Urban Land Institute

ULI Tenant Energy Optimization Program

Case Study: TPG Architecture LLP

Executive Summary: TPG Architecture's Story

In 2013, TPG Architecture, an architecture firm headquartered in New York City, signed a lease for 40,000 square feet on Floors 4 and 5 at 31 Penn Plaza, an 18-story, pre-war office building located between Sixth and Seventh Avenues. The 444,000-square-foot property, also known as 132 W. 31st St., is located in the heart of Midtown Manhattan.

When it was time to design and construct its new space, TPG had several major goals, including building out a model office space that demonstrates energy efficiency's strong return on investment, which would serve as a model for design clients. 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 a team of experts, TPG evaluated an integrated packages of energy performance measures (EPMs)[1] on Floors 4 and 5. 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 TPG's 11-year lease, the project is estimated to provide energy cost savings of $275,372, a 162% return on TPG's investment[2], and a 33.9% internal rate of return (IRR)[3]. The projected payback: only 3.2 years.

TPG'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 a replicable model to expand the demand for high-performance tenant spaces, and supply the 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.
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: TPG Project Information and Projected Performance

Building Information	
Tenant Name	TPG Architecture LLP
Building Owner	Savanna (at time of lease)
Location	31 Penn Plaza, Midtown Manhattan
Building Size	444,000 SF (18 Floors)
Principal Use	Office
Construction Type	Class-B, Pre-World War II Tower
TPG Architecture Lease Term	11 years

Floors 4 and 5 Buildout	Projected Design		M&V Calibration	
Modeled Square Footage	40,000 square feet		40,000 square feet	
Modeled Energy Reduction	20.2%		21.6%[6]	
Annual Electricity Reduction	95,175 kWh	2.4 kWh/SF	139,077 kWh	3.4 kWh/SF
Total Electricity Savings over Lease Term	1.0 GWh	26.0 kWh/SF	1.5 GWh	37.9 kWh/SF
Incremental Implementation Cost: ***Energy Modeling Soft Cost:*** ***State Incentives:***	$72,214 *$9,000* *$0*	$1.79/SF *$0.22/SF* *$0/SF*	$72,214 *$9,000* *$0*	$1.79/SF *$0.22/SF* *$0/SF*
Adjusted Incremental Implementation Cost	$81,214	$2.01/SF	$81,214	$2.01/SF
Total Electricity Costs Savings over Lease Term	$188,447	$4.67/SF	$275,372	$6.83/SF
Electricity Cost Savings over Lease Term (Present Value)	$145,534	$3.61/SF	$212,665	$5.27/SF
Net Present Value of Project Investment	$64,319	$1.59/SF	$131,450	$3.26/SF
Return on Investment over Lease Term	79%		162%	
Internal Rate of Return	19.8%		33.9%	
Payback Period (with incentives)	4.7 years		3.2 years	

6. Differences in modeled projected design and M&V calibrated energy reduction may be attributed to baseline and assumption adjustments and actual energy use documented during the M&V 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 TPG Architecture Selected 31 Penn Plaza

As a leader in office space planning and design for corporate clients, TPG was attracted by the opportunity to start with a clean slate of 27,000 square feet on Floor 5 and 13,000 square feet on Floor 4, connected via an open stair.

TPG founder Jim Phillips noted, "We looked at many buildings in several neighborhoods and thought that this space was the most efficient and convenient, and offered the greatest potential."

"When we were first visiting the building, we could stand in the middle of the floor and see through the block, with 10' high windows looking out along a straight axis from 31st Street to 30th Street; this gave us a sense of largesse and possibility," said TPG managing design director Larry Berger.

Location was also an important factor, and TPG wanted to be close enough to the mass transit utilized by its employees.

The new space was designed as a "working lab," with bench seating, collaborative space, and a centrally located electronic resource area for employees. The partners solicited the opinions of the design staff as they started to envision the form the new space would take, and when they sent out a planning strategy survey on employees' needs, 89% of the firm responded.

The results showed that employees overwhelmingly wanted more open spaces and technology, which influenced TPG's sustainability strategy. Technology that could measure and audit systems like lighting and HVAC was particularly important.

A Collaborative Effort

When TPG signed its lease at 31 Penn Plaza, it negotiated in the tenant work letter for high efficiency HVAC units to be installed by the building owner. By locating in a building with low static pressure from ductwork design, TPG would reduce electricity consumption in its leased premises.

Although the measure was ultimately not implemented, 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 landlord engages with the tenant in the process; openly shares the building's energy information; and implements building-wide energy saving measures.

A 2014 survey[7] 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.

7. 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: TPG Architecture

TPG Architecture LLP was founded in 1979 and is headquartered in New York City with offices in Long Island and London.

While its core business focuses on corporate interiors and retail design, it also has practice groups in advanced technology and broadcast, architecture, healthcare, education, and branding and graphics. Organized in sector-specific studios, TPG provides the strong personal and specialized service of a small firm, as well as the breadth and depth of resources offered by a large organization.

TPG is committed to green, sustainable design and understanding the global impact of its decisions. It believes sustainable design is here to stay and will become the only acceptable way to design.

The Building Owner: Savanna

Founded in 1992, Savanna is a NYC-based real estate private equity firm and asset management company that pursues real estate equity and debt investments in the Northeast Corridor. Since raising Savanna Real Estate Fund I, LP In 2006, it has launched and invested a series of subsequent funds representing approximately $2.8 billion in total capital across 13 million square feet of real property.

In August 2015, Savanna sold 31 Penn Plaza to NYC-based The Vanbarton Group.

TPG Architecture Integrates the Tenant Energy Optimization Process

Many project team members from previous Tenant Energy Optimization projects were made aware of TPG's lease signing, and the architecture firm was familiar with the process implemented in some tenant spaces at the Empire State Building. Those tenants include Global Brands Group, Coty, LinkedIn, and Shutterstock. TPG recognized that utilizing the Tenant Energy Optimization process presented an opportunity to demonstrate a strong business case in the design and construction of its own space.

At a Glance: Floors 4 and 5

Total Rentable Square Feet	40,431 SF (181 SF/per person)
Total Conditioned Square Feet (Lighted)	25,361 SF (114 SF/per person)
Total Seating	223
Collaborative Seating	186 (includes café and all open seating)
Open Office	99%
Closed Office	1%

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

Selecting the Buildout Team

The TPG Buildout Team

Company	Role
TPG Architecture	Project Manager
TPG Architecture	Architect
JRM Construction Management	General Contractor
CFS Engineering	Engineer
Wendy Fok	Energy Project Director
Integral Group	Energy Consultant
Savanna	Building Owner

Many of those on the project team, including the energy modeler, had already been involved in other tenant buildouts utilizing the process.

Plug load management using ENERGY STAR® equipment leads to a reduced plug load in the open office areas. Photo by Eric Laignel.

Setting Energy Performance Goals and Developing a Menu of Measures

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

TPG wanted to use the space to spotlight its design capabilities, including sustainability services. The budget was limited, therefore design decisions had to make sense—which made natural daylight and efficient lighting important elements, as they had quick paybacks and lower operating costs. As densification of employees in an open office benching layout allowed for more staff in less space, community areas where staff could meet and interact were also extremely important.

With TPG's objectives in mind, the project team put together base building and tenant space parameters, which formed the basis for the project's energy performance goals in a menu of measures:

Base Building Parameters

High-Efficiency HVAC Units: Selecting high-efficiency packaged air conditioning units for floor cooling can reduce energy consumption at the compressor and the fan motor.

Demand-Controlled Ventilation: 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/cooling costs associated with conditioning outside air. 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.

Tenant Space Parameters

Low Lighting W/SF: Low ambient lighting power by design (0.7 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.

Local Lighting Occupancy Sensors: Occupancy control of lights is an excellent method of minimizing power consumption in private offices and conference rooms.

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. Daylight penetration can be extended through the use of lighter-colored surfaces, interior light shelves, and high ceiling heights.

Plug Load Control (Computer Software): Specialized computer software automatically backs up computers and shuts down computers to save energy during unoccupied periods

Plug Load Control (Occupancy Sensors): Typically, plug loads are reduced at night and continue to draw power at a reduced rate, when they are in sleep or off mode. One approach to minimizing these phantom loads is to provide some number of outlets with active controls that turn off power completely when the space is unoccupied.

ENERGY STAR® Equipment: Specifying that all office equipment and appliances be ENERGY STAR® certified ensures the most recent low-energy technology is used for plug loads.

High Efficiency Servers (ENERGY STAR® Equipment): Existing building server and IT loads have been estimated for the IDF and MDF rooms as 30-50 W/SF. Use of high-efficiency ENERGY STAR®-rated server equipment could reduce these loads significantly.

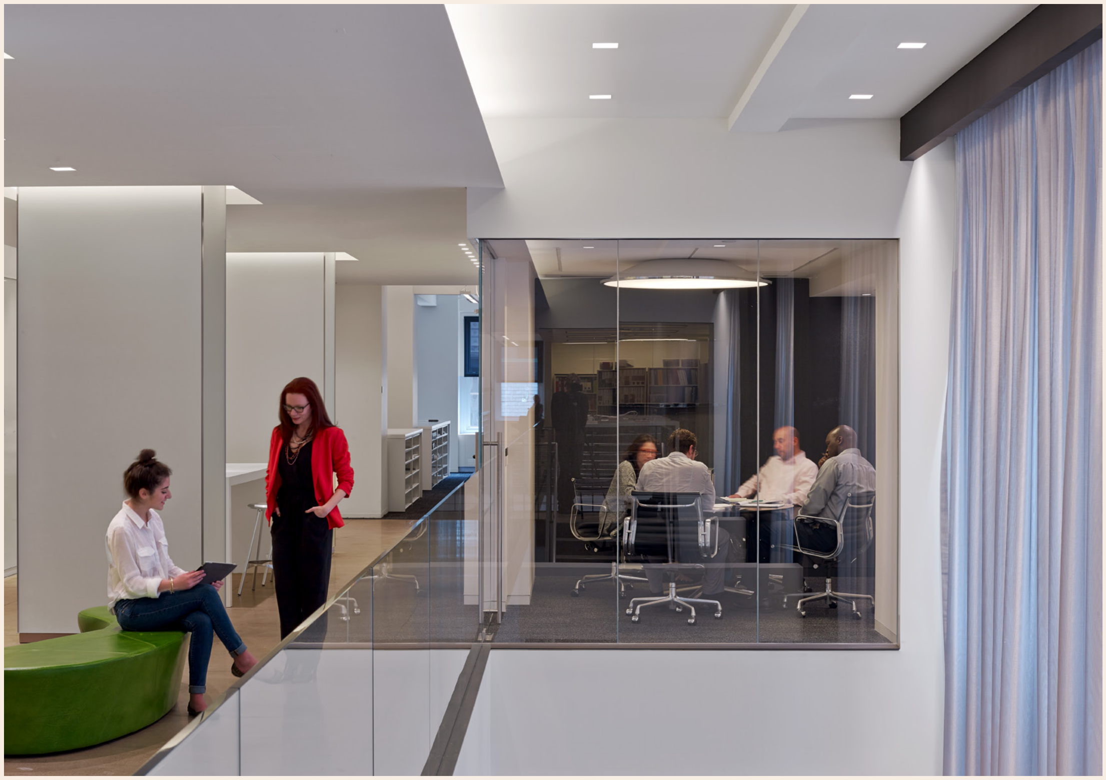
Heat Recovery: Implement in main distribution frame (MDF) and intermediate distribution frame (IDF) rooms.

Best Practices Setpoints (No Humidification in Data Center): Conforming to ASHRAE TC 9.9: Thermal Guidelines[8] for Data Processing Environments is recommended to minimize impact on HVAC system of IT closets and server equipment. For small data closets, such as those at TPG, humidification control is unnecessary and energy intensive.

Modeling the Projected Energy Performance

During design development, a predictive energy model[9] was created using eQuest software, which modeled energy consumption and EPM results for TPG's space on Floors 4 and 5. The model was later calibrated using metered data gathered during tenant occupation.[10]

8. More information can be found at http://tc99.ashraetcs.org/
9. There are three baselines shown in the energy model: the as-built baseline of the 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.
10. See Appendix A for detailed analysis.



Local lighting occupancy sensors exceed the code requirements of ASHRAE, which state that they must be installed in conference/meeting rooms. Photo by Eric Laignel.

Questions for Building Owners to Improve Model Results

- What is the source of building cooling—direct expansion air cooled units, water-cooled chiller system, or other?
- What is the manufacturer and model number efficiency rating of the building cooling system? Is the design efficiency available?
- Is there CO_2 control of the outdoor air volume supply, or is it a balanced damper?
- How are building systems scheduled?
- Are there variable-frequency drives on the building air supply? What is the typical range of speed variation observed on them?

Assumptions Present in the Modeling:

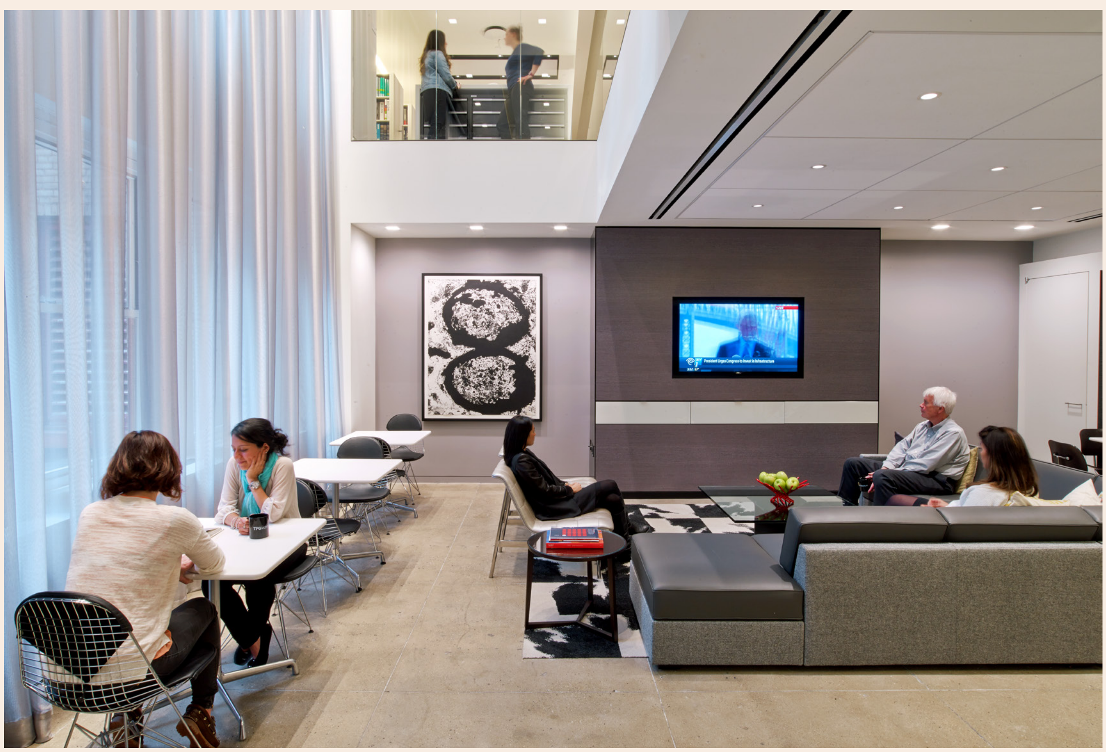
- The number of people on the floor is estimated at 60 GSF (including storage and corridors, but excluding unconditioned core) per person, a typical value for this type of office space. Over 40% of the model is open office (50 SF/person), hence the high density.
- On a typical day, only 90% of the maximum occupancy will be present and working on the floor. Lower occupancy is typically due to offsite meeting, absences, and travel. The space ends occupancy at 6 p.m., with a few people staying until 7 p.m.
- Most lights are turned on at 7 a.m. and off at 7 p.m.
- On a typical day, 90% of the installed lighting is turned on (ignoring daylight harvesting controls but including occupancy 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 TPG'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[11]	Target Area	Incremental First Cost
As-Designed Daylight Dimming	Lighting	$14,400
As-Designed Lighting Power (1.229 and 1.007 W/SF on Floors 4 and 5)	Lighting	$20,638
Occupancy Control of Lights	Lighting	$8,400
Reduced Lighting Power Density (0.868 and 0.768 W/SF on Floors 4 and 5)	Lighting	$20,638
Extended Daylighting	Lighting	$15,020
Reduced Lighting Power Density (0.5 W/SF)	Lighting	$13,759
ENERGY STAR® Equipment	Plug Loads	$0
Computer Shutdown Equipment	Plug Loads	$3,495
Occupancy Sensor Plug Strips	Plug Loads	$5,350
Upgraded HVAC Units	HVAC	$0
CO_2 Demand Control on Return Air to Outside-Air Dampers	HVAC	$17,700
Economization of Computer Room	Data Center	$8,984
No Humidification in Computer Room	Data Center	$0

11. For a more detailed analysis, see the following table, TPG's Space: The Preliminary Value Analysis



Natural daylighting and exterior views are captured in the double-height communal spaces and circulation pathways. Photo by Eric Laignel.

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 investment return threshold desired by TPG.

TPG's Space: The Preliminary Value Analysis

EPM ID	EPM Description	Electricity Reduction (kWh/year)	Percent Electricity Reduction	Annual Electricity Savings	Incremental First Cost	Costing Assuptions	Simple Payback	11-Year Cost Savings
1.0	Upgraded HVAC Units	19,252	3.8%	$3,465	$0	Landlord expense negotiated in work letter	Immediate	$38,115
1.1	As-Designed Daylight Dimming	21,486	4.4%	$3,867	($14,400)	18 sensors and installation ($300 each); 90 dimming ballasts ($100 each); no incremental cost per fixture	3.7 years	$42,542
1.2	As-Designed Lighting Power (1.229 and 1.007 W/SF on Floors 4 and 5)	28,985	6.0%	$5,217	($20,638)	27,517 modeled SF ($0.75/SF)	4.0 years	$57,390
1.3	Occupancy Control of Lights	4,145	0.9%	$746	($8,400)	42 additional sensors ($200 each)	11.3 years	$8,207
1.4	ENERGY STAR® Equipment	34,904	7.2%	$6,283	$0	No incremental cost	Immediate	$69,110
2.1	Reduced Lighting Power Density (0.868 and 0.768 W/SF on Floors 4 and 5)	9,928	2.0%	$1,787	($20,638)	Additional $0.75/SF over current design (27,517 modeled SF)	11.5 years	$19,657
2.2	Extended Daylighting	2,984	0.6%	$537	($15,020)	372 linear feet of 18" lightshelves ($35/LF); add $2,000 for light colored ceiling, floor, and furniture specification	28.0 years	$5,908
2.3	Computer Shutdown Equipment	13,875	2.9%	$2,498	($3,495)	NightWatchman software $15/computer for 1st year (233 computers); $2/computer for remaining lease years	1.4 yrs initially; 2.3 months each subse-quent year	$27,473
2.4	CO_2 Demand Control on Return Air to OSA Damper	313	0.1%	$56	($17,700)	39 CO_2 sensors ($300 each); 6 damper actuator controls ($1,000 each)	314.2 years	$620
3.1	Reduced Lighting Power Density (0.5 W/SF)	19,062	3.9%	$3,431	($13,759)	Additional $0.50/SF over EPM 2.1 above (27,517 modeled SF)	4.0 years	$37,743
3.2	Occupancy Sensor Plug Strips	8,582	1.8%	$1,545	($5,350)	One per 100 SF office space (one shared between side-by side benched desks); 107 count ($50 each)	3.5 years	$16,992
3.3	Economization of Computer Room	6,507	1.3%	$1,171	($8,984)	Ductwork 100 LB ($14.44/lb); 2 dampers ($377.77 each); additional AHU at $6,785 (NOTE: Only a fan is needed, not AHU, so actual cost may be lower)	7.7 years	$12,884
P3.4	No Humidification in Computer Room	10,464	2.2%	$1,884	$0	Avoided cost from eliminating humidifier option and piping to DHW	Immediate	$20,719
Total	**All Measures**	**180,487**	**35.7%**	**$32,488**	**($128,383)**		**4.0 yrs**	**$357,364**

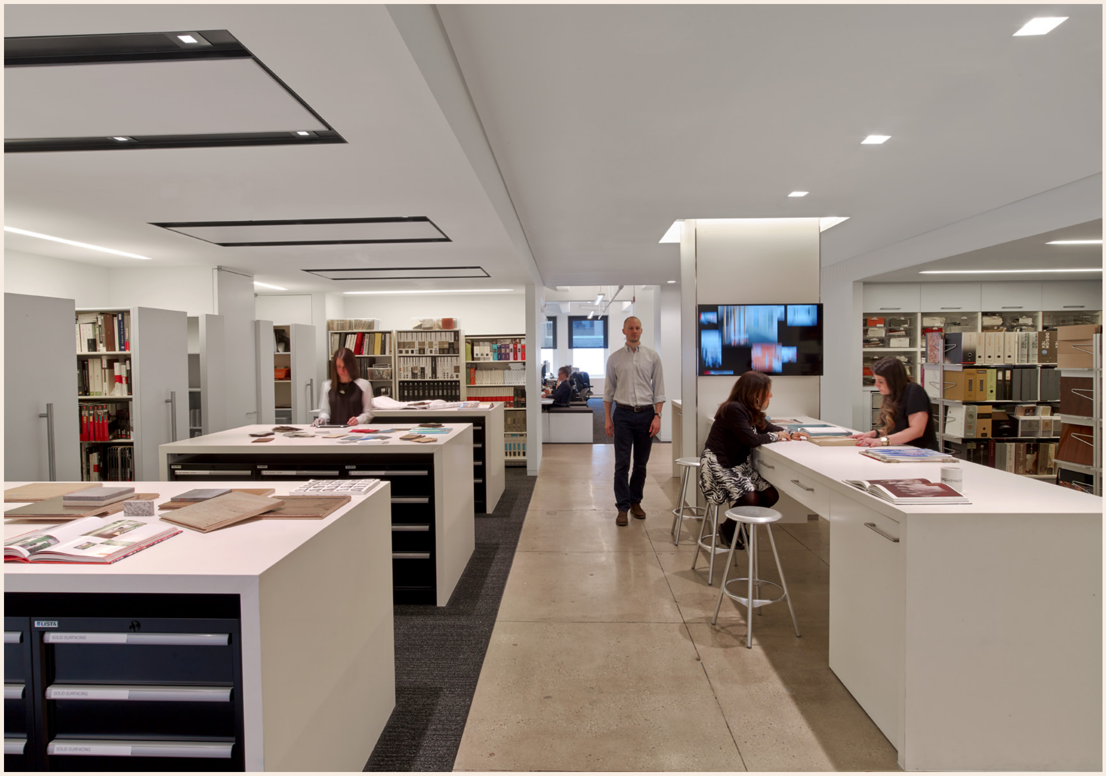
As part of the modeling process, the project team created several sets of measures, also known as "packages," which account for the interactive effects of various EPMs and how they impact payback periods, IRR, and ROI metrics.

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

Comparing TPG's EPM Packages

Energy Performance Measure	Least Energy Reduction	Moderate Energy Reduction	Significant Energy Reduction
As-Designed Lighting (1.08 W/SF)	+	+	+
Daylight Harvesting	+	+	+
Local Lighting Occupancy Sensors	+	+	+
ENERGY STAR® Equipment	+	+	+
Demand Control Ventilation	+	+	+
No Humidification in Data Center	+	+	+
Computer Shut-Off Software		+	+
Occupancy Sensor Plug Strips			+
High Efficiency Lighting (0.8 W/SF)			



Metering showed that peak lighting power never exceeded 80% of the total connected lighting power. Photo by Eric Laignel.

Reviewing the Budget and Selecting the EPMs

Energy modeling and costing analysis determined the following nine EPMs would offer the best value for TPG:

1. **As-designed lighting (1.08 W/SF)**
2. **Daylight harvesting**
3. **Local lighting occupancy sensors**
4. **ENERGY STAR® equipment**
5. **Demand-controlled ventilation**
6. **No humidification in data center**
7. **Computer shut-off software**
8. **Occupancy sensor plug strips**
9. **High-efficiency lighting (0.8 W/SF)**

Building the Space

The chosen energy performance measures were delivered as expected.

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 TPG.

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 TPG 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, TPG 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 first monitoring period of TPG's space took place between the dates of May 27 and June 5, 2015. Integral Group collected actual tenant energy consumption data and calibrated the existing energy model to correspond to observed usage.

Results show that the original, uncalibrated energy model underestimated overall energy consumption in the original model by approximately 30%. Peak lighting and plug load power was modeled accurately; however, metering revealed higher than expected unoccupied and overnight usage. Adjustment has also been made to the occupancy profile (affecting lighting and plug load consumption), with profiles revealing significant floor occupancy until 9 p.m. to 10 p.m. nightly. Main distribution frame IT power was also slightly underestimated, increasing from 8.0 to 9.2 kW. IT power, occupancy patterns, and overnight diversity of equipment is not explicitly called out in ASHRAE baseline, and therefore these adjustments increased both the calibrated baseline and proposed total consumption.

Total implemented package savings (including the effects of building implemented measures) have decreased by 10% from 168,400 to 151,390 kWh annually compared to ASHRAE baseline. Reduction is a result mostly of the building implementing high-efficiency HVAC units, with metering showing consumption of AC units only slightly better than baseline-modeled results.

Savings from tenant-implemented EPMs showed improvement, with an overall increase in savings from 87,450 kWh to 139,077 kWh. The large increase is due to higher-than-expected overnight lighting levels (therefore increasing the baseline overall lighting consumption) and better-than-expected performance from plug load management measures.

A comparison summary of input parameters, total tenant energy consumption, and energy savings by EPM is shown in Appendix A.

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

	Uncalibrated Model	Calibrated Model
Occupancy Hours (Weekday)	6 a.m.–6 p.m.	7 a.m.–10 p.m.
Peak Office Plug Load Power Design (W/SF)	1.5	1.5
Peak Office Plug Load Power Actual: With Diversity (W/SF)	1.35	1.2
Peak Lighting Power (W/SF)	0.96	0.96
Minimum Lighting Power (W/SF)	0.05	0.35
HVAC Fan Schedule Hours	6 a.m.–6 p.m.	12 a.m.–12 a.m.
Cooling Availability Hours	6 a.m.—6 p.m.	6 a.m.–6 p.m.
Peak MDF IT Power kW	8.0	9.2
Total Tenant Electricity Consumption—90.1 2007 Baseline (kWh)	550,930	656,393
Total Tenant Electricity Consumption—Building HVAC Baseline (kWh)	469,982	644,080
Total Tenant Electricity Consumption—Implemented Package (kWh)	382,532	505,003

Lighting

Total connected lighting power was accurately modeled and taken from design electrical drawings. Overnight lighting was underestimated by the original model. Such an underestimation is typically a result of emergency lighting circuits remaining on at all times, not specifically called out in preliminary lighting drawings or irregular work hours by a few employees, which drives the need for lighting in large portions of the office.

- **As-Designed Lighting:** This measure reduced installed lighting power to the designed 0.96 W/SF. A well-designed lighting system can take advantage of proper fixture selection and placement to reduce the needed luminaries to provide adequate work slighting to all occupants of a space. Metering showed that peak lighting power never exceeded 80% of the total connected lighting power. Additional reduction in in lighting power results from an adjustment of peak-activated lighting through calibrating the lighting diversity schedule.
- **Daylight Harvesting:** The use of daylighting sensors/photocells on the perimeter spaces can reduce lighting requirements when there is sufficient natural light. Comparing daily variations in peak lighting power to actual weather data on cloud cover and sun exposure can be used to determine proper function of such a daylight harvesting system.
- **Local Lighting Occupancy Sensors:** Occupancy sensors are included per the lighting design and exceed the requirements of ASHRAE, which state that they must be installed in conference/meeting rooms, and employee lunch and break rooms. This measure assumes occupancy sensors reduce overall power by 10% due to diversity.

TPG should verify all lighting possible is shut off at night. The lighting power consumption at night looks plausible, but is higher than often seen for systems of this type. Verify lighting control schedules and occupancy sensors are properly set up to allow lighting power to drop down to the minimum required for emergency exit at night.

HVAC

The original model assumed that floor AC units run in parallel to floor occupancy, approximately 6 a.m. to 6 p.m. Metered data revealed that cooling availability did indeed operate during these hours. Continuous overnight consumption, however, suggests that fans are kept operating at a minimum speed of 30%. Additional saving may be realized if units are completely powered down during unoccupied hours. Metering took place during unusually warm weather, near design temperatures, allowing for accurate calibration of peak HVAC power.

- **High-Efficiency HVAC Units:** The most significant changes to the calibrated model energy savings were that of these HVAC units. Floor AC units were pre-installed by the building prior to tenant occupancy. Initial submittals were used to estimate fan and compressor power of installed units, the improvement of which over the ASHRAE 90.1-2007 baseline resulted in saving reported by this measure. Metered power of the AC units showed operation matching that of the baseline model. Additional savings were shown via the election of high efficiency CRAC units serving IT equipment.
- **Demand Controlled Ventilation:** Demand controlled ventilation savings are a result of heating and cooling savings from the reduction in outdoor ventilation air. This measure is modeled through the built-in eQuest module, which regulates minimum required outdoor air levels via zone air sensors.
- **Eliminate Humidification in Main Distribution Frame Room:** Typical MDF room CRAC units maintain a 40% to 50% relative humidity, though this is not necessarily required for the IT equipment. Foregoing humidity controls on the CRAC cooling equipment is a no-cost way to achieve energy savings in the design phase. Modern IT equipment is not sensitive to humidity levels, and humidity control is often designed as an artifact of outdated equipment technology.

TPG should verify HVAC system scheduling; the energy metering found that the HVAC fans appear to be running (at a reduced speed during unoccupied hours) 24 hours a day. The project team recommended verification that this is the intended operation.

Plug Loads/Equipment

Total equipment power was not able to be explicitly broken out; however, it is assumed that peak connected load was initially modeled accurately with plug load density varying from 0.2 W/SF to 1.5 W/SF based on space type. Plug load diversity schedules were adjusted slightly based on actual observed profile, particularly for unoccupied hours.

- **Plug Load Management (ENERGY STAR® Equipment):** Use of ENERGY STAR®-rated office equipment leads to a reduced plug load for the office, conference room, and café spaces. This measure assumes that the plug-in equipment in the conference and office areas will be per the specified ENERGY STAR® equipment. The baseline standard efficiency equipment is assumed to be 15% higher in energy consumption than the selected ENERGY STAR® equipment.
- **Plug Load Management (Night Shutoff Software and Occupancy Sensors):** Without a separate breakout of total plug load power, it is difficult to determine the implementation of separate plug load management measures. It is assumed that connected equipment power was initially modeled accurately.

Typically, plug loads are reduced at night, but not to zero. Many plug loads continue to draw power, at a reduced rate, when they are in sleep or off mode. One approach to minimizing these phantom loads is to provide some number of outlets with active control that turns off power when the area is unoccupied. This can be achieved via occupancy sensor plug strips, dedicated outlets controllable by wall switch, or computer management software.

TPG should verify configuration of plug load management. The metered plug load profile suggests that a significant amount of plug load is not shutting off at night during the week, but it is shutting off during the weekend. This can often be due to computers being configured to not go into an idle mode during the week. Proper configuration of schedule-based plug load controls could reduce nighttime loads down to the weekend levels and saving significant energy.

Computer management software automatically backs up and shuts down computers to save energy during unoccupied periods. The metered plug load profile indicates that no such software is activated during the week, however a drop-off of equipment power during weekend hours is observed. An adjustment to the diversity reduces overnight plug load power from 30% of peak to 22% of peak during weekends. Occupied hours peak has also been reduced from baseline of 90% of peak to 80% of peak, which is assumed to be achieved through implementation of occupancy sensor plug strips or another plug load management scheme.

TPG's Sustainability Initiatives and Their Impacts on Employees

Employees' reactions to the new space has been overwhelmingly positive since TPG moved in, and company executives have found the space more interactive and collaborative due to the design of the work stations, sight lanes, and planning area. The new space is nearly 100% open, which allows management to sit near teams and give support more easily. The new space is light and brighter, and the design has pushed employees to be more mobile and flexible in where they work. Among the spaces they frequently utilize are the cafeteria, otherwise known as "The Hub," as well as touchdown spaces that allow them space to get needed work—whether calls, conversations, or emails—completed.

TPG has formed an internal organization called TPGreen, comprised of like-minded individuals spanning multiple disciplines—architects, interior designers, graphic artists, and IT professionals—who believe that the design of high-performance, sustainable spaces fosters a healthy eco-system beneficial to its clients, their staff, and their communities. Green design is known to improve productivity and reduce operational costs as well as provide improved image and marketing advantages.[12]

When TPG gives office space tours, it highlights the EPMs and sustainable measures it has implemented to guests and potential clients. For instance, by its pantry, there is a sign that notes the space uses ENERGY STAR®-rated equipment. Other signs feature the use of materials with low off-gassing and explain the installed daylight harvesting system and occupancy sensors.

"It helps to tell our story," said TPG associate Samantha McCormack. "You may not realize that these fixtures are there, and clients are interested in how to implement these sustainable technologies without having to go for certifications."

12. Read more about TPG's sustainability initiatives at http://www.tpgarchitecture.com/sustainability.cfm.

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

Original Model Results: Tenant Electricity

	Description	Total Tenant Electricity					Electricity Reduction	
#	**Name**	**Total kWh**	**Lighting kWh**	**Equipment kWh**	**HVAC (Including CRACs) kWh**	**IT kWh**	**vs ASHRAE Baseline**	**vs Building Baseline**
BL	ASHRAE 90.1-2007 Baseline	550,930	88,990	129,916	240,044	91,980	N/A	N/A
BBL	High-Efficiency HVAC Units (Building Baseline)	469,982	88,990	129,916	159,096	91,980	14.7%	N/A
G2	As-Designed Lighting	458,987	77,682	129,916	159,409	91,980	16.7%	2.3%
G3	Daylight Harvesting	442,066	59,584	129,916	160,586	91,980	19.8%	5.9%
G4	Local Lighting Occupancy Sensors	438,679	56,316	129,916	160,467	91,980	20.4%	6.7%
G5	Plug Load Management - ENERGY STAR® Equipment	405,403	56,316	113,713	157,190	78,183	26.4%	13.7%
G6	Demand Controlled Ventilation	398,826	56,316	113,713	150,613	78,183	27.6%	15.1%
G7	Eliminate Humidification in MDF	395,414	56,316	113,713	147,202	78,183	28.2%	15.9%
B1-B2	Plug Load Management (NightWatchman and Occupancy Sensor Strips)	382,532	56,316	100,458	147,574	78,183	30.6%	18.6%
	Incremental Savings vs Previous Run						**Percentage Savings**	
BL	ASHRAE 90.1-2007 Baseline	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BBL	High-Efficiency HVAC Units (Building Baseline)	80,948	0	0	80,948	0	14.7%	N/A
G2	As-Designed Lighting	10,995	11,308	0	-314	0	2.0%	2.3%
G3	Daylight Harvesting	16,921	18,098	0	-1,177	0	3.1%	3.6%
G4	Local Lighting Occupancy Sensors	3,387	3,268	0	119	0	0.6%	0.7%
G5	Plug Load Management - ENERGY STAR® Equipment	33,276	0	16,202	3,277	13,797	6.0%	7.1%
G6	Demand Controlled Ventilation	6,577	0	0	6,577	0	1.2%	1.4%
G7	Eliminate Humidification in MDF	3,411	0	0	3,411	0	0.6%	0.7%
B1-B2	Plug Load Management (NightWatchman and Occupancy Sensor Strips)	12,882	0	13,255	-373	0	2.3%	2.7%

Calibrated Model Results: Tenant Electricity

	Description	Total Tenant Electricity					Electricity Reduction	
#	**Name**	**Total kWh**	**Lighting kWh**	**Equipment kWh**	**HVAC (Including CRACs) kWh**	**IT kWh**	**vs ASHRAE Baseline**	**vs Building Baseline**
BL	ASHRAE 90.1-2007 Baseline	656,393	154,557	177,558	221,786	102,492	N/A	N/A
BBL	High-Efficiency HVAC Units (Building Baseline)	644,080	154,557	177,558	209,473	102,492	1.9%	N/A
G2	As-Designed Lighting	607,656	124,995	177,558	202,612	102,492	7.4%	5.7%
G3	Daylight Harvesting	582,411	105,715	177,558	196,645	102,492	11.3%	9.6%
G4	Local Lighting Occupancy Sensors	575,927	99,953	177,558	195,924	102,492	12.3%	10.6%
G5	Plug Load Management - ENERGY STAR® Equipment	547,704	99,953	154,209	191,050	102,492	16.6%	15.0%
G6	Demand Controlled Ventilation	546,064	99,953	154,209	189,410	102,492	16.8%	15.2%
G7	Eliminate Humidification in MDF	541,752	99,953	154,209	185,098	102,492	17.5%	15.9%
B1-B2	Plug Load Management (NightWatchman and Occupancy Sensor Strips)	505,003	99,953	123,326	179,233	102,492	23.1%	21.6%
	Incremental Savings vs Previous Run						**Percentage Savings**	
BL	ASHRAE 90.1-2007 Baseline	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BBL	High-Efficiency HVAC Units (Building Baseline)	12,313	0	0	12,313	0	1.9%	N/A
G2	As-Designed Lighting	36,424	29,562	0	6,862	0	5.5%	5.7%
G3	Daylight Harvesting	25,246	19,280	0	5,966	0	3.8%	3.9%
G4	Local Lighting Occupancy Sensors	6,483	5,762	0	721	0	1.0%	1.0%
G5	Plug Load Management - ENERGY STAR® Equipment	28,224	0	23,349	4,875	0	4.3%	4.4%
G6	Demand Controlled Ventilation	1,639	0	0	1,639	0	0.2%	0.3%
G7	Eliminate Humidification in MDF	4,312	0	0	4,312	0	0.7%	0.7%
B1-B2	Plug Load Management (NightWatchman and Occupancy Sensor Strips)	36,749	0	30,883	5,865	0	5.6%	5.7%

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**
BL	ASHRAE 90.1-2007 Baseline	N/A	N/A	N/A	N/A	N/A	N/A
BBL	High-Efficiency HVAC Units (Building Baseline)	80,948	N/A	$13,356	12,313	1.9%	$2,032
G2	As-Designed Lighting	10,995	2.3%	$1,814	36,424	5.7%	$6,010
G3	Daylight Harvesting	16,921	3.6%	$2,792	25,246	3.9%	$4,166
G4	Local Lighting Occupancy Sensors	3,387	0.7%	$559	6,483	1.0%	$1,070
G5V	Plug Load Management - ENERGY STAR® Equipment	33,276	7.1%	$5,491	28,224	4.4%	$4,657
G6	Demand Controlled Ventilation	6,577	1.4%	$1,085	1,639	0.3%	$271
G7	Eliminate Humidification in MDF	3,411	0.7%	$563	4,312	0.7%	$711
B1-B2	Plug Load Management (NightWatchman and Occupancy Sensor Strips)	12,882	2.7%	$2,126	36,749	5.7%	$6,064
	Total Implemented Package (vs BBL)	**87,450**	**18.6%**	**$14,429**	**139,077**	**21.6%**	**$22,948**

Notes: Electric rate of $0.165/kWh assumed
Total Package and % Savings reported versus the Building Baseline (BBL)

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.

Funders

Funding to develop the program was generously provided by the Goldman Sachs Center for Environmental Markets, John and Amy Griffin, the Helmsley Charitable Trust, the Natural Resources Defense Council, the Malkin Fund, the SL 2012 Fund, the Ripple Foundation, the Robertson Foundation, and the Rockefeller Foundation.

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**.