Integrated Building and Tenant Space Case Study:
Skanska and The Empire State Building

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NRDC
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Abbreviations

ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers
CI - Commercial Interior
ECM - Energy Conservation Measure
EQ – Environmental Quality
ESB - Empire State Building
FSC - Forest Stewardship Council
HVAC - Heating Ventillation Air Conditioning
IEQ - Indoor Environmental Quality
KWH - Kilo Watt Hour
LCD - Liquid Crystal Display
LEED - Leadership in Energy and Environmental Design
M&V - Monitoring and Verification
NPV - Net Present Value
NYSERDA - New York State Energy Research and Development Authority
ROI - Return on Investment
RSF - Rentable Square Footage
USGBC - US Green Building Council
VAV - Variable Air Volume
VOC – Volatile Organic Compound

EXECUTIVE SUMMARY

Skanska USA undertook an extensive build-out of their flagship New York City office in 2008 by moving to a new space that focused on energy efficiency and sustainability. This resulted in a Leadership in Energy and Environmental Design (LEED) Platinum rating, the first for Skanska offices in the United States, and the first of any office space in the Empire State Building (ESB).

Skanska's objective for expansion of its new space was to achieve a LEED Platinum rating, the highest level LEED certification the United States Green Building Council (USGBC) awards for green commercial interiors. The goal was to offset the higher initial cost of building to the LEED Platinum level (compared to a traditional Class A office space) with an estimated 30 percent annual energy savings over the 15-year lease. Many ESB central system building improvements provide tenant benefits, and Skanska realized that situating their offices in the ESB would help them achieve their energy savings and rating goals more quickly.

To achieve greater cost savings over time, Skanska incorporated measures with a small initial cost premium over traditional building materials (such as electrical metering and control devices, etc.). Design choices, especially when made very early, played a critical role in reducing many of the project's initial costs. Skanska was able to achieve the LEED Platinum rating at break-even costs in less than five years by utilizing energy savings from the build-out itself.

Table 1 reflects Skanska's budget analysis, comparing best estimates for initial costs of a traditional Class A office space and the actual LEED Platinum cost of Skanska's space (see appendix for details); Table 2 is a life cycle cost analysis.

Table 1: Cost analysis summary

	Total Project Cost[1]	Total Cost Per Rentable Square Foot*	Construction Cost Per Rentable Square Foot
Traditional Class A Office Budget	$4,413,404	$180.88	$121.45
Skanska Actual Costs for LEED Platinum Fit-Out	$4,624,262	$189.52	$132.95
LEED Premium	$210,858	$8.64	$11.50
	(Total LEED Premium 4.7% (LEED incremental total cost/LEED project total cost)		
Electricity Savings (NPV for 15 years)	$683,200		
NYSERDA New York State Energy Research and Development Authority Grant	$20,527		
Net Savings	**$492,869 (Total electricity savings +NYSERDA grant) – (LEED premium)**		
	Total net savings: 11% (over 15 years) (Total electricity savings +NYSERDA grant)/(LEED premium)		

*See appendix for details of total and construction costs
NPV=Net Present Value NSERDA=New York State Energy Research and Development Authority

Table 2: Life cycle cost analysis

Year	Projected Cost Per Year		Savings
	LEED	Class A	
2009	$36,760	$85,039	$48,279
2010	$38,965	$90,142	$51,176
2011	$41,303	$95,550	$54,247
2012	$43,781	$101,283	$60,952
2013	**$46,408**	**$107,360**	**$60,952**
Subtotal = $272,155.84 (a less than 5-year payback)			
2014	$49,193	$113,802	$64,609
2015	$52,144	$120,630	$68,485
2016	$55,273	$127,867	$72,594
2017	$58,589	$135,540	$76,950
2018	$62,105	$143,672	$81,567
2019	$65,831	$152,292	$86,461
2020	$69,781	$161,430	$91,649
2021	$73,968	$171,116	$97,148
2022	$78,406	$181,382	$102,977
2023	$83,110	$192,265	$109,155
Total	**$855,618**	**$1,979,369**	**$1,123,751**
Electricity Cost Reduction		**57%**	
Net Present Value Electricity Savings*		**$683,200**	

*Assumes annual ConEd increase of 6 percent. Present value savings assuming 6 percent annual discount rate.
LEED = Leadership in Energy and Environmental Design

The project's total cost was $4,624,262, which was higher than a similar-sized Class A office budget by $210,858, or $8.64/rentable square foot, a 4.7 percent increase. However, the up front investment is on track to pay for itself in five years, exceeding expectations. The life cycle cost analysis shows an electricity cost reduction of 57 percent over 15 years, with a net present value of electricity savings of $683,200.

ELECTRICITY CONSUMPTION COMPARISON WITH PREVIOUS OFFICE SPACE

In the new larger space, Skanska is paying a lower energy bill on an overall larger space due to efficiency improvements; see Tables 3 and 4.

Table 3: Electricity consumption in Class A Office space

136 Madison Avenue (Class A Office) Electricity Consumption				
2008 (Actual)	**Total Electricity Cost**	**Consumption (kWh)**	**Average Cost Per kWh**	**Electricity Cost Per RSF**
January	$3,677	13,760	0.27	0.22
February	$3,921	15,520	0.25	0.24
March	$4,209	17,920	0.23	0.26
April	$3,721	14,880	0.25	0.23
May	$4,905	19,893	0.25	0.30
June	$6,896	26,160	0.26	0.42
July	$6,015	21,840	0.28	0.36
August	$8,476	24,320	0.35	0.51
September	$4,847	19,360	0.25	0.29
October	$3,915	18,560	0.21	0.24
November	$3,701	14,880	0.25	0.22
December	$3,223	13,760	0.23	0.20
Total Annual	**$57,506**	**220,853**	**0.26**	**3.49**
Comparison of annual adjusted (Adjusted Class A Office to the same RSF as ESB)	**$85,039**	**326,595**	**0.26**	**3.49**

kWh=Kilo watt hour RSF=rentable square footage ESB=Empire State Building

Table 4: Energy consumption in Leadership in Energy and Environmental Design Platinum office space				
State Building (LEED Platinum) Energy Consumption				
2009 (Actual)	**Total Electricity Cost**	**Consumption (kWh)**	**Average Cost Per kWh**	**Electricity Cost Per RSF**
January	$1,989	10,516	0.19	0.08
February	$1,987	10,506	0.19	0.08
March	$2,500	11,686	0.21	0.10
April	$2,151	10,523	0.20	0.09
May	$2,525	12,220	0.21	0.10
June	$3,414	15,733	0.22	0.14
July	$3,004	13,387	0.22	0.12
August	$2,497	11,899	0.21	0.10
September	$2,729	11,589	0.24	0.11
October	$2,602	11,597	0.22	0.11
November	$2,656	11,276	0.24	0.11
December	$2,329	10,451	0.22	0.11
Total Annual	**$30,383**	**141,383**	**0.21**	**1.25**
October	$3,915	18,560	0.21	0.24
November	$3,701	14,880	0.25	0.22
December	$3,223	13,760	0.23	0.20
Total Annual	**$57,506**	**220,853**	**0.26**	**3.49**
Comparison of annual adjusted (Adjusted Class A Office to the same RSF as ESB)	**$85,039**	**326,595**	**0.26**	**3.49**

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SUMMARY OF BENEFITS

- Raised floor and underfloor air distribution, exposing the full height of the windows and maximizing daylight
- 35 percent less lighting power density over American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) Standard 90.1-2004
- 90 percent of the office receives natural light
- 99 percent of occupants have outside views
- 100 percent individual controls for comfort and lighting
- Lighting sensors
- 89 percent of wood is Forest Stewardship Council (FSC) certified for improved indoor environmental quality

MOST IMPACTFUL MEASURES UNDERTAKEN

The two largest contributors to the project's energy reduction were:

- The underfloor air system
- The daylight-based lighting scheme

The body of the case study contains details of both measures. While Skanska's experience demonstrates a positive case overall for efficient and sustainable tenant build-outs, we do not have detailed cost data for each individual measure, which is necessary to evaluate the efficacy of each measure. Skanska's build-out process was primarily driven by the desire to achieve LEED platinum certification, rather than a direct focus on tracking the specific energy savings of every individual measure; a detailed breakout of the costs and expected savings of each measure is not available. However, tracking the monitoring and verification (M&V) of specific measures (like lighting, plug loads, HVAC) for the years following the fit-out will allow a more detailed description of the business case of the project.

For further tenant fits-outs, we recommend including energy efficiency criteria, decisions, and tracking at the design stage (such as Skanska) and throughout the build-out process. This will allow a robust cost-benefit analysis of, ideally, each energy conservation measure (ECM) and indoor environmental quality (IEQ) measure undertaken, making the creation of an efficient fit-out transparent, scalable, and replicable.

CASE STUDY BACKGROUND

Tenants play a critical role in the overall demand for commercial building retrofits. We are preparing a series of case studies to highlight the compelling business case and replicable blueprint increase that the market for high performance can build-out of large tenant spaces and energy-efficient retrofits of central building systems. The replicable models showcased in this series present tenants and owners with compelling business opportunities that demonstrate the value that can be achieved by:

- Tenants, from energy savings and increased productivity as a result of high performance build-outs/retrofits of their work spaces (and central building system improvements); and
- Building owners, from increased tenant demand, increased asset value, and energy savings, as a result of retrofitting their buildings' central systems and addressing the split incentive.

As this particular case study documents a historical analysis of a project that has already been undertaken, we have showcased all available relevant information on tenant benefits from investing in energy efficiency and increased environmental air quality measures.

PROJECT BACKGROUND

Tenant: Skanska USA, New York Headquarters
Building owners: Empire State Building Company, LLC, Malkin Holdings

Tenant company background. Skanska AB, founded in 1887 in Stockholm, Sweden, is one of the world's largest construction companies. In 2010, Skanska employed 52,000 individuals and a total of $19 billion in revenue. Skanska USA is Skanska's second-largest operating business unit, with its specialized units Skanska USA Building and Skanska USA Civil construction.[3]

In 2000, Skanska was the first global and construction company to receive International Organizational Standards (ISO) 14001 environmental certification.[4] In 2007, the company launched a new green initiative—to strengthen the company's role in environmental and energy conservation by creating energy-efficient buildings with reduced carbon dioxide emissions. To further its commitment to sustainable development, in 2008 Skanska formed a corporate Green Construction team to accelerate access to markets emerging from climate change regulation and voluntary carbon reduction activities.[5] Skanska USA's green expertise now includes more than 500 LEED-accredited professionals. Through 2008, Skanska USA had completed 70 LEED projects, and was ranked the top U.S. green builders by *Engineering News-Record*'s Top Green Contractors survey released in 2007. In 2008, Skanska USA created its local "Green Councils," and introduced its first "Green Office Manual."

Building owners company background. Malkin Holdings LLC (originally Wien & Malkin), under the direction of Anthony E. Malkin, and its operating units and partnerships has approximately 11 million square feet of trophy office property in the Greater New York area, 1.9 million square feet of retail space, 1.4 million square feet of warehouse/distribution space, and 2,700 multi-family units in 15 states. In 2010, for the second consecutive year, the office and retail properties supervised by Malkin Holdings LLC had an aggregate record level of lease transactions, totaling 1,396,314.[6]

EMPIRE STATE BUILDING (ESB): OVERVIEW OF BUILDING RETROFIT

Building background. The Empire State Building (ESB), a 102-floor skyscraper built between 1930 and 1931, was once the earth's tallest building. Many consider it the world's most famous office building, and it draws between 3.5 and 4 million visitors each year. At a height of 1,472 feet (449 meters), the spire is used for broadcasting by most of the region's major television and radio stations. The ESB has approximately 2.8 million square feet of leasable office space with a range of large to small tenants, drawn by the building's prestige, skyline views, and convenient location.

In 2008, ESB's owner, Malkin Holdings, committed to establishing the ESB as one of the most energy-efficient buildings in New York City, and the world's most environmentally conscious office tower built before World War II. He began an open source retrofit process that could serve as a leading example for other commercial building retrofit projects.[7]

Retrofit Team

- Program Manager: Jones Lang LaSalle
- Energy Service Company: Johnson Controls, Inc.
- Design Partner & Peer Reviewer: Rocky Mountain Institute
- Facilitator: Clinton Climate Initiative

Building location. Midtown Manhattan, 5th Avenue and 34th Street, New York City, NY

Building construction type. Historic skyscraper, pre-WW II

Building square footage. 2,700,000 square feet

Building use information. Office space and street-level retail

Dates of building retrofit—2008 to 2011. (As of November 2010 the window, radiant barrier, chiller rebuild, control systems, and demand control ventilation projects were complete. The remaining energy-efficiency measures are ongoing and dependent on tenant turnover/refinishing schedules.)

Energy savings target. ESB's goal was to cost-effectively reduce energy use by 38 percent (at current energy costs) and save a minimum of 105,000 metric tons of CO2 over the next 15 years, using both base building measures and tenant participation.

ESB Project Details

Motivation to undertake the whole building retrofit. ESB's owners were looking to reposition ESB and showcase the benefits and economic viability of whole-building retrofits. ESB's owners were also seeking to create a replicable model for entire-building retrofits that would significantly reduce greenhouse gas emissions. By renovating its central systems, the ESB has made it easier for tenants to realize energy savings as spaces turn over. Skanska, with its advanced efficiency goals, was an excellent complement to the newly retrofitted ESB.

Project costs. ESB's efficiency retrofit included an incremental cost of about $13 million on a $107-million capital project cost. Annual energy savings are $4.4 million, with a less than five-year pay-back, as detailed in Table 5.

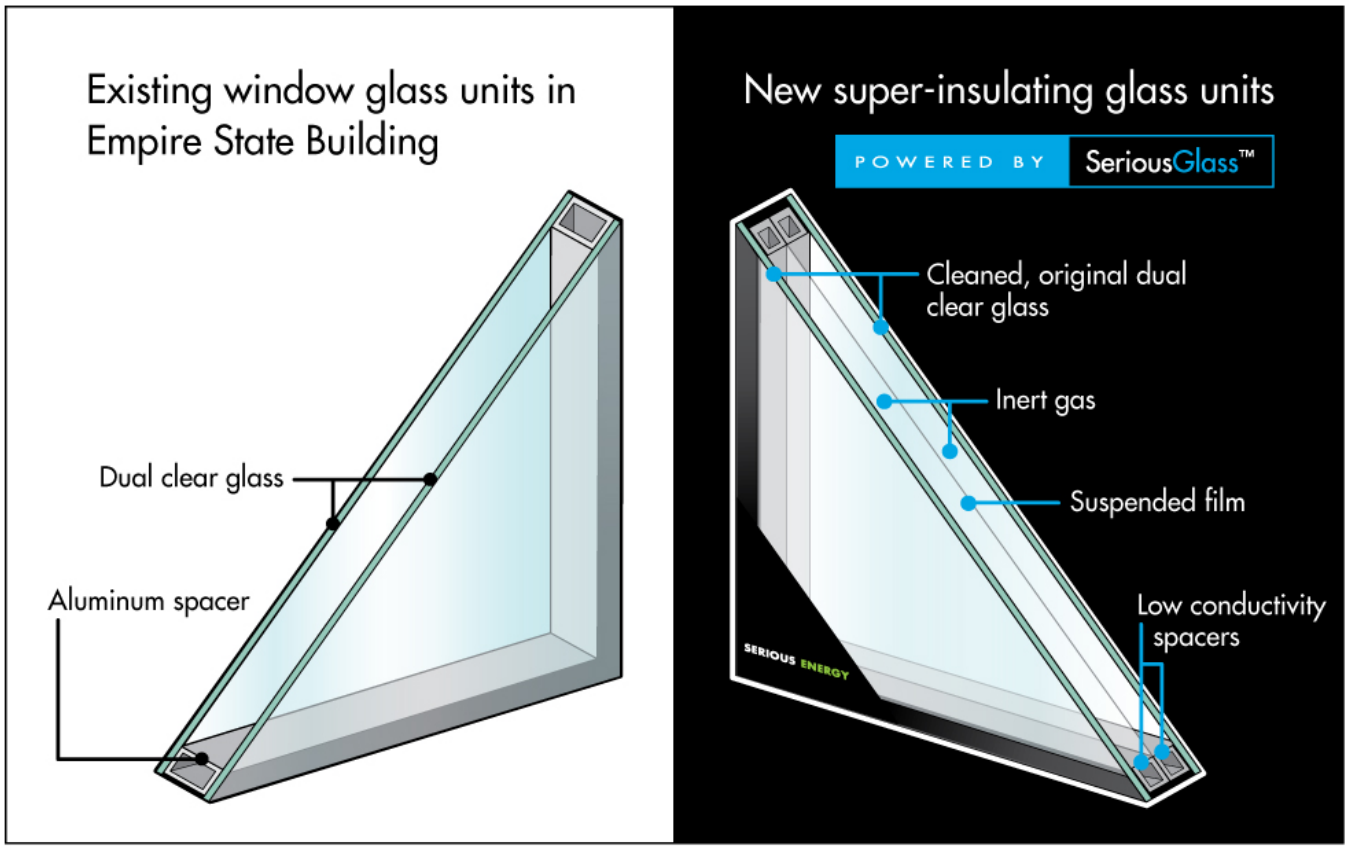

Table 5: Incremental cost and estimated savings of each ECM for the ESB

Project Description	Projected Capital Cost (in U.S. dollars)	Incremental Cost (in millions)	Estimated Annual Energy Savings
Windows	$4.5 million	$4 million	$410,000
Radiative barrier	$2.7 million	$2.7 million	$190,000
Direct digital controls	$7.6 million	$5.6 million	$741,000
Demand control vent	Included above	Included above	$117,000
Chiller plant retrofit	$5.1 million	-$17.3 million	$675,000
Variable air volume air handling units	$47.2 million	$2.4 million	$702,000
Tenant day/lighting/plugs	$24.5 million	$8.4 million	$941,000
Tenant energy management	$365,000	$365,000	$396,000
Power generation (*optional*)	$15 million	$7 million	$320,000
TOTAL (excluding power generation)	$106.9 million	$13.2 million	$4.4 million

ECM=energy conservation measure ESB=Empire State Building

CASE STUDY: SKANSKA BUILD-OUT

Lease type and term. Under the ESB's traditional lease structure, tenants paid a base monthly rental amount that included a standard electricity charge per square foot of the tenant's premises. In addition to the base rent, a tenant paid for its proportionate share of the buildings' monthly common area utility (water, electricity, steam, etc.) costs such as lobby, public corridors, restrooms, etc. As this lease structure would not incentivize a high performance build-out (under these terms the energy savings from Skanska's ECMs would accrue to the owner), Skanska negotiated its lease to include an annual base rent that excluded charges for the electricity used by Skanska, which would be sub-metered and paid directly by Skanska. This allows Skanska to directly benefit from the energy cost savings that its efficient build-out produce.

Skanska build-out team:

- Design Architect: Cook+Fox Architects
- Architect of Record: Swanke Hayden Connell Architects
- General Contractor: Skanska USA
- Mechanical, Electrical Engineer: Cosentini Associates
- Lighting Design: Ove Arup & Partners
- Environmental Consultant: Terrapin Bright Green
- LEED Consultant: Skanska USA

Tenant location. 32nd floor, Empire State Building, New York

Project square footage. Skanska RSF: 24,400 square feet
Skanska conditioned/useable square footage (USF): 16,600 square feet

Principal use. Office space for 90 employees

Dates of build-out. Started 2008; substantial completion/occupancy—November 2008
Completion: 2009

Project Scope

Integrated retrofit background. The Skanska high performance build-out coincided with the ESB owner's decision to make deep central system retrofits. This integrated building retrofit approach would provide Skanska with an enhanced Return on Investment (ROI) from the energy conservation and indoor environmental quality (collectively, "high performance") measures that Skanska decided to incorporate into the build-out of its tenant space. In particular, the improvements made to the ESB's building envelope (through window improvement and radiant barrier work) would help maximize the energy savings accruing to Skanska from its newly installed energy conservation measures. Additional benefits accrue with this approach since more than half the total energy savings in a multi-tenant building retrofit can come from retrofitting tenant spaces (see Appendix for more detail).

Energy savings target. Skanska's objective was to achieve a LEED Platinum rating, the highest level LEED certification the United States Green Building Council (USGBC) awards for green commercial interiors. The goal was to offset the higher initial cost of building to the LEED Platinum level (compared to a traditional Class A office space) with an estimated 30 percent annual energy savings over the 15-year lease. Their aim was to show their customers that building sustainably is good for business, and to further the company's ambition to be the leading green project developer and contractor in its markets. The life cycle cost analysis of the build out shows an electricity cost reduction of 57 percent over 15 years.

Project Details

Motivation to undertake the build-out. In June 2008, Skanska relocated its flagship New York City offices from their 16,500 square feet space at 136 Madison Avenue to an entire floor of the ESB. The building's central location, iconic structure, brand recognition, and competitive rate all influenced Skanska's choice.[8] The opportunity for full floor (24,400 gross square feet or 16,600 occupiable square feet) tenancy, and the ability to utilize ESB's inherent sustainability helped Skanska convert the floor to the first LEED Platinum Skanska office in the United States, and the first LEED Platinum office in the ESB.

Most office buildings in Manhattan have 10 to 13 percent of their core taken up by elevator shafts; the ESB has a 50 percent core. Tenants looking for large, contiguous space usually see such a large core as a drawback, but with a distance of only 28 feet from the operable windows (for ventilation) to the core, the ESB's 32nd floor offered a considerable sun exposure. Because it stands at a distance from other high-rise buildings in its immediate vicinity, with the right window-shades, lighting controls, and glass wall partitions, energy costs could be reduced and a pleasant environment provided for Skanska employees. The ESB is also close to mass transit, and is an older building that is being rehabilitated, rather than new construction—all of which further Skanska's goal to maximize LEED points for the project.

The project also fulfills Skanska's global sustainability goals, including demonstrating that it is possible to attain LEED Platinum status with a Class A office budget, and creating a model project to promote sustainability. Skanska was also motivated to participate in ESB's $500 million green integrated building retrofit, because it would help them reach their own energy savings and rating goals faster, particularly as many of the central system building improvements provide benefits to the tenant spaces.

Skanska's standard working practices (reuse of existing building's original materials, sorting and recycling of construction waste, contracting of local subcontractors and workers, sourcing of local materials) and use of environmentally responsible materials (certified, recycled, and zero or low volatile organic compound) could easily score 20 LEED points, and achieve a LEED Gold rating for the Skanska ESB office. However, the company's goal was to achieve the highest possible award, and the decision was made to undertake additional improvements to make the facility healthier and more productive, with lower operating costs, and to become even more energy-efficient, with the expectation of achieving a LEED Platinum rating. The company's aim was to utilize energy savings from the retrofit to offset the higher first cost and attain the Platinum rating at no additional net cost.

Challenges and solutions to efficient build-out. The goal of achieving a LEED Platinum rating at no additional net cost presented several challenges:

- The LEED Platinum design had a higher initial cost. This was overcome shortly after implementation, as the up-front investment is on track to pay for itself in five years, exceeding expectations. The life cycle cost analysis (Table 2) shows an electricity cost reduction of 57 percent over 15 years.

- The future benefits from these designs were not immediately accessible (particularly under the standard ESB lease form where future electricity savings passed on to the owner and not Skanska). Also, some benefits such as better working conditions,[9] attraction and retention of talent,[10] increased green construction experience, increased chances of getting future green business were hard to quantify and, in some cases, assign to the project itself. To meet this challenge, Skanska worked with ESB to modify the lease so that the energy savings accrue to the tenant. They were also able to justify the incremental cost based on short-term savings from decreased energy use and reap the benefits of increased productivity gains.

Decision-making process for selecting appropriate, cost effective, high performance measures. The project team, led by Cook+Fox Architects, held an environmental charrette to ensure that the team was well integrated and capable of optimizing financial resources, natural resources, and time. The charrette included key members from the tenant company, building owners, architecture, space planning, and engineering teams. A day of brainstorming led to the establishment of the following goals:

- Provide an outside view for all employees
- Use daylight as the primary light source
- Maximize energy efficiency, individual controls, and the ability to monitor energy use
- Ensure overall quality of the indoor environment (air quality, temperature, visual acuity, acoustics, controls)
- Target zero construction waste through recycling and modular design
- Track overall costs and share cost-effective green strategies, systems, and materials to help others seeking to achieve LEED Platinum on a budget

The goal was to maximize opportunities to achieve LEED points while minimizing costs. As the contractor and future occupant, Skanska was equipped to track construction, development, and operations costs, as well as all soft costs. Using electric bills from its existing Class A office on Madison Avenue, the company established a baseline for comparison with the new space.

Financing Mechanisms

Financial incentives used. A NYSERDA (New York State Energy Research and Development Authority) grant was obtained for $20,527 for the New Construction Program, which provides assistance incorporating energy-efficiency measures into the design, construction, and operation of new and substantially renovated buildings.

Tenant fit-out financing details. The Skanska floor fit-out was entirely self-financed (net of NYSERDA incentives). The grand total cost of the project was $4,624,262.

ECMs and IEQs Installed

Daylight-based lighting scheme. By leasing the entire 32nd floor, the firm gained a 360° view over Manhattan, as well as daylight in every season and direction. At that level, the skyscraper's H-shaped floor plan centers on a building core with 38 elevators. The resulting core-to-footprint ratio of approximately 50 percent is two to three times greater than typically found in a mid-rise office building, making the amount of floor area available for occupancy a relatively shallow ring around the perimeter. The design team took maximum advantage of the daylight and view opportunities by:

- Positioning private executive offices against the core, no perimeter offices
- Ensuring daylight and views for all occupants
- Using indirect lighting with daylight sensors
- Providing individual lighting controls
- Using glass partitions to give all work spaces exposure to the outdoors
- Using "borrowed" daylight through the translucent wall of an adjoining conference room for the reception area
- Using corridors for circulation and daylighting purposes, providing uninterrupted views to maintain a sense of orientation.

The lighting scheme uses strategically placed, energy-efficient fluorescent fixtures and LED task lamps at each workstation, reducing the lighting power density by 35 percent over ASHRAE Standard 90.1-2004. Occupancy sensors and daylight dimming controls, which further reduce the lighting load, are based on a networked digital system that allows each fixture to be individually managed. As a result, the office's lighting system is highly responsive to available daylight, occupancy patterns, and local and manual controls.

Raised floor and underfloor air distribution. Skanska's renovated office features a 10-inch raised floor with underfloor air distribution, which permits the removal of the previously existing hung ceiling and overhead ventilation systems. The underfloor air system is one of the two largest contributors to the project's energy reduction. With the raised floor and an underfloor air distribution system, occupants enjoy greater ceiling heights, more flexibility, and improved daylighting.

As a result of this system, ceiling heights increased by 12 inches under structural beams, and 9 feet 10 inches in the rest of the space. Each quadrant of the floor is served by an air tower supplying conditioned filtered air with an effective radius of 50 feet to 75 feet, allowing the system to be tailored for different solar orientations. The new scheme:

- Exposes the full height of the windows, increasing the clear vision area by 19 percent
- Delivers daylight to 90 percent of office space
- Delivers outside views to 99 percent of employees
- Includes individual thermal comfort controls, and typical workstations have exposed ceilings and swirl diffusers for controlling airflow from the raised floor
- Raises the occupant's line of sight (appreciably increasing the perception of glazed window area) by reducing the typical sill height from 32 inches to 22 inches

The underfloor system uses a low static pressure of 0.15 inch w.g. (water gauge) (external), reducing fan energy use and allowing an increased supply air temperature of 63°F to 68°F dry bulb. Moisture is removed from incoming outside air by a separate cooling coil, which pre-treats outside air before it is mixed into the return airstream. Variable-frequency drives in each air tower save energy by constantly adjusting airflow according to variations in space loads and static pressure in the raised plenum. This also allows employees to easily manage the airflow in their working environment.

Other operational practices:

- ENERGY STAR-rated computers and appliances used throughout
- All eight conference rooms are equipped with projectors instead of energy-intensive LCD screens
- A two-year commitment was made to purchase renewable energy credits for 144,000 kWh of electricity generated from wind, biomass, and hydroelectric sources, an amount that exceeds annual company electricity consumption
- As the floor directly below Skanska's space was unoccupied and unconditioned, the floor penetrations are minimized to maintain thermal comfort levels

EQ measures:

- Increased energy efficiency of the HVAC system, and improve the system's performance in terms of air quality, thermal comfort, and control
- Utilized MERV 13 filters to provide high quality filtered air throughout the office, delivered at a maximum of 26 cfm (cubic feet per minute) per person; a MERV 13 filter will move the HVAC filtration system into the realm of controlling respirable-size particles, including most bacteria and airborne mold spores; the overall efficiency of the system makes up for the 0.6 inch pressure drop across the filters
- All spaces receive 30 percent more outdoor air than required, providing a healthier air environment
- Variable air volume (VAV) diffusers in high density spaces such as conference rooms bring in additional outdoor air when triggered by CO2 or temperature sensors, helping achieve an optimum balance between energy use and indoor air quality
- Low-VOC carpeting, paints, adhesives, wood products, and furniture used
- Office chairs are GREENGUARD certified, and systems furniture uses Forest Stewardship Council (FSC)-certified core materials with no added urea formaldehyde

Building envelope details:

- Windows U-value: 0.36 (the rate of heat loss is indicated in terms of the U-factor/value of a window assembly; the lower the U-factor, the greater a window's resistance to heat flow and the better its insulating properties. High-performance double-pane windows can have U-factors of 0.30 or lower.)
- Solar Heat Gain Coefficient (SHGC): 0.36 (The SHGC is the fraction of incident solar radiation admitted through a window, both directly transmitted and absorbed and subsequently released inward. SHGC is expressed as a number between 0 and 1. The lower a window's solar heat gain coefficient, the less solar heat it transmits. For the climate in New York, a SHGC of below 0.40 is recommended.)

Skanska pushed all the design solutions to their limits and systematically pursued all the LEED points that could be gained in order to achieve an LEED Platinum rating. Plans for the ESB retrofit include re-glazing all of the skyscraper's windows; once this is completed, energy performance on Skanska's floor can be expected to improve even more.

Monitoring and Verification Protocols

Details of sub-metering. Meters were installed for electricity, chilled water (i.e. cooling), and steam consumption (i.e. heating.), and the data from the office at 136 Madison Avenue and the LEED office at ESB were noted (see Tables 6 and 7).

Table 6: Electricity consumption at 136 Madison Avenue

2008 (Actual)	Cost	Consumption (kWh)	Average Cost Per kWh	Electricity Cost Per RSF
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December	$3,223	13,760	0.23	0.20
Total Annual	**$57,506**	**220,853**	**0.26**	**3.49**
Comparison of annual adjusted (Adjusted Class A Office vs. same RSF as ESB)	**$85,039**	**326,595**	**0.26**	**3.49**

kWh=Kilo watt hour RSF=rentable square foot ESB=Empire State Building

Table 7: Electricity consumption for the Skanska LEED Platinum office at Empire State Building				
2009 (Actual)	**Cost**	**Consumption (kWh)**	**Average Cost Per kWh**	**Electricity Cost Per RSF**
Jan	$1,989	10,516	0.19	0.08
Feb	$1,987	10,506	0.19	0.08
Mar	$2,500	11,686	0.21	0.10
Apr	$2,151	10,523	0.20	0.09
May	$2,525	12,220	0.21	0.10
Jun	$3,414	15,733	0.22	0.14
Jul	$3,004	13,387	0.22	0.12
Aug	$2,497	11,899	0.21	0.10
Sep	$2,729	11,589	0.24	0.11
Oct	$2,602	11,597	0.22	0.11
Nov	$2,656	11,276	0.24	0.11
Dec	$2,329	10,451	0.22	0.11
Total Annual	**$30,383**	**141,383**	**0.21**	**1.25**
ESB LEED Office Annual Adjusted (Madison office rate used)	$36,760	141,383	0.26	1.51

kWh= kilo watt hour RSF=rentable square foot ESB=Empire State Building LEED=Leadership in Energy and Environmental Design

Skanska Project Costs

The total project cost was $4,624,262, which was higher than a hypothetical Class A office budget by $210,858 (or $8.64/rentable square foot, a 4.7 percent increase). However, the up-front investment is on track to pay for itself in five years, exceeding expectations.

Projected over Skanska's 15-year lease, the net present value of energy saved is $683,200. When combined with a $20,527 grant anticipated from the NYSERDA, a public agency funded by a statewide utility surcharge, the project represents a net gain of $492,869, or 11 percent. Even before accounting for health, productivity, or marketing benefits, the documented energy savings were enough to tip the cost equation in favor of pursuing LEED Platinum.

Cost Analysis Summary

Skanska's budget analysis (see Table 8), containing best estimates for initial costs of a traditional Class A office space and the actual LEED Platinum fit out-cost of Skanka's space (see Appendix for details):

Table 8: Cost analysis summary: Class A office vs. LEEDS premium office			
	Total Project Cost	**Total Cost (Per RSF)**	**Construction Cost (Per RSF)**
Class A Office Budget	$4,413,404	$180.88	$121.45
Actual Costs	$4,624,262	$189.52	$132.95
LEED Premium	$210,858	$8.64	$11.50
	Total LEED Premium 4.7% (LEED incremental total cost/LEED project total cost)		
Electricity Savings (NPV for 15 years)	$683,200		
NYSERDA Grant	$20,527		
Net Positive	**$492,869 (Total electricity savings + NYSERDA grant)/LEED premium**		
	Total Savings 11%		

The project's total cost was $4,624,262, $210,858 or $8.64/rentable square foot (4.7 percent) higher than a hypothetical Class A office budget. However, the up-front investment is on track to pay for itself in five years, exceeding expectations. The life cycle cost analysis shows an electricity cost reduction of 57 percent over 15 years, with a net present value of electricity savings of $683,200.

Skanska does not have a measure by measure breakdown of the cost, because they believe it is difficult to separate out the costs, and more effective to look at the integrated cost of the entire project.

Energy Performance Project Results

Skanska's project team has tracked electricity consumption and costs since the December 2008 move-in date. For the first year, the office's electricity consumption totaled 141,383 kWh, or an average of 11,782 kWh per month. After adjustment for square footage and electricity rates in the company's previous Class A office space, Skanska's new office saved 57 percent in electricity costs.

Over the 15-year lease, Skanska forecasts a savings of more than $650,000 in electrical costs alone. Chilled water and steam use were not measured at the previous office, but are metered in the new space to produce a baseline and track efficiency, even though they are included in the base rent.

The two largest contributors to the project's energy reduction were the underfloor air system and the daylight-based lighting scheme. Project engineers modeled overhead and underfloor air systems, and calculated that the underfloor system would consume 27 percent less electricity.

Energy use intensity:

- Electricity: 29 kBtu/sq. ft.
- Chiller water and steam meters were installed recently: data not yet available
- Annual source energy (electricity only): 97 kBtu/sq. ft.

Table 9: Life cycle cost analysis

		Projected Cost Per Year		
Year Number	**Year**	**LEED**	**Class A**	**Savings**
1	2009	$36,760	$85,039	$48,279
2	2010	$38,965	$90,142	$51,176
3	2011	$41,303	$95,550	$54,247
4	2012	$43,781	$101,283	$57,502
5	**2013**	**$46,408**	**$107,360**	**$60,952**
Subtotal = $272,155.84 (Less than 5 year payback)				
6	2014	$49,193	$113,802	$64,609
7	2015	$52,144	$120,630	$68,485
8	2016	$55,273	$127,867	$72,594
9	2017	$58,589	$135,540	$76,950
10	2018	$62,105	$143,672	$81,567
11	2019	$65,831	$152,292	$86,461
12	2020	$69,781	$161,430	$91,649
13	2021	$73,968	$171,116	$97,148
14	2022	$78,406	$181,382	$102,977
15	2023	$83,110	$192,265	$109,155
Total		**$855,618**	**$1,979,369**	**$1,123,751**
Electricity Cost Reduction				**57%**
Net Present Value Electricity Savings Note: Assuming annual Con Ed increase of 6%. Present value savings assuming 6% annual discount rate. Carbon footprint reduction: 159,282 lb/year or 79.64 tons/year				**$683,200**

PROJECT OUTCOMES

Awards achieved:

- 1st USGBC LEED Platinum-CI office for Skanska USA
- 1st USGBC LEED Platinum-CI office space in the ESB

Summary of benefits:

- 35 percent less lighting power density over ASHRAE Standard 90.1-2004
- 90 percent of the office receives natural light
- 99 percent of occupants have outside views
- 100 percent individual controls for comfort and lighting
- Lighting sensors
- Pressurized raised floor
- 89 percent of wood is FSC-certified

The two largest contributors to the project's energy reduction were:

- The underfloor air system
- The daylight-based lighting scheme

The body of the case study contains details of both of these measures.

Lessons learned that can be replicated in similar projects. Skanska's Empire State Building office renovation demonstrates the potential for energy savings in existing buildings.

LEED on a budget. Skanska evaluated the costs and benefits of each potential LEED strategy. Some, such as indoor chemical and pollutant source control, were deemed technically feasible, but financially untenable. While they were not able to stay within a first-cost Class A budget, Skanska was able to offset its marginal incremental first cost with the annual energy savings it will accrue from the efficiency measures. The project's NPV is $683,000 with a five-year payback. Design choices, especially when made at a very early stage, played a critical role in reducing many of the project's first costs.

Early adopter challenges. Because Skanska's renovation preceded the building's larger retrofit, the project broke ground in some areas. For example, seeking approval for waterless urinals pitted Skanska against New York City's 1968 plumbing code, changes to which had not yet been fully implemented. Winning approval for bringing bicycles into the building was an easier process, and placed the building ownership a step ahead of a 2009 law requiring owners to provide reasonable access to freight elevators. However, being an early adopter also benefits Skanska by enhancing its reputation as a leader in green buildings.

Top-down commitment. Skanska's corporate commitment to sustainability shaped the project's goals and some of its details. For example, many staff members initially wanted private offices along the perimeter windows, but all offices were eventually positioned against the core to provide maximum daylight and views to all. Having top level buy-in to the efficiency and cost savings goals were critical to the success of the project.

Tenant incentives. Lease terms can influence tenants to make energy-efficient choices. Conventional leases in New York City call for electric capacity of 7.5 W/square feet, but Skanska's project team calculated that the office would need less than one-third of that amount. As the lease was negotiated, Skanska was cautious about adjusting its terms to such a low capacity, seeing no benefit and potential risks in doing so. Skanska's landlord at the Empire State Building helped address this situation by deploying a new "use it or lose it" clause. While tenants are not prevented from using the full electric capacity in their leases, if they are not consuming it after a period of time, they must either pay to keep it in reserve or lose the right to excess watts per square foot.

Leading by example. Skanska's project is a model for other prospective tenants. The ESB has used the Skanska office to demonstrate the possibilities for interior build-out projects, and is working with other tenants to create high performance spaces that maximize strategies such as daylighting and automated lighting controls.

Monitoring and verification (M&V) for future projects. Skanska tracked overall project costs, and the results of their submetering in the years following the fit-out will yield a more detailed description of the project business case. For similar projects involving future tenant fit-outs, including further energy efficiency cost-benefit analysis and making decisions at the design stage itself, and throughout the build-out process, is recommended. This will allow a robust cost-benefit analysis of, ideally, each ECM and IEQ measure undertaken, making an efficient fit-out transparent, scalable, and replicable for the wider community.

As this particular case study documents historical analysis of a project that has already been undertaken, we have showcased as much relevant information as is available on these benefits to the tenants that resulted from investing in energy efficiency and increased environmental air quality measures.

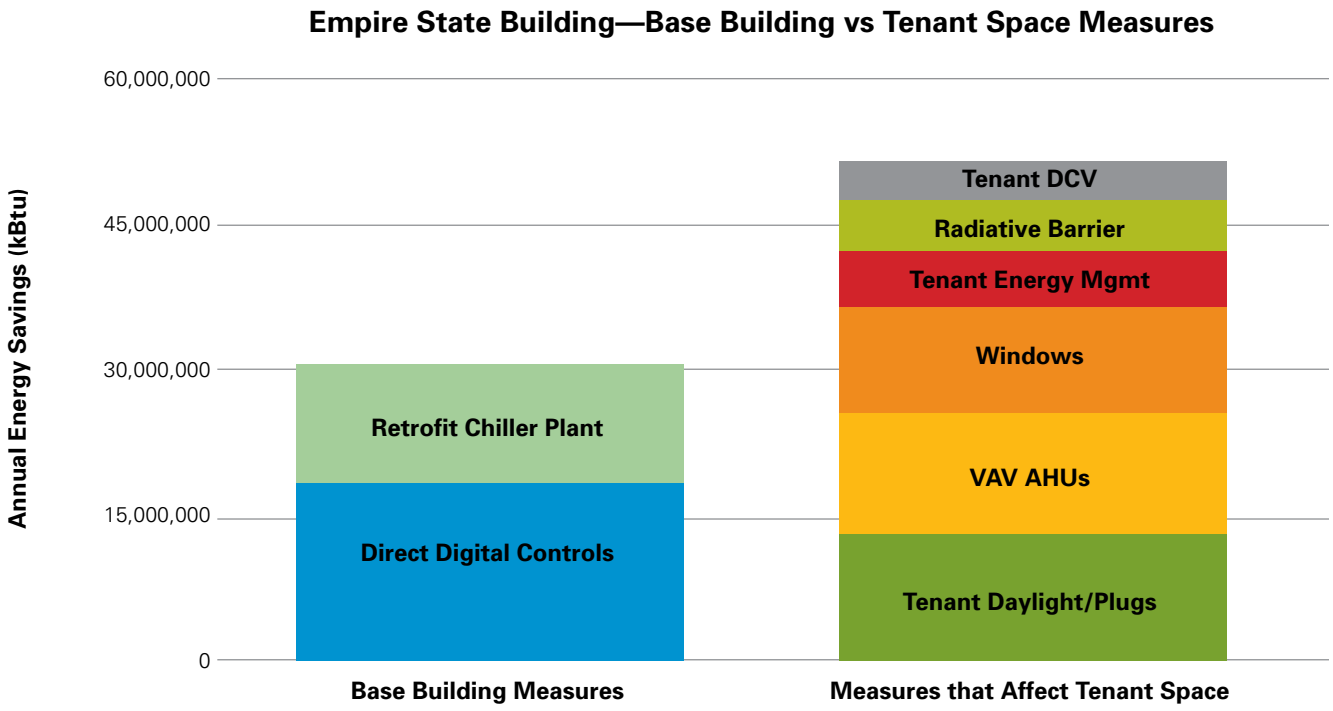
This demonstration project is a partnership among Goldman Sachs, Johnson Controls, Jones Lang LaSalle, Vornado, YR&G, and Greenprint Foundation. This project is made possible by the generous support of Goldman Sachs and Rockefeller Foundation.

APPENDIX

Figure 1: Skanska USA Building Project Budget Analysis

Description	Class A Budget	LEED Platinum
General Requirements	$7,400	in GC
Concrete	$25,000	in GC
Waterproofing	$3,375	in Trades
Appliances	$3,750	$5,490
Ornamental Metals	$25,000	$10,700
Millwork	$248,462	$342,000
Firestopping	$8,703	in Trades
Joint Sealers	$8,703	in Trades
Hollow Metal and Hardware	$41,250	In Rough Carp.
Architectural Metal & Interior Glass	$274,000	$94,000
Rough Carpentry	$11,203	$267,000
Drywall	$99,156	In Rough Carp.
Ceilings	$179,010	In Rough Carp.
Carpet	$96,708	$105,000
Ceramic Tile	$48,525	$46,000
Painting	$29,581	$72,800
Raised Floor	$0	$126,000
Architectural Wall Systems	$0	$276,000
Moveable Walls	$0	$12,000
Specialties	$79,000	in Plumbing
Window Treatments	$31,680	in Furniture
Plumbing	$104,514	$80,000
HVAC	$734,559	$720,000
Fire Protection	$159,273	$115,000
Electrical	$309,845	$703,000
Telecommunications	$79,865	$43,652
Security	$26,758	$26,190
Indirects	$26,353	$0
Construction Subtotal	**$2,661,673**	**$3,044,832**
General Conditions	$270,000	$270,000
Bond (Subguard)	$0	$0
GLI	$31,731	$28,377
Construction Total w/o furniture	**$2,963,404**	**$3,343,209**
Audio Visual	$0	$130,704
Office Move Consultant	$100,000	$17,920
Office Movers	$0	$12,464
Furniture	$900,000	$577,615
Window Shades	$0	$68,500
Furniture Allowance Remaining	$0	$0
Furniture Grand Total	**$1,000,000**	**$807,203**
Architect, Space Planning, LEED Consult.	$450,000	$294,850
MEP Engineering and Elec Consult.	$0	$152,000
Permit and Expediting	$0	$12,000
Controlled Inspections	$0	$15,000
Professional Services Total	**$450,000**	**$473,850**
Project Grand Total	**$4,413,404**	**$4,624,262**

Figure 2: ESB Energy Savings seen from Base Building and Tenant Space Efficiency Measures



METHODOLOGY

This case study was based on primary research (conversations with managers at Skanska), and secondary research, in particular drawing from the following documents:

- Darden Business School, University of Virginia: Case study on the Skanska USA Building
- Skanska's power point on their ESB build out
- Inside the Icon, by Elizabeth J. Heider and Alice Hartley; High Performance Buildings, Spring 2010
- ESB's website: esbsustainability.com/SocMe/Content/Files/ESBOverviewDeck.pdf

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SOURCES AND ENDNOTES

1. Heider EJ, Hartley A. Inside the Icon. High Performance Buildings, Spring 2010.
2. See appendix for details of total and construction costs.
3. *Skanska Annual Report 2010*, www.skanska.com. skanska.com/Global/Investors/Reports/2010/Annual%20Report/Skanska_Annual_Report_2010.pdf. Accessed September 14, 2011.
4. ISO 14001 Environmental Management. *BS EN ISO 14001*. iso14000-iso14001-environmental-management.com, iso14000-iso14001-environmental-management.com/iso14001.htm. Accessed September 14, 2011. ISO 14001 specifies the actual requirements for an environmental management system. It applies to those environmental aspects which the organization has control and over which it can be expected to have an influence;.
5. *Skanska Annual Report 2007*. www.skanska.com. skanska.com/Global/Investors/Reports/2007/annual_report/skanska_annual_report_2007.pdf. Accessed September 14, 2011.
6. malkinsecurities.com/pdf/reinvestor/REINV_WINT_11.pdf
7. The retrofit of the ESB was done in conjunction with a major renovation of the entire building itself.
8. One of the reasons why the rate was competitive was the need for any new tenant to do significant refurbishment work—which was at the same time an opportunity for Skanska to create a LEED certified facility.
9. Katz G, Capital E. *The cost and financial benefits of green buildings, a report to California's sustainable building task force*. www.usgbc.org. (2003), usgbc.org/Docs/News/News477.pdf. 2003. Accessed September 14, 2011. It is shown in this report that the initial cost of a green building—in the range of $3 to 5 per square foot is more than compensated by the respective NPVs over 20 years of energy savings ($ 5.8 per square foot), emission savings ($ 1.2), operating and maintenance savings($ 8.5) and productivity and health benefits (which at $ 36.9 to $55.3 are by far the largest).
10. From the 2008 Annual report: "Being a green builder […] has a positive effect on recruiting and human resource development. Employees are proud of green projects and of being able to contribute to an enhanced environment on our planet."