urban green | U.S. GREEN BUILDING COUNCIL CHAPTER

Fall
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COST OF GREEN IN NYC

CONTENTS

INTRODUCTION

Advocates of green building have long held that environmentally friendly, energy efficient construction need not be more expensive; in the long run, green building will be cost effective both for the building owner and society at large. Several national studies and leading practitioners suggest that if there is a cost premium for building green, it is very small. Yet without a study specifically addressing buildings located in dense, urban environments, many question the applicability of these findings to the New York City market.

The number of LEED projects registered each year in New York City has increased exponentially, but there is still a long way to go before LEED design becomes the construction standard. In New York City, nearly 5,000 permits for new construction projects were issued in 2007, but only around 200 of these projects registered for LEED certification. One explanation for the comparatively slow adoption of sustainable building practices in New York City is the perception that green building is expensive, but is this perception accurate?

Urban Green Council, a leader in advancing sustainability of the urban built environment, recognized a critical research need. The Council, with funding assistance by the New York State Research and Development Authority (NYSERDA), engaged Davis Langdon to conduct a data-based study of the cost of building green in the City. This report examines recent construction projects in New York City in order to determine whether or not sustainability adds to project costs, and, if so, how much.

Figure 1:
CUMULATIVE NUMBER OF REGISTERED LEED PROJECTS IN NYC
as of October 2008

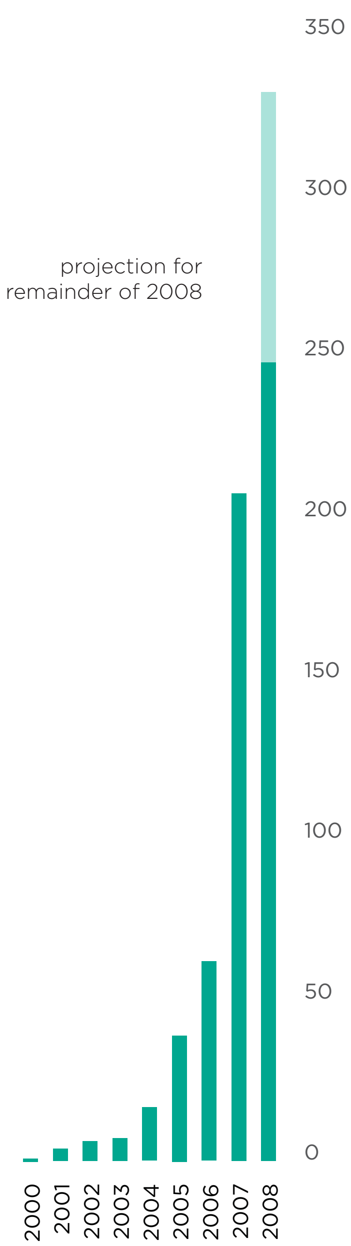
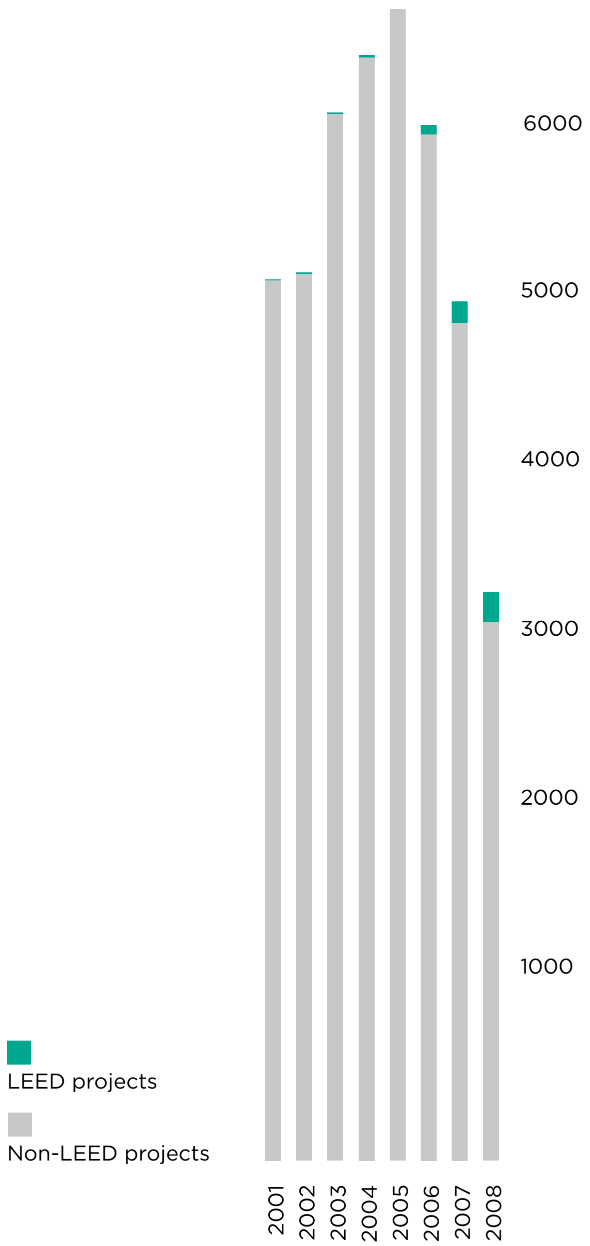


Figure 2:
NUMBER OF NEW CONSTRUCTION BUILDING PERMITS AND LEED APPLICATIONS IN NYC



PROJECT SPONSORS

URBAN GREEN COUNCIL

Urban Green Council is the New York Chapter of the U.S. Green Building Council (USGBC). Urban Green's mission is to lead the advancement of sustainability in the urban built environment through education, advocacy, collaboration, and research. Established in 2002, Urban Green is supported by contributions from members and sponsors, as well as foundation and government grants. In-house experts in environmental law, architecture, and engineering work with a dedicated network of volunteers to realize a common vision: cities that function in harmony with the natural environment and contribute to the health and well-being of all.

DAVIS LANGDON & SEAH INTERNATIONAL

Davis Langdon provides comprehensive consulting services to owners, architects, government agencies, and institutions. Founded in 1974, Davis Langdon has eight offices nationwide. With five interrelated specialist business units which cover cost management, sustainability consulting, research, project management and risk consulting, Davis Langdon is able to service its clients' projects from a broad perspective. The firm is a member of Davis Langdon & Seah International (DLSI), the largest construction cost consulting group in the world. Membership in DLSI provides Davis Langdon with a global perspective on the quickly changing world economy and access to shared technology and data.

The Davis Langdon research group provides analysis and strategic advice on all aspects of the economics of project procurement, covering such topics as global commodity prices, local bid market conditions, and the cost and benefits of sustainable design. Davis Langdon was awarded the USGBC Leadership Award in 2008 for research in sustainability and cost.

NEW YORK STATE ENERGY RESEARCH & DEVELOPMENT AUTHORITY

The New York State Energy Research and Development Authority (NYSERDA) was established by law in l975 as a public benefit corporation. NYSERDA provides energy-related technical and financial packaging assistance to businesses and institutions to promote energy efficiency and economic development, as well as providing energy research and development programs that promote safe and economical energy production efficiency technologies in New York State. NYSERDA also analyzes the effect of New York's energy, regulatory and environmental policies on the State's business, institutional, and residential energy consumers.

EXECUTIVE SUMMARY

The Cost of Green in New York City found no significant difference in the cost per square foot between green and non-green buildings, based on analysis of luxury high-rise residential and commercial interiors projects.

In analyzing the data, the study also discovered that New York City LEED projects exhibit similar patterns of LEED credit achievement; certain credits are commonly achieved and others are rarely pursued.

EXECUTIVE SUMMARY

Throughout 2008, data was gathered on 107 recent projects, of which 63 were either pursuing or had achieved LEED certification. These projects were evaluated and reviewed as a group; subsequently, construction costs for two subsets were analyzed statistically: high-rise residences (38 projects) and office interiors (25 projects).

The study investigated a variety of construction measurements in order to obtain a full picture of green building practices in New York City. In the **costs** section of the report, statistical analysis was used to assess the impact on construction costs of building to LEED standards. In addition, soft costs associated with LEED were also examined. In the **characteristics of green** section, the study looked at LEED credit achievement patterns in order to determine how LEED buildings in New York City differ from those built elsewhere. The final section uses **case studies** to provide a detailed look at the costs and benefits associated with building to LEED standards. This section also explores carbon modeling as a methodology to measure and compare projects' environmental impacts.

COSTS

In analyzing high-rise residential buildings, the study found that there is no statistically significant difference in construction cost between LEED and non-LEED projects. Visual examination of this data set indicates that projects with various levels of LEED certification are distributed throughout the range of costs with no apparent pattern.

The distribution of commercial interiors projects appeared to follow that of the residential buildings, but the pattern was not statistically clear. In addition, a visual examination of this data set suggests that the highest levels of LEED may have been achieved at a lower cost than other levels of LEED.

Soft costs associated with LEED certification were not substantial in terms of overall project cost. The median cost of LEED design fees was $0.56/sf, the median cost of LEED documentation was $0.30/sf, and the median commissioning cost was $1.55/sf. The range in LEED fees was considerable, with some projects, for example, adding nothing for LEED design fees and others adding as much as $6.62/sf.

CHARACTERISTICS OF GREEN IN NYC

New York City LEED projects exhibit similar patterns of credit achievement: over 75% of New Construction (NC) projects surveyed in New York City achieved 25 common LEED points, and over 75% of Commercial Interiors (CI) projects achieved 24 common LEED points.

These sets of commonly achieved credits, which are similar to those found in San Francisco , may be unique to dense urban environments with strong public transportation infrastructure; construction projects throughout the rest of the United States typically incorporate a somewhat different set of sustainable design features. Going green in New York City follows a specific path, shaped by factors such as the city's infrastructure, density, building codes, and construction practices.

Table 1:
HIGH-RISE RESIDENTIAL BUILDINGS
Cost Normalized to Construction Year

	LEED	NON-LEED
AVERAGE	$440/sf	$436/sf
MEDIAN	$439/sf	$407/sf

Table 2:
COMMERCIAL INTERIORS PROJECTS
Cost Normalized to Construction Year

	LEED	NON-LEED
AVERAGE	$191/sf	$204/sf
MEDIAN	$158/sf	$163/sf

Figure 3:
NORMALIZED COST OF 16 LEED AND 22 NON-LEED HIGH RISE RESIDENTIAL CONSTRUCTION PROJECTS IN NYC

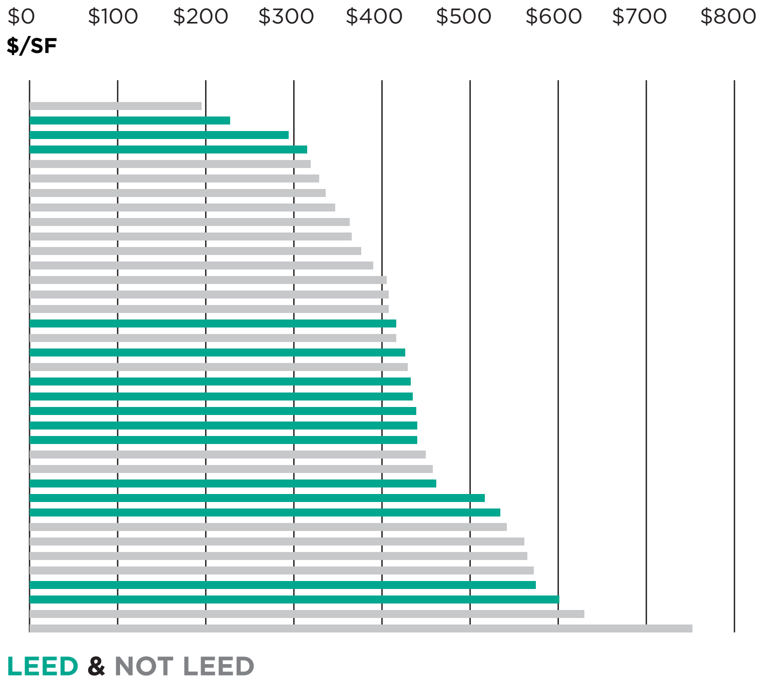
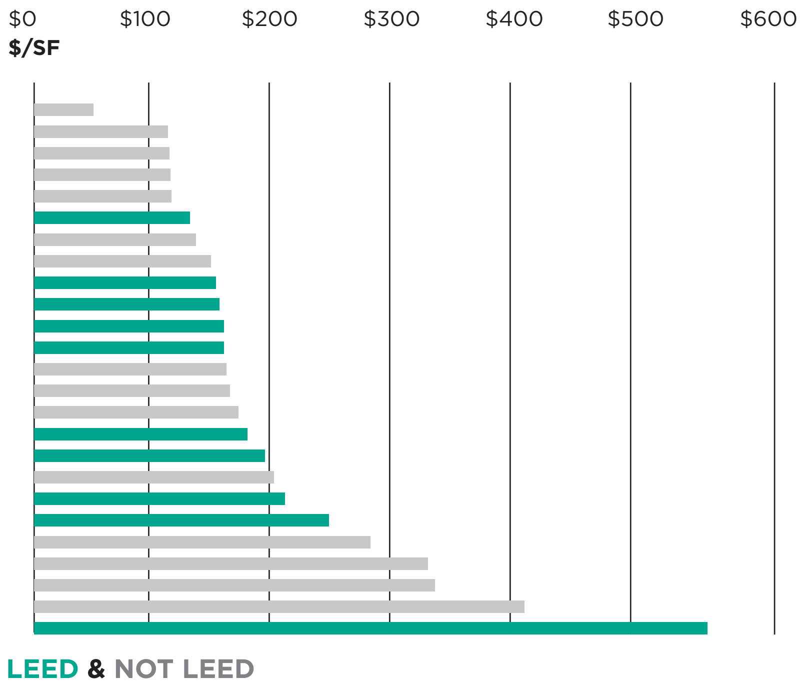


Figure 4:
NORMALIZED COST OF 12 LEED AND 13 NON-LEED COMMERCIAL INTERIOR CONSTRUCTION PROJECTS IN NYC



LOOKING FORWARD
In 2007 and 2008, as world economies began to tumble, New York City experienced a significant drop in construction starts. From 2003 to 2006, the number of New York City permits issued for new construction projects hovered at or above 6,000 per year, but in 2007 the permits issued by the City dropped to around 5,000, and in 2008 dropped again to near 4,000 . The current recession is strongly impacting the construction and real estate industries and, by extension, the green construction industry.

Undoubtedly, project teams are now on the lookout for every opportunity to save money. However, where green is a stated project goal, teams find ways of incorporating green elements into their projects by tailoring their design choices and budgets appropriately. Observations of the construction market across the country shows that teams with reduced funding sources are not debating the inclusion of sustainable design measures, but are instead considering whether to continue with the project at all, regardless of green goals. For those projects able to continue with construction, green has become an added selling point and turning away from sustainability would be a poor long-term strategy. As Jeff Blau, President of Related Companies, contends, “Building green is no longer just an option that we consider, but as a leading developer, it is a responsibility that we embrace. In this difficult economic environment, we all need to be more vigilant then ever to reinforce our commitment to building green.”

GATHERING DATA

GATHERING DATA

To obtain the data used in this study, Davis Langdon worked with Urban Green Council to develop and conduct surveys of recent and current local construction projects. All buildings in this study were located within the five boroughs of New York City and, if not still under construction, had completed construction within the last two years. Surveys were conducted for buildings with and without sustainability goals, and various data points were requested, including:

- Construction Costs
- Design Fees
- LEED Design Fees
- LEED Additional Fees
- Commissioning Fees

The USGBC national office also provided statistics for LEED credit achievement across the United States, enabling a comparison of credit achievement patterns between New York City projects and national averages.

The LEED rating system was used as the metric for assessing the level of sustainability achieved in the projects studied. With registered projects across the country and the world, LEED is widely accepted and understood and was thus a logical choice to serve as a proxy for green design in this report. Furthermore, LEED is built on a set of measurable indicators that lend themselves to statistical analysis.

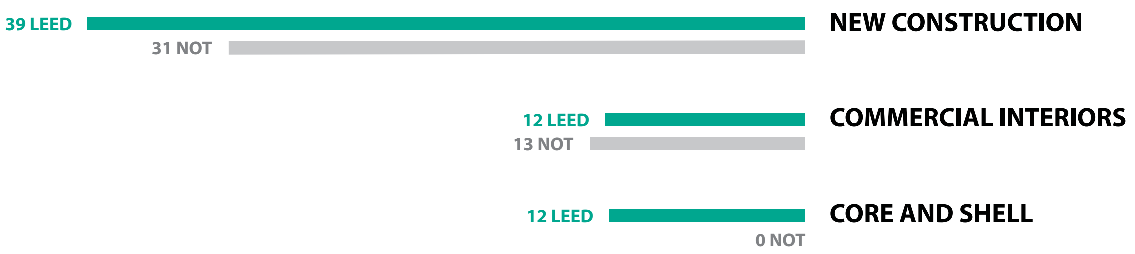
The completed surveys yielded data from 107 recent New York City projects, 63 of which had achieved or were actively pursuing LEED certification. The majority of these projects were using either LEED for New Construction (NC) or LEED for Commercial Interiors (CI), with the remaining projects using LEED for Core and Shell (CS).

In order to conduct a meaningful analysis, comparisons were made only between projects with similar programs and scopes that were using the same type of LEED rating system. Furthermore, data from a substantial number of similar projects was needed in order to identify anomalies and prevent them from skewing the evaluations. Analysis of Core and Shell projects was not possible given the low number of survey responses received for these types of projects. This study, therefore, only provides analysis of New Construction and Commercial Interiors projects.

Of the 70 New Construction projects included in the study, 39 were pursuing or had achieved LEED certification, and 31 were not. These NC projects consist of high and low-rise residences, high and low-rise office buildings, libraries, academic buildings, and cultural institutions. All NC projects were included in the comparison of LEED credit achievement, but there were only enough data points to allow a statistical analysis of high-rise residential buildings. Overall, the costs of 38 recently-constructed high-rise residential buildings were analyzed, of which 16 were pursuing LEED certification.

Of the 25 Commercial Interiors projects studied, 12 were pursuing LEED certification and 13 were not. Given that CI projects have similar programs whether located in a high or low-rise building, all 25 of these projects were included in the statistical cost analysis.

Figure 5:
NUMBER OF PROJECTS INCLUDED IN STUDY BY CATEGORY



COSTS

The cost-related data collected for this study include project construction costs, LEED design fees, LEED additional fees, and commissioning fees.

COSTS

CONSTRUCTION COSTS – DATA OVERVIEW

To begin analyzing the financial costs associated with green building, the study team first examined the construction costs per square foot for all the surveyed projects. Construction costs excluded acquisition fees, soft costs, site work, and parking structure costs. All costs were normalized for year of construction in order to ensure consistency.

Given the variety of project types and programs, it is not surprising that there was a large range in costs among the buildings analyzed. For new construction and major renovation projects, costs ranged from under $200 per square foot to upwards of $1500 per square foot. The majority of projects, however, fell within the range of $300 to $600 per square foot. Costs for commercial interiors ranged from around $100 per square foot to over $400 per square foot, with the majority falling in the range of $100 to $200 per square foot.

Building type and program are the primary cost drivers for most projects, dwarfing the cost implications of other factors such as sustainability. In order to isolate the cost impact of LEED, it was necessary therefore to compare like to like and segment the cost analysis by building and program type.

Among NC projects, sufficient data was obtained to perform a statistical analysis for high-rise residences. For CI, all projects were deemed sufficiently similar in program to perform a statistical analysis, independent of building type.

Cost data for 38 high-rise residences and 25 commercial interiors was analyzed. Construction costs for the bulk of high-rise residential projects fell within the $300 to $600 per square foot range. When separating the residential buildings into rentals and condominiums, rental buildings tended to fall at the lower end of the residential building cost range, between $200 and $400 per square foot, while condominium construction costs fall at the higher end, between $300 and $600 per square foot. Commercial Interior construction costs fell predominantly in the range of $100 to $200 per square foot.

Figure 6:
COST OF ALL NEW CONSTRUCTION PROJECTS, SHOWING LEVEL OF LEED CERTIFICATION

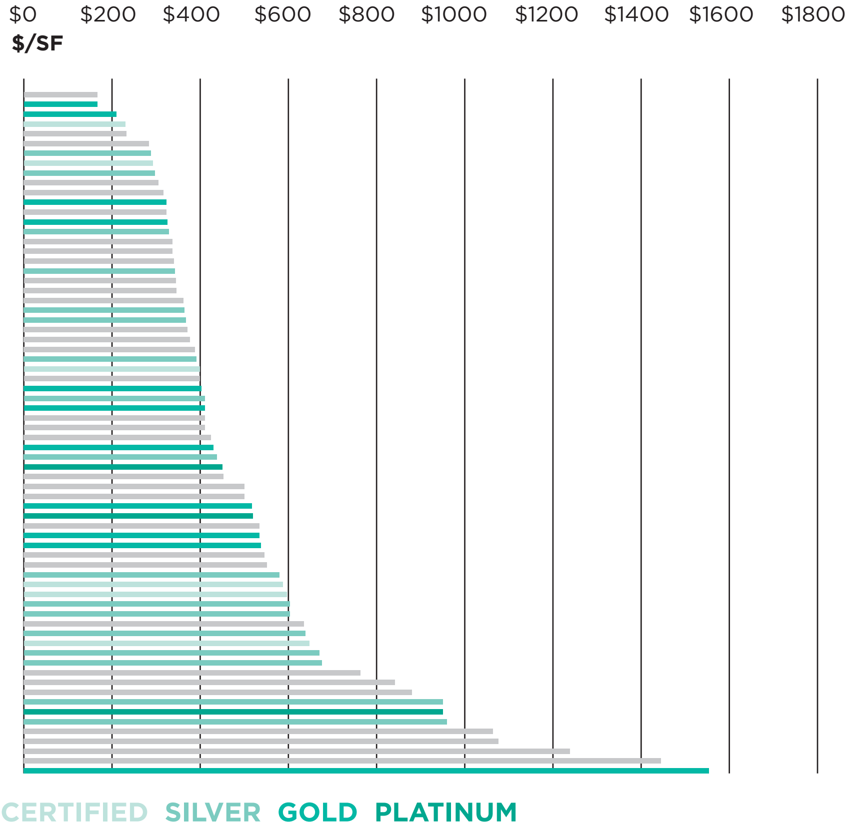
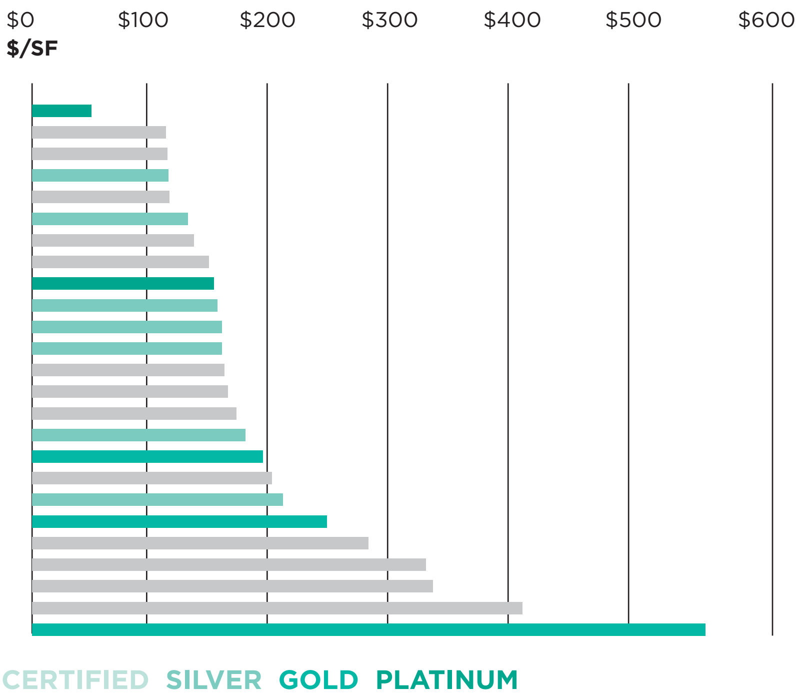


Figure 7:
COST OF HIGH RISE RESIDENTIAL PROJECTS, SHOWING LEVEL OF LEED CERTIFICATION

Figure 8:
COST OF COMMERCIAL INTERIORS PROJECTS, SHOWING LEVEL OF LEED CERTIFICATION



CONSTRUCTION COSTS – ANALYSIS
The analysis of New York City residential buildings found no statistically significant difference in construction costs between LEED and non-LEED buildings. LEED projects do not dominate the high end of building costs. In other words, compared to other factors influencing construction costs, LEED is insignificant.

This is not to say that LEED certification is without direct costs; LEED buildings often require the use of higher cost materials, systems, and construction processes. Why is it, then, that we find no difference in construction costs between LEED and non-LEED buildings? Anecdotal evidence suggests several reasons for this lack of cost differential. Firstly, LEED project teams simply make different choices about how to spend the monies available to them; they reallocate funding within the project budget to accommodate green measures. Secondly, the market is maturing with respect to sustainability; many of the additional costs currently associated with LEED are dropping as LEED-compliant materials, systems, and processes become more common. Finally, project teams are learning to take a more disciplined and integrated approach to design, and this may reduce costs. In Davis Langdon's experience, some projects achieve LEED Gold or Platinum at lower cost than Silver or Certified by effectively integrating building systems and design.

In summary, although the measures typically used to achieve LEED can have associated costs, those costs are not significant or prohibitive. The construction cost analysis shows that high-rise residential projects achieve LEED within budget parameters, and within budgets comparable to non-LEED projects.

SOFT COSTS
The implementation of green construction practices can have a financial impact beyond the realm of construction costs. Successful LEED projects typically require a disciplined, integrated design and construction process, and these changes to standard practice can add time and therefore cost. In addition, the documentation and commissioning required for LEED can also carry an associated cost. The study therefore looked beyond construction costs and also examined the following types of LEED fees:

- LEED design fees include the additional amount paid to the design team to alter the project so that it includes sustainable features.
- LEED related fees refer to work

associated strictly with the LEED documentation process, including fees paid to the USGBC. This documentation work does not make the design any greener, but confirms sustainable design strategies and ensures that the project will receive LEED certification.

- Commissioning fees include the expenses incurred in hiring a Commissioning Agent and performing diagnostic checks of the building's systems.

For the New Construction projects surveyed , the median cost of design fees associated with LEED compliance was $0.56 per square foot, whereas the average cost was $1.47 per square foot. For LEED related fees, these values were a median of $0.30 per square foot and an average of $0.59 per square foot, and for commissioning fees, the median cost was $1.55 per square foot and the average was $2.35 per square foot. This large difference between median and average figures is due to the wide range of values reported by projects in the study; most reported low fees, but a few reported much higher figures, thereby driving up the average. For example, two projects reported that their LEED design fees were over $6 per square foot, whereas most projects reported design fees at under $2 per square foot. Given this high degree of skew in costs for LEED fees, the median is the more relevant reference.

The median percentage for design fees associated with LEED compliance was 0.14% of construction cost, which represents roughly 1% to 2% of a typical architectural fee. For LEED related fees, the median percentage was 0.08% of construction cost, and for commissioning fees, the median percentage was 0.27% of construction cost. Collectively these come to well under one half of one percent of construction cost for the average project.

These considerable variations in LEED fees among projects indicate that the design and construction industry has not yet standardized the processes associated with LEED. However, despite this variation across projects, analysis of soft costs confirms that the fees associated with achieving LEED do not significantly affect the total cost of construction. Design fees and related soft costs, in general, only account for about 10 to 12 percent of construction costs for residential projects, so the additional fees have minimal impact on total construction cost.

Table 3:
CONSTRUCTION COSTS: HIGH-RISE RESIDENTIAL ($/SF)

	ALL	LEED	NON-LEED	CERT	SILVER	GOLD	PLAT
AVERAGE	438	440	436	315	467	433	463
MEDIAN	431	439	407	315	439	440	463

Table 4:
CONSTRUCTION COSTS: COMMERCIAL INTERIORS ($/SF)

	ALL	LEED	NON-LEED	CERT	SILVER	GOLD	PLAT
AVERAGE	197	191	204	N/A	156	330	100
MEDIAN	160	158	163	N/A	158	244	100

Table 4:
LEED FEES: ALL NEW CONSTRUCTION PROJECTS ($/SF)

	LEED DESIGN	LEED RELATED	CX
AVERAGE	1.47	0.59	2.35
MEDIAN	0.56	0.30	1.55

CHARACTERISTICS OF GREEN IN NYC

New York City has a unique real estate market. Distinctive factors include the high cost and limited availability of land, building codes, labor costs, and the extraordinary rental and resale demand. These characteristics, together with unique physical conditions such as high density, availability of public transportation, and limited open space, shape the nature of green building in New York City.

Credit achievement analysis—a profile of the LEED credits achieved for a select group of projects—is a useful indicator of the cost implications of building green for that particular population. Past Davis Langdon studies have shown that design measures (or LEED points) achieved by a majority of projects are normally those with the lowest added cost.

There are 25 LEED points typically achieved by over 75% of all NC building projects in New York City. These common practices can be used to define a starting point for any New York City project seeking to incorporate elements of sustainable design. LEED CI projects in New York City also exhibit patterns in credit achievement; 24 LEED points are typically achieved by over 75% of all CI building projects in New York City.

In order to gain insight as to how location can influence a project's level of sustainability, the study compared the patterns of credit achievement of projects in New York City to those of projects in the entire country. The USGBC provided anonymous LEED checklists for every project that had been certified or registered through 2008 in the United States. These checklists were then compared to the checklists provided by all the buildings in this study to determine the frequency with which certain green building practices are used in New York City as compared with LEED projects nationwide.

Table 9:
TYPICAL COMMERCIAL INTERIOR CHECKLIST: USA AND NYC

SUSTAINABLE SITES	WATER EFFICIENCY	ENERGY & ATMOSPHERE	MATERIALS & RESOURCES	ENVIRONMENTAL QUALITY	INNOVATION IN DESIGN
SS 1	**WE 1.1**	EA 1.1	**MR 1.1**	**EQ 1**	**ID 1.1**
SS 2	**WE 1.2**	EA 1.2	MR 1.2	EQ 2	**ID 1.2**
SS 3.1		EA 1.3	MR 1.3	**EQ 3.1**	**ID 1.3**
SS 3.2		**EA 1.4**	**MR 2.1**	EQ 3.2	**ID 1.4**
SS 3.3		EA 2	**MR 2.2**	**EQ 4.1**	**ID 2**
		EA 3	MR 3.1	**EQ 4.2**	
		EA 4	MR 3.2	**EQ 4.3**	
			MR 3.3	EQ 4.4	
			MR 4.1	**EQ 4.5**	
			MR 4.2	EQ 5	
			MR 5.1	EQ 6.1	
			MR 5.2	EQ 6.2	
			MR 6	**EQ 7.1**	
			MR 7	EQ 7.2	
				EQ 8.1	
				EQ 8.2	
				EQ 8.3	

CREDITS ACHIEVED BY OVER 75% OF BOTH USA AND NYC PROJECTS
ADDITIONAL CREDITS ACHIEVED BY OVER 75% OF NYC PROJECTS, BUT NOT BY USA PROJECTS
ADDITIONAL CREDITS ACHIEVED BY OVER 75% OF USA PROJECTS, BUT NOT BY NYC PROJECTS

Table 10:
TYPICAL NEW CONSTRUCTION CHECKLIST: USA AND NYC

SUSTAINABLE SITES	WATER EFFICIENCY	ENERGY & ATMOSPHERE	MATERIALS & RESOURCES	ENVIRONMENTAL QUALITY	INNOVATION IN DESIGN
SS 1	**WE 1.1**	**EA 1.1**	MR 1.1	**EQ 1**	**ID 1.1**
SS 2	WE 1.2	EA 1.3	MR 1.2	EQ 2	**ID 1.2**
SS 3	WE 2	EA 1.5	MR 1.3	**EQ 3.1**	ID 1.3
SS 4.1	**WE 3.1**	EA 1.7	**MR 2.1**	EQ 3.2	ID 1.4
SS 4.2	WE 3.2	EA 1.9	**MR 2.2**	**EQ 4.1**	**ID 2**
SS 4.3		EA 2.1	MR 3.1	**EQ 4.2**	
SS 4.4		EA 2.2	MR 3.2	**EQ 4.3**	
SS 5.1		EA 2.3	**MR 4.1**	EQ 4.4	
SS 5.2		**EA 3**	MR 4.2	**EQ 5**	
SS 6.1		EA 4	**MR 5.1**	EQ 6.1	
SS 6.2		EA 5	MR 5.2	EQ 6.2	
SS 7.1		EA 6	MR 6	**EQ 7.1**	
SS 7.2			MR 7	EQ 7.2	
SS 8				EQ 8.1	
				EQ 8.2	

CREDITS ACHIEVED BY OVER 60% OF BOTH USA AND NYC PROJECTS
ADDITIONAL CREDITS ACHIEVED BY OVER 75% OF NYC PROJECTS, BUT NOT BY USA PROJECTS
ADDITIONAL CREDITS ACHIEVED BY OVER 75% OF USA PROJECTS, BUT NOT BY NYC PROJECTS

NEW CONSTRUCTION
Various LEED points are typically achieved by a substantially greater percentage of New York City New Construction projects than projects in the rest of the country. These include:

SS credit 2:
Development Density and Community Connectivity

NYC: 92% ACHIEVEMENT
USA: 21% ACHIEVEMENT

SS credit 3:
Brownfield Redevelopment

NYC: 54% ACHIEVEMENT
USA: 16% ACHIEVEMENT

SS credit 4.1:
Public Transportation Access

NYC: 97% ACHIEVEMENT
USA: 64% ACHIEVEMENT

SS credit 7.1:
Non-Roof Heat Island Effect

NYC: 90% ACHIEVEMENT
USA: 61% ACHIEVEMENT

There are also LEED points or green measures that are less commonly achieved in New York City than elsewhere in the U.S:

MR credit 4.2:
Recycled Content [20%]

NYC: 49% ACHIEVEMENT
USA: 71% ACHIEVEMENT

MR credit 5.2:
Regional Materials [10%]

NYC: 36% ACHIEVEMENT
USA: 71% ACHIEVEMENT

The remaining LEED NC points are achieved by similar percentages of both New York City and country-wide projects.

In an effort to determine if these achievement discrepancies are unique to New York City or are shared by other large cities, a similar analysis was performed for San Francisco LEED NC projects. Achievement percentages in San Francisco were revealed to be similar to those in New York, implying that dense urban areas with strong public transportation infrastructure share patterns of LEED credit achievement.

COMMERCIAL INTERIORS
LEED CI projects exhibit different patterns than those found for NC projects when comparing New York City credit achievement to national averages. Of 57 possible points in the LEED CI rating system, 22 exhibit a differential of at least 20% between New York City and country-wide rates of achievement.

Many points, including the following, are more often achieved by New York City CI projects than those in other parts of the country:

SS credit 3.3:
Alternative Transportation, Parking Availability

NYC: 100% ACHIEVEMENT
USA: 59% ACHIEVEMENT

WE credit 1.2:
Water Use Reduction [30%]

NYC: 93% ACHIEVEMENT
USA: 55% ACHIEVEMENT

EA credit 3:
Energy Use, Measurement & Payment Accountability

NYC: 89% ACHIEVEMENT
USA: 46% ACHIEVEMENT

MR credit 2.2:
Construction Waste Management, Divert 75%

NYC : 93% ACHIEVEMENT
USA : 58% ACHIEVEMENT

IEQ credit 1:
Outside Air Delivery Monitoring

NYC : 86% ACHIEVEMENT
USA : 40% ACHIEVEMENT

IEQ credit 4.5:
Systems Furniture and Seating

NYC: 86% ACHIEVEMENT
USA: 48% ACHIEVEMENT

Points more often achieved in other parts of the country than in New York City suggest that the city environment may be less conducive to certain sustainable practices:

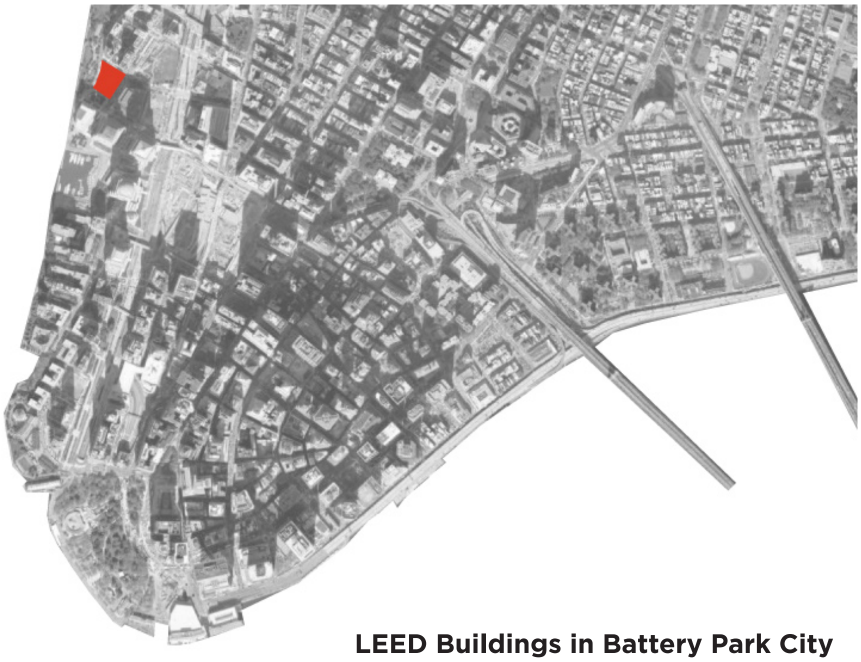
SS credit 3.2:
Alternative Transportation, Bicycle Storage & Changing Rooms

NYC : 29% ACHIEVEMENT
USA : 62% ACHIEVEMENT

CASE STUDIES

The following case studies seek to further illustrate the various methods by which LEED buildings can be analyzed in order to form a cohesive picture of the costs and benefits of building green.

CASE STUDIES: RIVERHOUSE



LEED Buildings in Battery Park City

Riverhouse is a high-rise residential project in Manhattan's Battery Park City neighborhood. Located on the southwestern tip of the island, Battery Park City is unique in that it has adopted residential environmental guidelines requiring a higher level of sustainability than the standard New York City building codes demand. The Battery Park City Authority (BPCA) requires that its buildings, in addition to achieving a minimum of LEED Gold certification, also go beyond LEED requirements by including:

- photovoltaics
- blackwater treatment systems
- green roofs
- cogeneration power
- a central heating and cooling system which filters and humidifies the air

Projects in Battery Park City have higher levels of average LEED credit achievement than other high-rise residential buildings in New York City. For the projects in this study, there are 44 common LEED points achieved by over 60% of buildings within Battery Park City whereas there are only 31 common LEED points achieved by more than 60% of LEED-seeking high-rise residential projects in other New York City neighborhoods.

As designed, Riverhouse is expected to achieve LEED Gold certification by earning 41 points. Some of the significant sustainable features integral to Riverhouse's design

CASE STUDIES: RIVERHOUSE

are the triple-glazing on the curtainwall (instead of the more common double glazing), the tracking photovoltaic panels, the blackwater and rainwater treatment systems, and the combined heat and power system.

In LEED's Sustainable Sites category, Riverhouse anticipates achieving 10 of the 14 available points, many of which are a result of its New York City location. Riverhouse is pursuing 4 out of 5 possible water points due partly to the Battery Park City Authority's requirements for blackwater treatment and reuse. Despite having photovoltaic panels that track the movement of the sun, the project pursued only 5 of the 17 energy points. This is likely due to the high energy demands of the on-site blackwater treatment plant and central air filtration and dehumidification system. Riverhouse anticipates achieving 7 of 13 possible points for materials and resources as well as 10 of the 15 points for indoor environmental quality, in part due to the BPCA's prioritization of indoor air quality and comfort. The project's innovative green strategies and adherence to the BPCA guidelines allow for the pursuit of all five points for innovation and exemplary performance.

RIVERHOUSE
COSTS & PAYBACKS

Many of the systems required by BPC for sustainability have begun paying for themselves, either directly through reduced operational costs or indirectly as selling points to tenants. Although installing a filtered central air system involved substantial up-front costs, the developer believes this system more than pays for itself by attracting and securing customers. The project is also anticipating considerable paybacks through energy cost savings. The central air system, tracking photovoltaics, triple-glazing on the curtainwall façade, extensive lighting sensors and efficiencies, and programmable thermostats have all contributed to a projected 19.9 percent savings in energy costs as compared to a base case design. As a result, the DOE-2 model indicates a $200,000 annual savings in energy costs. The blackwater system and other water conservation measures (50% total reduction in potable water consumption) are also anticipated to yield significant cost savings over time.

The Riverhouse team identified certain features as having been added solely as part of sustainable design goals that added significantly to construction costs. These include:

- central air system
- blackwater system
- photovoltaics
- triple-glazed curtainwall façade
- bamboo flooring
- programmable thermostats
- low-flow plumbing fixtures

Some of these features, however, are common to other luxury New York residences not pursing LEED, such as programmable thermostats and curtainwall facades (although double-glazing instead of triple-glazing is more often seen). Other features, such as low-flow plumbing fixtures and bamboo flooring, are comparable in cost to similar features typically used in high-end residential projects. This suggests that, at least when compared to similar luxury residential projects, those features could be viewed as part of the base costs rather than the green "additions."

Given the fact that BPCA guidelines go beyond those of the LEED rating system in many areas, the construction cost analysis of Riverhouse involved a comparison to both a conventional New York City luxury condominium as well as a New York City luxury LEED condominium. Contrasted with comparable luxury condominium buildings in New York City, Riverhouse's construction costs were just over 5 percent higher, and when compared to a LEED luxury condominium, the increase in cost was just over 4 percent. These numbers remain comparable when LEED-related fees are included.

Figure CS1:
TYPICAL NEW CONSTRUCTION CHECKLIST: HIGH-RISE RESIDENTIAL + BPCA PROJECTS

SUSTAINABLE SITES	WATER EFFICIENCY	ENERGY & ATMOSPHERE	MATERIALS & RESOURCES	ENVIRONMENTAL QUALITY	INNOVATION IN DESIGN
SS 1	WE 1.1	EA 1.1	MR 1.1	EQ 1	ID 1.1
SS 2	WE 1.2	EA 1.3	MR 1.2	EQ 2	ID 1.2
SS 3	WE 2	EA 1.5	MR 1.3	EQ 3.1	ID 1.3
SS 4.1	WE 3.1	EA 1.7	MR 2.1	EQ 3.2	ID 1.4
SS 4.2	WE 3.2	EA 1.9	MR 2.2	EQ 4.1	ID 2
SS 4.3		EA 2.1	MR 3.1	EQ 4.2	
SS 4.4		EA 2.2	MR 3.2	EQ 4.3	
SS 5.1		EA 2.3	MR 4.1	EQ 4.4	
SS 5.2		EA 3	MR 4.2	EQ 5	
SS 6.1		EA 4	MR 5.1	EQ 6.1	
SS 6.2		EA 5	MR 5.2	EQ 6.2	
SS 7.1		EA 6	MR 6	EQ 7.1	
SS 7.2			MR 7	EQ 7.2	
SS 8				EQ 8.1	
				EQ 8.2	

CREDITS ACHIEVED BY OVER 60% OF HIGH-RISE RESIDENTIAL PROJECTS
CREDITS ACHIEVED BY OVER 60% OF BPCA PROJECTS BUT NOT BY OTHER HIGH-RISE RESID. PROJECTS
CREDITS ACHIEVED BY OVER 60% OF HIGH-RISE RESIDENTIAL PROJECTS BUT NOT BY BPCA PROJECTS

CASE STUDIES: RIVERHOUSE

**RIVERHOUSE
CARBON FOOTPRINT**
Carbon footprinting can be a useful tool for understanding and quantifying the environmental impacts of a specific project; a carbon model was therefore developed to compare Riverhouse, as built, to a hypothetical Riverhouse, if built to meet code. Appendix B describes carbon modeling methodology and issues in more detail.

In order to reduce the carbon footprint of its building materials, Riverhouse used recycled coal fly ash as a supplementary cementitious material (SCM) in its concrete. However, given that the concrete in Riverhouse accounts for only 12 percent of the project's total material carbon emissions, the incorporation of fly ash does not have a large impact on the overall material carbon footprint. Nonetheless, the reduction in carbon emissions resulting from the use of recycled SCMs alone equates to removing about 24 cars from the road for one year.

Riverhouse employed certain design features such as tracking photovoltaics, a triple-glazed curtainwall, central air, and programmable thermostats in an effort to reduce the energy required to operate the building. Together, these measures reduce the operational CO emissions by 17 percent, which translates into removing approximately 164 cars from the road.

In New York City, there are numerous public transportation options. The ample bus routes and subway lines enable City residents and visitors to viably choose public transportation over private cars or taxis. As Riverhouse is located directly in Manhattan with easy access to multiple subway and bus lines, the majority of building users opt for public transportation when traveling to and from the site.

This predominant use of public transportation plays a large role in the reduction of Riverhouse's carbon footprint. When compared to a standard, non-urban case in which all building users would travel in private vehicles to and from the site, Riverhouse cuts transportation carbon emissions in half and takes the equivalent of 51 cars off the road every year.

Riverhouse's reduction in CO emissions from using recycled material, minimizing energy use, and encouraging users to travel via public transportation, when assessed over a 50 year period, will together show the building's lifetime carbon reduction. All of the measures undertaken by Riverhouse's design to reduce its carbon footprint should, when combined, prevent roughly 62,800 tons of carbon emissions from entering the atmosphere. This translates into removing about 219 cars from the road for each year the building is in operation.

Figure CS2:
CO MATERIAL EMMISSIONS

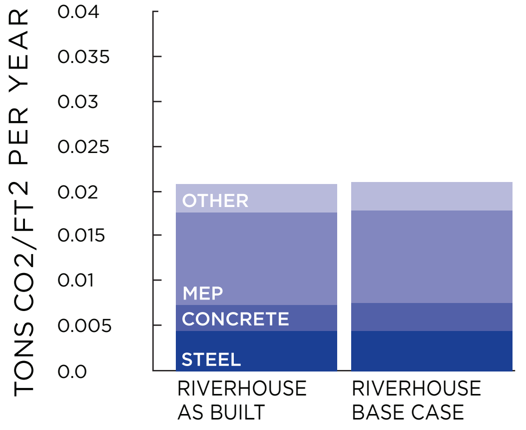


Figure CS3:
ANNUAL CO TRANSPORTATION EMISSIONS

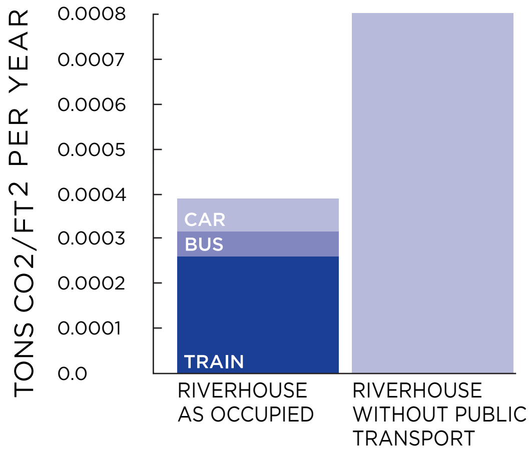
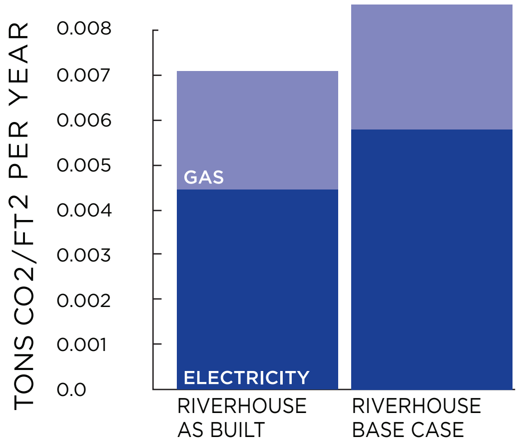


Figure CS4:
ANNUAL CO OPERATION EMISSIONS



CASE STUDIES: COOPER UNION

Cooper Union's New Academic Building is the first green academic laboratory building in New York City. Designed by Morphosis, the building anticipates achieving 53 LEED points for Platinum-level certification.

A laboratory building requires significant energy for its operation. Many of Cooper Union's sustainable strategies are geared toward reducing the overall energy grid demands of the building. Some of these strategies include:

- microturbine combined heat
- and power (CHP) system
- windows with integrated photovoltaics
- external shading systems
- radiant heating and cooling
- green roof
- The building also includes a system that uses greywater for irrigation and waste, yielding dramatic reductions in overall water use.

With its many energy reducing features, Cooper Union anticipates receiving all ten points for LEED EA Credit 1: Optimize Energy Performance. In addition, significant attention was paid to the air quality inside the building, enabling Cooper to comply with 14 of the 15 points in LEED's section regarding Indoor Environmental Quality.

Like Riverhouse, Cooper Union includes many sustainable features related to site and location. Out of the 14 possible LEED points for Sustainable Sites, Cooper Union anticipates achieving 11. Some of these, like the credits for development density and access to public transportation, were achieved by virtue of being located in New York City. Others, however, required conscious design decisions, such as controlling the quantity of stormwater runoff and minimizing light pollution.

CASE STUDIES: COOPER UNION

COOPER UNION
COSTS & PAYBACKS

As the design of Cooper Union's New Academic Building progressed, the project team realized that LEED Platinum certification was within reach. Extensive meetings were held discussing the additional sustainable features required for Platinum certification. Construction cost estimates are available for both stages of Cooper Union's design, allowing insight into the additional costs it took to advance from Gold to Platinum.

In order to analyze the increased costs associated with progressing from LEED Gold to Platinum certification, the study pinpointed which sustainable features were added after the team's decision to pursue the higher level of sustainability. These additional features included:

- installation of a system to capture and reuse greywater
- provision of low-emitting vehicles for users of the building
- photovoltaics
- purchase of green power for the operation of the building
- Implementation of a Measurement and Verification commissioning plan to evaluate the building's performance over time.

There were also additional design, LEED, and commissioning fees associated with the shift from Gold to Platinum. The hard cost of the additional sustainable features amounted to a 0.26 percent increase in the guaranteed maximum price of the project, and the additional fees resulted in a 0.57 percent increase. Together, the additional sustainable design features added 0.83 percent to the project's cost, or $4.96 per square foot.

These additional features yielded substantial savings in both energy and water costs for the operation of the building. By deciding to include a system for greywater reuse, the Cooper Union project anticipates a water use savings of 51 percent. These measures were significant enough to enable the project to pursue all five LEED points for water efficiency.

The microturbine CHP system installed within the building produces a significant amount of the building's energy and is expected to do so with greater efficiency than power produced offsite. The yearly estimated energy costs for the

Figure CS5:
CO MATERIAL EMMISSIONS

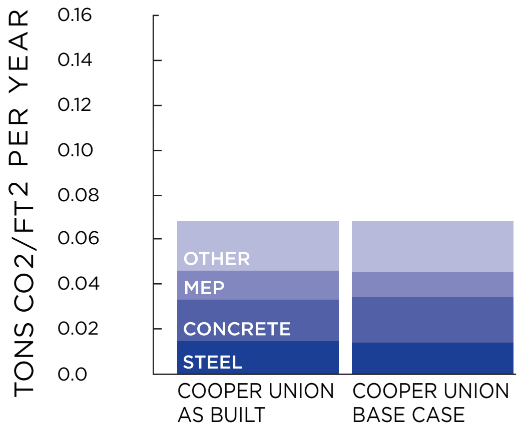


Figure CS6:
ANNUAL CO TRANSPORTATION EMISSIONS

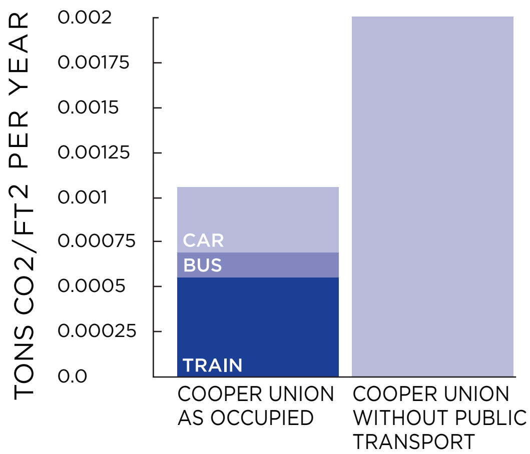
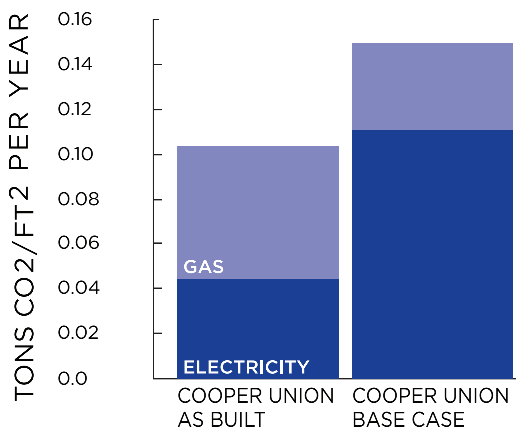


Figure CS7:
ANNUAL CO OPERATION EMISSIONS



base case building are $895,318. With all of Cooper Union's energy-saving design features and its on-site energy production, the annual estimated energy costs drop to $516,813—a savings of $379,135 or 42.3 percent every year.

- $895,318 yearly energy costs—base case
- $516,183 yearly energy costs-design case
- $379,135 saved per year
- 42.3% annual energy cost savings
- 51% Water Use Savings

COOPER UNION CARBON FOOTPRINT

A carbon footprint comparison of the project and its comparable base case served to quantify the environmental benefits resulting from Cooper Union's sustainable design features.

As with Riverhouse, Cooper Union's primary reduction in the carbon footprint of its materials came from the incorporation of slag in its concrete. In the Cooper Union project, concrete accounts for roughly 29 percent of the carbon emissions from the project's materials, and thus the use of recycled content in the concrete has a slightly greater influence than was the case for Riverhouse. The incorporation of fly ash in Cooper Union's concrete reduced carbon emissions equal to those produced by about 81 cars driving an average amount for one year.

The installation of on-site CHP microturbines provided the Cooper Union project with a significantly more efficient source of energy than if acquiring all gas and electricity from off-site sources. The project's design also included photovoltaics integrated into the building's windows, further reducing the building's external electricity requirements. Certain design elements, such as the external shading system and a green roof, served to temper the indoor air temperature and reduce demand on mechanical systems. Together, Cooper Union's energy saving strategies will reduce carbon emissions by about 31 percent. This reduction equates to removing about 170 cars from the road each year that the building is in operation.

The final contributor to a building's carbon footprint comes from occupants traveling to and from the site. As the building is located in New York City, the majority of occupants will use public transportation. Thus, Cooper Union's carbon footprint associated with occupant travel is roughly half of what would be expected from a base case project; the building's access to public transportation prevents carbon emissions equal to those produced by 34 cars each year.

By assuming a building lifetime of 50 years, we can see how the three contributors to a project's carbon footprint will accrue to estimate of the building's overall impact. When looking at the material production and transportation, the building's energy use, and occupant travel, the Cooper Union New Academic Building is estimated to produce just over 138,300 tons of CO_2 emissions over 50 years. A comparable base case building would produce over 198,600 tons of CO_2 emissions over 50 years—about 60,000 tons more than the Cooper Union design. This additional 60,000 tons of carbon emissions equates roughly to the emissions produced by 10,500 cars, or 210 cars for each year of building operation.

APPENDIX A: STATISTICAL ANALYSIS

METHODOLOGY
For the study, the project team collected cost data where possible from respondents. The cost data was normalized for time through the use of a Davis Langdon market index . Since all projects were from New York, location normalization was not necessary. The cost data for both green and standard buildings represented statistically small samples from the broader population of buildings within New York.

When sampling from a large population, it is reasonable to expect that any two samples will differ slightly, in fact, it would be remarkable if two random samples were identical. It is therefore important to establish whether the difference between two selected samples is within the variation that would be expected from two entirely random samples, or is indicative of a significant difference between the selected samples. For example, if one were to take the average age of two groups of fifteen to twenty people on the street, it would be very surprising if the two averages were identical. Since some difference is to be expected, it would be appropriate to test further to find out if the difference was within the normal range of variation, or whether it was attributable to some other factor.

The statistical significance analysis used for this type of further testing is the Student 't' test. The Student 't' test is appropriate for evaluating differences in small samples from a large population. The 't' test is a widely accepted methodology for evaluating whether differences between samples are likely to have occurred by the random variations within a population, or are likely to be due to non-random variations. The test works by evaluating the probability that the results occur due to natural variation. If the probability is high, then the variations are viewed as not statistically significant. If the probability is low, the variation can be viewed as significant.

In this study, when looking at the sample of green buildings, compared to a sample of standard buildings, the goal was to discover whether the difference between the samples is within the range that would normally be expected between any two groups of buildings, or whether it is due to the 'greenness' of the building.

For both building types included in the statistical analysis, we found that the difference in samples was likely to have arisen from natural variations in the population. In the case of Residential buildings, the confidence was at a level of 99%. For Commercial Interiors, the confidence was at a level of 77%.

VARIABILITY
One challenge of this type of population analysis for building costs is the very large variation in costs for project types regardless of sustainability goals. For all projects in the set, regardless of type, the costs ranged, for new construction from $165/SF to over $1,500/SF. Analysis across such a wide range would not be meaningful. Narrowing the range to the two population subsets where we had sufficiently large samples, allowed us to undertake a more meaningful analysis. For Residential buildings, the cost range was still large, but reasonable, running from a low of $195/SF to a high of $751/SF, with the majority of the projects lying in the $100 band from $360/SF to $460/SF. For Commercial Interiors, the range was more challenging, with costs running from a low of $50/SF to a high of $560/SF, with the majority lying in the $100 band from $100/SF to $200/SF.

While the wide variation is problematic for statistical analysis, it is informative in that it highlights the fact that there is a high degree of variability in building costs, and that sustainability is a very small component within that variability. The data sets show that it is possible to build very low cost buildings, both green and standard, and very high cost buildings, both green and standard, and that using averages as a predictive tool for cost modeling is not effective.

Table 5:
ANALYTICAL RESULTS –
COST PER SQUARE FOOT OF ANALYZED PROJECTS

RESIDENTIAL NEW CONSTRUCTION PROJECTS

	LEED	NON-LEED
POPULATION	15	22
MEAN	$437	$437
MEDIAN	$440	$408
STANDARD DEVIATION OF DATA	$100	$123

COMMERCIAL INTERIORS PROJECTS

	LEED	NON-LEED
POPULATION	12	13
MEAN	$191	$204
MEDIAN	$158	$163
STANDARD DEVIATION OF DATA	$125	$98

APPENDIX B: CARBON MODELING

METHODOLOGY
Carbon footprint analysis has become popular as a method of measuring the lifetime environmental impact of everything from products and buildings to companies or events. Carbon footprint analysis provides a quantitative way to conduct environmental comparisons and make informed choices.

For construction projects, a carbon footprint analysis involves looking at three major sources of carbon dioxide (CO_2) emissions:

- extraction, production, and transportation of building materials
- operation of the building
- occupants' transportation
- to and from the building

MATERIALS
Selection of local building materials can decrease carbon impact by reducing transportation emissions, but the most significant way to reduce the carbon footprint of building materials is to reduce the amount of virgin materials used. This can be achieved both by reducing the total materials going into the building and by maximizing their recycled content.

When calculating the carbon footprint reductions, there is a question of "additionality": what additional steps are being taken that wouldn't typically occur? Nowadays, for example, most construction steel already has a high recycled content, and thus selection of steel with recycled content is not an additional choice that will impact a building's footprint as compared to a base case. Concrete, on the other hand, can change a building's footprint as compared to a base case through the incorporation of recycled supplementary cementitious materials (SCMs) such as slag or coal fly ash.

OPERATIONS
Reduction of a building's operational carbon footprint through a decrease in total energy and "dirty" energy consumption can have a significant impact on emissions. There are multiple strategies for reducing consumption of carbon-dirty energy: designing a more efficient building envelope, producing renewable energy on-site, cogeneration, using energy efficient systems, lighting, and appliances, and encouraging a change in tenant and staff usage patterns.

Energy sources vary for different sectors of the country. Some areas use predominantly "cleaner" energy sources such as hydro or nuclear, whereas other sectors use "dirtier" energy produced from oil or coal. It is difficult, however, to argue that energy source profiles impact a project's carbon footprint given that power is shared across large areas of the country. Every new building constructed, and its associated energy demands, will have a ripple effect on energy source profiles elsewhere in the nation.

TRANSPORTATION
The carbon emissions associated with regular transportation to and from a given building can constitute a major portion of its life-time carbon emissions. The carbon footprint of project occupants' travel to and from the building is largely dependent upon the existing transportation options available in the region. Choosing a project site within a dense city center typically provides building occupants with the option to utilize public transit while traveling to and from the site. Projects in large cities like NYC typically have comparatively low transportation carbon footprints due to the ample public transportation options available. Projects in smaller cities and towns typically have a much higher carbon emissions related to transportation.

ENDNOTES

1. LEED is a green building certification system developed and maintained by the U.S. Green Building Council. For further information on LEED, please visit the USGBC web site at www.usgbc.org.

2. NYC Department of Buildings, 2008 Monthly Statistical Reports, at http://www.nyc.gov/html/dob/html/guides/foilmonthly_2008.shtml.

3. Only New Construction projects were compared to San Francisco, not Commercial Interiors projects.

4. NYC Department of Buildings, 2008 Monthly Statistical Reports, at http://www.nyc.gov/html/dob/html/guides/foilmonthly_2008.shtml.

5. It should be noted that many of the high-rise residential LEED projects in the study were not only compliant with LEED, but also with Battery Park City guidelines. These requirements are more stringent than LEED and mandate certain sustainability features that are typically high-cost.

6. Not all NC projects included in the cost analysis provided data on soft costs. The information presented in this section is based on an analysis of data from the following:

- LEED Design Team Fees: 23 projects
- Additional LEED Related Fees: 27 projects
- Commissioning Fees: 24 projects

7. Matthiessen L. & Morris P., (2007) The Cost of Green Revisited http://www.davislangdon.us/USA/Research/ResearchFinder/2007-The-Cost-of-Green-Revisited/

8. Of the 12 LEED CI projects that were a part of this study, seven represent different floors of the same office tower and have similar LEED checklists. The patterns of LEED CI achievement seen in the data might be partially due to the characteristics of this particular building; readers should be cautious about drawing conclusions about commercial interiors in New York City at large.

9. Riverhouse, completed in 2008, was developed by the Sheldrake Organization and designed by Polshek Partership Architects and Ismael Leyva Architects.

10. BPCA Residential Environmental Guidelines (http://www.batteryparkcity.org/pdf_n/BPCA_Residential_Environmental_Guidelines.pdf) and BPCA Commercial / Institutional Environmental Guidelines (http://www.batteryparkcity.org/pdf/BPCA_CommercialGuidelines.pdf)

11. This discussion is based on a comparison of 8 BPC high-rise residences with 8 high-rise residences located elsewhere in NYC.

12. For purposes of this report, Davis Langdon reviewed its internal data on typical standards for luxury condominium buildings in NYC, and confirmed these assumptions with local architects experienced in this project type.

13. The project originally aspired only to LEED Silver. However, Gold and then Platinum became the target once it was clear that this goal was achievable within budget constraints.

14. NYC relies on nuclear power for over 40 percent of its energy needs (US EPA Power Profiler), with the balance comprised of gas and oil power. Denver, Colorado, on the other hand, obtains over 70 percent of its power from coal. Given that coal energy produces significantly more carbon emissions than nuclear power, a building in NYC appears to have a lower carbon impact than the same building in Denver. In reality, however, power is shared across large areas of the country, making it difficult to make the argument that power sources impact a project's carbon footprint. Every new building constructed and its associated energy demands will have a ripple effect on energy use elsewhere in the nation. Nuclear power not used in NYC, for example, will be sent across the grid, offsetting coal or oil use in other areas (Malin, Nadav. "Counting Carbon: Understanding the Carbon Footprints of Buildings", Environmental Building News, July 1, 2008).

Furthermore, NYC already uses all of the nuclear power produced for the city. Barring the construction of additional alternative energy sources, new NYC buildings have to rely on energy sources such as oil and gas. Thus, although NYC as a region uses primarily carbon-clean energy, each individual building does not necessarily follow this profile.

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