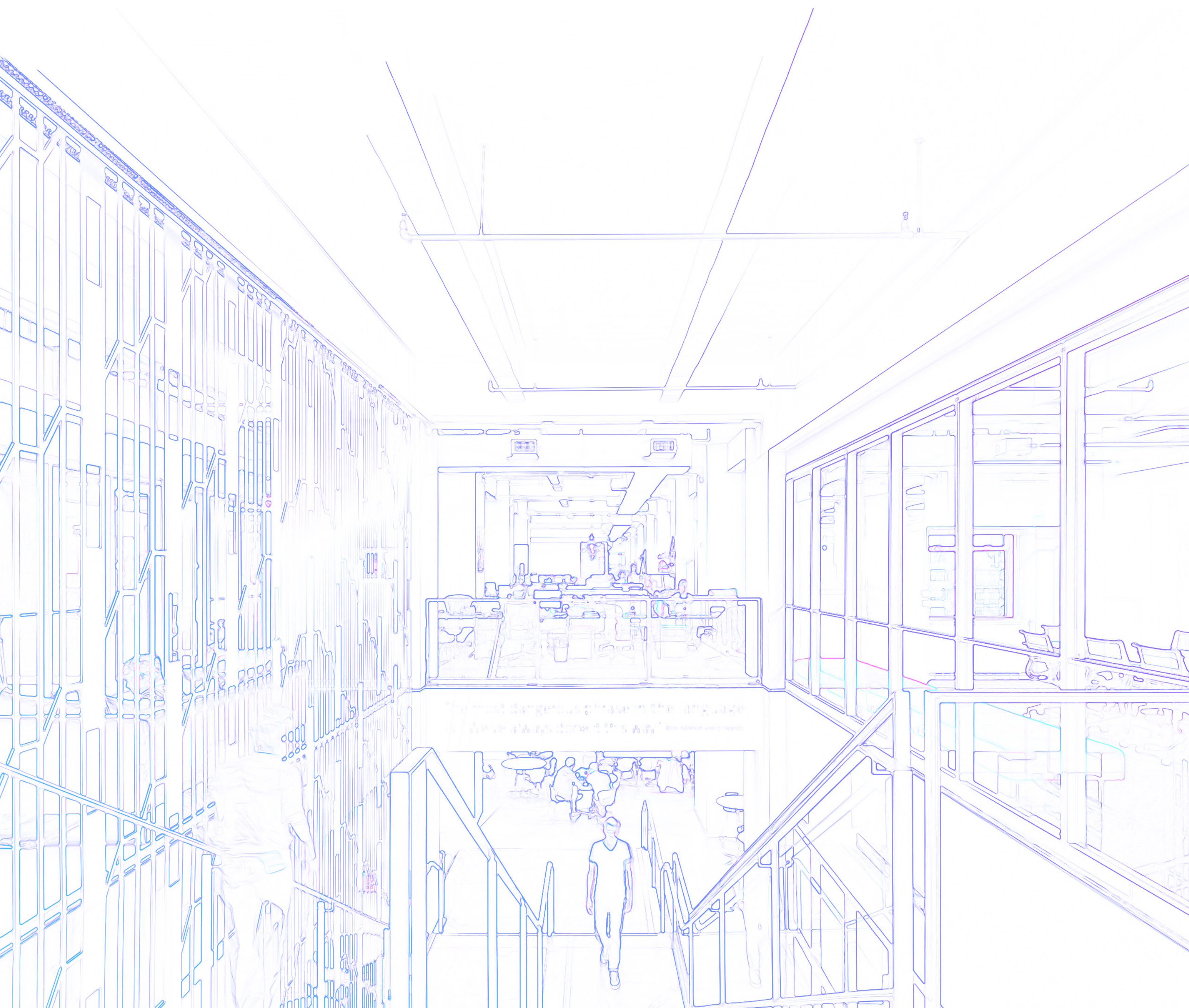
ULI Urban Land Institute

ULI Tenant Energy Optimization Program

Case Study: Shutterstock Inc.



Executive Summary: Shutterstock's Story

In 2013, Shutterstock Inc., a leading global provider of high-quality licensed photographs, videos, and music, leased approximately 60,000 square feet at the Empire State Building, occupying the entire 20th and 21st floors.

"The Empire State Building has transformed into an ideal setting for Shutterstock's innovative tech culture," said Shutterstock founder and CEO Jon Oringer at the time. "It's an icon of New York and we're excited to make the move."

But the Empire State Building's historic status wasn't the only appeal: Before Shutterstock signed its lease, the 2.8 million square-foot property had just undergone major retrofit and repositioning, transforming it into a Class-A, high-performance building located in the heart of Midtown Manhattan at Fifth Avenue and West 34th Street.

When it was time to design and construct its new space, Shutterstock had five major goals: to create a space that embodied the brand of Shutterstock; that was appropriate for both employee individual and communal work; that brought people together in a flexible hospitality space for internal and external events; that supported a variety of work styles; and included a good balance of natural light and access to views.

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 tandem with landlord Empire State Realty Trust (ESRT) and a team of experts, Shutterstock evaluated an integrated package of energy performance measures (EPMs)[1] for the two new floors. 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 Shutterstock's 11-year lease, the project is estimated to provide energy costs savings of more than $369,897, a 40% return on Shutterstock's investment[2], and an annualized 12.7% internal rate of return (IRR)[3]. The projected payback: 6.1 years. The new premises is designed to perform 22.9% better than a standard code-compliant design.

Shutterstock'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. Projects 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: Shutterstock Project Information and Projected Performance

Building Information	
Tenant Name	Shutterstock Inc.
Building Owner	Empire State Realty Trust
Location	350 Fifth Avenue, Midtown Manhattan
Building Size	2.8 million square feet (102 floors)
Principal Use	Class-A office with street-level retail
Construction Type	Pre-World War II skyscraper
U.S. EPA ENERGY STAR® Rating	90
Energy Retrofit Completion Date	2011
Shutterstock Lease Term	11 years

Buildout: Floors 20 and 21[6]	Projected Design		M&V Calibration	
Modeled Square Footage	58,600 square feet		58,600 square feet	
Modeled Energy Reduction	23.5%		22.9%[7]	
Annual Electricity Reduction	201,626 kWh	2.6 kWh/SF	210,169 kWh	2.7 kWh/SF
Total Electricity Savings over Lease Term	2.2 GWh	28.5 kWh/SF	2.3 GWh	29.7 kWh/SF
Incremental Implementation Cost: ***Energy Modeling Soft Cost:*** ***State Incentives:***	$194,283 *$10,100* *$0*	$2.50/SF *$0.13/SF* *$0/SF*	$194,283 *$10,100* *$0*	$2.50/SF *$0.13/SF* *$0/SF*
Adjusted Incremental Implementation Cost	$204,383	$2.63/SF	$204,383	$2.63/SF
Total Electricity Costs Savings over Lease Term	$354,861	$4.56/SF	$369,897	$4.75/SF
Electricity Cost Savings over Lease Term (Present Value)	$274,052	$3.52/SF	$285,664	$3.67/SF
Net Present Value of Project Investment	$69,669	$0.89/SF	$81,281	$1.04/SF
Return on Investment over Lease Term	34%		40%	
Internal Rate of Return	11.7%		12.7%	
Payback Period (with Incentives)	6.3 years		6.1 years	

6. Does not include the cost of the high-efficiency lighting EPM.
7. Differences in modeled energy reduction is usually due to a discovered underestimation or overestimation of energy use in the measurement and verification process

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 Shutterstock Chose the Empire State Building

One of the strongest drivers that persuaded Shutterstock to take space in the Empire State Building was owner Empire State Realty Trust's (ESRT) commitment to establishing the 2.8 million-square-foot Empire State Building as one of the most energy-efficient buildings in New York City. By choosing to locate in this building, Shutterstock immediately improved its energy performance compared to a typical New York building.

A Collaborative Effort

When Shutterstock signed its lease with the Empire State Building, the lease language required the tenant implement specific EPMs that demonstrate an acceptable payback period. In Shutterstock's case, the lease required measures such as certain lighting, plug, and cooling EPMs that produce a five-year (or shorter) payback period.

ESRT began introducing this language in lease documents back in 2008 in order to reach its energy savings target, realizing that tenant participation is critical in achieving that. (In fact, actions taken by tenants in the building would ultimately account for more than one-quarter of the anticipated energy reduction from the initiative. For one, Shutterstock's electricity consumption is sub-metered, and the tenant pays for electricity based upon its actual sub-metered electrical usage. The innovative provisions ensure that the impact of the base building upgrades would be maximized across the tenant spaces, which account for more than half of the building's energy consumption.

The Empire State Building retrofit team also built a whole-building energy model for all 102 floors; upon each lease signing, ESRT makes this model available to tenants to refer to in the design process. Although a new energy model must be customized for each space design, the base-building model saves time and money—engineers can better understand the building's design and energy improvements therefore reducing upfront energy modeling costs and enabling more accurate projections. By packaging the analysis to include current and future floor designs, further upfront soft costs for energy modeling savings were realized.

The entire Tenant Energy Optimization 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 building owner engages with the tenant in the process; openly shares the building's energy information; and implements building-wide energy saving measures. The collaboration between ESRT and Shutterstock is a great example of this partnership.

A 2014 survey[8] discovered that 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.

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

The Project's Key Stakeholders

The Tenant: Shutterstock

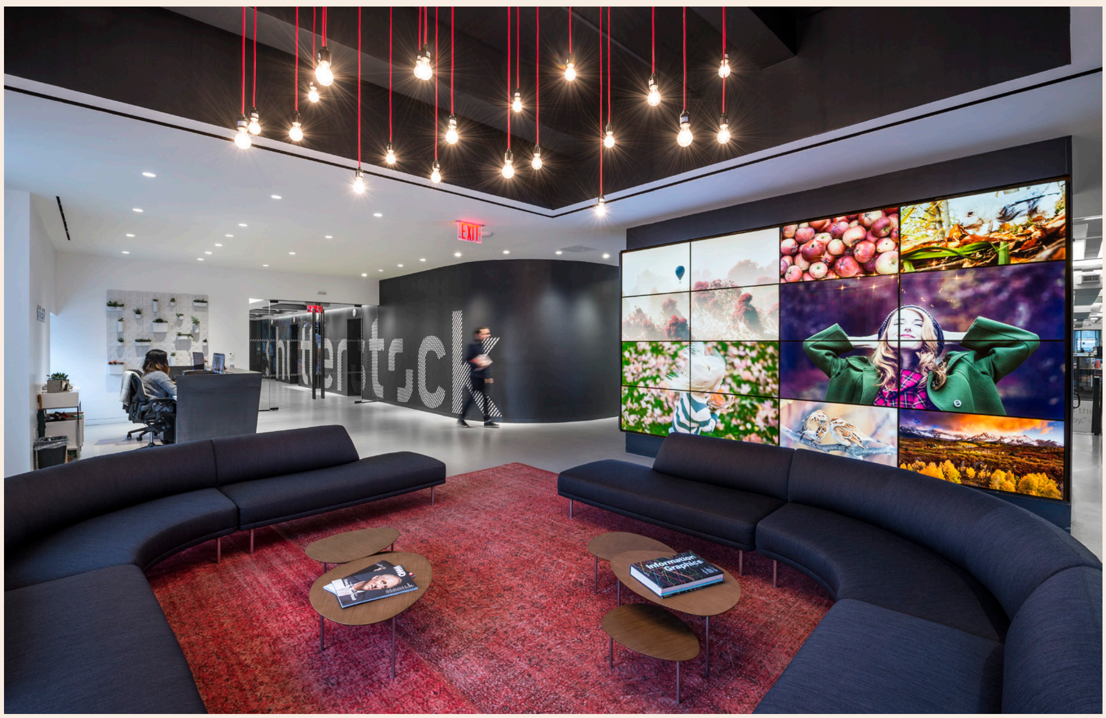
Shutterstock, Inc. (NYSE: SSTK) is a leading global technology company that has created the largest and most vibrant two-sided marketplace for creative professionals to license content—including images, videos, and music, as well as innovative tools that power the creative process.

The company has expanded its portfolio to include: Bigstock, a value-oriented stock media agency; Offset, a high-end image collection; PremiumBeat, a curated royalty-free music library; Rex Features, a premier source of editorial images for the world's media; and WebDAM, a cloud-based digital asset management service for businesses.

Its annual revenue in 2014 was $328 million.

The Building Owner: Empire State Realty Trust

Empire State Realty Trust, Inc. (NYSE: ESRT), a leading real estate investment trust (REIT), owns, manages, operates, acquires, and repositions office and retail properties in Manhattan and the greater New York metropolitan area, including the Empire State Building, the world's most famous building. ESRT is a leader in energy efficiency in the built environment.



Shutterstock integrated energy performance measures into the design, including high-efficiency lighting. The long-term costs of running and managing the facility from an energy-use cost point of view were an important design consideration from the start. Photo by Timothy Schenck.

Shutterstock Integrates the Tenant Energy Optimization Process

To start, the Empire State Building provided Shutterstock with energy-use and building guidelines early in the planning process. The architect, mechanical engineers, and the lighting designers incorporated these into the design thinking of floor-wide building systems.

At a Glance: Floors 20 and 21

Space Type	Tenant Premises
Project Area	56,800 SF
Conference	17%
Corridor	13%
Mechanical/Electrical	3%
Office	52%
Other	9%
Restroom	3%
Storage	3%

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

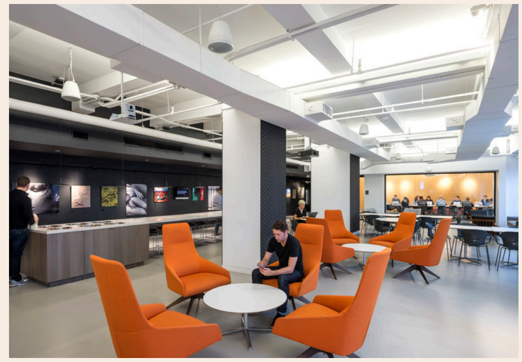
Step 8: Build out the space

PHASE III: POST-OCCUPANCY

Step 9: Execute the post occupancy plan

Step 10: Communicate results

Overall, employees have responded well to the lighting, power, and air handling systems. Photo by Timothy Schenck.



The space is comfortable and flexible with its power and not overbuilt, providing unnecessary electrical capacity. Photo by Timothy Schenck.

Selecting the Buildout Team

The Shutterstock Buildout Team

Company	Role
Gardiner & Theobald	Project Manager
STUDIOS Architecture	Architect
ICON Interiors	General Contractor
Lilker Associates	Engineer
Wendy Fok	Energy Project Director
Integral Group	Energy Consultant and Modeler
SKANSKA	Energy Costing
Empire State Realty Trust	Landlord
JLL	Owner's Representative

Many of those leading the project team, including the energy modeler, had already been involved in the Empire State Building retrofit and were experienced in the process.

Setting Energy Performance Goals and Developing a Menu of Measures

The process was kicked off with an energy design workshop in July 2013, which brought together the design and construction team that would be involved in Shutterstock's build out. These groups worked in tandem to make sure all energy reduction strategies conformed to the goals and intent of Shutterstock's design.

Among important factors Shutterstock wanted to consider in the design was:

1. The space should not be "over-lit" with artificial lighting sources that were too bright or had to be turned off once they were installed;
2. The space needed to be open and loft-like with as few enclosed rooms as possible in order to create better air flow, requiring less air handling fans and controls;
3. The space would flexible with its power and not be overbuilt, providing unnecessary electrical capacity; and
4. The long-term costs of running and managing the facility from an energy-use cost point of view.

With Shutterstock's objectives in mind, the project team put together tenant space parameters, which formed the basis for the project's energy performance goals. The accompanying Menu of Measures summarizes the energy efficiency measures that were discussed at the energy design workshop:

Menu of Measures

Low Lighting W/SF: Low ambient lighting power by design (0.5 W/SF or less) is a feasible goal. Wide deployment of mature LED lighting systems has brought efficient lighting into the high-end design market, offering efficiency and design flexibility.

Daylighting Dimming/Harvesting Controls: Automatic lighting controls offer an excellent opportunity to reduce power use. There are a number of options on the market that, when properly installed and configured, reduce lighting power when windows are providing comfortable levels of illumination, reducing both power use and cooling load while also giving a pleasant work space. Maximizing the interior ceiling height at the perimeter and use of interior glazing on perimeter conference room and office partitions are key design features. The open-ceiling approach intended for the open office areas is an excellent daylighting asset proposed for this design and makes the most of the limited floor-to-floor height at the Empire State Building. Daylight penetration can be extended through the use of lighter-colored surfaces, interior light shelves, and high ceiling heights. Currently, active daylight harvesting controls are specified for the perimeter light fixtures. The use of high ceilings is already intended. If matched with light-colored finishes, it is typically feasible to extend daylight harvesting to the fixtures located further inboard.

Local Lighting Occupancy Controls: Occupancy control of lights is an excellent method of minimizing power consumption in private offices and conference rooms. To ensure savings are realized, verification that the occupancy sensors are properly adjusted and enabled (often by dipswitch settings) should be done as part of project commissioning and spot checked in the punchlist.

Plug Load Management: The use of power by plug loads when they are not actively being operated can be significant in a modern office space. There are several approaches to reducing this power cost by switching off outlets, including: manually switched outlets; occupancy sensor-based outlet switching; and WattStopper Isolé[9] (post construction). Any outlet control approach must include a mix of non-controlled outlets to prove an always-on outlet for occupants, typically identified by a different color outlet socket. The use of dual-technology occupancy sensors (acoustic and IR) is recommended for automatically controlled outlets in large open areas to minimize the risk of nuisance switching.

Heat Recovery from IT Rooms: Configure the computer room to allow air to be cascaded from the computer room out to the general office space towards the perimeter in the winter. Using this method, heat can be supplied to perimeter zones in winter. If hot IT room air is introduced into the main system return air stream, it will also reduce the outdoor air preheat load when it is mixed with ventilation air intake. Heat recovery is best implemented in combination with a hot-aisle enclosure. Hot-aisle enclosures can be site fabricated, typically using flexible plastic curtains or panels, or purchased as a freestanding enclosure structure. They serve to collect hot air exhaust from the computer racks so it can be directly returned to the computer room air conditioning units without causing potentially damaging recirculation and hot spots. Collecting the hot air also has efficiency benefits and would allow for effective harvest of heat from the IT rooms.

Low-Face Velocity Air Handlers (AHUs): A significant portion of the HVAC fan power is used to push air through the filters and coils in the AHU. This pressure drop could be reduced by using a larger air handler unit—a coordination challenge that may ultimately cost some floor area, but a feasible option that is not hampered by the strict floor-to-floor height limits. Larger AHUs also reduce the noise generated by the fans, provide future expansion flexibility, and can reduce the maintenance requirements slightly (longer filter change intervals, lower RPM fan). Pressure drop is reduced with the square of the airflow velocity. This magnifies the impact of area changes; a 50% increase in face area reduces fan power by over 75%. Typically, the fan power reduction also allows for a downsizing of the fan motor and drive, recouping some of the initial cost of a larger unit casing immediately.

Chilled Water Data Center Cooling Unit: The building chilled water system is the most efficient source of cooling at this site. Specifying computer room air conditioners (CRACs) that are able to use it directly is a more efficient approach than using ones that have a (relatively low efficiency) standalone compressor always in operation. The elimination of humidification in the data center is also a best practice that significantly reduces energy use and maintenance costs. Humidification in data centers is a legacy of the punch card and tape drive era, but in modern computer rooms can be more of a reliability liability by injecting a pressurized water supply directly into the data center envelope. There may be control options available for the computer room air conditioner worth pursuing, including variable speed fans and networked controls that allow for a lag unit to shut off the fan when it is not required.

Demand-Controlled Ventilation with Optimized VAV Box Minimums: The amount of outside air needed to maintain space comfort is roughly proportional to the number of people in the space. Controls can accurately measure how many people are in the space by continuous measurement of the amount of carbon dioxide in the air. This allows for outdoor air volumes to be reduced somewhat when there are few people in the space, reducing the heating/costs. The active control of outside air also allows for the minimum airflow to spaces to be reduced, saving fan power. Modern electronically actuated VAV boxes are capable of stable control at significantly lower airflow rates than their default setting. Utilizing lower airflow settings reduces fan power and, when coupled with demand controlled ventilation, maintains space ventilation.

Sub-Metering and Power Monitoring: Sub monitoring of power to break down power use by lighting, plug power or HVAC power, respectively, can be done very economically provided good practice is followed and separate panels are used for each load type. The addition of this sub-metering allows the tenant to monitor where their energy is going—a pre-requisite for optimizing and effectively managing their consumption.

9. http://www.wattstopper.com/resources/sustainability/plug-loads/isole.aspx

Modeling the Projected Energy Performance

During design development, a predictive energy model[10] was created using eQuest software, which modeled energy consumption and EPM results for Shutterstock's new office space and was later calibrated using metered data gathered during tenant occupation.[11]

Assumptions Present in the Modeling:

- Operable windows will be open a negligible amount of time.
- The number of people on the floor is estimated by using a guideline of 200 GSF (including storage and corridors, but excluding unconditioned core) per person. This is a typical occupant density for this type of office space.
- On a typical day, only 75% of the maximum occupancy will be present and working on the floor. Lower occupancy is typically due to offsite meetings, absences, and travel. For example, Floor 20 is estimated as having maximum design occupancy of 86 people but a typical day maximum occupancy of 64 people.
- The space begins occupancy at 7 a.m. The space ends occupancy at 5 p.m., with a few people staying until 6 p.m. (lights and plug loads).
- On a typical day, 90% of the installed lighting is turned on (ignoring daylight harvesting controls but including occupancy sensors). The design LPD baseline to be used for comparison is 1.235 W/SF
- On a typical day, 70% of the design plug loads are turned on.

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 Shutterstock'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.

Recommended EPM[12]	Target Area	Incremental First Cost[13]
Current Lighting Design	Lighting	$39,667
As-Designed Daylighting	Lighting	$128,112
Local Occupancy Control of Lights	Lighting	$1,200
Reduced Lighting Power Density	Lighting	$95,561
Extend Daylight Dimming/Harvesting	Lighting	$53,603
Occupancy Sensor Plug Strips	Plug Loads	$12,600
Plug Load Management	Plug Loads	$45,000
Chilled Water Data Center Cooling Unit	Data Center	$18,000 Net
Computer Shutoff Software	Plug Loads	$6,870
Low-Velocity AHYs	HVAC	$15,570
Demand-Controlled Ventilation with Reduced Minimum Flow Rates on VAV Boxes	HVAC	$11,000

10. There are three baselines shown in the energy model: the as-built baseline of the Empire State Building; an ASHRAE 90.1-2007 baseline, which has been used for the majority of the savings calculations; and an ASHRAE 90.1-2010 baseline.
11. See Appendix A for detailed analysis.
12. For a more detailed analysis, see Shutterstock's Space: The Preliminary Value Analysis
13. These assessments are rough at this stage of design; it is likely that as the design develops some measures may become prohibitively expensive while others may be able to be implemented for little or no cost if they are designed in from the beginning.

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 Shutterstock and prescribed by ESRT's lease.

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

Shutterstock's Space: A Preliminary Value Analysis

EPM Description	Electricity Reduction (kWh/year)	Percent Electricity Reduction	Annual Electricity Savings	Incremental First Cost	Costing Assumptions	Simple Payback	11-Year Cost Savings
Current Lighting Design (0.986 W/SF)	38,930	4.7%	$6,801	$39,667	Fixture cost: 60,101 USF @ $10.61/SF compared to baseline cost @ $9.95/SF	5.8 yrs	$74,807
As-Designed Daylighting	15,306	1.8%	$2,674	$128,112	As-designed daylighting; cost of F1A and F2 fixtures above non-dimming F1 fixture, plus sensors and ballasts	47.9 yrs	$29,412
Local Occupancy Control Of Lights	1,190	0.1%	$208	$1,200	6 above-code sensors @ $200 each	5.8 yrs	$2,287
Economization of Data Center and No Humidity	75,968	9.1%	$13,271	$18,000	As-designed data center installation. Avoided cost of no humidification and retrofit of compressors	Immediate	$145,978
Occupancy Sensor Plug Strips	20,087	2.4%	$3,509	$12,600	1 shared between side-by-side desk space, as feasible; 252 count @ $50 each	3.6 yrs	$38,599
Computer Shutoff Software	37,629	4.5%	$6,573	$6,870	NightWatchman software $15/computer for first year (458 computers); $2/computer for remaining lease years	1.0 yr initial payback; 1.7 months each subsequent lease year	$72,307
Low-Velocity AHUs	17,365	2.1%	$3,033	$15,570	Upsize AHUs @ $15,570	5.1 yrs	$33,368
Demand-Controlled Ventilation with Reduced Minimum Flow Rates on VAV Boxes	50,191	6.0%	$8,768	$11,000	20 CO_2 sensors @ $250 each; 8 damper actuator controls @ $750 EA; minimum flow rate setpoint has no incremental cost	1.3 yrs	$96,445
Reduced Lighting Power Density (0.7 W/SF)	40,905	4.9%	$7,146	$95,561	Increase LEDs by 20% for total of $12.73/SF; reduce number of fixtures by 5% ($0.53)/SF – Net incremental cost above as-designed $1.59/SF	13.4 yrs	$78,602
Extend Daylight Dimming and Harvesting	15,210	1.8%	$2,657	$53,603	Extend to first bay of open office area; replace all F1 fixtures with F1A dimming fixtures	20.2 yrs	$29,227
All Measures	**312,781**	**37.5%**	**$54,639**	**$346,183**		**6.4 yrs**	**$601,030**

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 with all of the other tenants in the building). Savings from lighting, plug load, and server room EPMs typically benefit the tenant directly.

Comparing Shutterstock's EPM Packages

Energy Performance Measure	Least Energy Reduction	Moderate Energy Reduction	Significant Energy Reduction
ASHRAE 90.1 2007 and Radiator Controls (Empire State Building Baseline)	+	+	+
Lighting: LPD 0.986 W/SF	+	+	
Minor Daylighting: Dimming and Harvest Controls on Fixtures at Perimeter	+	+	
Lighting: Local Occupancy Sensor Control	+	+	+
Chilled Water Data Center Cooling Units (Economizer Coil)	+	+	+
Demand-Controlled Ventilation and Setpoints	+	+	+
Eliminate Datacenter Humidifiers	+	+	+
Plug Load Management: Occupancy Sensor Plugs/Modlets/Equivalent		+	+
Plug Load Management: NightWatchman Computer Software		+	+
Low-Velocity Air Handlers		+	+
Demand-Controlled Ventilation with Reduced Vav Box Minimum Flow Rates		+	+
Lighting: LPD 0.7 W/SF			+
Major Daylighting: Extend to First Bay Fixtures in Open Office Area			+
Plug Load Management: 50% of Outlets Switchable and Sub-Metering			+

The library provides employees a place for quiet work with natural light and views. Photo by Timothy Schenck.

Reviewing the Budget and Selecting the EPMs

Energy modeling and costing analysis determined the following six EPMs would offer the best value for Shutterstock:

1. As-Designed Lighting (0.986 W/SF)
2. Daylight Harvesting
3. Local Occupancy Sensors
4. Economization of Data Center Space
5. Demand-Controlled Ventilation
6. Chilled Water Data Center Cooling Unit

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 Shutterstock.

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 Shutterstock project, M&V was vital in demonstrating that the energy value analysis achieved the level of value promised.

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, Shutterstock 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 period of Shutterstock's space took place between the dates of February 8 and February 14, 2014. Integral Group collected actual tenant energy consumption data and calibrated the existing energy model to correspond to observed usage.

Results show that the original energy model was fairly accurate, underestimating total tenant electric consumption by approximately 7%. Design power densities and peak HVAC energy were modeled accurately; however occupancy profiles and HVAC system configuration has been modified to reflect actual tenant operation. Savings and energy consumption are compared for implemented EPMs and are revealed through metered data and observed construction.

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

	Uncalibrated Model	Calibrated Model
Occupancy Hours (weekday)	7 a.m.–7 p.m.	8 a.m.–10 p.m.
Peak Office Plug Load Power Design – Office/Conference (W/SF)	1.2	1.1
Peak Office Plug Load Power Design – Other Spaces(W/SF)	0.20	0.15
Peak Lighting Power (W/SF)	0.70	0.70
Minimum Lighting Power (W/SF)	0.015	0.14
Daylight Harvesting Controlled kW Fraction of Perimeter Lights	0.3	0.3
HVAC Fan Schedule Hours	7 a.m.–5 p.m.	12 a.m.–12 p.m.
Peak IT Power kW (IDF and MDF total)	29.6	19.3
Total Tenant Electricity Consumption—Implemented Package (kWh)	655,968	705,959

Lighting

Peak lighting power density was accurately predicted in the original energy model, representing lighting levels of approximately 0.70 W/SF for lighted spaces (excluding core). Overnight and weekend usage, however, was higher than expected, resulting in overall increase of lighting power from the original model. Lights also remained on for longer, with metered data showing lighting continuing past 10 p.m., indicating longer space occupancy than originally predicted. Metered data showed a near instantaneous drop to minimum levels at night, representing well-controlled lighting system via a time-clock or occupancy sensors. A minimum lighting level of 20% of peak is shown, indicating decorative or emergency circuits not originally modeled.

Metered data suggests that overall lighting power exceeded design expectations, which has significant impact in the value analysis results. Verification of actual lighting fixtures, as compared to the cost estimates presented in the value analysis, can provide clarity on the exact contribution of the various lighting measures to overall savings.

HVAC

The most significant changes to the calibrated model were to the HVAC system configuration and air handler unit (AHU) fan power.

- **Air Handler Fan Power:** Metered data revealed that air handler fans ran continuously. It is assumed that conditioning is required at all times due to the extended occupancy schedule of workers. Fans are shown to reduce to minimum speed of approximately 40% during overnight hours. The calibrated model was adjusted to input actual design flow of the AHU with fan speed scheduled by VAV box output, determined through metered fan power profile.
- **Low-Velocity AHUs:** Based on design documents of the AHUs, overall fan efficiency is reduced from ASHRAE baseline to 0.00075 kW/CFM. This is achieved through high-efficiency fans and slightly oversized ducting which reduces overall system pressure drop.
- **Demand-Controlled Ventilation**: DCV savings are a result of heating and cooling savings from the reduction in outdoor ventilation air. Since cooling and heating energy for ventilated spaces is provided by the building's central plant, minimal impact is seen in tenant electric consumption.
- **Floor-Packaged Units:** Several small packaged DX units serve miscellaneous spaces throughout Floors 20 and 21. These systems were not originally modeled, and all floor conditioning was previously assumed to be served by the main floor AHUs.

As for the AHUs, the project team recommended that system scheduling and control should be verified to confirm 24/7 ventilation is required at these levels. If fans are able to be scheduled off during unoccupied hours (as originally assumed) significant energy savings can be achieved.

IDF Rooms

Four small intermediate distribution frame (IDF) rooms were originally modeled as served by computer room air condition units (CRACs). The energy model was modified to represent actual design, in which case these rooms are exhausted to the general floor, conditioned by main floor AHUs. A main distribution frame (MDF) room on Floor 20 is served by dedicated CRAC units, served by a dedicated electrical panel.

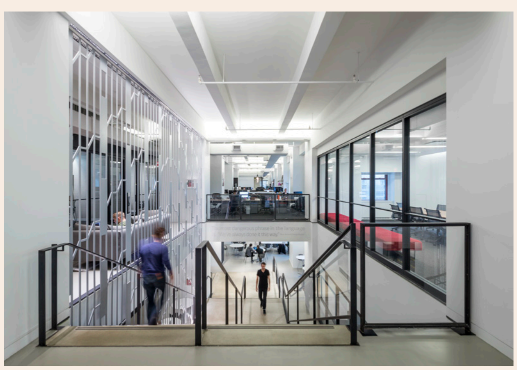
- **Water Side Economizer on CRAC units:** The originally modeled measure indicated chilled water CRAC units. This measure was modified to reflect actual implementation of packaged DX CRAC units, equipped with ECONOCOIL[14] free cooling. The ECONOCOIL system consists of a secondary cooling coil within the CRAC unit, which can be served directly with condenser water cooled to 45°F when weather conditions allow. This system shows more savings than originally predicted chilled water CRAC units, and allows for full separation of critical cooling from building chilled water, ideal for data center use.

CRAC unit power data was not broken out from plug loads due to mixed load panels. Also, since measurement was performed in summer, observation of the operation of the economizing system was not possible. Verification that economizer system was installed, and humidity control has been disabled on CRAC units will ensure model accuracy, and confirm implementation (or lack thereof) of the other plug load management measures.

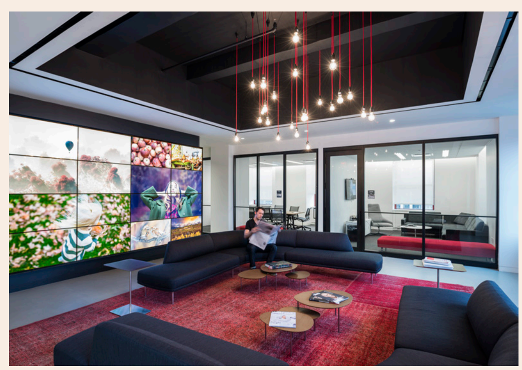
Plug Loads/Equipment

Equipment power was initially modeled accurately, with plug load density varying from 0.2 W/SF to 1.2 W/SF based on space type. Slightly lower levels were revealed through metering, and the model was adjusted accordingly with new levels of 0.15 W/SF to 1.1 W/SF. Similarly to lighting, the schedule was extended past the originally predicted 6 p.m. to reflect additional hours of occupancy.

The project team observed that due to combined loads on individual panels, some assumptions were made based on the profile and relative density of partial lighting and plug load measurements. As such, some assumptions from the original energy model were required in determining measure implementation. For example, if NightWatchman was implemented on only some of the plug load circuits, it may have been missed in analyzing only one dedicated plug panel.



The space is open and loft-like with as few enclosed rooms as possible in order to create better air flow, requiring fewer air handling fans and controls. Photo by Timothy Schenck.



Daylight and visibility connect the reception area and conference rooms. Photo by Timothy Schenck.

14. A light duty, plate-type heat transfer product designed to handle a wide range of heating and cooling applications.

Shutterstock's Sustainability Initiatives and Their Impacts on Employees

The Empire State Building's energy guidelines proved to be a positive factor in the development of the space and encouraged Shutterstock to think harder about how the buildout of its space has an effect on energy use.

This space has performed well from a services management point of view and as a high-performance technology office space. The employees have responded well to the lighting, power, and air handling systems overall and feel as though this space is working with them instead of against them. Over time, there have been fewer complaints about lighting and comfort than the past.

The yoga room reflects the design intent to not be over-lit with artificial lighting sources that are too bright or need to be turned off once installed. Photo by Timothy Schenck.

Further Recommendations

In addition to measures in the "moderate energy reduction" package, the project team recommended optimizing mechanical performance by designing VAV boxes with a reduced minimum airflow set point of 20%. When coupled with demand-control ventilation (implemented in the as-designed package), a reduced minimum airflow set point in the zonal VAV boxes can significantly reduce fan energy while still meeting the ventilation demands of the space. Shutterstock's as-designed, demand-controlled ventilation specifies a minimum flow rate of 30% in most zones. Improving lighting performance through a lower lighting power density design (0.70 W/SF) and increasing daylight harvesting by maintaining a 15-foot penetration around the entire perimeter are both cost effective measures that further enhance energy performance.

Ongoing energy management systems will help ensure energy use is well managed. End-use sub-metering (lighting, plug, IT room, and HVAC loads) and a tenant energy management platform would provide feedback for ongoing commissioning and maintenance of the systems and assist in maintaining energy savings consistent over the life of the investment.

Shutterstock electricity sub-meters and the base building tenant energy management system will provide data to measure and verify detailed energy consumption in order to further understand energy consumption and trends by end use through temporary data logging instrumentation.

Looking Forward

Shutterstock has since leased an additional floor; The entire Floor 36 floor will add another 25,000 square feet of upon its delivery in September 2016. What Shutterstock learned from the Tenant Energy Optimization process will provide measured results in reviewing design and construction of the new floor.

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

Uncalibrated Corrected Baseline Model Results: Tenant Electricity

	Description	Total Tenant Electricity					Tenant Electricity Reduction	
#	**Name**	**Total kWh**	**Lighting kWh**	**Equipment kWh**	**HVAC kWh**	**IT (Inc. CRACs) kWh**	**vs. Empire State Building Baseline (B-1)**	**vs. ASHRAE Baseline (B-2)**
BL-1	Empire State Building Baseline	916,606	192,831	202,731	127,636	393,408	-	-
BL-2	ASHRAE 90.1-2007	857,594	192,831	202,731	72,467	389,566	6.4%	-
G-1	High-Efficiency Lighting (.986 W/SF)	818,434	153,952	202,731	72,918	388,833	10.7%	4.6%
G-2	Daylight Harvesting	803,083	138,207	202,731	73,354	388,791	12.4%	6.4%
G-3	Occupancy Sensor Controlled Lighting	801,887	137,019	202,731	73,357	388,780	12.5%	6.5%
G-4	Water Side Economizer on CRAC units	784,540	137,019	202,731	73,357	371,433	14.4%	8.5%
G-5	Demand-Controlled Ventilation	784,498	137,019	202,731	73,305	371,444	14.4%	8.5%
G-6	No Humidity Control in MDF	705,986	137,019	202,731	73,344	292,892	23.0%	17.7%
B-3	Low-Velocity Air Handlers	695,615	137,019	202,731	62,975	292,890	24.1%	18.9%
BB-1	High-Efficiency Lighting (0.7 W/SF)	655,968	97,275	202,731	63,280	292,682	28.4%	23.5%
	Incremental Savings vs Previous Run						**Percentage Savings**	
BL-1	Empire State Building Baseline	n/a	n/a	n/a	n/a	n/a	-	-
BL-2	ASHRAE 90.1-2007	59,011	0	0	55,168	3,843	6.4%	6.9%
G-1	High-Efficiency Lighting (.986 W/SF)	39,160	38,878	0	-451	732	4.3%	4.6%
G-2	Daylight Harvesting	15,351	15,745	0	-436	42	1.7%	1.8%
G-3	Occupancy Sensor Controlled Lighting	1,196	1,188	0	-3	11	0.1%	0.1%
G-4	Water Side Economizer on CRAC units	17,347	0	0	0	17,347	1.9%	2.0%
G-5	Demand-Controlled Ventilation	42	0	0	52	-11	0.0%	0.0%
G-6	No Humidity Control in MDF	78,512	0	0	-39	78,552	8.6%	9.2%
B-3	Low-Velocity Air Handlers	10,371	0	0	10,369	2	1.1%	1.2%
BB-1	High Efficiency Lighting (0.7 W/SF)	39,647	39,744	0	-305	208	4.3%	4.6%

Final Model Results: Tenant Electricity

	Description	Total Tenant Electricity					Tenant Electricity Reduction	
#	**Name**	**Total kWh**	**Lighting kWh**	**Equipment kWh**	**HVAC kWh**	**IT (Inc. CRACs) kWh**	**vs. Empire State Building Base-line (B-1)**	**vs. ASHRAE Baseline (B-2)**
BL-1	Empire State Building Baseline	1,041,383	315,707	175,034	318,709	231,932	-	-
BL-2	ASHRAE 90.1-2007	916,128	315,707	175,034	195,856	229,531	12.0%	-
G-1	High-Efficiency Lighting (.986 W/SF)	854,812	252,055	175,034	198,513	229,211	17.9%	6.7%
G-2	Daylight Harvesting	836,443	233,549	175,034	198,716	229,145	19.7%	8.7%
G-3	Occupancy Sensor Controlled Lighting	830,643	227,464	175,034	199,025	229,120	20.2%	9.3%
G-4	Water Side Economizer on CRAC units	813,871	227,464	175,034	201,571	209,801	21.8%	11.2%
G-5	Demand-Controlled Ventilation	813,865	227,464	175,034	201,565	209,801	21.8%	11.2%
G-6	No Humidity Control in MDF	800,628	227,464	175,034	201,572	196,557	23.1%	12.6%
B-3	Low-Velocity Air Handlers	768,925	227,464	175,034	169,870	196,557	26.2%	16.1%
BB-1	High-Efficiency Lighting (0.7 W/SF)	705,959	161,486	175,034	173,132	196,307	32.2%	22.9%
	Incremental Savings vs Previous Run						**Percentage Savings**	
BL-1	Empire State Building Baseline	n/a	n/a	n/a	n/a	n/a	-	-
BL-2	ASHRAE 90.1-2007	125,225	0	0	122,854	2,401	12.0%	13.7%
G-1	High-Efficiency Lighting (.986 W/SF)	61,316	63,653	0	-2,658	321	5.9%	6.7%
G-2	Daylight Harvesting	18,369	18,506	0	-202	66	1.8%	2.0%
G-3	Occupancy Sensor Controlled Lighting	5,800	6,085	0	-309	25	0.6%	0.6%
G-4	Water Side Economizer on CRAC units	16,773	0	0	-2,546	19,319	1.6%	1.8%
G-5	Demand-Controlled Ventilation	6	0	0	6	0	0.0%	0.0%
G-6	No Humidity Control in MDF	13,237	0	0	-7	13,244	1.3%	1.4%
B-3	Low-Velocity Air Handlers	31,703	0	0	31,703	0	3.0%	3.5%
BB-1	High-Efficiency Lighting (0.7 W/SF)	62,966	65,979	0	-3,262	250	6.0%	6.9%

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

EPM Description		Uncalibrated Results (Original Model)			Uncalibrated Results (Corrected Baseline Model)			Calibrated Model		
		Annual Tenant Electricity Savings (kWh)	**Percent Savings**	**Annual Cost Savings**	**Annual Tenant Electricity Savings (kWh)**	**Percent Savings**	**Annual Cost Savings**	**Annual Tenant Electricity Savings (kWh)**	**Percent Savings**	**Annual Cost Savings**
BBL-1	Empire State Building Baseline	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BL-2	ASHRAE 90.1 2007	59,012 kWh	6.6%	$9,737	59,011 kWh	6.4%	$9,737	125,255 kWh	12.0%	$20,667
G-1	High-Efficiency Lighting (.986 W/SF)	39,081 kWh	4.6%	$6,448	39,160 kWh	4.6%	$6,461	61,316 kWh	6.7%	$10,117
G-2	Daylight Harvesting	15,322 kWh	1.8%	$2,528	15,351 kWh	1.8%	$2,533	18,369 kWh	2.0%	$3,031
G-3	Occupancy Sensor Controlled Lighting	1,195 kWh	0.1%	$197	1,196 kWh	0.1%	$197	5,800 kWh	0.6%	$957
G-4	Water Side Economizer on CRAC units	11,665 kWh	1.4%	$1,925	17,347 kWh	2.0%	$2,862	16,773 kWh	1.8%	$2,767
G-5	Demand-Controlled Ventilation	44 kWh	0.0%	$7	0 kWh	0.0%	$0	0 kWh	0.0%	$0
G-6	No Humidity Control in MDF	78,520 kWh	9.3%	$12,956	78,512 kWh	9.2%	$12,955	13,237 kWh	1.4%	$2,184
B-3	Low-Velocity Air Handlers	10,420 kWh	1.2%	$1,719	10,371 kWh	1.2%	$1,711	31,703 kWh	3.5%	$5,231
BB-1	High-Efficiency Lighting (0.7 W/SF)	41,175 kWh	4.9%	$6,794	39,647 kWh	4.6%	$6,542	62,966 kWh	6.9%	$10,389
	Total Implemented Package	**197,422 kWh**	**23.5%**	**$32,575**	**201,626 kWh**	**23.5%**	**$33,628**	**201,130 kWh**	**22.9%**	**$34,678**

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**.