

# The Economics Of Green Retrofits

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## Abstract

This is the first study focused on the economics of green renovations. With existing building renovation surpassing new construction in recent years we now have sufficient data to perform reasonable national level analysis on the economic impacts of retrofitting existing buildings. Our findings are focused on LEED (Leadership in Energy and Environmental Design) buildings which have become certified within the “EBOM” (Existing Building: Operations and Maintenance) category over the 2005 – 2010 period. We compare rents and occupancy rates and investigate the types of improvements undertaken as well as the types of investments required. We include a survey among building owners on the typical improvements and attitudes towards the benefits and costs of upgrade investments. Our findings show that investments in “green” retrofits are incorporated by the market, which is consistent with past studies that mostly focused on new construction. These findings indicate that such sustainable efforts are economically viable. We expect renovation of the existing stock to continue and even accelerate.

## Introduction

During the past several decades, we have observed average new annual construction within the office market run about 2.1 percent of the existing stock.<sup>1</sup> If all of this new construction were “green” and if no renovation took place it would take several decades to “green up” the stock. By “green” we mean here LEED, and although we could have also included Energy Star- labeled buildings we focus strictly on those with the LEED EBOM (Existing Building: Operations and Maintenance) certification noting that most are also Energy Star- labeled.<sup>2</sup> From casual surveys by the authors it appears that EBOM is an easier target to hit than NC (New Construction) and that the older buildings have an advantage in that points are scored for relative performance so the worse your building is in terms of energy efficiency, the greater your opportunity to hit LEED with an EBOM scorecard.

To date there have been several studies focused on new office construction, mostly because that was where the action was and the United States Green Building Council (USGBC) started with a scorecard for new construction that became widely adopted. EBOM is of more recent vintage and with the dearth of new construction in the post-2007 commercial market period, existing building renovations are now surpassing new construction certification rates. Exhibit I provides some evidence of the growth of LEED-certified space in the marketplace and the role of existing buildings therein. Aside from the completion of the EBOM rating system by the USGBC, buildings that lost major tenants found it an opportune time to renovate and modernize.

The data in this study is from CoStar and includes 374 EBOM- certified properties (at all levels) and nearly 600 control properties for comparison purposes and empirical analysis. We also include a modest survey on the benefits and costs of retrofits. Many of the buildings in our sample were in the process of renovating to become more sustainable at the time the EBOM system was published. We identify the

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<sup>1</sup> Source: The CoStar Group, 2010 study by one of the authors.

<sup>2</sup> If using UK data we would examine BREEAM designated property or CASBEE in Japan and GreenStar in Australia, and we acknowledge that any starting place for “green” is going to be based on some third-party measuring system.

renovation period as generally starting in years 2005 through 2009 with certification received from 2008 through 2011.

The average rents on our now EBOM group were below those of our control group prior to 2006, but have exceeded the average rents of the control group since 2006. Vacancy within the EBOM group was 7 percent higher than the control group in 2005. Since 2005 the EBOM group has gained occupancy relative to the control group but still lags slightly behind, primarily due to the soft real estate market since 2007. When we use regression analysis to control for class, age, location, size and distance to transit we find a 7.1% rental premium for LEED buildings versus non-LEED. When the Energy Star label is included we continue to find a significant premium for both Energy Star and LEED certification. We discuss these results in more detail below.

## **Literature Review**

Prior published literature on the financial implications of “green” certification mostly focuses on new construction within the U.S., and results generally indicate a positive relationship between environmental certification and financial outcomes in the marketplace. One study, based in Australia, by Miller and Buys (2008) examined the benefits of retrofits from the perspective of tenants in a large office property. They found very positive sentiments that green retrofits would continue and were well received by tenants.<sup>3</sup> No study we are aware of has examined the economics from a broadly selected sample.

Eichholtz, Kok and Quigley (2010a) document large and positive effects on market rents and selling prices following environmental certification of office buildings. Relative to a control sample of conventional office buildings, LEED or Energy Star-labeled office buildings’ rents per square foot are about 2 percent higher, effective rents are about 6 percent higher, and premiums to selling prices per square foot are as high as 16 percent. Other studies (Fuerst and McAllister 2011; Miller, Spivey and Florance 2008)

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<sup>3</sup> Miller E. and L. Buys (2008), Retrofitting commercial office buildings for sustainability: tenants’ perspectives.” *Journal of Property Investment and Finance*, 26(6), pp. 552-561.

confirm these findings. Moreover, these results appear robust over the course of the financial crisis, as Eichholtz, Kok and Quigley (2011) document for a recent dataset of 3,000 green buildings that both energy efficiency and “greenness” of buildings are capitalized into rents and sales prices. Moreover, this effect is not dented by the recent downturn in property markets. Other studies mention evidence suggesting positive economic benefits from faster absorption, higher occupancy rates, lower operating expenses, higher residual values as well as greater occupant productivity. See Chau, Tse and Chung, 2010, Pivo, 2010, Fuerst and McAllister, 2009, Miller and Pogue, 2009, Miller, Florance and Spivey, 2008, Miller, Pogue, Saville and Tu, 2010 as examples.

To date, there are no academic studies investigating the market performance of “green” renovations. There are numerous case studies of single buildings which have been retrofit for the owner-occupant but less so in the private rental market. Anecdotal evidence suggests that the move of tenants towards “green” real estate is due to enhanced reputation benefits, corporate social responsibility mandates and employee productivity.<sup>4</sup> Such a shift in tenant preferences suggests that tenants are using the buildings that they occupy to communicate their corporate vision to shareholders and employees. The literature on corporate social responsibility (CSR) has generally investigated this link between corporate social performance, reputation benefits and employer attractiveness (Margolis and Walsh 2003; Turban and Greening 1997). In a recent broader study Pivo and Fisher (2010) suggest higher rents and returns for those engaged in CSR.<sup>5</sup>

Another frequently invoked rationale for occupying green office space is tenant productivity. Miller et al. (2009) document in a survey that over half of occupants of environmentally certified buildings found their employees to be more productive. Interpretation of these results is problematic, though, as these responses cannot be controlled for with management style and individual employee characteristics. However, surveys reporting on tenants in London indicate that there is indeed a shift in corporate

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<sup>4</sup> Nelson, A, and AJ Rakau 2010. Green Buildings: A Niche Becomes Mainstream. Deutsche Bank Research.

<sup>5</sup> Pivo, Gary and Jeff Fisher Income, Value, and Returns in Socially Responsible Office Properties *The Journal of Real Estate Research*; Jul/Sep 2010; 32, 3.

preferences. A 2008 research report documents that 58 percent of tenants find energy efficiency “essential” and 50 percent find green attributes “essential.”<sup>6</sup>

Improving the bottom line through building energy efficiency is often reported as one of the direct economic benefits for real estate investment companies when considering energy efficiency and sustainability in their portfolios. Jones Lang LaSalle (2010) reports that of 115 office properties in its portfolio for which the energy efficiency was improved in 2006, the average realized savings for 2007 and 2008 were \$2.24 million and \$3 million respectively. British Land (2010) reports that across its portfolio, there is a reported 12 percent decrease in energy use, amounting to \$1.12 million in annual savings in energy, and a decrease of 11.1 million kWh of energy used in 2009.

Another stimulus for demand of sustainable space is government regulation and in many markets such as Boston or San Francisco or Washington, D.C., we see increased government pressure both on the regulatory side and from direct government office demand from the government services offices (federal GSA or California GSA) that require Energy Star- labeled space for most new leases.

## **Data**

Using CoStar data, we started with those markets where we observed the greatest number of EBOM-certified office buildings as of first quarter 2011 with the following filters. All buildings were built prior to 1990, were at least 15,000 square feet, were multi-tenant, multiple floors, Class A or B. We found 374 such office buildings in 14 markets, where there were at least a dozen or more observations in any one market. The 14 markets included:

- New York City
- Washington, D.C.
- San Francisco
- Houston
- Los Angeles
- Chicago
- Seattle/Puget Sound

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<sup>6</sup> CBRE 2010. Locational Preferences of Central London Occupiers. CBRE Research.

- Boston
- Orange County
- East Bay/Oakland
- Denver
- Atlanta
- Dallas/Ft. Worth
- Minneapolis/St. Paul

These 374 buildings were managed by 317 property managers to whom surveys were sent to ask about the types of improvements that were made. CoStar data on property details was used to perform the empirical analysis and to select a control sample group. The control group was matched in terms of the above filters but then we also adjusted the selection so that the ages and sizes were as similar as possible. The control sample was just south of 600 properties after the filters, location, and age and size adjustments. Exhibit 2 summarizes the information available on the samples and reports the means and standard deviations for a number of hedonic characteristics of green buildings and control buildings, including their size, quality and number of stories, as well as indexes for building renovation and proximity to public transport. Exhibit 3 provides a map showing the location of the EBOM observations. Compared to earlier studies on the economics of green building, the samples are quite similar. Green buildings are slightly younger and have a higher renovation propensity, but the differences are clearly limited through the data selection procedure. The renovation investments ranged in size from just over \$400,000 to just over \$2 million with the average LEED building being just over one half million square feet.

### **Digging deeper: regression results**

To investigate how EBOM certification influences the rent and occupancy of commercial office buildings, we start with the standard valuation framework for commercial real estate. The sample of rated office buildings and the control sample consisting of nearby nonrated office buildings in the same city are used to estimate a semi-log equation

relating office rents (or effective rents) per square foot to the hedonic characteristics of the buildings (e.g., age, building quality, amenities provided, etc.) and the location of each building:

$$(1) \quad \log R_{in} = \alpha + \beta_i X_i + \sum_{n=1}^N \gamma_n c_n + \delta g_i + \varepsilon_{in}$$

In this formulation,  $R_{in}$  is the contract rent (or effective rent) per square foot commanded by building  $i$  in city  $n$ ;  $X_i$  is the set of hedonic characteristics of building  $i$ , and  $\varepsilon_{in}$  is an error term. To control more precisely for locational effects, we include a set of dummy variables, one for each of the  $N$  cities.  $c_n$  has a value of one if building  $i$  is located in city  $n$  and zero otherwise.  $g_i$  is a dummy variable with a value of one if building  $i$  is rated by USGBC and zero otherwise.  $\alpha$ ,  $\beta_i$ ,  $\gamma_n$  and  $\delta$  are estimated coefficients.  $\delta$  is thus the average premium, in percent, estimated for a labeled building relative to those buildings in its geographic cluster.

Exhibit 4 presents the basic results for the sample, relating the logarithm of rent per square foot in commercial office buildings to a set of hedonic and other characteristics of the buildings. Results are presented for ordinary least squares regression models corrected for heteroskedasticity (Halbert White, 1980). Column (1) reports a basic model relating rent to building quality, measured by class designation, size, age and distance to public transportation. The regression, based upon 956 observations on buildings, explains some 63 percent of log rent, which is comparable to similar studies in this field. Higher quality buildings, as measured by building class, command a substantial premium. Rent in a Class A building is about 12 percent higher than in a Class B building. Rent is not significantly higher in larger buildings, as measured by the logarithm of building size. Distance to public transport, which represents an important element of “sustainability,” is negatively and significantly related to the rent commanded by an office building: For each mile increase to public transport, location rents decrease by about 11 percent. This corroborates evidence from other studies on sustainability in the U.S. property market that measured the impact of “green” aspects on building performance using density tools, like the Google “Walkability” Index. For example, Pivo and Fisher (2011) use an index to calculate distances from commercial facilities to

prominent and important neighborhood amenities. Results indicate that for every 10-point increase in “walkability,” property values increase by about 9 percent, providing the first evidence that sustainability matters beyond the physical attributes of a building.

In column (2), green certification is indicated by a dummy for LEED-rated buildings. Importantly, holding all other hedonic characteristics of the buildings constant, an office building with a LEED EBOM rating rents for a 7 percent premium, on average. Measured attributes of sustainability and energy efficiency are incorporated in property rents, and this seems to have persisted through periods of volatility in the property market. These developments will affect the existing stock of non-certified office buildings.

In column (3), the green rating is disaggregated into two components: an Energy Star label and a LEED registration. The coefficients of the other variables are unaffected when the green rating is disaggregated into these component categories. Importantly, the relationship between LEED and the rental premium remains significant when Energy Star certification is taken into account as well. These results imply that energy efficiency and other indicia of sustainability are complementary. The estimated premium for buildings registered with the EPA is not significantly higher than the premium for LEED-certified office buildings. A recent analysis of the thermal properties of a small sample of LEED-certified buildings indeed concluded that these buildings do consume less energy, on average, than their conventional counterparts. However, 18-30 percent of LEED buildings used more energy than their counterparts. “The measured energy performance of LEED buildings had little correlation with the certification level for the buildings” (Guy R. Newsham, Sandra Mancini and Benjamin Birt, 2009). In our LEED sample, there are 299 buildings (87% of those with LEED certification at any level) with both LEED and Energy Star certification.

Exhibit 5 presents the results when the dependent variable is measured by the logarithm of effective rent. When endogenous rent-setting policies are taken into account (we may expect property owners to adopt differing asking rent strategies, *ceteris paribus*, landlords who charge higher rents will experience higher vacancy rates), the results suggest that the effect of a green rating is even larger. In column (2), the statistical results suggest that a green rating is associated with a 9 percent increase in effective rent. In the



regression reported in column (2), which is exactly similar to results documented by Eichholtz, Kok and Quigley for a large sample of LEED-certified office buildings in 2009. Taken together, the results reported in Tables 2 and 3 suggest that the occupancy rate of green buildings is about 2 percent higher than in otherwise comparable non-green buildings.

Aggregate rental results are shown in Exhibit 6 and average occupancy rates are shown in Exhibit 7 for both the EBOM and control samples. Note that the rents on the renovated property were less than the control sample prior to the renovation. Similarly the occupancy rates prior to the renovations were lower than for the control sample. We use a bright red line to show the period prior to renovation and a green line to indicate approximately when on average the improvements were complete, although improvements continued throughout the time period after 2005. Of significance is the fact that average rents increased faster than for the control group through 2008. While premiums were maintained for the EBOM group, the rents declined after 2008 at about the same rates as for the control sample. We see the occupancy gap narrowed after the improvements but never completely dissipated during the rather soft rental period from 2007 through 2010.

Rental and occupancy results varied by market, and we show these respectively in Exhibits 8 and 9 for the 14 markets studied here. Significant rental premiums are observed in the major markets of Washington, D.C., New York City and Boston. Occupancy rates depend on when the LEED buildings came on line; with many of the LEED buildings coming on line during a soft period, we continue to see lower occupancy rates in a few markets.

## **Survey Results**

We tried to ascertain what percent of the improvements were related to sustainability and which were simply necessary to update obsolete buildings. So, we asked a simple question as shown in Exhibit 10. Here we see that only 13.6% say that all the improvements were related to sustainability and over 18% say that this is impossible to separate. But a significant portion of the improvements were related to

sustainability, and we show the most common improvements in Exhibit 11. Not surprisingly we have what many in the industry refer to as the low hanging fruit on the right side of the exhibit, that is, lighting where paybacks are very fast. Next we see HVAC followed by water flow systems and then recycling containers. Note that recycling containers may have been higher but a large portion of existing buildings certainly had recycling containers prior to renovation, so there was no need to add them. Next we see motion detectors that turn systems like plug loads off and then as we move left we enter the more expensive improvements like roofs and PV solar cells and floors, insulation and operable windows and better glazing. We will expand on these types of improvements and the costs and benefits in the next section of the paper.

Expected paybacks are shown in Exhibit 12. This measure is quite common among the engineers and contractors engaged in building renovations. We note that the most typical answer is fairly quick at less than 5 years. This reflects the concerns about picking the wrong vendor, buying an item like LED lights when prices are declining quickly and the investment in education required when exploring new building features. However, we also note that the payback required is slower than we would have observed back in 2007 when there was even less familiarity with the products and choices and price trends.

Rents, based on the survey results, were compared to the rents prior to the renovation. Here we found that 68% said there was no change, but that was often during a declining rental period so in this case “No change” is not bad. Twenty-four percent said it was impossible to estimate the change in rents with multiple tenants or did not know, and 8% said that rents were up after the renovations. We compared the LEED EBOM buildings to the non-LEED in Exhibit 13 and here we see that many report similar rents, but some report positive premiums, and no one reported lower rents.

Our average empirical results suggest a rental premium of \$2 per square foot a year or more resulting in a value impact of at least \$25 dollars per square foot. We also note energy savings of significance but do not count these as they may accrue to the benefit of the tenant depending on the kind of lease and pass-through terms. This well-known problem is referred to as the split incentive problem, where landlords making investments in energy savings that primarily benefits the tenants who may or may not be

willing to pay as much in additional rent as the suggested energy savings. Still we do see rental premiums for a variety of reasons. Tenants generally refer to air quality, day lighting and temperature controls as very important in surveys, and part of any rent premium may be for non-energy related improvements.<sup>7</sup> Some of the renovated properties had converted to full-service leases. Others have green lease provisions where a third-party auditor assists in determining how much the utility costs would be in the absence of specific improvements, and a portion of this is paid in additional rent. But we do not have sufficient detail to match up the energy savings with the rental changes to be able to draw any detailed conclusions beyond those provided by Eicholtz, Kok and Quigley (2011). We can however, estimate the energy-related savings and the strategies based on the work of Davis Langdon Global Construction Managers.<sup>8</sup> These strategies are summarized briefly in the next section.

### **Incremental Costs and Benefits of Energy Savings Related Improvements**

There are several easy strategies to save energy, and we note that even non-green buildings can be well managed and green buildings can be poorly managed. Among the easiest strategies discovered in studies by Miller, Pogue, Saville and Tu (2010) are day-time cleaning and sub-metering where permitted. Davis Langdon lists out the most common renovated related strategies as dealing with:

- ✓ Plug loads
- ✓ Lighting
- ✓ Ventilation
- ✓ Cooling
- ✓ Heating
- ✓ Deeper Retrofits

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<sup>7</sup> See the work by Miller, Pogue, Saville and Tu (2010) as an example of such surveys or the continued work of CBRE in annual surveys with the University of San Diego.

<sup>8</sup> See <http://www.davislangdon.com/Global/>

Each of these will be briefly discussed below but overall and excluding the deeper retrofits for some \$10 to \$20 per square foot one can reduce the energy consumption measured by KBtus per square foot per year by 30 to 50 KBtus resulting in savings, that varies by market, but typically would be \$1.50 to \$2.50 per square foot. See Exhibit 14 for an illustration of the costs of energy by market as you move to higher and higher efficiency levels as depicted by the Energy Star rating.

**Plug loads:** The typical office property runs 10 to 20 KBtu's per square foot per year but can easily be improved to 4 to 10 KBtu's by replacing outdated appliances and equipment (printers, faxes, computer screens) and adding occupancy sensors that shut off power when no one is around (after an appropriate delay). Vampire kill switches also shut down the entire suite or floor power when the last person leaves the premises and hits the kill switch. The cost for these strategies is negligible.

**Lighting:** The typical office property runs 10 to 15 KBtu's per square foot per year (1.25 watts/SF) for lighting with the best practices at 4 to 7 KBtu's. Simply replacing the lights with T5/T8's and motion sensors and adding task lighting and day lighting controls and moving to day- time cleaning will easily accomplish this energy reduction for a cost of \$3 to \$5 per square foot. LED lighting is even more efficient and prices are rapidly dropping so soon there will be even more efficient options. For example, a 75 watt equivalent LED (13 watts actual) is only \$13.99 at Home Depot compared with \$25.99 one year earlier. LED's are twice as efficient as most fluorescent fixtures so even greater efficiency will soon be possible. Day lighting can be brought in by a variety of new skylights, some with reflectors and sun tracking as well as light diffusers.

**Ventilation:** The ideal here is operable windows, but that is considered a deeper retrofit. The typical office property requires 6 to 10 KBtu's per square foot per year and can reduce that to 3 to 6 KBtu's for a cost of \$2 to \$5 per square foot. The work required includes sealing air ducts, optimizing air handlers and terminal

units and better balancing heating and cooling with integration, if possible, with shade controls and windows. In some cases, large fans are brought in and the maximum comfortable temperature can be raised prior to any cooling.

Cooling: Typical office buildings require 15 to 40 KBtu's per square foot per year for cooling, except for those cooler climate zones. The current best practices are 10 to 20 KBtu's; it costs about \$3 to \$7 dollars per square foot to reach these with a retrofit. The typical strategies include replacing primary equipment, drying the air prior to cooling, adding large fans and better ventilation as mentioned above so that the equipment capacity can be decreased. Shading windows also helps control heat gain or adding glazing, although this is considered a deeper retrofit.

Heating: The typical office property requires 5 to 15 KBtu's per square foot per year for heat while the best practices are at 2 to 8 KBtu's. This is accomplished for only \$1 to \$2 dollars per square foot by replacing primary equipment, improving controls, optimizing terminal units and balancing heating and cooling with more localized controls.

Deeper Retrofits: For \$10 to \$75 per square foot deeper, retrofits can be accomplished including envelope sealing, improved glazing, new additional insulation, chilled beams or some form of radiant cooling. Computer-controlled window shades may be considered along with solar photovoltaic cells or wind turbines. Energy recapture systems can also be employed on elevators. Such strategies reduce the energy consumed by 10 to 25 KBtu's and can add energy generation equal to that consumed in some cases.

Water conservation: Water flow equipment investments are economically justified when fixtures must be replaced anyway but there is no reasonable economic payoff at present as water prices are too low for any kind of significant return on investment or reasonable payback.

These strategies that pay off reasonably well are summarized below, excepting for the deeper retrofits:

<u>Strategy</u>	<b>KBtu/SF/Yr (Reduction)</b>	<b>Cost/SF</b>
Plug load	6 - 15	Minor
Lighting	6 - 8	\$3 - \$5
Ventilation	4 - 5	\$2 - \$5
Cooling	10 - 15	\$3 - \$7
Heating	3 - 10	\$1 - \$2
<b>Total</b>	<b>30 - 50</b>	<b>\$10 - \$20</b>

### **Summary and Conclusions**

Existing building retrofits will continue to accelerate over the next several years. Since 2008, LEED EBOM certifications have become a fairly attainable goal. Investment in some of the features and strategies discussed here result in value impacts likely to exceed costs with positive rental premiums and lower energy costs. These buildings are lower-risk to own as energy cost uncertainties are less of a concern. Faster absorption and higher occupancy are likely going forward along with better tenant retention and lower leasing commission fees. Some insurance firms even charge lower premiums once buildings have been upgraded to LEED.<sup>9</sup> Our results here are consistent with those findings observed on new construction LEED-certified buildings, except that the EBOM program applies to a much larger pool of candidate properties.

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<sup>9</sup> For example, Fireman's Fund charges about 5% less for such buildings.

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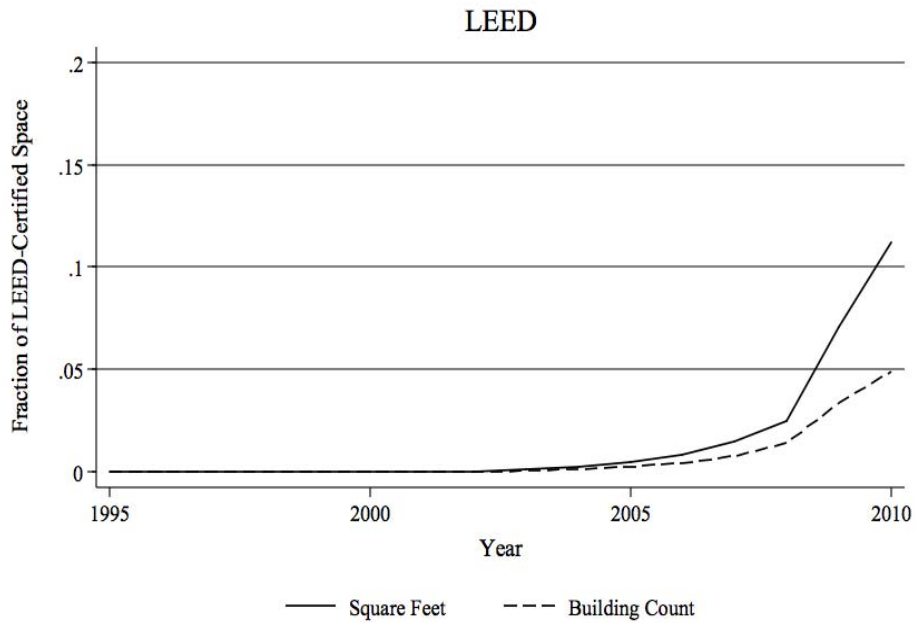
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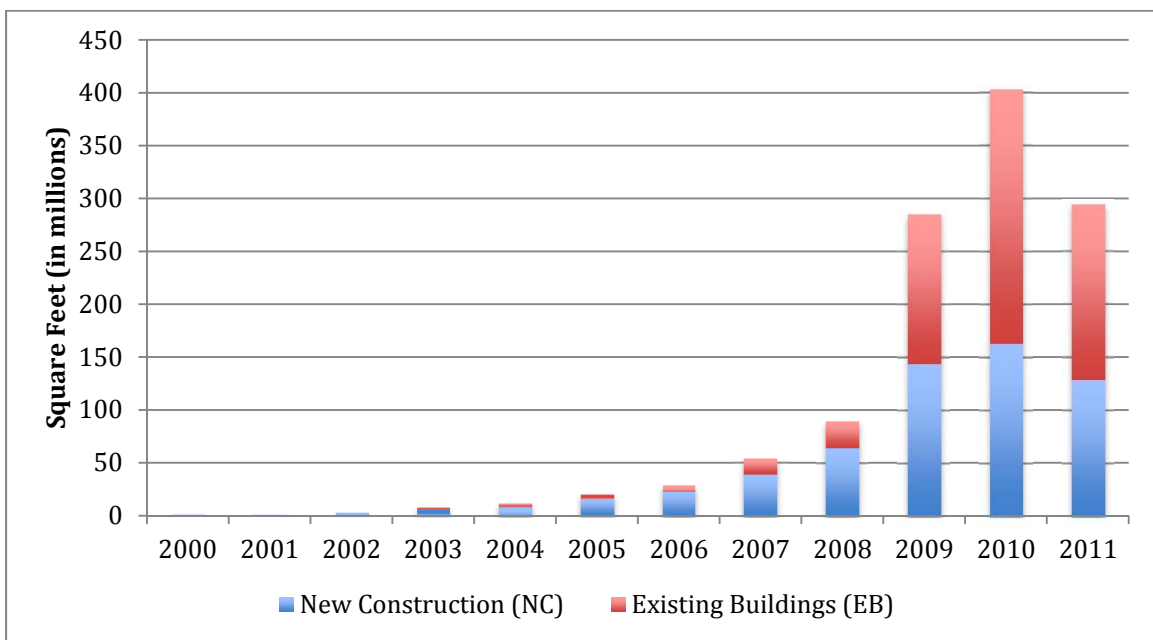
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## Exhibit I Growth in Green Buildings

### A. LEED-Certified Space as a Fraction of Total Office Space (Kok et al., 2011)



### B. Composition of LEED-Certified Commercial Space



**Exhibit 2**  
**Descriptive Statistics**

	LEED Certified	Control Sample
Rent (\$ per sq.ft.)	28.15	29.23
Occupancy Rate (percent)	83.73	87.38
Effective Rent (\$ per sq.ft.)	23.83	25.05
Energy Star (1 = yes)	86.88	37.35
Building Class		
Class A (percent)	83.09	66.34
Class B (percent)	16.91	33.66
Building Size (thousands sq.ft.)	522.40	495.10
Typical Floor Area (thousands sq.ft.)	27.10	45.60
Age (years)	22.33	26.93
Renovated (percent)	41.40	31.90
Distance to Transit (miles)	0.30	0.43

### Exhibit 3: EBOM Sample Locations



**Exhibit 4  
Green Ratings and Rents**

	(1)	(2)	(3)
LEED Certified		0.071***	0.052**
(1 = yes)		[0.023]	[0.023]
Energy Star			0.056***
(1 = yes)			[0.020]
Building Class			
Class A	0.115***	0.110***	0.101***
(1 = yes)	[0.022]	[0.022]	[0.022]
Building Size	-0.022	-0.024	-0.032
(log)	[0.020]	[0.020]	[0.020]
Typical Floor Area	0.030	0.034*	0.037*
(log)	[0.020]	[0.019]	[0.019]
Age	0.002	0.002	0.002
(years)	[0.001]	[0.001]	[0.001]
Age <sup>2</sup>	-0.000*	-0.000**	-0.000**
(years)	[0.000]	[0.000]	[0.000]
Distance to Transit	-0.112***	-0.110***	-0.106***
(miles)	[0.015]	[0.015]	[0.015]
City-Fixed Effects	Y	Y	Y
Constant	2.941***	2.887***	2.932***
	[0.279]	[0.278]	[0.277]
Observations	970	970	970
R-squared	0.636	0.640	0.643
Adj R <sup>2</sup>	0.629	0.632	0.635

Standard errors in brackets

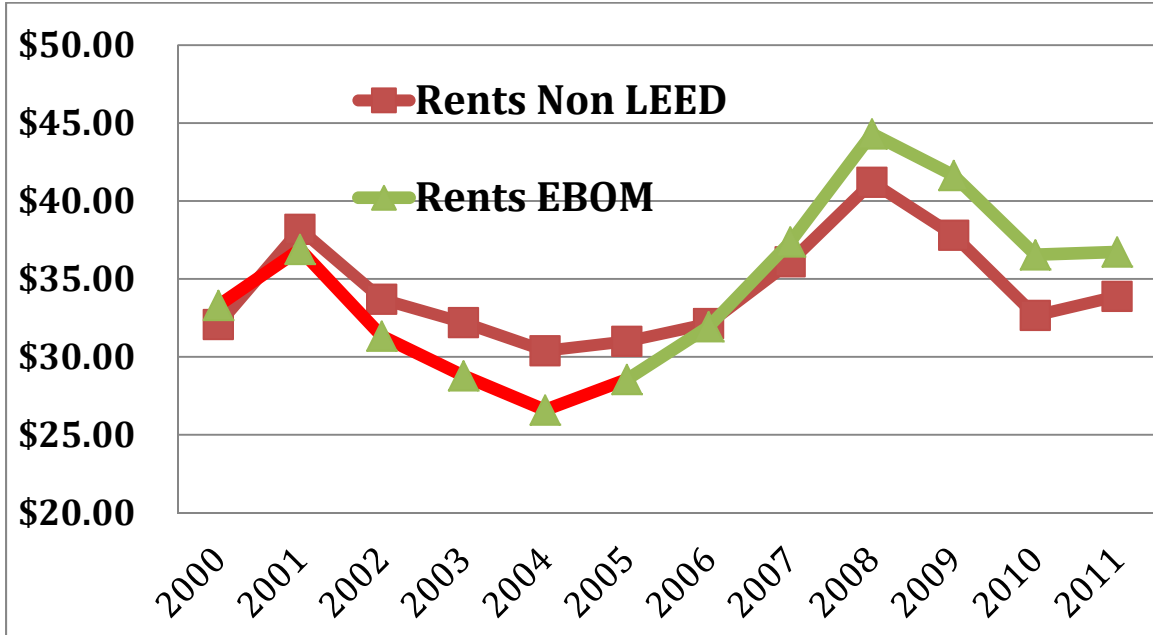
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

**Exhibit 5**  
**Green Ratings and Effective Rents**

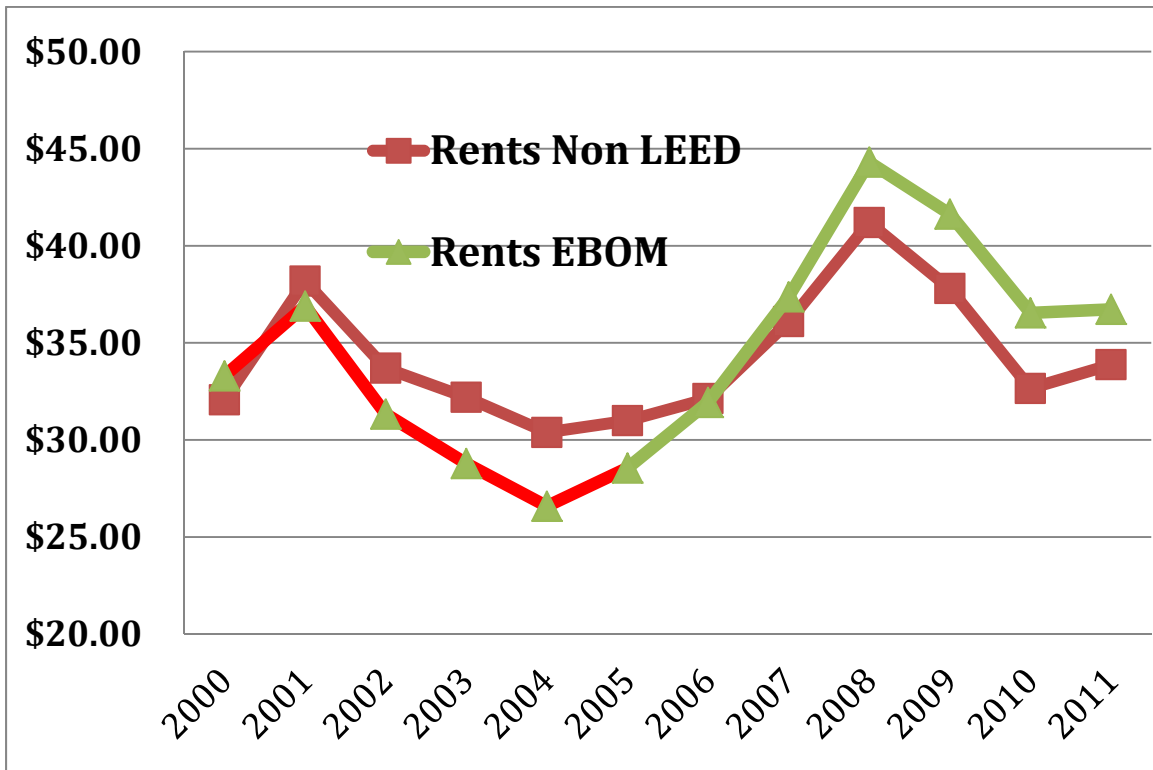
	(1)	(2)	(3)
LEED Certified		0.091***	0.058
(1 = yes)		[0.035]	[0.037]
Energy Star			0.098***
(1 = yes)			[0.031]
Building Class			
Class A	0.155***	0.147***	0.132***
(1 = yes)	[0.034]	[0.034]	[0.034]
Building Size	0.035	0.033	0.019
(log)	[0.032]	[0.032]	[0.032]
Typical Floor Area	0.033	0.038	0.044
(log)	[0.031]	[0.031]	[0.030]
Age	0.007***	0.007***	0.007***
(years)	[0.002]	[0.002]	[0.002]
Age <sup>2</sup>	-0.000**	-0.000***	-0.000***
(years)	[0.000]	[0.000]	[0.000]
Distance to Transit	-0.135***	-0.132***	-0.126***
(miles)	[0.023]	[0.023]	[0.023]
Constant	1.907***	1.839***	1.915***
	[0.436]	[0.435]	[0.434]
City-Fixed Effects	Y	Y	Y
Observations	952	952	952
R-squared	0.487	0.491	0.496
Adj R <sup>2</sup>	0.477	0.480	0.485

Standard errors in brackets  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

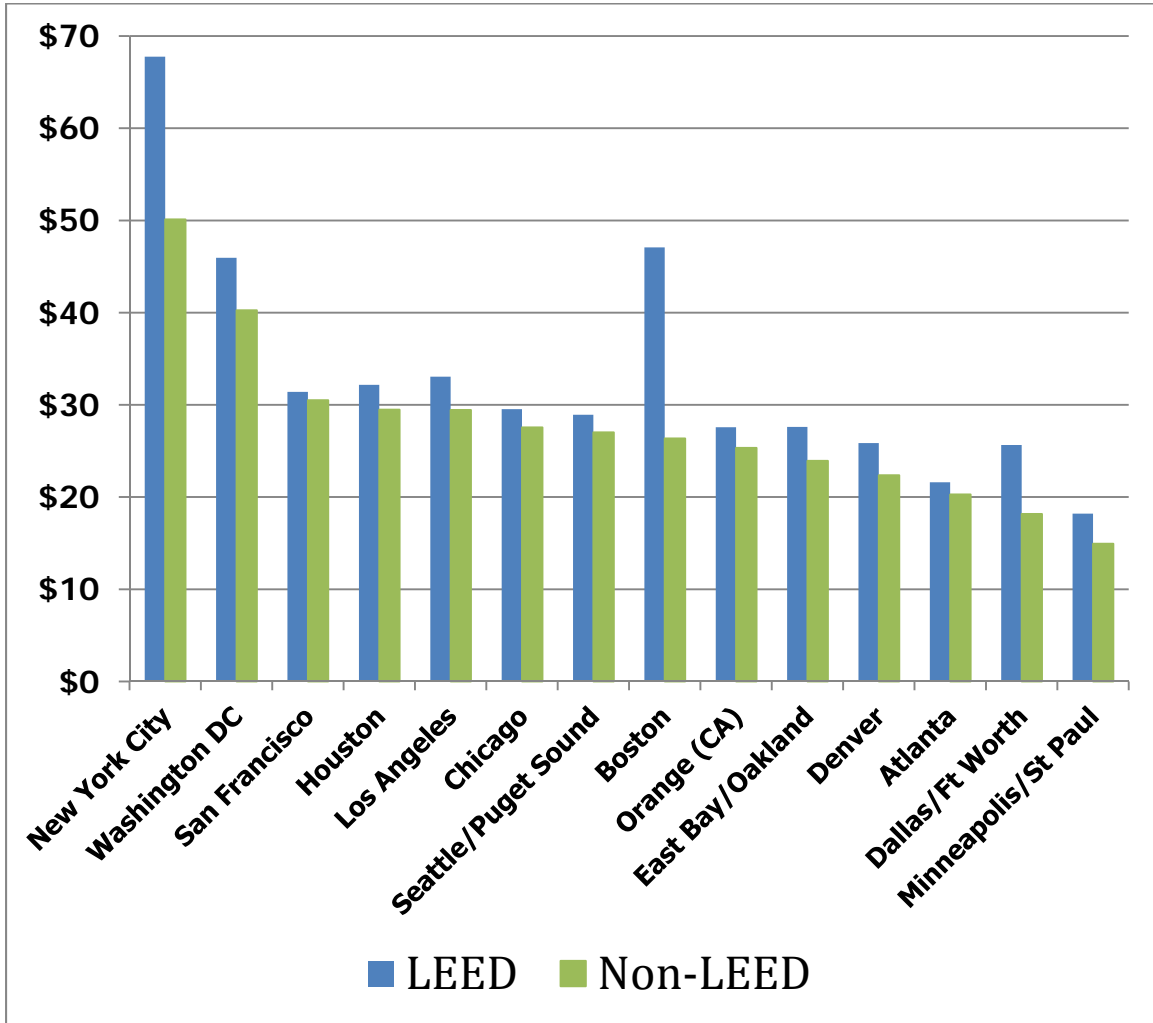
**Exhibit 6: Rents prior to and after renovation**



**Exhibit 7: Occupancy Prior to and After Renovation**



**Exhibit 8: Rents by Market for LEED EBOM and Non-LEED Buildings (Control Sample) as of Mid-2011**





**Exhibit 9: Occupancy by Market for LEED EBOM and Non-LEED Buildings  
(Control Sample) as of Mid-2011**

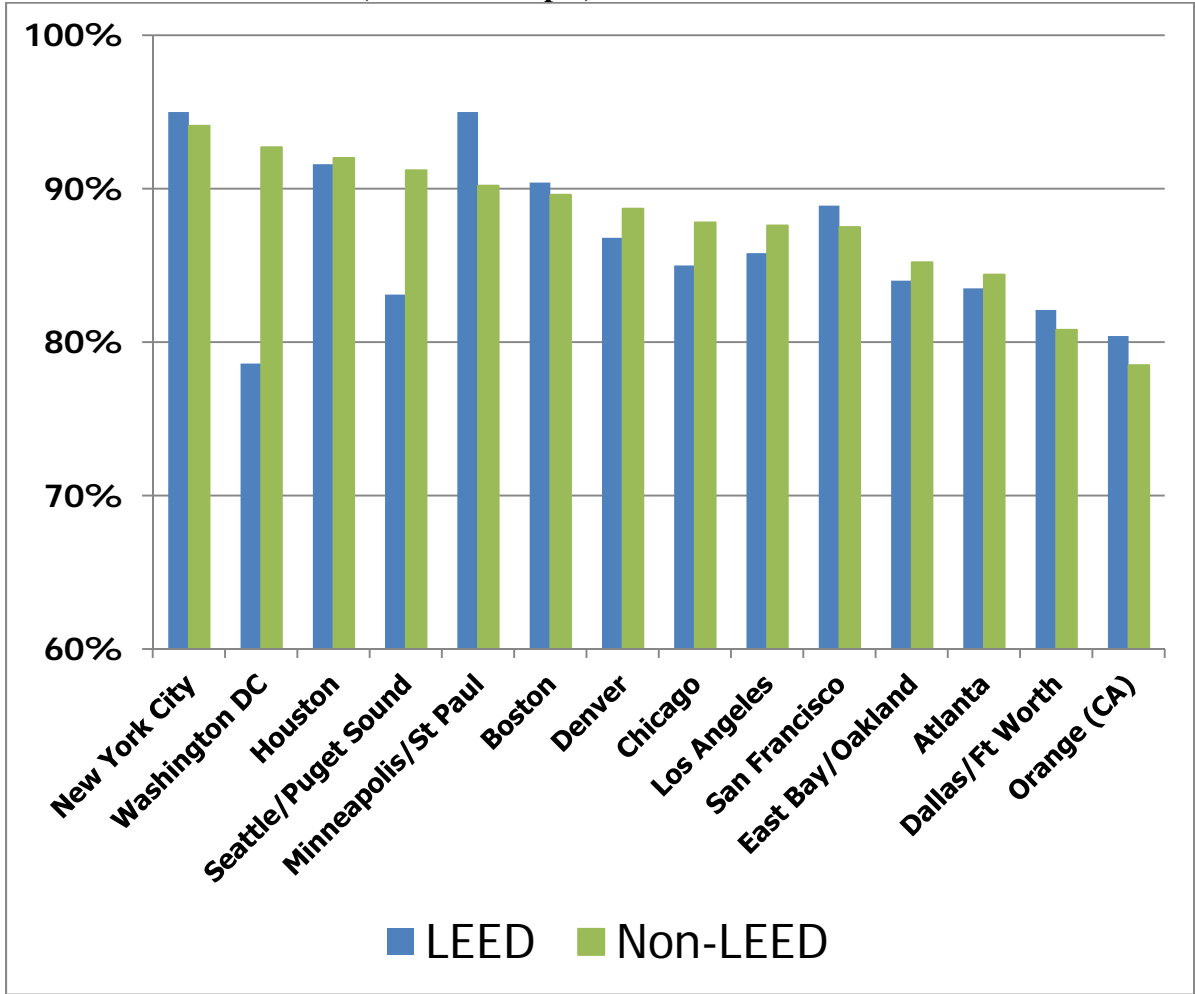
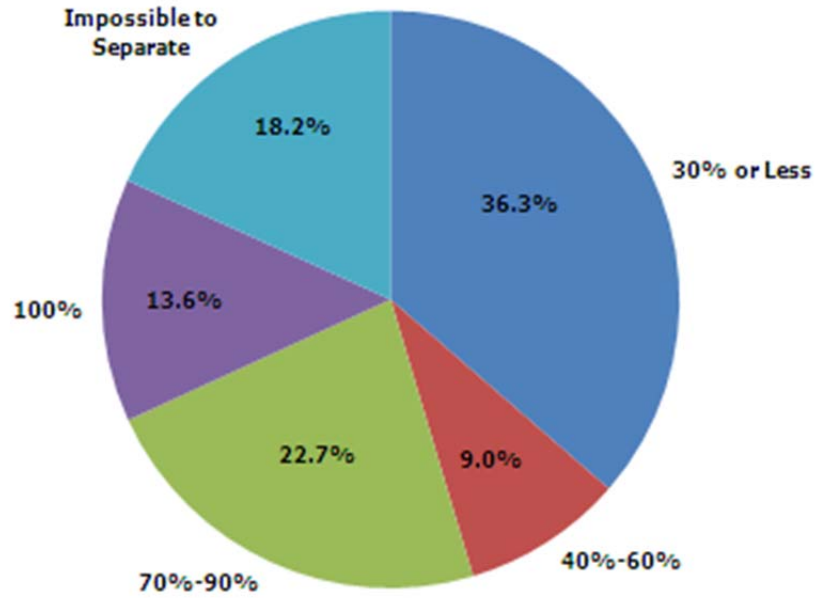


Exhibit 10

**Percent improvements related to sustainability  
*vs. improvements to merely remain competitive***

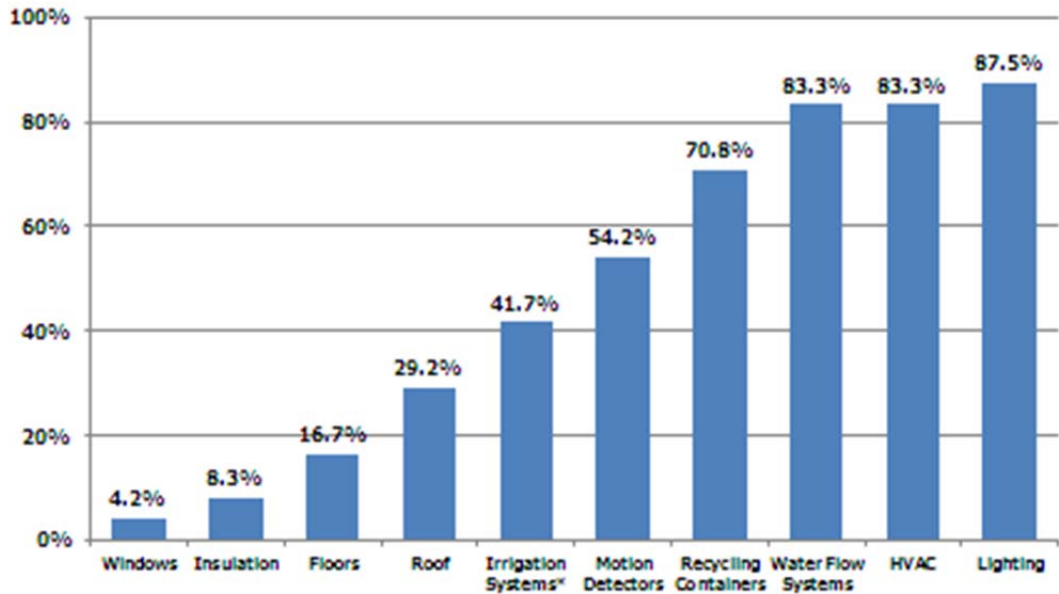


Source: Survey of 1,000 buildings in 14 major U.S. markets

## Exhibit 11

# Major improvements during retrofit

*Strong focus on energy, but water is increasingly important*

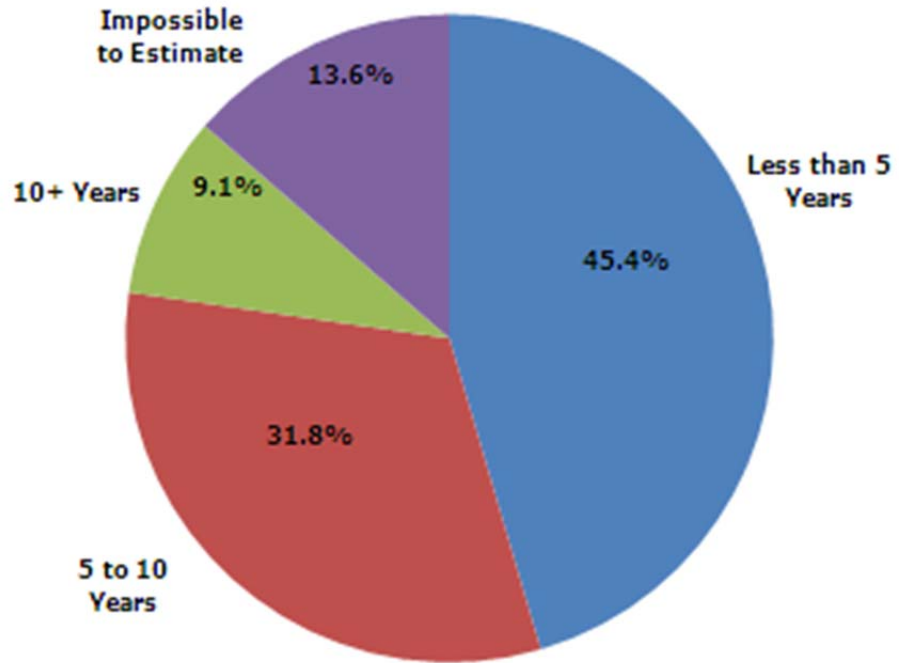


Source: Survey of LEED buildings in 14 major U.S. markets

\*Includes rain capture systems

Exhibit 12

## Expected payback in years *on sustainable-related improvements*

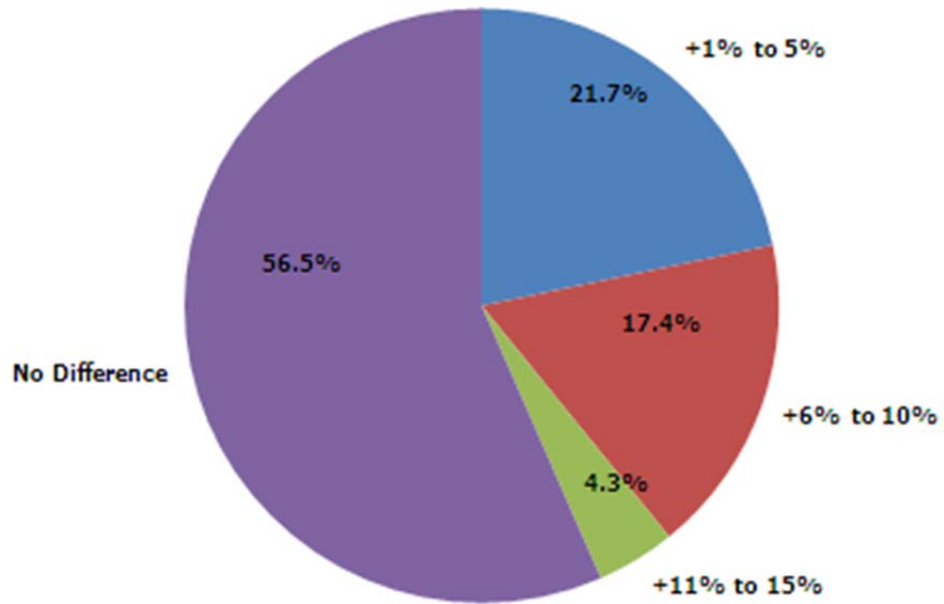


Source: Survey of LEED buildings in 14 major U.S. markets

Exhibit 13

**Current rental level**

*Compared to similar but non-LEED buildings*



Source: Survey of LEED buildings in 14 major U.S. markets

Exhibit 14: How Much You Save Varies By Market

