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Controlling Energy Performance on the Big Stage - The New York Times Company

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Energy Technologies Area

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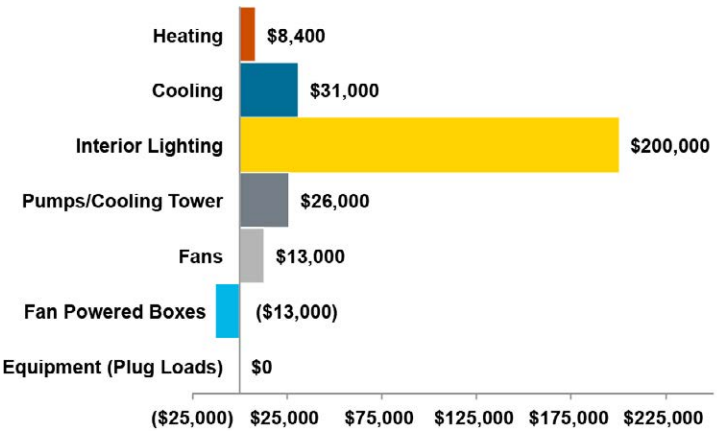
Controlling Energy Performance on the Big Stage — The New York Times Company

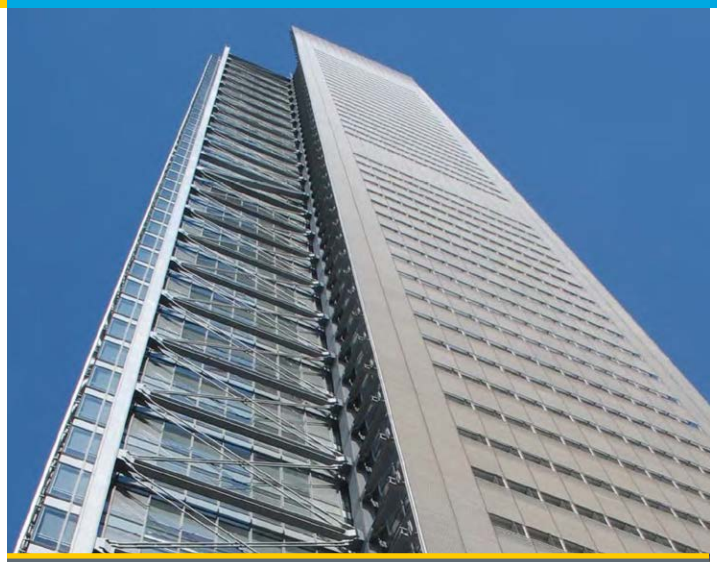
Overview

The Times partnered with the U.S. Department of Energy (DOE) as part of DOE's Commercial Building Partnerships (CBP) Program to develop a post-occupancy evaluation (POE) of three EEMs that were implemented during the construction of The Times building between 2004-2006. With aggressive goals to reduce energy use and carbon emissions at a national level, one strategy of the US Department of Energy is looking to exemplary buildings that have already invested in new approaches to achieving the energy performance goals that are now needed at scale. The Times building incorporated a number of innovative technologies, systems and processes that make their project a model for widespread replication in new and existing buildings. The measured results from the post occupancy evaluation study, the tools and processes developed, and continuous improvements in the performance and cost of the systems studied suggest that these savings are scalable and replicable in a wide range of commercial buildings nationwide.

Energy Cost Reductions[5]



1. The Commercial Building Partnerships (CBP) program is a public/private, cost-shared initiative that demonstrates cost-effective, replicable ways to achieve dramatic energy savings in commercial buildings. Through the program, companies and organizations, selected through a competitive process, team with U.S. Department of Energy (DOE) and national laboratory staff who provide technical expertise to explore energy-saving ideas and strategies that are applied to specific building project(s) and that can be replicated across the market.
2. 20 floors of The Times building (based on 20th floor analysis) vs ASHRAE 90.1-2001 baseline.
3. Electricity = 2.58 kWh/ft²-yr (based on 20th floor analysis).
4. Natural Gas = 1.36 kBtu/sf/yr (based on 20th floor analysis).
5. Results for 20 Floors of The Times building. Based on analysis of 20th floor.
6. Internal Rate of Return (IRR) of 12%.



Exterior of the tower portion of The Times building.

Copyright: NYT

Project Type	Commercial Office Building
Climate Zone	ASHRAE Zone 4A, Cold, Hot and Humid
Ownership	Owner Occupied
Barriers Addressed	• A yearlong performance evaluation of dimmable electronic ballasts and daylighting, automated interior shading, and underfloor air distribution system • Breaking down the myth of high cost daylighting design • Evaluating and monitoring daylighting system performance before buying the system • Creative solutions to high on-site labor costs of installation
Square Footage of Project	• 1,500,000 (Overall building, 52 stories) • 630,000 (The Times, 20 stories) • 26,000 (20th Floor POE analysis focus)
Actual Energy Savings[2]	1,300,000 kWh/yr electricity[3] 700,000 kBtu/yr natural gas[4]
Energy Cost Savings[5]	~$260,000/yr
Project Simple Payback[6]	7.9 years
Estimated Avoided Carbon Dioxide Emissions[5]	~4,000 metric tons per year
Construction Completion Date	2007. 2011-2012 — Post-occupancy monitoring and evaluation (POE)

The headquarters of The Times is a 52-story, 1.5 million gross square feet commercial office building constructed in 2007, and located in Manhattan, New York. During the original design phase (2003-2006) The Times collaborated with Lawrence Berkeley National Laboratory (LBNL) to develop and implement innovative energy efficiency measures (EEMs) for automated shading and lighting controls. The EEMs were designed to create a high quality, comfortable workplace environment for their employees while minimizing energy use, demands on the utility grid, and greenhouse gas emissions. The HVAC system had already been designed at the time the collaboration began, so additional HVAC efficiency measures for the innovative central plant approach and the underfloor air distribution (UFAD) were not able to be incorporated into those systems.

When The Times embarked on their journey of exploring the use of controllable shading and lighting systems in their new building, LED (Light Emitting Diodes) lighting for general applications were not available and only fluorescent lighting solutions were considered. Dimmable lighting was more of a rarity than it is today and digital lighting control systems had made little headway into the new construction market. Then (as now) the use of dynamic shading components was a significant risk with many unknowns. To reduce risk and cost, and increase understanding of application and performance, The Times invested time and money to learn about appropriate advanced systems. After visiting LBNL's testbed facilities and seeing the value of both engineering mockups and occupant assessments, they decided to construct a full scale ~4,300 ft^2 outdoor mock-up of the southwest corner of the new building off-site, which allowed the team to test and evaluate the performance over a 12-month period for these different systems. The full-scale mock-up proved critical in understanding the site-specific limitations and feasibility of the different technologies, systems and approaches prior to purchase. LBNL's technical assistance continued from design through commissioning and into operations to ensure that initial intentions were realized in the final occupied building.

In 2011, The Times once again launched a collaborative effort with LBNL and the Center for the Built Environment (CBE). This time it was to conduct a year-long post occupancy evaluation (POE) to assess how the efficiency measures implemented were actually performing. The POE also involved evaluating the Under Floor Air Distribution (UFAD) operations and energy savings compared to overhead systems. This case study is a summary of both of these collaborative efforts.

Decision Criteria

Even though The Times and LBNL collaboration began later in the design process and focused specifically on the three systems of interior lighting, automated shading and UFAD, these systems were the primary drivers related to the working environment. A core goal for The Times was to develop a comfortable working environment across the wide range of tasks associated with publishing a daily newspaper and managing a large media company. The work environment needed to be bright, connected to the outdoors through view and daylight, visually comfortable for all tasks including flat-screen visual display terminal (VDT)-based tasks, and thermally comfortable during the winter and summer. Energy-efficiency was an important related goal.

Design

The Times was interested in a sustainable building design that enhanced the way employees work while promoting the use and improvement of available technologies.

- The Times issued a challenge to industry in the form of a "big, hairy, audacious goal (BHAG)" (made popular by the *Harvard Business Journal* [Collins et al. 1994]): 1) there should be no premium for a dimmable lighting system in a commercial office building, 2) lighting control systems need to self-commission, and 3) whoever can do this will own the market.
- Work patterns guided the design: transparency, flexibility, ease of movement from floor to floor, while providing a sense of community and guaranteeing necessary privacy. A core design concept was that there should not be a place where an employee does not see natural light and a view to the outdoors.
- To achieve a competitive marketplace and allow an opportunity to evaluate the performance of the available products, the building owner built a full-scale daylighting mockup and invited two sets of vendors to install their shading and daylighting equipment. This field test formed a key strategic cornerstone for accelerating an industry response to the building owners' challenge. At this point in time, US automated shading and daylighting control products had few major technical advances over the past 10 years.

Economic

The Times was constrained to a fixed capital budget for construction. Because occupancy was for the long-term, they were willing to make investments in innovative systems, which often can cost more when first introduced to the market because the manufacturer must recover large initial capital investments to design and produce new products. They evaluated the approach for each energy efficiency measure based on capital cost, annual operating cost, and annual energy savings.

- The Cost of Innovative Systems – The added cost of the innovative systems was a critical issue in the decision making process. As an early adopter, The Times was able to purchase the systems at a near mature market rate based on two main factors. First, the sheer volume of the purchase of the systems for a large high rise building. Second, because they took the time to research and evaluate the incremental differences between the innovative and conventional products and independently determine the added costs associated with those differences, those added costs and their benefits could be clearly understood.
- Minimizing Labor in the Field – Construction costs in New York City are heavily influenced by installation labor costs. To reduce costs, The Times tasked their architectural and engineering (A/E) teams to design the systems to minimize labor in the field. Lighting fixtures were designed to be placed

end to end so that power and communications cabling could be integrated as part of the fixture, and then installed in the field using simple quick connectors. Sensors could be installed in a standard pre-wired port located on each fixture. Fixtures were shipped with lamps and ballasts already in place. This unique approach provided significant savings.

- Competitive bidding – In order to reduce excess contingency fees associated with uncertainty and risk with novel systems, qualified competing contractors were invited to attend a pre-bid meeting in which the contractors were shown all the technical work that would be required.

Operations

The Times targeted incorporating operational elements that would maintain the core design concepts and allow spaces to effectively respond to exterior conditions and the occupants.

- To avoid the added cost and inconvenience of trying to fix systems that didn't work properly after the space was occupied, The Times included provisions in their procurement specification for the systems to be commissioned by the vendor and proven to perform per the specifications prior to final sign-off and payment.
- After the selection of the vendors, the final shading and lighting system selection was field tested by LBNL in the full-scale building mockup for six months to work out any remaining feasibility issues and to verify system performance before installation in the final building.
- LBNL also designed and built commissioning tools and protocols for their use so that The Times could verify shading and lighting system performance in the final building. CBE built a measurement system to commission and verify UFAD operations. The Times used these tools to conduct systematic checks as the systems were installed on a floor-by-floor basis in the final building.
- A year-long post occupancy evaluation collected a number of different data and information sources including detailed field measurements and observations, sub-metering and monitoring of the 20th floor. Key components of the POE included analyzing the available performance data for the building and systems, an occupant survey, and developing a calibrated energy model of the 20th floor to bring the different data pieces together to synthesize understanding of the current performance.

Energy Efficiency Measures Snapshot

The following table summarizes the EEMs implemented for the 20th floor of The Times building with their expected savings, costs, simple payback, and cost of conserved energy. In order to provide an accurate estimate of energy savings for the three innovative energy efficiency measures, several critical modeling challenges were addressed, with particular attention paid to modeling all zone heat gains as accurately as possible:

- Energy savings are shown for packages of measures rather than for individual measures to capture the overall impact of the measures on the whole-building design option.
- Accurate modeling of both the quantity and distribution of window heat gains was critically tied to UFAD system performance. Modified versions of the EnergyPlus and Radiance lighting simulation tools were developed by LBNL and used to determine the transmitted and absorbed solar radiation due to the facade system.
- Interior Shade Positioning: Shade position was derived from monitored data provided by the manufacturer on a 15-minute time step and used in the calibrated simulation model. Bidirectional scattering distribution function data were derived from goniophotometric measurements made from a sample of the shade fabric. The final computed values were input as schedules in the modified version of EnergyPlus.
- Lighting energy use data were derived from LBNL monitored data for the year, where the data were averaged for each 15-min increment and assigned to the modeled thermal zones.
- Equipment energy use and schedules were derived from CBE monitored data gathered from September through December 2011 (4 months) and these loads were assumed to be the same over the modeled 12-month period.
- Occupant Loads: Estimated based on occupancy design levels, observation and discussions.
- UFAD System: A CBE-developed version of EnergyPlus was used to model the UFAD system. To obtain a more accurate simulation of HVAC energy use, CBE used the 4 months of monitored data to set equivalent values in the input model (e.g., air temperatures, set points, energy use of fan powered boxes, etc.) and to modify model parameters to minimize differences between modeling results and the measured data. The UFAD building model used some of the same assumptions (e.g., economizer) and settings (e.g., thermostat settings) as the baseline in an attempt to provide a fair comparison.
- Local weather data: Weather data was obtained and used to run the model. Weather for 2011 was found to be within the norm of TMY values. The period that was modeled was January 1, 2011 to December 31, 2011.
- Assumed average energy prices in the New York area of $0.19/kWh and $1.20/therm.

Energy-Efficiency Measures for The Times Building 20th Floor

EEM	Considering for this Project	Will Consider for Future Projects	Actual Annual Savings		Improvement Cost, $ (Initial)	Simple Payback, years	Cost of Conserved Energy (CCE)
			kWh/year	$/year			
20th Floor (26% Energy Savings)							
Dimmable Lighting Controls:	Yes	Yes	1,500,000	$260,000[7]	~$2,000,000[7]	7.9	0.14
Set point Tuning and Daylight Dimming: Scheduling and occupancy controls implemented with on-off relay switching.							
Automated Roller Shade System:							
Fabric: a twill weave fabric with white and black yarns. Darker surface facing exterior.							
Weave Openness: 1.5% for S,E,W-facing elevations; 3.0% for all north-facing elevations.							
Motor: One motor for multiple shades (20-30 linear ft).							
Automated Control: indoor and outdoor roof top sensors combined with computational algorithms to determine the position of the shades.							
Underfloor Air Distribution (UFAD) system:							
Underfloor plenum (both HVAC and cable management across the floor plate) and diffusers near each workstation.							

7. Results for 20 floors of The Times Building. Based on results for analysis on 20th floor.

Energy Use Intensities by End Use

Understanding the performance of the three systems being evaluated in the context of a high-rise, high profile and highly active building is not a trivial task. As a component of the post occupancy evaluation, energy modeling was a critical part to determining and understanding the total energy savings for a typical tower floor of The Times building. The 20th floor of the high-rise tower portion of the building, where office computer-based tasks were performed by occupants over the course of the work day, was the focus of the POE study and analysis. The modeling challenges were very significant, so the team was unable to separate out energy savings that were attributable to each of the energy efficiency measures. Instead, whole floor energy use data are presented.

Two energy models were created as part of the post occupancy evaluation to determine the total energy savings for the typical floor, which provides some insight into potential savings for other typical floors in the building with similar office occupancy. The first model is the baseline based on ASHRAE 90.1-2001, which was the relevant code at the time of construction. The second model is a calibrated model representing the current energy use of the 20th floor of The Times building.

Total energy savings were defined as the difference in energy use between The Times building and an equivalent building with a conventional VAV system that conforms closely to the prescriptive standards of ASHRAE 90.1-2001. A customized version of the EnergyPlus building energy simulation program (version 6.0) was developed and used to determine energy performance. Actual measured data were used as either direct inputs or to calibrate the EnergyPlus model.

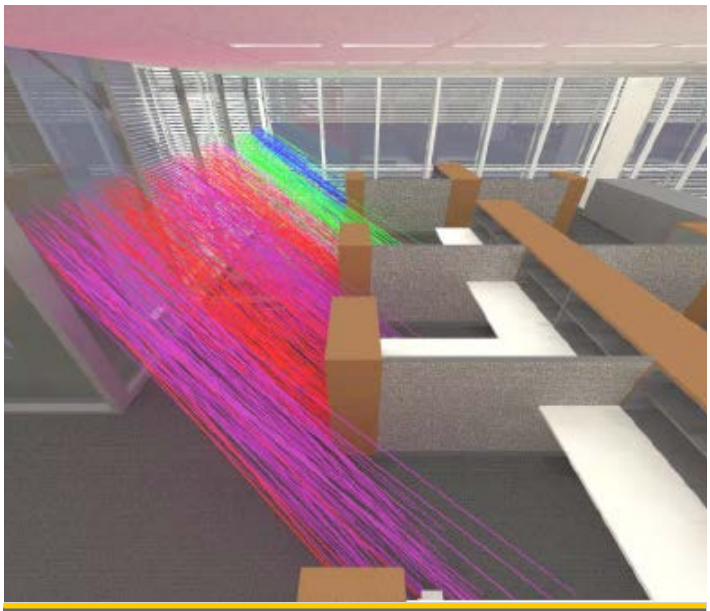
Based on the Post Occupancy Evaluation combined with other research that has been conducted by the LBNL team over the years, overall, it appears, that the contributions of the lighting load reductions and thermal effects of the envelope system are the primary causes of the lowered HVAC energy use with secondary benefits from improved economizer performance and interior zone room air stratification for UFAD. The overall result was twenty-six percent (26%) energy savings for the calibrated model of The Times building compared to the ASHRAE 90.1-2001 baseline model.

Model 1 – ASHRAE 90.1-2001 Baseline (20th Floor)

Model 1 represents the code standard requirement applicable at the time of construction for The Times building.

Model 2 – Actual Design (20th Floor)

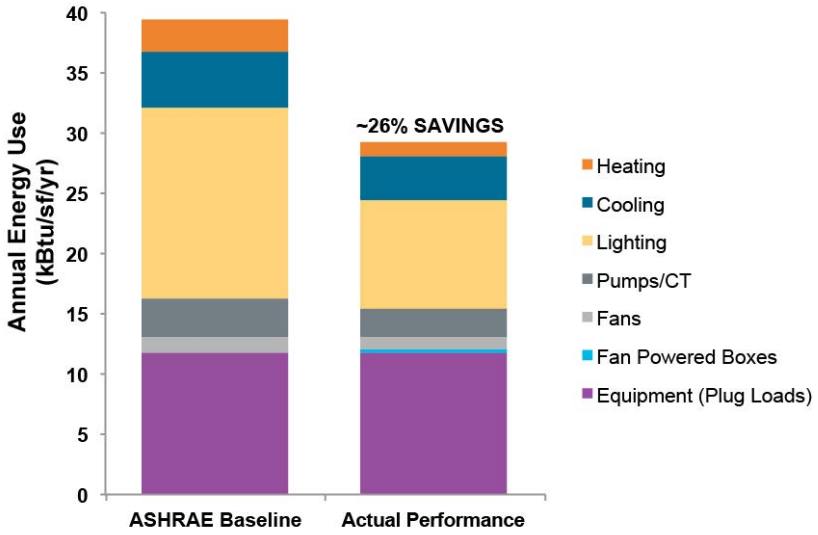
Model 2 incorporates the daylight dimming controls, automated shading and UFAD design and represents the current performance for The Times building. The model for the 20th floor has been calibrated based on metered and sub-metered actual performance data, as well as by field assessment and measurements during the post occupancy evaluation period. For the 20th floor, lighting energy use savings were the most significant (43% savings), which were due to the installed high performance lighting control system, which included tuning, occupancy sensors and daylight dimming controls, performing in alignment with the design intent. Cooling energy use was also shown to have significant savings (23%). While the window-to-wall area ratio (WWR) of The Times building (WWR=0.76) was significantly greater than the ASHRAE 90.1 baseline (WWR=0.40), the combined effect of low-E insulating glass (whole window SHGC=0.30, U-factor=2.43 W/m2-°K, Tvis=0.53), exterior shading, automated interior shading, and dimmable lighting resulted in significant overall reductions in cooling demand compared to the smaller code baseline glazing. Another savings contributor were the HVAC fans (31%), which was due to a complex coupling of factors related to the UFAD system.



An analysis to determine absorbed and transmitted solar radiation for each time step, façade layer and surface. The color of the rays indicate surface and zone the transmitted solar radiation was assigned to.

Source: LBNL

Comparing Energy Use Intensity (EUI) for S&E Building



S&E Building Annual Energy Use and Percent Savings by End Use

End Use Category	Model 1 – ASHRAE 90.1-2001 Baseline (20th Flr)	Actual Performance (20th Flr)	
	Annual EUI (kBtu/ft²)	Annual EUI (kBtu/ft²)	Percent Savings Over Baseline
Heating	2.7	1.3	51%
Cooling	4.7	3.6	23%
Lighting	15.8	8.9	43%
Pumps/CT	3.2	2.3	28%
Fans	1.3	0.9	31%
Fan Powered Boxes	0	0.4	NA
Equipment (Plug Loads)	11.7	11.7	0%
Electricity Total	**39.4**	**29.1**	**26%**

Building Energy Savings from Implemented EEMs by End Use

Electricity End Use Category	Energy Savings[8] (kWh)
Cooling	~170,000
Interior Lighting	~1,000,000
Interior Equipment	0
Pumps	~130,000
Fans	~13,000
Electricity Total	**~1,400,000**

Natural Gas End Use Category	Energy Savings[8] (therms)
Heating	~7,000
Natural Gas Total	**~7,000**

8. Results for 20 floors of The Times building. Based on results for analysis on 20th floor.

Lessons Learned

From CBP work on The Times building, the project team (LBNL for original design technical assistance and LBNL and CBE for the post occupancy evaluation) learned lessons that can be applied more widely to a number of other building types beyond high-rise buildings.

The Owner as a Change Agent

In the case of The Times building, the owner was driven to continually ask questions, and invest time and resources to increase their understanding of the challenging issues of design, construction and operations. If that drive would not have been in place, then the significant contributions of the analysis and research conducted on the full-scale mock-up and the post occupancy evaluation for a high profile building implementing innovative dimmable lighting controls and automated shading would not have been made available to the industry.

The Times could have based their decision on whether to include the innovative systems or not based on the initial increased costs they received from industry. Instead, they demonstrated "the will" to pursue a pioneering path that addressed the challenges head on, which has resulted in a building meeting their requirements and providing a substantial contribution of research to industry. The resulting body of work already has and will continue to serve as a driver for change.

Integrated Systems Can Provide a Comfortable and Energy Efficient Environment

The series of studies confirm that office buildings in an urban environment can deliver measured energy performance that substantially beats a similar code compliant building. By using a combination of smart design, efficient technology and properly integrated building systems, with a process that starts in design and continues through to construction, commissioning, and into operations, the benefits of integrated systems can be realized. It is essential to start with a sound, integrated building design, and then to pay attention to details such as procurement of building equipment, and verifying the proper performance of the equipment after it is installed.

The Analysis Helped Get It Right

The high profile nature of The Times building provided a big stage to not only make the project better, but to draw industry attention and interest, and motivate industry to improve their products. Data from this study, coupled with the improved design tools that were created, along with these lessons learned, will allow designers to capture these performance benefits in future projects without the use of such sophisticated studies or mock-ups. The ability to "get it right" was enabled due to the owner collaborating with LBNL, so that they were part of the project during design, construction, commissioning and after occupancy occurred.

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