Urban Land Institute

ULI Tenant Energy Optimization Program

Case Study:
Cushman & Wakefield Inc.

Executive Summary: Cushman & Wakefield's Story

In July 2015, Cushman & Wakefield Inc.—the global commercial real estate services provider—moved its Lower Manhattan office into 7,500 square feet on Floor 45 of the iconic and newly built One World Trade Center.

It was critical that Cushman & Wakefield's new space capture the company's core values and culture. A lease in the One World Trade Center was a great start: the 3 million-square-foot icon is a symbol of Lower Manhattan's revitalization. So when it was time to design and construct its space, Cushman & Wakefield had three major goals: to showcase its brand and culture in the iconic building; build out the space as energy efficiently and sustainably as possible; and maximize employee comfort and satisfaction.

Enter the Tenant Energy Optimization process—a proven, replicable approach that integrates energy efficiency into tenant space design and construction and delivers excellent financial returns through energy conservation. Working in partnership with building owners The Durst Organization and The Port Authority of New York & New Jersey (PANYNJ), as well as a team of experts, Cushman & Wakefield evaluated an integrated package of energy performance measures (EPMs)[1] for its offices on the 45th floor. The chosen EPMs were incorporated into the space design to achieve substantial, cost-effective energy savings and a superior workplace environment.

Over the term of Cushman & Wakefield's 10-year lease, the project is estimated to provide energy costs savings of more than $87,862, a 359% return on Cushman & Wakefield's investment[2], and a 78.6% internal rate of return (IRR)[3]. The projected payback: only 1.7 years. Cushman & Wakefield's project is particularly notable because it was part of the Tenant Energy Optimization process pilot project rollout and effectively served as training for both Cushman & Wakefield and professional consultants for use in future client projects. The results were also used to inform future projects by other tenants in New York City.

Cushman & Wakefield's project is part of a series of case studies aimed at presenting the energy and cost savings impact of high-performance tenant design. The case studies and companion resource guides[4] provide the market a replicable model to expand the demand for high-performance tenant spaces and supply of market expertise to deliver strong results from such projects. Spaces using this step-by-step design and construction process typically demonstrate energy savings between 30% to 50%[5], have payback periods of three to five years, and average a 25% annual return.

1. EPMs are technologies and systems that aim to reduce energy use through efficiency and conservation. They are also frequently referred to as Energy Conservation Measures (ECMs).
2. Assuming zero escalation in electricity prices over the lease term and a 5% administrative fee per the terms of tenant's lease.
3. The discount rate often used in capital budgeting that makes the net present value of all cash flows from a particular project equal to zero. Generally speaking, the higher a project's internal rate of return, the more desirable it is to undertake the project. (See more: http://www.investopedia.com/terms/i/irr.asp)
4. The guides can be accessed at TenantEnergy.uli.org.
5. Compared to American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) 90.1 2007 code requirements.

What Is the 10-Step Tenant Energy Optimization Process?

The Tenant Energy Optimization process is a proven, replicable approach that integrates energy efficiency into tenant space design and construction and delivers excellent financial returns through energy conservation.

What Are the Benefits of the Tenant Energy Optimization Process?

It generates an attractive return on investment (ROI)—Tenants using the step-by-step design and construction process typically have experienced:

- ☐ Energy savings of 30 percent to 50 percent
- ☐ Payback in as little as three to five years
- ☐ An average annual internal return rate of 25 percent

It provides a competitive edge—Companies with more sustainable, energy-efficient workplaces enhance their ability to attract, retain and motivate workers who are healthier, happier, and more productive.

It is scalable and replicable—The process can provide energy and financial savings whether the tenant leases 2,500 or 250,000 square feet. Tenants and service providers who have gained expertise through implementation of the process have demonstrated that there is high potential for transferability beyond tenant office space to other property sectors.

It is proven—Through measurement and verification, tenants are able to demonstrate and communicate energy and financial savings.

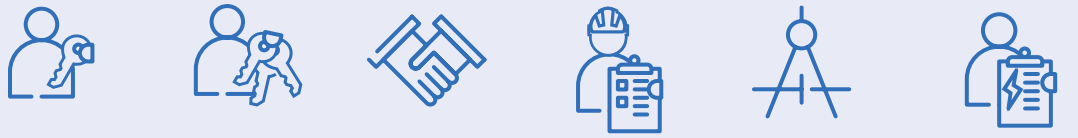
It is environmentally critical—Energy use in buildings is the largest source of climate-changing carbon pollution and tenant spaces generally account for more than half of a building's total energy consumption, making this process essential to improving the environmental performance of buildings and addressing global climate change.

Overview: Cushman & Wakefield Project Information and Projected and Measured Performance

Building Information				
Tenant Name	Cushman & Wakefield Inc.			
Building Owner	The Durst Organization / Port Authority of New York & New Jersey			
Location	One World Trade Center, Lower Manhattan			
Building Size	3 million square feet (1,776 feet high)			
Principal Use	Class-A office			
Construction Type	Modern skyscraper			
Cushman & Wakefield Lease Term	10 years			
Floor 45 Build Out	**Projected Design**		**M&V Calibration**	
Modeled Square Footage	5,932 square feet		5,932 square feet	
Modeled Energy Reduction	52.6%		47.5%	
Annual Electricity Reduction	46,696 kWh	7.9 kWh/SF	42,889 kWh	7.2 kWh/SF
Total Electricity Savings over Lease Term	0.5 GWh	78.7 kWh/SF	0.4 GWh	72.3 kWh/SF
Incremental Implementation Cost: ***Energy Modeling Soft Cost:*** ***State Incentives:***	$13,790 *$5,500* *$0*	$2.32/SF *$0.93/SF* *$0/SF*	$13,790 *$5,500* *$0*	$2.32/SF *$0.93/SF* *$0/SF*
Adjusted Incremental Implementation Cost	$19,290	$3.25/SF	$19,290	$3.25/SF
Total Electricity Costs Savings over Lease Term	$95,663	$16.13/SF	$87,862	$14.81/SF
Electricity Cost Savings over Lease Term (Present Value)	$74,942	$12.63/SF	$68,831	$11.60/SF
Net Present Value of Project Investment	$55,652	$9.38/SF	$49,541	$8.35/SF
Return on Investment over Lease Term	404%		359%	
Internal Rate of Return	57.5%		78.6%	
Payback Period (with incentives)	2.2 years		1.7 years	

Who Is Involved in the Tenant Energy Optimization Process?

It is collaborative—The process connects the dots between tenants, building owners, real estate brokers, project managers, architects, engineers, and other consultants to create energy-efficient workplaces. In this regard, the process reflects ULI's longstanding tradition of bringing together professionals from a variety of real estate disciplines to improve the built environment.



Tenants | Building Owners | Real Estate Brokers | Project Managers | Architects, Engineers, and Contractors | Energy Consultants

Supply and Demand: The Role of the Broker, Tenant, Building Owner, and Consultants

Leasing brokers are influential tenant advisers during the pre-lease phase. If experienced in energy efficiency conversations, brokers can help tenants demand and understand building energy performance information during the site-selection process. Brokers who highlight case studies or examples of work representing tenants in the selection of high-performance spaces may gain additional clients.

Tenants create demand for energy-efficient, high-performing space. Tenants also create demand for consultants who can advise them on how to reach their sustainability goals through the design and construction of energy-efficient space. By prioritizing energy-efficient space and working closely with their advisers, tenants can develop better workplaces to attract and motivate employees, attain recognition for sustainability leadership, and manage costs.

Building owners supply high-performance buildings that help tenants meet their energy performance and financial goals. Real estate owners can gain competitive advantages by marketing energy-efficient buildings' cost-saving energy and operations improvements to attract high-quality, sophisticated tenants. Tenants may prefer longer lease periods in highly efficient buildings that better align with their corporate environmental and social responsibility goals, provide financial benefits, and add recognition value.

Consultants (e.g., architects, engineers, project managers, energy consultants, and contractors) provide the expertise to optimize energy performance and present the technical options and economic case for a comprehensive, cost-effective, and high-performance space while meeting the tenant's schedule and budget. Consultants offering these services may attract additional clients by demonstrating cost savings and other benefits to tenant's business goals.

Key steps for choosing a high-performing space include:

1. Select a leasing broker experienced in energy efficiency.
2. Convene a workplace strategy and energy performance optimization workshop.
3. Perform a financial analysis.
4. Assess high-performance space feasibility.
5. Meet with the building owner to discuss collaboration to improve energy performance.

Selecting an Efficient Base Building

Good:

- ☐ Building reports ENERGY STAR score
- ☐ Ongoing tenant-landlord energy efficiency coordination
- ☐ Landlord willing to allow submetered tenant space

Better—includes all of Good, plus:

- ☐ Building ENERGY STAR score of 75 or higher
- ☐ Central building management system (BMS) with tie-in of tenant heating, ventilating, and air conditioning (HVAC) and lighting
- ☐ Building energy audit, ongoing commissioning activities, and energy capital projects completed
- ☐ Submetered tenant space with energy billed on actual usage

Best—includes all of Better, plus:

- ☐ Subpanels to measure tenant lighting, HVAC, and plug loads separately
- ☐ Tenant energy management program (such as a dashboard)

Questions to Ask the Building Owner

What is the building's ENERGY STAR score? The EPA recognizes top-performing buildings that meet or exceed a score of 75. Even if a building has not achieved ENERGY STAR recognition, an owner that tracks and reports the building's score may be more willing to collaborate on energy efficiency efforts than one who does not currently monitor energy performance.

Is the space submetered, and is the utility billing structure based on actual use? What is the utility rate and average energy cost per square foot? A recent study found that submetered spaces save 21 percent in energy compared to spaces without energy-use information.

What has the building done to improve and maintain energy efficiency and conservation, and when were the improvements installed? Buildings with excellent natural daylight, energy-efficient windows and lighting, envelope walls, advanced equipment controls, and efficient HVAC equipment reduce tenant equipment and energy costs.

Does the building have resources or programs to help with design, construction, and ongoing management of energy-efficient spaces? Request from ownership any design and energy efficiency criteria for the buildout of tenant spaces, recommended cost-effective energy measures with financial value analysis, or a building energy model for reference. Owner-provided resources are a starting point for sensible energy strategies and promote a collaborative relationship between the building owner and tenant. An existing energy model will reduce the upfront cost and effort of implementing the process. Experts can help identify opportunities for cost-saving lighting, outlet plug load, and HVAC opportunities throughout the lease term.

Why Cushman & Wakefield Selected One World Trade Center

As the leasing agent for One World Trade Center, Cushman & Wakefield was aware of the newly built trophy office tower's energy efficiency; in fact, efficiency measures incorporated into the construction of One World Trade Center would already have reduced the building's energy use in serving Cushman & Wakefield's space, including reducing energy consumption by around 5.2%.

The building was a natural fit for Cushman & Wakefield to locate its Downtown NYC office. Additionally, its column-free design also allowed for a more collaborative and open work environment.

A Collaborative Effort

From the start, The Durst Organization and PANYNJ recommended that energy and sustainability play an important role in the buildout of Cushman & Wakefield's space. National c-suite executives were introduced to the Tenant Energy Optimization process as a way to articulate the investment return of energy efficiency measures; it was also complementary to lease requirements.

The entire process emphasizes the importance of owner and tenant collaboration, particularly since tenant spaces typically account for more than half of a commercial office building's total energy. Overall, the process has seen the strongest results and most significant savings when the landlord engages with the tenant in the process; openly shares the building's energy information; and implements building-wide energy saving measures. The collaboration between The Durst Organization, PANYNJ, and Cushman & Wakefield is one of the best examples of this partnership.

In a recent survey[6], 36% of facility, real estate and energy management executives said they were willing to pay a premium for space in a certified green building—a jump from 15% the previous year—and 28% planned to build out tenant space to high-performance standards, an increase from 18% in 2013. Project stakeholders can take advantage of the energy efficiency opportunity by gathering the right information and putting it in front of the right people at the right time during the tenant engagement and decision making process—the earlier the involvement, the more successful the project.

6. From the 2014 Energy Efficiency Indicator Survey conducted by Johnson Controls' Institute for Building Efficiency. The survey can be found at http://www.institutebe.com/Energy-Efficiency-Indicator/2014-EEI-executive-summary.aspx.

The Project's Key Stakeholders

The Tenant: Cushman & Wakefield

Cushman & Wakefield Inc. is a global leader in commercial real estate services, with 43,000 employees in more than 60 countries serving occupiers and investors around the world. Cushman & Wakefield is among the largest commercial real estate services firms, with revenues of $5 billion across core services of agency leasing, asset services, capital markets, facility services, global occupier services, investment management, project and development services, tenant representation, and valuation and advisory.

The Building Owners: The Durst Organization and the Port Authority of New York & New Jersey

The Durst Organization is the owner, manager, and builder of 13 million square feet of premier Manhattan office towers. The Durst Organization is recognized as a world leader in the development of high-performance and environmentally advanced commercial and residential property.

The Port Authority of New York & New Jersey builds, operates, and maintains many of the most important transportation and trade infrastructure assets in the country. The agency's network of aviation, ground, rail, and seaport facilities is among the busiest in the country, supports more than 550,000 regional jobs, and generates more than $23 billion in annual wages and $80 billion in annual economic activity. The Port Authority also owns and manages the 16-acre World Trade Center site, including One World Trade Center.

Photo sensors measure the strength of daylight coming in through the windows and dims the election lights when they are not needed to maintain the desired design light levels in the space. Photo by Timothy Schenck.

Cushman & Wakefield Integrates the Tenant Energy Optimization Process

Cushman & Wakefield's 10-year lease encompasses 7,500 square feet on Floor 45 of the World Trade Center. While many tenants who have undergone the Tenant Energy Optimization process occupy markedly larger footprints, Cushman & Wakefield's project demonstrates how the process is scalable, whether a tenant leases 6,000 square feet (the occupied square footage that was modeled for Cushman & Wakefield's space) or 60,000 square feet. In both instances, the same principles and process can be applied.

Cushman & Wakefield's office space at One World Trade Center consists of interior offices and an open-plan design, including motorized height-adjustable (sitting/standing) desks arranged in "tripods," an intermediate distribution frame (IDF) room, a conference room, an open kitchen, and a hub area in the middle of the space.

When Cushman & Wakefield was approached with the Tenant Energy Optimization process, its move to One World Trade Center was on the horizon and targeting a sustainable certification. The process was seen by both executives and the Cushman & Wakefield project management team as a valuable program to ensure the new buildout would help to amplify the firm's energy efficiency goals.

The reception area features natural daylight from the adjacent conference room, ENERGY STAR® equipment, and LED lighting. Photo by Timothy Schenck.

The 10-Step Tenant Energy Optimization Process

PHASE I: PRE-LEASE

Step 1: Select a team

Step 2: Select an office space

PHASE II: DESIGN AND CONSTRUCTION

Step 3: Set energy performance goals

Step 4: Model energy reduction options

Step 5: Calulate projected financial returns

Step 6: Make final decisions

Step 7: Develop a post-occupancy plan

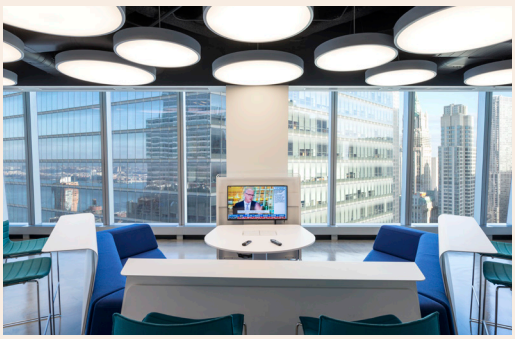
Step 8: Build out the space

PHASE III: POST-OCCUPANCY

Step 9: Execute the post occupancy plan

Step 10: Communicate results

Lighting controls in the meeting room optimize energy use and accommodate various presentation needs during daytime and evening hours. Photo by Timothy Schenck.



Expansive windows provide natural lighting and views for the open office and group work areas. Photo by Timothy Schenck.

Selecting the Buildout Team

The Cushman & Wakefield Buildout Team

Company	Role
Cushman & Wakefield	Client, Project Manager
Mancini Duffy	Architect
Robert Derector Associates	Engineer
Robert Derector – Mission Critical	Energy Modeler
Syska Hennessy	Lighting Designer
Wendy Fok	Energy Project Director
Integral Group	Energy Consultant
Turner Interiors Construction	Contractor/Costing
The Durst Organization	Building Owner
The Port Authority of New York & New Jersey	Building Owner

Setting Energy Performance Goals and Developing a Menu of Measures

The process was kicked off with an energy design workshop in November 2014, which brought together the design and construction team that would be involved in Cushman & Wakefield's build out. These groups worked in tandem to make sure all energy reduction strategies conformed to the goals and intent of Cushman & Wakefield's design.

During schematic design and the energy design workshop, Cushman & Wakefield outlined multiple important factors for its buildout, which align with its ultimate goals of showcasing the Cushman & Wakefield brand, energy efficiency and sustainability, and employee satisfaction.

With Cushman & Wakefield's objectives in mind, the project team put together a menu of measures, which formed the basis for the project's energy performance goals:

Cushman & Wakefield's Menu of Measures

Cushman & Wakefield's Menu of Measures
LED Lighting
Daylight Harvesting
Lighting Control System (Timeclock and Vacancy Sensors)
No Humidity Control in IDF Room
High-Efficiency Tenant HVAC and Motors
ENERGY STAR® Equipment
Server Power Management
Equipment Power Management (Cisco EnergyWise[7] or Similar)
Allow IDF Rooms to Cycle Off
Raise IDF Room Setpoint from 77°F to 79°F
Temperature Setpoints (77°F Cooling, 70°F Heating)

7. http://www.cisco.com/c/en/us/solutions/enterprise-networks/intro_content_energywise.html

Modeling the Projected Energy Performance

During design development, a predictive energy model[8] was created using eQuest software, which modeled energy consumption and EPM results for Cushman & Wakefield's new office space; the model was calibrated using metered data gathered during tenant occupation.[9]

As part of the modeling process, the project team created several sets of measures, also known as "packages," which account for the interactive effects of various EPMs, and how they impact payback periods, IRR, and ROI metrics.

In order to understand the interactive effects of measures within a package, the model must be run through repeated cycles incorporating a new EPM with each run, a process called iterative modeling. The results of iterative modeling predict the cumulative effect of implementing a package of EPMs, which accounts for interactions between individual measures that may affect overall energy consumption. For example, a unit of energy saved by utilizing daylight harvesting cannot be saved again through high-efficiency lighting, thus iterative modeling would show less energy savings for this package of EPMs compared to modeling the measures independently.

The output of the model will provide estimated annual energy savings based upon the selected package of measures as compared to the modeled baseline scenario, which can be broken out into identified savings for both the tenant space and the base building systems. For example, certain EPMs may reduce the overall demand on the central building systems, including centralized conditioned air, steam, condenser, and chilled water savings. Depending on the utility billing structure in the lease, such savings are likely to accrue to the building owner (or be shared withall of the other tenants in the building). Savings from lighting, plug load, and server room EPMs typically benefit the tenant directly.

Comparing Cushman & Wakefield's EPM Packages

Energy Performance Measure	Less Energy Reduction	Moderate Energy Reduction	Significant Energy Reduction
1.1 LED lighting	+	+	+
1.2 Daylight Harvesting	+	+	+
1.3 No Humidity Control in IDF Room	+	+	+
1.4 High-Efficiency Tenant HVAC and Motors	+	+	+
2.1 ENERGY STAR® Equipment		+	+
2.2 Server Power Management		+	+
2.3 Allow IDF Room Fans to Cycle Off		+	+
2.4 Raise IDF room Setpoint from 77°F to 79°F		+	+
2.5 Temperature Setpoints (77°F Cooling, 70°F Heating)		+	+
3.1 Equipment Power Management (Cisco EnergyWise or Similar)			+
3.2 Lighting Control System (Timeclock and Vacancy Sensors)			+

Reviewing Incremental Costs and Incentives

With the baseline standards in place, the project team moved on to the impact that potential EPMs would make on Cushman & Wakefield's space performance. The model analyzed a range of EPMs in terms of three types of quantifiable results: cost estimates for energy efficiency measures; projected energy savings for each measure and for packages of complementary measures; and projected payback period, return on investment, and other key financial metrics.

8. There are three baselines shown in the energy model: the as-built baseline; an ASHRAE 90.1-2007 baseline, which has been used for the majority of the savings calculations; and an ASHRAE 90.1-2010 baseline.survey can be found at http://www.institutebe.com/Energy-Efficiency-Indicator/2014-EEI-executive-summary.aspx.
9. See Appendix A for detailed analysis.

Recommended EPM	Target Area	Incremental First Cost
LED Lighting	Lighting	$5,000
Daylight Harvesting	Lighting	$6,000
Lighting Control System (Timeclock and Vacancy Sensors)	Lighting	$2,000
High-Efficiency Tenant HVAC and Motors	HVAC	$1,750
No Humidity Control in IDF Room	HVAC	$3,600
ENERGY STAR® Equipment	Plug Loads	$4,640
Server Power Management	Plug Loads	N/A
Equipment Power Management (Cisco EnergyWise[10] or Similar)	Plug Loads	$412
Allow IDF Rooms to Cycle Off	Control Settings	N/A
Raise IDF Room Setpoint from 77°F to 79°F	Control Settings	N/A
Temperature Setpoints (77°F Cooling, 70°F Heating)	Control Settings	N/A

10. http://www.cisco.com/c/en/us/solutions/enterprise-networks/intro_content_energywise.html

Performing the Value Analysis

Using energy modeling and incremental costing information, the project team then performed a quantitative value analysis that determined the projected electricity cost savings annually and over the lease term; the resulting payback period; and the tenant's return on investment. This analysis enabled the team to package the energy performance measures to meet the payback threshold desired by Cushman & Wakefield.

Reviewing the Budget and Selecting the EPMs

Energy modeling and costing analysis determined the following nine EPMs would offer the best value for Cushman & Wakefield on Floor 45.

1. **LED Lighting:** Would provide a significant reduction in the lighting installed power density.
2. **Daylight Harvesting:** Photo sensors measure the strength of daylight coming in through the windows and dims the election lights when they are not needed to maintain the desired design light levels in the space.
3. **No Humidity Control in IDF Room:** Modern IDF equipment can safely operate through the range of humidity found in conditioned office space. Eliminating a dedicated humidifier from IDF rooms reduces the power usage, first cost, and ongoing maintenance costs.
4. **High-Efficiency Tenant HVAC and Motors:** Purchasing motors with efficiencies significantly higher than the code-required "Premium" motor ratings can often be done without additional first costs.
5. **ENERGY STAR® Equipment:** Plug loads are among the highest power consumers in an office space. Use of ENERGY STAR® computers, refrigerators, and other equipment significantly reduces the floor energy consumption.
6. **Server Power Management:** The savings from server power management are dampened by the small amount of server power installed: 450 W compared to the 2,370 W of load used for HVAC sizing.
7. **Allow IDF Rooms to Cycle Off:** IDF rooms do not have ventilation or noise concerns, allowing for cycling control to be used to minimize fan power.
8. **Raise IDF Room Setpoint from 77°F to 79°F:** Modern IDF equipment can safely operate through the range of temperatures found in conditioned office space. The current recommended conditions from ASHRAE's TC9.9 committee include an upper end of over 80°F for data centers.
9. **Temperature Setpoints (77°F Cooling, 70°F Heating):** Avoiding overcooling and overheating is a simple approach to reducing energy consumption while providing a comfortable environment for occupants whose dress (clothing insulation value) varies with the seasons and weather.

Building the Space

Cushman & Wakefield project stakeholders reviewed the data and made the final decision to move forward on the energy recommendations. The EPMs were all implemented on schedule and within the anticipated timeframe.

Developing a Post Occupancy Plan: The Measurement & Verification Process

As one of the final phases of the process, measurement and verification (M&V) has been performed for Cushman & Wakefield on Floor 45. This formalized process shows whether the EPMs have the effect on energy consumption as projected. Often the M&V process is not utilized, as it is assumed the measures were installed and commissioned to work. However, for the Cushman & Wakefield project, M&V was vital in demonstrating that the energy value analysis achieved the level of value projected.

Energy use projections are based on assumptions, and operations and behavior can alter design intent and projects. If the actual results diverge from the projected results, then something went wrong—savings were incorrectly calculated, or a piece of equipment was incorrectly programmed or not operated as intended, or a product did not perform to its specifications. Naturally, Cushman & Wakefield wanted to be certain that the demonstration project yielded the projected ROI, and if the M&V process showed otherwise, the team would need to re-examine the analysis and implementation to account for the discrepancy between the simulated and measured results.

The monitoring of Cushman & Wakefield's space took place for 10 days between August 20, 2015 and September 1, 2015. Integral Group collected actual tenant energy consumption data and calibrated the existing energy model to correspond to observed usage.

Overall energy consumption was underestimated in the original model; significantly, peak lighting and plug load power was underestimated. Metering revealed weekend operation, when the original modeling assumed no weekend operation. The lower plug and IT room loads found through measurement reduce the impact of the ENERGY STAR® and server management measures.

Occupancy

The baseline model underestimated occupied hours significantly, with measured data indicating both weekend use and overnight use of the space.

Plug Loads

Computer room load was 70% lower than designed; however, the original load estimate of only 2.3 kW was relatively low compared to the full space, so the size mismatch has minimal impact on the gross performance.

An unusually high nighttime plug load suggests that ENERGY STAR® energy management features are not fully implemented for the site's computer equipment. A lower

Cushman & Wakefield's Initial Energy Model versus the Calibrated Model after the M&V Process

	Uncalibrated Model	Calibrated Model
Occupancy Hours (Weekday)	9 a.m.–6 p.m.	9 a.m.–6 p.m.
Occupancy Hours (Weekend)	None	9 a.m.–5 p.m.
Peak Office Plug Load Power Actual: With Diversity (W/SF)	1.1	0.91
Peak Lighting Power (W/SF)	0.61	0.31
Minimum Lighting Power (W/SF)	0.00	0.00
HVAC Fan Schedule Hours	7 a.m.–7 p.m.	7 a.m.–7 a.m.
Peak MDF IT Power kW	2.37	0.45
Total Tenant Electricity Consumption: Code-Compliant Baseline (kWh)	71,914	90,349
Total Tenant Electricity Consumption: Implemented Package (kWh)	44,331	47,462

unoccupied plug load on the weekend (seen in the early morning hours of Monday) could indicate that computers are not going into their lowest power modes except over the weekend, when many occupants may manually turn them off. A regular power spike is visible in the minute trended data; this spike is likely a refrigerator compressor cycling on.

The baseline plug load power drawn during unoccupied nighttime hours is lower on the weekend than during weekdays. This suggests that a significant amount of plug loads, likely computers, are manually shut off at the end of the week. The project team suggested that activating ENERGY STAR® shut-off or hibernation controls on this equipment could reduce weeknight plug loads and harvest savings on days an employee is out.

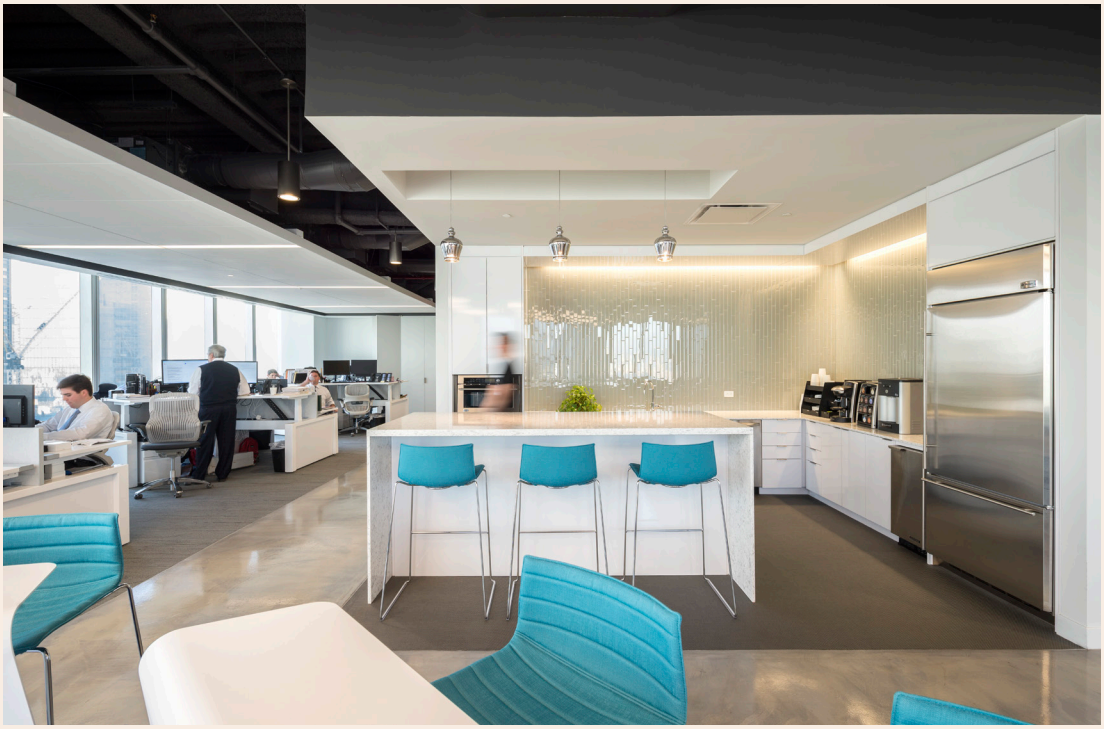
The project team recommended that Cushman & Wakefield verify that lights are not connected to the circuits labeled as serving the fan-powered terminal units, which showed higher-than-expected loads while lighting showed lower-than-expected loads. It is possible some lighting power is connected to these circuits.

Lighting

Metered data clearly shows the daylight harvesting system in operation. When the lights were on overnight, the lighting power was seen to drop as expected starting at sunrise. Lighting showed an unusual drop to 0 W/SF at night, suggesting either a best-in-class emergency lighting control (which is possible) or emergency lighting may be on a mislabeled circuit and missed in the M&V.

The lights were observed to operate overnight on one night, August 26 through 27, during the occupied period. It is assumed that the space was occupied past normal office hours on the 26th, but plug loads suggest occupation ended at midnight. The project team recommended that Cushman & Wakefield verify after-hours overrides on lighting operates on a timer, which will allow for both after-hours work and lighting power shutoff after unplanned occupation ends.

Lights are scheduled to operate on weekends; however, the plug load data suggests the space may not always be in use. The project team also recommended implementing manual on/automatic off timer control for off-hours lighting control.



Plug loads are among the highest power consumers in an office space. Use of ENERGY STAR® computers, refrigerators, and other equipment significantly increases the ROI from energy performance measures. Photo by Timothy Schenck.

Cushman & Wakefield's Sustainability Initiatives and Their Impacts on Employees

Cushman & Wakefield has a commitment to reduce the environmental footprint of the buildings it occupies and manage, engaging its employees and clients in these efforts and through thought leadership. As the only commercial real estate services firm to sign a memorandum of understanding with the U.S. Environmental Protection Agency, Cushman & Wakefield successfully reduced the carbon emissions at participating properties in its managed portfolio by 10% from 2008 to 2012. It is currently setting reduction targets for its corporate offices.

Cushman & Wakefield supports focused education and training that keeps its workforce at the cutting edge of sustainability, maintaining numerous knowledge and best-practice sharing networks including its Energy & Sustainability Task Force and specialty practice groups. Innovative programs such as its award-winning C&W Environmental Challenge encourage greater achievement, while its C&W Green Office, Earth Day, and Earth Hour activities inspire creative thinking, individual expression, and collective action. Serious engagement, partnering with technical experts, and taking part in industry dialogue to develop and mold legislation beneficial to the building industry is also priority.

"As both employees and their visitors walk into the new space at One World Trade Center, Cushman & Wakefield's commitment to its goals of showcasing its brand, energy efficiency and sustainability, and employee satisfaction is apparent," said Eric Duchon, director of sustainability strategies for Cushman & Wakefield. The improvement from Cushman & Wakefield's prior Downtown NYC office is remarkable, he noted; the entire office is notably lit by LED lights, daylight flows in freely without offices lining the perimeter, and sit-stand adjustable desks arranged in tripods make great use of the floor space. "The Cushman & Wakefield employees in the space are quick to point out these great features, too. In one case, employees along the only full wall in the space asked for the lighting along the wall to be reduced, as they were receiving enough light from the windows."

Further Recommendations

Overall, the project team has recommended Cushman & Wakefield use ongoing energy management systems to ensure energy use is well managed. End-use sub-metering (lighting, plug, IT room, and HVAC loads) and a tenant energy management platform would keep the energy savings in line and provide feedback for ongoing commissioning and maintenance of the systems.

Looking Forward

Cushman & Wakefield is currently reviewing the findings from the M&V process. Its operations team is working with both their internal IT team and The Durst Organization's building management team to ensure the new office operates at the optimal energy efficiency as designed.

As Cushman & Wakefield re-invigorates its corporate workplace strategy following its recent merger with DTZ, it maintains the same three major goals for all of its buildouts: showcase its brand; energy efficiency and sustainability; and employee satisfaction and wellness. The Tenant Energy Optimization process will continue to play a significant role in determining the energy efficient attributes of Cushman & Wakefield spaces.

Appendix A: Original and Final Energy Model Results for Tenant Electricity

Original Model Results

EPM ID	Energy Model Run Description	Tenant Space			Base Building		Total						Peak	
		Electric kWh	Reduction from Existing Baseline	Electric kW	Electric kWh	Nat. Gas Therms (Therms)	Electric kWh	Nat. Gas Therms (Therms)	Lighting kWh	Equipment kWh	Fans kWh	HVAC kWh	Cooling Tons	Electric kW
	ASHRAE 90.1-2007 Appendix G Base Building	**86,829**	N/A	**32**	20,293	796	107,122	796	20,345	45,862	14,645	23,030	**16**	**39**
Building (Code-Compliant)	**One WTC Base Building (Code-Compliant)**	**88,745**	N/A	**32**	26,511	498	115,256	498	20,345	45,862	19,053	26,757	**18**	**41**
	One WTC Base Building (As Constructed)	88,745	N/A	31	25,138	500	113,884	500	20,345	45,862	19,053	25,614	18	40
1.1	LED Lighting	80,282	9.5%	29	22,891	599	103,174	599	12,354	45,862	17,909	24,038	17	37
1.2	Daylight Harvesting	77,661	12.5%	27	22,170	631	99,832	631	9,880	45,862	17,553	23,526	17	35
1.3	No Humidity Control in IDF Room	77,587	12.6%	27	21,615	632	99,203	632	9,880	45,862	17,551	22,899	17	35
1.4	High-Efficiency Tenant HVAC and Motors	76,011	14.3%	27	21,534	632	97,545	632	9,880	45,862	17,160	21,403	17	35
2.1	ENERGY STAR® Equipment	62,320	29.8%	21	18,966	832	81,286	832	9,880	32,705	15,864	19,595	15	28
2.2	Server Power Management	45,543	48.7%	18	18,589	836	64,132	836	9,880	22,320	11,700	16,990	15	26
2.3	Allow IDF Room Fans to Cycle Off	43,129	51.4%	18	18,566	838	61,695	838	9,880	22,320	9,584	16,669	15	26
2.4	Raise IDF Room Setpoint from 77°F to 79°F	42,725	51.9%	18	18,562	820	61,287	820	9,880	22,320	9,311	16,535	15	26
2.5	Temperature Setpoints (77°F Cooling, 70°F Heating)	42,049	52.6%	17	18,265	744	60,314	744	9,880	22,320	8,857	16,016	14	25
3.1	Equipment Power Management (Cisco EnergyWise or Similar)	37,404	57.9%	15	17,500	820	54,904	820	9,880	17,824	8,495	15,463	13	22
3.2	Lighting Control System (Timeclock and Vacancy Sensors)	36,386	59.0%	15	17,353	836	53,739	836	8,892	17,824	8,421	15,360	13	22

Calibrated Model Results

EPM ID	Energy Model Run Description	Tenant Space			Base Building		Total						Peak	
		Electric kWh	Reduction from Existing Baseline	Electric kW	Electric kWh	Nat. Gas Therms (Therms)	Electric kWh	Nat. Gas Therms (Therms)	Lighting kWh	Equipment kWh	Fans kWh	HVAC kWh	Cooling Tons	Electric kW
	ASHRAE 90.1-2007 Appendix G Base Building	**85,473**	N/A	**23**	14,292	507	99,765	507	30,206	49,691	1,092	15,578	**13**	**27**
	One WTC Base Building (Code-Compliant)	**90,349**	N/A	**24**	18,989	399	109,338	399	30,206	49,691	6,018	20,226	**15**	**29**
	One WTC Base Building (As Constructed)	90,350	N/A	24	17,852	400	108,202	400	30,206	49,691	6,018	19,089	15	28
1.1	LED Lighting	67,630	25.1%	19	14,575	664	82,205	664	8,657	49,691	5,147	15,509	15	23
1.2	Daylight Harvesting	66,076	26.9%	18	14,311	683	80,387	683	7,204	49,691	5,050	15,240	14	22
1.3	No Humidity Control in IDF Room	66,067	26.9%	18	13,857	683	79,924	683	7,204	49,691	5,050	14,778	14	22
1.4	High-Efficiency Tenant HVAC and Motors	65,854	27.1%	18	13,850	683	79,704	683	7,204	49,691	5,042	14,565	14	22
2.1	ENERGY STAR® Equipment	49,540	45.2%	15	12,324	912	61,864	912	7,204	33,905	4,604	12,946	14	19
2.2	Server Power Management	47,622	47.3%	15	11,498	930	59,120	930	7,204	32,216	4,584	11,909	14	19
2.3	Allow IDF Room Fans to Cycle Off	47,566	47.4%	15	12,409	910	59,975	910	7,204	32,216	4,552	12,797	14	19
2.4	Raise IDF Room Setpoint from 77°F to 79°F	47,463	47.5%	15	11,749	902	59,212	902	7,204	32,224	4,564	12,015	14	19
2.5	Temperature Setpoints (77°F Cooling, 70°F Heating)	47,462	47.5%	15	11,003	840	58,465	840	7,204	32,224	4,520	11,311	13	18

Appendix B: Energy Model Output by Measure (Original and Calibrated)

Energy Model Output by Measure

		Uncalibrated Baseline vs Proposed Savings			Calibrated Baseline vs Proposed Savings		
EPM	**Description**	**Annual Tenant Electricity Savings (kWh)**	**Percent Savings**	**Annual Cost Savings**	**Annual Tenant Electricity Savings (kWh)**	**Percent Savings**	**Annual Cost Savings**
	ASHRAE 90.1-2007	N/A	N/A	N/A	N/A	N/A	N/A
	Code-Compliant Base Building	N/A	N/A	N/A	N/A	N/A	N/A
	As Constructed	N/A	N/A	N/A	N/A	N/A	N/A
1.1	LED Lighting	8,298	12%	$1,494	22,721	25%	$4,090
1.2	Daylight Harvesting	2,633	4%	$474	1,554	2%	$280
1.3	No Humidity in IDF	(1)	0%	$0	9	0%	$2
1.4	Efficient Tenant HVAC	15	0%	$3	213	0%	$38
2.1	ENERGY STAR® Equipment	10,216	14%	$1,839	16,315	18%	$2,937
2.2	Server Power Management	6,301	9%	$1,134	1,917	2%	$345
2.3	Allow IDF Fans to Cycle	69	0%	$12	56	0%	$10
2.4	IDF Setpoint to 79°F	(3)	0%	($1)	103	0%	$19
2.5	Cool Setpoint to 77°F	55	0%	$10	1	0%	$0

About the Urban Land Institute

The mission of the Urban Land Institute is to provide leadership in the responsible use of land and in creating and sustaining thriving communities worldwide. Established in 1936, the Institute today has more than 39,000 members worldwide representing the entire spectrum of the land use and development disciplines. ULI relies heavily on the experience of its members. It is through member involvement and information resources that ULI has been able to set standards of excellence in development practice. The Institute has long been recognized as one of the world's most respected and widely quoted sources of objective information on urban planning, growth, and development.

About the Center for Sustainability

The ULI Center for Sustainability is dedicated to creating healthy, resilient, and high-performance communities around the world. Through the work of ULI's Greenprint Center for Building Performance, the ULI Urban Resilience Program, and other initiatives, the Center advances knowledge and catalyzes adoption of transformative market practices and policies that lead to improved energy performance and portfolio resilience while reducing risks caused by a changing climate.

Acknowledgments

Case Study Participants

The foundation of ULI's Tenant Energy Optimization Program is a ten-step process that, when implemented in ten pilot fit-out projects, yielded impressive energy and cost savings. Pilot projects applying this process were carried out in tenant spaces occupied by Bloomberg L.P., Coty Inc., Cushman & Wakefield, Estée Lauder Companies, Global Brands Group, LinkedIn, New York State Energy Research and Development Authority (NYSERDA), Reed Smith LLP, Shutterstock, and TPG Architecture. Case studies documenting their experiences were written to inform tenants, building owners, real estate brokers, project managers, architects, engineers, contractors, and energy consultants.

Project Director

ULI's Tenant Energy Optimization Program builds on the energy efficiency retrofit project conducted at the Empire State Building under the direction of Wendy Fok, principal of OpDesigned LLC. From 2011 to 2016, Fok led the development of a portfolio of tenant buildouts to create a financial and design template to incorporate energy efficiency in tenant spaces. Fok has been a key contributor to the standards set forth in the Energy Efficiency Improvement Act of 2015 (S. 535), which created the national Tenant Star framework. A registered architect, she received her degree from the University of Texas at Austin with real estate executive education from Harvard Business School.

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For More Information

Interested in implementing the process?
ULI provides tools such as technical resource guides, how-to documents, case studies, and other training materials. These materials can be found at: **tenantenergy.uli.org**.