/PlugLoad_Checklist_Form_Fields_508

122 https://www4.eere.energy.gov/alliance/activities/technology-solutions-teams/plug-process-loads Better Buildings, DOE. Better Buildings, DOE. (n.d.). Plug & Process Loads. https://www4.eere.energy.gov/alliance/activities/technology-solutions-teams/plug-process-loads

123 http://www.regulations.gov/#!documentDetail;D=EERE-2015-BT-BLDG-0012-0010 Regulations.gov. Regulations.gov. (2015). 2015-09-30 Comment response to the published Request for Information (RFI). NEMA Comments - DOE RFI on Energy Efficiency in Separate Spaces. http://www.regulations.gov/#!documentDetail;D=EERE-2015-BT-BLDG-0012-0010

124 http://www.regulations.gov/#!documentDetail;D=EERE-2015-BT-BLDG-0012-0010 Regulations.gov. Regulations.gov. (2015). 2015-09-30 Comment response to the published Request for Information (RFI). NEMA Comments - DOE RFI on Energy Efficiency in Separate Spaces. http://www.regulations.gov/#!documentDetail;D=EERE-2015-BT-BLDG-0012-0010

125 Sheppy; Michael,M., Lobato, Chad;C., Pless, Shanti;S., Polese, Luigi;L., & Torcellini, Paul.P. (2013). NREL. Assessing and Reducing Plug and Process Loads in Office Buildings. (2013). http://www.nrel.gov/docs/fy13osti/54175.pdf.

126 https://www.energystar.gov/products/certified-products?s=mega ENERGY STAR®. (n.d.). Certified Products. https://www.energystar.gov/products/certified-products?s=mega

127 https://www.energystar.gov/sites/default/files/buildings/tools/EPA_BUM_Full.pdf ENERGY STAR®. (2008). Building Upgrade Manual. https://www.energystar.gov/sites/default/files/buildings/tools/EPA_BUM_Full.pdf

Cost/Benefit analysis for a typical use or uses

High efficiency, ENERGY STAR® certified, supplemental HVAC equipment is 5-20% more efficient than standard efficiency units and on average have a cost premium of $100 – 180 per ton compared to standard efficiency models.[128] [129]

More Information

- ENERGY STAR® Building Upgrade Manual. ENERGY STAR®. Link.
- Certified Products. ENERGY STAR®. Link.

6.2.6 *Point-of-use domestic water heating*

Electric point-of-use (i.e., tankless) water heaters are typically the most cost-effective domestic water heating technology installed in tenant spaces and can reduce domestic hot water energy consumption by 27-50%. Unlike storage tank water heaters, point-of-use water heaters are installed at each hot water outlet and do not require water distribution piping. They save energy by providing hot water on-demand.[130] Properly maintaining the temperature at the DOE recommended setpoint (120°F) will ensure energy efficiency and safety.[131] [132]

Cost/Benefit analysis for a typical use or uses

Point-of-use water heaters cost on average $200 and can reduce domestic hot water energy consumption by 27-50%, when compared to storage tank water heaters.[133] [134]

More Information

- Tankless of Demand-Type Water Heaters. US DOE. Link.
- Point of Use (POU) Water Heaters. ENERGY STAR®. Link.

128 ENERGY STAR®. (n.d.). Certified Products. https://www.energystar.gov/products/certified-products?s=mega

129 EPA. (n.d.). State and Local Climate and Energy Program. Rules of Thumb. http://www3.epa.gov/statelocalclimate/documents/pdf/table_rules_of_thumb.pdf.

130 http://energy.gov/energysaver/tankless-or-demand-type-water-heaters DOE. DOE. (n.d.). Tankless or Demand-Type Water Heaters. http://energy.gov/energysaver/tankless-or-demand-type-water-heaters

131 https://www.energystar.gov/sites/default/files/buildings/tools/DataTrends_Savings_20121002.pdf http://www.energystar.gov/ia/partners/prod_development/new_specs/downloads/water_heaters/ElectricTanklessCompetitiveAssessment.pdf ENERGY STAR® Portfolio Manager®. (2011). Benchmarking and Energy Savings. https://www.energystar.gov/sites/default/files/buildings/tools/DataTrends_Savings_20121002.pdf

132 R. Milward, R. (2005). EPRI Retail Technology Application Centers. Electric Tankless Water Heating: Competitive Assessment. http://www.energystar.gov/ia/partners/prod_development/new_specs/downloads/water_heaters/ElectricTanklessCompetitiveAssessment.pdf

133 DOE. (n.d.).Estimating Costs and Efficiency of Storage, Demand, and Heat Pump Water Heaters. http://energy.gov/energysaver/estimating-costs-and-efficiency-storage-demand-and-heat-pump-water-heaters.

134 DOE. (n.d.). Tankless or Demand-Type Water Heaters. http://energy.gov/energysaver/tankless-or-demand-type-water-heaters

6.2.7 *Energy management and information systems (EMIS)*

Energy Management and Information Systems (EMIS) comprise a broad family of tools and services to manage commercial building energy use. While EMIS technologies are typically implemented at the building-level, they can be applied to individual tenant spaces to improve energy performance. These technologies include energy information systems (EIS), equipment-specific fault detection and diagnostic systems, benchmarking and utility tracking tools, and building automation systems (BAS).[135] A BAS is a computer-based control system that controls and monitors building mechanical and electrical equipment, including heating and cooling, ventilation, lighting, fire control systems, and security systems. Integrating tenant space HVAC and lighting controls into a well-programmed central BAS can lead to significant energy savings by automatically controlling tenant space operations using advanced control strategies. Benchmarking and monitoring the utility performance of submetered tenant spaces enables the tracking of savings associated with energy conservation measures and the identification of operational anomalies that can improve energy performance when addressed.

Cost/Benefit analysis for a typical use or uses

Benchmarking or closely monitoring tenant space energy consumption can lead to annual energy savings of 2-3%.[136] Integrating the control of tenant space mechanical and electrical systems into a well-programmed BAS can reduce energy consumption by 10-15%.[137] Proper installation and use of EMIS systems can lead up to 16% energy savings and average $0.30/square foot cost with a 1.1 year payback period for existing buildings and 13% energy savings and average $1.16/square foot with a 4.2 year payback in new construction.[138]

More Information

- Energy Management and Information Systems. DOE Better Buildings Alliance. Link.
- Energy Information Systems (EIS): Technology Costs, Benefit, and Best Practice Uses. Lawrence Berkeley National Laboratory. Link.

135 DOE. (n.d.) EMIS Technology Classification Framework. https://www4.eere.energy.gov/alliance/sites/default/files/uploaded-files/emis-technology-classification-framework.pdf

136 Better Buildings Alliance. (n.d.). Energy Management and Information Systems. https://www4.eere.energy.gov/alliance/activities/technology-solutions-teams/energy-management-information-systems

137 Granderson, Jessica;J., Lin, Guanjing;G., & Hult, ErinE. (2013). EMIS: Crash Course. Better Buildings. http://eis.lbl.gov/pubs/emis-crash-course.pdf

138 Mills, Evan. (2009). Building Commissioning A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions. Report Prepared for: California Energy Commission Public Interest Energy Research (PIER). http://cx.lbl.gov/documents/2009-assessment/lbnl-cx-cost-benefit.pdf

6.2.8 *Optimization of outside air volumes according to tenant occupancy*

Properly ventilated tenant spaces require the HVAC system to deliver adequate amounts of clean, fresh air to building occupants. This fresh air replaces stale air that has become polluted with airborne contaminants from occupant and equipment activities. These airborne pollutants include odors, CO2 (from breathing), equipment emissions (ozone and particulates from copiers and printers), moisture, dirt, dust, mold and various other airborne chemicals.[139] Sensing and control technologies can be employed to deliver fresh air on demand, based on indoor CO2 levels detected by sensors in individual areas within a tenant space. During the design process, the tenant should coordinate with the mechanical designer or building engineering team to ensure that outside air volumes delivered to the tenant space are optimized for the anticipated occupancy. Providing excessive volumes of outside air will increase HVAC system energy consumption, while lower levels of outside air will negatively impact indoor air quality. Additionally, emerging approaches to ventilation systems include scrubbing pollutants directly out of indoor air to reduce the requirement to condition outside air.

Cost/Benefit analysis for a typical use or uses

Optimizing outside air volumes according to tenant occupancy can save $0.05 to over $1.00 per square foot and can range in cost from $300 to $1,000 per HVAC zone.[140] [141] Although it is difficult to apply a specific rule of thumb for savings, studies show that large spaces that have significant variations in occupancy provide the best opportunity to achieve energy savings through optimizing outside air volumes.[142]

More Information

- Creating a High Performance Workspace. Portland's Green Tenant Improvement Guide. Link.

139 https://www.portlandoregon.gov/bps/article/285215 City of Portland Planning and Sustainability. (n.d.). Creating a High Performance Workplace. https://www.portlandoregon.gov/bps/article/285215

140 Oregon Office of Energy. (2003). Northwest Energy Efficiency Alliance. Demand-Controlled Ventilation: A Design Guide. http://www.oregon.gov/energy/cons/bus/dcv/docs/dcvguide.pdf.

141 Sand, James.J. (2004). DOE Federal Energy Management Program. Demand Controlled Ventilation Using CO2 Sensors. (2004). http://infohouse.p2ric.org/ref/43/42844.pdf.

142 Energy Design Resources. (2007). Design Brief: Demand-Controlled Ventilation. https://energydesignresources.com/media/1705/EDR_DesignBriefs_demandcontrolledventilation.pdf?tracked=true.

6.2.9 *Data centers and IT server room best practices*

Data centers and server rooms and are one of the most energy-intensive spaces in commercial buildings, consuming 10 to 50 times the energy per floor area of a typical commercial office building. Collectively, these spaces account for approximately 2% of the total U.S. electricity use, and as use of information technology grows, data center and server energy use is expected to grow too. There are many opportunities to reduce energy use in server closets and data centers,[143] including consolidating servers, decommissioning servers that are not in service, consolidating and organizing stored data to eliminate unnecessary redundancy, installing ENERGY STAR® qualified servers, arranging of server racks and isolating air flows to create hot/cold aisles that prevent the mixing of warm and cool air, adjusting the temperature set points and managing humidity levels, and utilizing air- and water-side economizers when weather conditions permit.[144] Building engineers can play a role in reviewing data center design and providing building-specific recommendations to optimize the performance of the data center.

Cost/Benefit analysis for a typical use or uses

Implementing design and operational strategies to improve energy performance can reduce data centers and server closet energy consumption by up to 80%.[145] A Lawrence Berkeley National Laboratory test on three data centers varying in size, design and energy load showed estimated costs to implement energy efficiency measures from $276,000 - $770,000 with an average payback of approximately 2 years.[146]

More Information

- Top 12 Ways to Decrease the Energy Consumption of your Data Center. ENERGY STAR®. Link.
- Energy Efficiency in Small Server Rooms: Field Surveys and Findings. Lawrence Berkeley National Laboratory. Link.

6.2.10 *Improving Building Envelope Performance*

Improving building envelope performance in tenant spaces is most cost-effective when evaluated during the design phase of new construction projects, as the incremental cost premium for upgrading the building envelope when designing new buildings is significantly lower than when retrofitting existing buildings. Opportunities for improving building envelope performance for new buildings include installing high-efficiency windows and glazing systems, operable windows that provide natural ventilation and increase occupant comfort, exterior shading systems, properly insulating pipes and ducts in perimeter walls, and increasing wall and roof insulation levels. Various strategies can be implemented to improve building envelope performance in existing buildings, which include installing high efficiency window films, interior window shading devices, reducing air infiltration through exterior doors, properly sealing the perimeter walls and openings, and installing a radiant barrier on the

143 http://energy.gov/eere/buildings/data-centers-and-servers DOE. DOE. Data Centers and Services. http://energy.gov/eere/buildings/data-centers-and-servers

144 http://www.energystar.gov/ia/products/power_mgt/downloads/DataCenter-Top12-Brochure-Final.pdf?d63b-c2a9 ENERGY STAR®. ENERGY STAR®. (n.d.). Top 12 Ways to Decrease the Energy Consumption of Your Data Center. http://www.energystar.gov/ia/products/power_mgt/downloads/DataCenter-Top12-Brochure-Final.pdf?d63b-c2a9

145 http://www.energystar.gov/ia/products/power_mgt/ES_Data_Center_Utility_Guide.pdf?ff29-42fa ENERGY STAR®. ENERGY STAR®. (2012). Understanding and Designing Energy-Efficiency Programs for Data Centers. http://www.energystar.gov/ia/products/power_mgt/ES_Data_Center_Utility_Guide.pdf?ff29-42fa

146 Mahdavi, Rod.R. (2014). Prepared for the US DOE's Federal Energy Management Program by the Lawrence Berkeley National Laboratory. Case Study: Opportunities to Improve Energy Efficiency in Three Federal Data Centers. (2014). http://energy.gov/sites/prod/files/2014/06/f16/casestudy_3federaldatacenters_0.pdf.

perimeter walls.[147] For tenant spaces in both new and existing buildings, it is essential to coordinate with the design and building management teams early in the design process to identify opportunities and limitations for improving building envelope performance.[148]

Cost/Benefit analysis for a typical use or uses

Envelope performance can have a wide range of costs and benefits, ranging from the trivial (minor caulking) to transformative (replacement of façade, new windows, comprehensive air sealing). As an example, in multiunit buildings, caulking has been estimated to save 3-12% on energy for conditioning, at a cost of less than $\$0.31/ft^2$.[149] Additionally, a study of non-residential buildings in Canada found that a 40% to 70% decrease in air infiltration resulted in "a 9% to 15% reduction in overall energy expenditure, with a payback period of less than 2 years."[152] By contrast, replacing the panes on a major office tower can yield significant energy savings with a correspondingly high cost. Envelope improvements at this scale are typically completed as part of a repositioning upgrade and need to be individually evaluated.[150] [151]

More Information

- High-Performance Tenant Build-Out: A Primer for Tenants. Institute for Building Efficiency. Link.
- Tenant Energy Performance in Commercial Office Buildings. Real Estate Roundtable. Link.

147 http://www.institutebe.com/InstituteBE/media/Library/Resources/Existing%20Building%20Retrofits/Primer_Tenant_Build_Outs.pdf Institute for Building Efficiency. (2011). High-Performance Tenant Build-Out: A Primer For Tenants. http://www.institutebe.com/InstituteBE/media/Library/Resources/Existing%20Building%20Retrofits/Primer_Tenant_Build_Outs.pdf

148 http://www.josre.org/wp-content/uploads/2013/02/CMI-PPT-on-Tenant-Energy-Performance.pdf NRDC. NRDC. (2013). Tenant Energy Performance in Commercial Office Buildings. NRDC Center for Market Innovation High Performance Tenant Demonstration Project. http://www.josre.org/wp-content/uploads/2013/02/CMI-PPT-on-Tenant-Energy-Performance.pdf

149 Dentz, J., Conlin, F., Podorson, D. (2012). Case Study of Envelope Sealing in Existing Multiunit Structures. NREL. http://www.nrel.gov/docs/fy13osti/54787.pdf

150 Hampson, R. (2010). Empire State Building goes green, one window at a time. USA Today. http://usatoday30.usatoday.com/news/nation/environment/2010-07-12-empire-state-building-windows-green_N.htm

151 Guevarra, L. (2010). A Tall Order: Serious Materials to Retrofit Empire State Building's Windows. GreenBiz. http://www.greenbiz.com/news/2010/03/03/tall-order-serious-materials-retrofit-empire-state-buildings-windows

6.2.11 *HVAC zoning*

Creating separate HVAC zones to align with hours of operation, occupancy, and unique heating and cooling requirements of tenant spaces will improve the comfort of building occupants and reduce HVAC energy consumption. When a tenant space is properly zoned, heating and cooling is provided based on the temperature requirements of each HVAC zone. For example, a conference room with a high occupant density will require more cooling than an infrequently occupied tenant break room. An effective strategy for HVAC zoning in tenant spaces is organizing the interior layout to create zones with similar needs for heating and/or cooling based on function, level of activity, exposure to the sun or wind, schedules and location in the building. Additionally, utilizing variable air volume (VAV) systems and providing separate thermostats for each zone to precisely control the temperature and volume of the air delivered will further reduce HVAC energy consumption in tenant spaces.

Cost/Benefit analysis for a typical use or uses

Increasing the number of HVAC zones in a space can cost an additional $3/square foot to $6/square foot on top of typical mechanical system costs.[152] Retrofitting a constant volume system to a VAV system can cost between $1/square foot and $4/square foot and can achieve a payback of 10 months to 12.1 years depending on available rebates.[153]

More Information

- Creating a High Performance Workspace. Portland's Green Tenant Improvement Guide. Link.
- Los Alamos National Laboratory Sustainable Design Guide. Chapter 5- Lighting, HVAC, and Plumbing. Link.

152 California Energy Commission. (2003). Advanced Variable Air Volume System Design Guide. http://www.energy.ca.gov/2003publications/CEC-500-2003-082/CEC-500-2003-082-A-11.PDF.

153 ENERGY STAR®. (2008). Building Upgrade Manual: Air Distribution Systems. https://www.energystar.gov/ia/.../EPA_BUM_CH8_AirDistSystems.pdf.

6.2.12 *Window attachments*

Window attachments are a cost-effective means of improving the energy efficiency of a tenant space by reducing solar heat gain and improving light distribution.

Window films:

- High-reflectivity films help reduce solar heat gain and cooling costs during the summer.
- Prismatic films redirect sunlight towards the ceiling to provide more natural light in tenant spaces, reducing lighting energy consumption when daylight sensors are utilized to control electric lighting.[154]
- Window films with a low-e coating provide the benefits of year-round energy savings by improving window insulating performance and helping to keep the heat in during the winter and out during the summer.

Awnings, low-cost shades, and roof overhangs provide a physical barrier from strong midday sunlight while allowing soft light in the early or late hours. The exterior nature of awnings and roof overhangs may be difficult for tenants in high-rise structures, but can prove useful for retail tenants with first floor rental space. In addition to conserving energy, window attachments can reduce glare, improve occupant health and productivity, improve access to daylight and views, and improve thermal comfort.[155]

Cost/Benefit analysis for a typical use or uses

Window films can reduce tenant space energy consumption by 5-17% and typically have a cost premium of ≤ $2/square foot, when compared to standard window systems.[156] [157]

Exterior window attachments, such as awnings, can reduce summertime solar heat gain between 65 and 77%.[158]

More Information

- Energy efficient window treatments. US DOE. Link.
- Windows and Building Envelope Research and Development: Roadmap for Emerging Technologies. US DOE. Link.
- Reducing Supplemental Loads. ENERGY STAR®. Link.

154 Thanachareonkit, Anothai;A., Lee, Elanor;E., & McNeil, AndrewA. (2013). Empirical assessment of a prismatic daylight-redirecting window film in a full-scale office testbed. http://eetd.lbl.gov/daylight/daylight-field-test.pdf

155 Regulations.gov. (2015). 2015-09-23 Comment response to the published Request for Information (RFI). EastmanChemicalCompanyCommentEERE2015BTBLDG0012. http://www.regulations.gov/#!documentDetail;D=EERE-2015-BT-BLDG-0012-0008

156 DOE. (2014). Windows and Building Envelope Research and Development: Roadmap for Emerging Technologies. http://energy.gov/sites/prod/files/2014/02/f8/BTO_windows_and_envelope_report_3.pdf

157 International Window Film Association (IWFA). Enegy Analysis for Window Films Applications in New and Existing Homes and Offices. http://www.iwfa.com/Portals/0/PDFDocs/IWFA%20Energy%20Study%20FINAL.pdf

158 DOE. (n.d.). Energy Efficient Window Treatments. http://energy.gov/energysaver/articles/energy-efficient-window-treatments

6.2.13 *Utility Metering and Submetering*

While submetering provides the opportunity for additional energy savings, it does not, in of itself, save energy. Submetering provides tenants and property management teams an additional level of insight into the energy performance of their space or sub-spaces. Data gathered through a well-designed submetering plan can greatly inform and influence the development of energy management strategies and can highlight the specific impact of energy efficiency projects, providing data-driven evidence of program effectiveness. Submeters also provide more accurate billing for energy usage in a specific tenant space when building operating expenses are normally billed pro rata. Submeters can be applied to measure large (entire building floors) or small scale (circuit-level or outlet-level) energy usage within a tenant space.

As discussed in section 4.1.5, building owners tend to favor less sophisticated meters over utility-grade meters. These meters are less expensive and "get the job done" when it comes to simple and consistent measurement of energy use from a single space. These same meters can be installed with technical options allowing electricity measurements to tie into systems mimicking utility tariff standards. Such sophisticated options are used for heightened accuracy of tenant energy use billback.

Installing permanent submeters is expensive. These costs discourage many owners and tenants from purchasing meters as an energy monitoring tool. While lower-cost wireless meters exist, they currently lack the ability to measure energy use over an extended period of time. Rather, they are most commonly used to temporarily monitor the energy use of a space in order to justify permanent submetering of above-average energy use spaces.

Cost/Benefit analysis for a typical use or uses

Submeters can cost between $700 and $5,000 and less robust models are available at a lower cost.[159] [160]

More Information

- Submetering Business Case: How to calculate cost-effectiveness solutions in the building context. GSA. Link.
- Submetering of Building Energy and Water Usage. National Science and Technology Council Committee on Technology. Link.

---

159 National Science and Technology Council Committee on Technology. (2011). Submetering of Building Energy and Water Usage. https://www.whitehouse.gov/sites/default/files/microsites/ostp/submetering_of_building_energy_and_water_usage.pdf

160 GSA. (2012). Submetering Business Case: How to calculate cost-effective solutions in the building context. http://www.gsa.gov/portal/mediaId/156791/fileName/Energy_Submetering_Finance_Paper_Knetwork_2012_11_269(508).action

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy