Urban Land Institute

ULI Tenant Energy Optimization Program

Case Study:

New York State Energy Research and Development Authority (NYSERDA)

Executive Summary: NYSERDA's Story

In 2013, the New York State Energy Research and Development Authority (NYSERDA)—a New York state authority that promotes energy efficiency and the use of renewable energy sources in an effort to reduce customer energy bills—decided to lease office space at 1359 Broadway in Manhattan. With NY Green Bank, a division of NYSERDA, it now occupies 15,200 square feet on the building's 19th floor.

The nearly 471,000-square-foot building at 1359 Broadway had recently undergone significant upgrades, including the addition of state-of-the-art HVAC, electrical, plumbing, and security systems.

When it was time to design and construct its new space, NYSERDA had three goals:

- Given NYSERDA and NY Green Bank's mission to promote and advance energy efficiency and clean energy throughout the state, this buildout should set the standard for a cost-effective, high-performance workplace;
- The project should create a more vibrant, productive work environment for NYSERDA/NY Green Bank staff, leading to lower absenteeism and enhanced staff attraction, retention, and productivity; and
- The project should inform the development of NYSERDA's program for the commercial office tenant buildout market.

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 with the project team partners, NYSERDA evaluated an integrated package of energy performance measures (EPMs)[1] for floor 19. 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 NYSERDA's 14-year lease, the project is estimated to provide energy cost savings of $188,017, a 179% return on NYSERDA's initial investment[2], and a 30.5% internal rate of return (IRR)[3]. The projected payback: 3.6 years.

NYSERDA'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 increase the 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: 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: NYSERDA Project Information and Projected Performance

Building Information				
Tenant Name	New York State Energy Research and Development Authority (NYSERDA)			
Building Owner	Empire State Realty Trust			
Location	1359 Broadway, Midtown Manhattan			
Building Size	471,229 square feet (22 floors)			
Principal Use	Office with ground-floor retail			
Construction Type	Pre-World War II tower			
NYSERDA Lease Term	14 years			
Floor 19 Buildout	**Projected Design**		**M&V Calibration**[6]	
Modeled Square Footage	15,200 square feet			
Modeled Energy Reduction	34.2%		39.0%[7]	
Annual Electricity Reduction	69,455 kWh	3.5 kWh/SF	72,437 kWh	3.6 kWh/SF
Total Electricity Savings over Lease Term	1.0 GWh	48.6 kWh/SF	1.0 GWh	50.7 kWh/SF
Incremental Implementation Cost: ***Energy Modeling Soft Cost:*** ***State Incentives:***	*$42,180* *$6,500* *$0.00*	*$2.11/SF* *$0.33/SF* *$0.00/SF*	*$42,180* *$6,500* *$0.00*	*$2.11/SF* *$0.33/SF* *$0.00/SF*
Adjusted Incremental Implementation Cost	$48,680	$2.43/SF	$48,680	$2.43/SF
Total Electricity Costs Savings over Lease Term	$180,277	$9.01/SF	$188,017	$9.40/SF
Electricity Cost Savings over Lease Term (Present Value)	$130,360	$6.52/SF	$135,957	$6.80/SF
Net Present Value of Project Investment	$81,680	$4.08/SF	$87,277	$4.36/SF
Return on Investment over Lease Term	168%		179%	
Internal Rate of Return	29.0%		30.5%	
Payback Period (with Incentives)	3.8 years		3.6 years	

6. The original energy model and projections were updated after the Measurement and Verification period that occurred post-occupancy. More information can be found in the “Developing a Post-Occupancy Plan: The Measurement & Verification Process” section below.
7. Differences in modeled energy reduction are usually due to a discovered under- or overestimation of energy use in the measurement and verification process. When the energy savings related to ENERGY STAR equipment are not taken into account, the modeled energy reduction is 35.7%. Although savings from ENERGY STAR equipment are not negligible, NYSERDA does not typically claim them because use of ENERGY STAR equipment is a NYSERDA standard.

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 NYSERDA Chose 1359 Broadway

When NYSERDA needed to move out of its previous New York City office, it worked with a leasing broker to narrow the field to a handful of potential spaces based on cost, location, floorplate, building amenities, and other considerations. One important reason NYSERDA chose 1359 Broadway over the other finalist locations was that it offered the tenant the opportunity to build out a cost-effective, high-performance space, in line with its organizational mission, that could support many mechanical design best practices for comfort and efficiency. Executives and staff had worked with some of the early developers of the Tenant Energy Optimization process and were also familiar with the overall process. The engineering firm compared the final group of potential locations to evaluate which space would provide the best fit for NYSERDA's energy efficiency goals.

The willingness of building owner Empire State Realty Trust (ESRT) to cooperate with tenants to build out energy-efficient, high-performance spaces facilitated NYSERDA's site selection decision. ESRT has a strong reputation for energy efficiency and sustainability leadership, and is well known for its deep retrofit of the Empire State Building, which helped the iconic skyscraper cut its energy usage by 38% for a savings of $4.4 million a year. By choosing to locate in 1359 Broadway, NYSERDA immediately improved its energy performance compared with tenants in other typical New York City buildings that have not chosen to implement base-building energy efficiency upgrades.

When NYSERDA signed its lease, it was important for its electricity consumption to be submetered, and for the tenant to pay for electricity based on its actual electrical usage. This structure ensures that the impact of the base building upgrades are maximized across the tenant spaces, which account for the bulk of the building's energy consumption, and that the tenant enjoys the full economic benefit of integrating various EPMs into the space buildout.

The entire process emphasizes the importance of owner and tenant collaboration, particularly given that tenant spaces typically account for more than half of a commercial office building's total energy consumption. 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 NYSERDA 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 www. buildingefficiencyinitiative.org/articles/2014-energy-efficiency-indicator .

The Project's Key Stakeholders

The Tenant: NYSERDA

The New York State Energy Research and Development Authority (NYSERDA) is a state agency that offers objective information and analysis, innovative programs, technical expertise, and funding to help New Yorkers increase energy efficiency, save money, use renewable energy, and reduce reliance on fossil fuels.

In 2014, NY Green Bank, a state-sponsored, specialized financial entity and a division of NYSERDA, opened for business to increase private investment in renewable energy and energy efficiency projects. NYSERDA works with state, industry, and citizen stakeholders to scale up the clean energy sector and develop a clean, resilient, reliable, affordable, and dynamic energy system that can withstand severe weather events as well as meet the growing demands of a more technological society. Using a more market-based, decentralized approach, NYSERDA professionals continue to find innovative ways to decrease energy costs, create opportunities for economic growth, and preserve the environment for current and future generations of New Yorkers.

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, one of the world's most famous buildings. ESRT is a leader in energy efficiency in the built environment.

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: Calculate 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

NYSERDA Integrates the Tenant Energy Optimization Process

NYSERDA's space on the 19th floor of 1359 Broadway houses NYSERDA's New York City office and NY Green Bank. In addition, NYSERDA leases a portion of the space to the New York City Energy Efficiency Corporation (NYCEEC), an organization that focuses on expanding the clean energy financing market. The space acts as a dynamic showcase of market-based best practices and replicable cost-effective, energy-efficient tenant space solutions made possible through the Tenant Energy Optimization process. Floor 19 consists of open-floor-plan office space, meeting and conference rooms, a pantry, and a small intermediate distribution frame (IDF) room.

Selecting the Buildout Team

The NYSERDA Buildout Team

Company	Role
Gardiner & Theobald	Project Manager
Corgan Architects	Architect
Henegan Construction Co.	General Contractor
Integral Group	Engineer
Wendy Fok	Energy Project Director
Integral Group	Energy Consultant
Empire State Realty Trust	Landlord
CBRE	Leasing Broker

Many members of the project team, including the energy modeler, had already been involved in the Empire State Building retrofit and other high-performance tenant buildouts and were experienced in the process.

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 NYSERDA's build out. These groups worked in concert to make sure all energy reduction strategies conformed to the goals and intent of NYSERDA's design. Among the factors NYSERDA wanted to consider:

- The project should serve as a model for responsible, economically minded tenants and incorporate commercially available, off-the-shelf solutions rather than cutting-edge or demonstration technologies.
- The project should reflect reasonable cost-effectiveness, i.e., payback of full incremental cost within five years.
- The project should meet at least LEED Commercial Interiors Silver requirements.

With NYSERDA'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

High-Efficiency Lighting: The use of a high-efficiency lighting layout with occupancy sensors will provide energy savings relative to the baseline whole-building allowance of 0.7 W/SF. Modern LED lighting offers a number of high-end fixtures and effects, making high-efficiency LEDs both an efficient and high-quality option. LED lighting also integrates well with a DC power distribution system.

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, 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.

Plug Load Control – Occupancy Sensors: 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 completely when the space is unoccupied. Active plug control is particularly attractive for facilities that utilize hoteling or have a large number of meetings, during which active controls could shut off plug loads and save significant power. A more difficult to quantify but promising approach to reducing plug loads is to put in place high-resolution power monitoring.

Radiant Ceiling: Radiant ceiling systems are a significant impact on the look of space, but can have a very high-end finish and almost silent conditioning. They require no fans, significantly reducing fan power use in the building for an overall 5% to 10% total savings. They also work well with high-efficiency cooling sources, such as medium-temperature chiller systems.

Variable Airflow Diffusers (Therma-Fuser[9] or Similar): This technology allows for a different temperature setpoint at each diffuser, but does not provide control points for monitoring purposes. They are a good, simple option if there is a desire to eliminate the majority of control system cost and complexity.

Variable Refrigerant Flow System: This technology is growing in popularity, and has a longer history throughout Asia and Europe. This system uses a central rooftop condenser and refrigerant piping to individual fan coils throughout the space. By operating at variable speeds, cooling is provided only where needed, resulting in highly controllable individual spaces, and highly efficient operation at part-load. Since all refrigerant is piped back to the same condenser, internal heat recovery is possible. This is a relatively inexpensive option that can offer good efficiency.

Energy Recovery Ventilator: Providing a generous amount of outside air is a critical part of maintaining a comfortable and healthy space. However, it is a significant energy cost due to the need to heat the air in the winter and dehumidify it in the summer. An energy recovery ventilator transfers thermal energy to (or from, depending on the season) the supply air from the air being exhausted from the building to significantly reduce this power cost.

Low-Face Velocity Air Handlers: Change in air pressure occurs at a larger proportion relative to the change in the air speed. 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.

9. www.acutherm.com/products/

Modeling the Projected Energy Performance

During design development, a predictive energy model was created using eQuest software, which modeled energy consumption and EPM results for NYSERDA's space on floor 19. The model was later calibrated using metered data gathered during tenant occupation.[10]

Assumptions Present in the Modeling

- The number of occupants was taken from the furniture plan, and assumes full utilization of desk space.
- On a typical day, only 85% 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 8 p.m.
- Most lights are turned on at 8 a.m. and off at 7 p.m.
- On a typical day, 90% of the installed lighting is turned on (excluding daylight harvesting controls and occupancy sensor control EPMs).
- On a typical day, 85% of the design plug loads are turned on (excluding plug load management EPMs).
- Baseline design total plug load density is 1.0 W/SF.
- Baseline design total lighting power density is 1.0 W/SF.

Recommended EPM[11]	Target Area	Incremental First Cost[12]
High-Efficiency AC Unit	HVAC	$2,000
Variable Refrigerant Flow System	HVAC	$0
Outside Air Economizer in Computer Room	HVAC	$2,500
Natural Ventilation	HVAC	$5,000
Energy Recovery Ventilator	HVAC	$17,500
Lighting to 0.7 W/SF	Lighting	$40,000
Lighting: LPD to 0.5 W/SF	Lighting	$20,000
Daylighting: Dimming/Harvesting Controls (On/Off)	Lighting	$20,000
Daylighting: Dimming/Harvesting Controls (Dimming)	Lighting	$30,000
Daylighting: Dimming/Harvesting Controls (Increased Depth)	Lighting	$60,000
NightWatchman[13] Software	Plug Loads	$1,800
ENERGY STAR Equipment	Plug Loads	$0
Occupancy Sensors	Plug Loads	$8,200
Occupancy Sensors (Increased Use)	Plug Loads	$0

10. See Appendix A for detailed analysis.
11. For a more detailed analysis, see NYSERDA: The Preliminary Value Analysis.
12. Engineer included EPMs at marginal cost above baseline including mark-ups, therefore project baseline and mark-up costs not included.
13. www.1e.com/nightwatchman-pc-power-management/

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 ROI for various packages of EPMs. This analysis enabled the team to package the EPMs to maximize performance while meeting the simple payback threshold desired by NYSERDA and prescribed by ESRT's lease.

NYSERDA's Space: The Preliminary Value Analysis

ID	Energy Performance Measure	Electricity Reduction (kWh/yr)	Electricity Reduction	Annual Electricity Savings	Incremental First Cost	Simple Payback
G-1	High-Efficiency AC Unit	903	0.4%	$167	($2,000)	11.9 years
G-2	Lighting to 0.7 W/SF	18,091	9.0%	$3,354	($40,000)	11.9 years
G-3	Daylighting: Dimming/ Harvest Controls (On/Off)	8,937	4.4%	$1,657	($20,000)	12.1 years
G-4	Plug Load Management: NightWatchman	10,983	5.4%	$2,036	($1,800)	0.9 years
G-5	Variable Refrigerant Flow System (VRF)	18,045	9.0%	$3,346	$0	0.0 years
B-1	Outside Air Economizer in Computer Room	2,085	1.0%	$387	($2,500)	6.5 years
B-2	ENERGY STAR Approved Equipment	11,730	5.8%	$2,175	$0	0.0 years
B-3	Natural Ventilation	1,405	0.7%	$260	$5,000	19.2 years
B-4	Daylighting: Dimming/ Harvest Controls (Dimming)	1,292	0.6%	$240	($30,000)	125.2 years
B-5	Plug Load Management: Occupancy Sensors	4,156	2.1%	$771	($8,200)	10.6 years
BB-1	Daylighting: Dimming/ Harvest Controls (Increased Depth)	1,081	0.5%	$200	($60,000)	299.4 years
BB-2	Plug Load Management: Occupancy Sensors (Increased Depth)	6,181	3.1%	$1,146	$0	0.0 years
BB-3	Lighting: LPD to 0.5 W/SF	7,374	3.7%	$1,367	($20,000)	14.6 years
BB-4	Energy Recovery Ventilator	-3,992	-2.0%	($740)	($17,500)	N.A.
Sub-Total	**Package of Measures**	88,271	43.8%	$16,365	($207,000)	12.6 years

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. Because NYSERDA's space is submetered and it pays for electricity based on actual usage, NYSERDA can capture the full benefits of these savings.

Comparing NYSERDA's EPM Packages

Energy Performance Measure	Least Energy Reduction	Moderate Energy Reduction	Significant Energy Reduction
High-Efficiency Lighting (to 0.7 W/SF)	+	+	+
Daylight Harvesting	+	+	+
ENERGY STAR Equipment	+		+
Computer Shutoff Software	+	+	+
Demand Controlled Ventilation	+	+	+
Energy Recovery Ventilator (ERV)	+	+	+
Natural Ventilation	+	+	+
Variable Refrigerant Flow System (VRF)	+	+	+
Master Shutoff Switch		+	+
High-Efficiency Lighting (to 0.5 W/SF)			+
Daylight Harvesting (Increased Depth)			+
Occupancy Sensor Plug Strips			+

Reviewing the Budget and Selecting the EPMs

Energy modeling and costing analysis determined that the following eight EPMs would offer the best value for NYSERDA.

1. **High-Efficiency Lighting:** Low ambient lighting power by design (0.7 W/SF or less) is a difficult but attainable goal. Wide deployment of mature LED lighting systems has brought efficient lighting into the high-end design market, offering efficiency and design flexibility. Achieving the 0.7 W/SF lighting power level requires the use of higher-end lighting fixtures to ensure that light can be generated as efficiently as possible and placed precisely where desired. These fixtures and light sources tend to be more expensive, running 20% to 25% more than equivalent standard equipment, however the higher efficiency they offer results in energy cost savings over the life of the facility. Moving to LED fixtures also results in ongoing maintenance cost savings due to longer life, however this savings versus fluorescent is minimal and neglected in the analysis at this time.
2. **Daylight Harvesting:** To provide the highest level of control, dimmable ballasts that can be independently controlled (addressable) are desired. The addition of daylighting control to this high-end Lutron control system[14] can be done for a lower cost than adding daylighting to a bare-bones manual switch system. Maximizing the interior ceiling height at the perimeter, avoiding closed offices along the perimeter, and use of interior glazing on interior conference room and office partitions are key design features. Daylight penetration can be extended using lighter-colored surfaces, interior light shelves, and high ceiling heights. Currently, active daylight harvesting controls are specified for the perimeter light fixtures. If ceiling height is maximized and light colored finishes used, it could be feasible to extend daylight harvesting controls to the fixtures located further inboard.
3. **ENERGY STAR Equipment:** This analysis assumed that the use of ENERGY STAR equipment will reduce plug loads by 15%, which is the common improvement in efficiency that is required to earn the ENERGY STAR label. This savings is achieved simply by the higher efficiency of the equipment.
4. **Computer Shutoff Software:** Specialized computer software automatically backs up computers and shuts down computers to save energy during unoccupied periods.

14. www.lutron.com/en-US/Pages/default.aspx

This analysis assumes that the use of the computer power control software will reduce plug loads by 50% during unoccupied hours. Typically, computer software control is required to ensure that computers shutoff at night. However, ENERGY STAR equipment has this capability built in but it requires more detailed configuration that is not properly performed. It is assumed that NYSERDA will properly configure the night shutoff capabilities and/or implement an equal approach to ensuring equipment shut down at night. The installed plug load power monitoring provides the ability to check the effectiveness of the solution used.

5. **Energy Recovery Ventilator:** Savings from the energy recovery ventilator combine with the savings in peak load from the demand-controlled ventilation to reduce the peak load enough to allow for an incremental reduction in system capacity—a first-cost reduction. These two measures do not stand alone well, only achieving their maximum cost savings in combination. Outdoor air is a significant portion of the cooling load in this climate, due in large part to the dehumidification requirements on the peak cooling days. Including an energy recovery ventilator reduces the peak cooling load by over eight tons, allowing for elimination of a condensing unit and a net first cost savings. The annual electricity savings are negligible, negated by the increased fan cost incurred by the recovery unit and the typically low cooling temperature differences (85°F to 75°F is only a 10°F difference). However, the heating energy savings are significant, even if they do accrue to the building plant.
6. **Natural Ventilation:** Existing operable windows at 1359 Broadway allowed for the opportunity to ventilate directly using open windows, rather than the fan-driven central system. When outside air conditions are comfortable for occupants, cooling and heating systems can be shut down, while windows are open to allow fresh outside air into the space.
7. **Variable Refrigerant Flow (VRF) System:** The standard HVAC system for this type of space is a variable air volume (VAV) reheat system. This approach uses centralized air handlers to supply the entire floor via duct work. The alternative EPM considered here is a VRF system that distributes fan coils throughout the space. The fan coils reject heat via small refrigerant piping to central condensers. The VRF system has a significant impact on the aesthetics of the space, particularly since most of the space has open ceilings with fully exposed, unpainted, utilities. However, by eliminating much of the ducting, a VRF system uses radically less fan power, saving energy. It also can transfer heat between zones during periods of simultaneous heating and cooling, offering energy efficiency benefits.
8. **Demand-Controlled Ventilation (DCV):** 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 was observed for tenant electric consumption.

Building the Space

Incorporating the recommended improvements proved to be a relatively simple process. From the beginning, NYSERDA selected its contractors—from the architect and project management team to the designers and consultants and general contractor—based, in part, on their experience with energy-efficient projects and equipment. The earliest design charrettes included discussion of the performance objectives for the space. The design team worked together—the lighting designer coordinated with HVAC engineers, the controls consultant worked with the energy consultant, etc.—to ensure that the systems worked together and performed as expected. All EPMs were implemented on schedule and within the anticipated time frame.

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 NYSERDA.

This formalized process shows whether the EPMs have had the projected effect on energy consumption. Often the M&V process is not utilized, as it is assumed the measures were installed and commissioned to work. For the NYSERDA 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, potentially leading to actual results diverging from the projected results. If actual savings significantly diverge from projected savings, it could be that projections were incorrectly calculated, a piece of equipment was incorrectly programmed or not operated as intended, or a product did not perform to its specifications. Naturally, NYSERDA wanted to be certain that the demonstration project yielded the promised ROI. 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 NYSERDA's space took place between September 22 and October 1, 2015. Integral Group collected actual tenant energy consumption data and calibrated the existing energy model to correspond to observed usage.

Results show that overall final energy savings were very close to the original model; however, the specific measures responsible for savings varied. The nighttime plug load savings predicted from configuring computers to shut off (hibernate) at night was not seen in the measurement data, losing those savings. However, significant additional savings were won from a higher-efficiency lighting system than originally predicted, with the peak lighting power measured at 0.61 W/SF—almost 15% lower than originally estimated. This high efficiency is achieved by design and includes decorative lighting located in key areas throughout the space.

Implemented package savings (at the tenant level) have remained almost the same as

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

	Uncalibrated Model	Calibrated Model
Occupancy Hours (Weekday)	7 a.m.–7 p.m.	7 a.m.–7 p.m.
Occupancy Hours (Weekend)	None	None
Peak Office Plug Load Power Actual – With Diversity (W/SF)	1.1	0.91
Peak Lighting Power (W/SF)	0.7	0.6
Minimum Lighting Power (W/SF)	0.04	0.08
HVAC Fan Schedule Hours	7 a.m.–7 p.m.	7 a.m.–7 p.m.
Peak MDF IT Power kW	5.1	0.6
Total Tenant Electricity Consumption—Code Compliant Baseline (kWh)	202,995	185,636
Total Tenant Electricity Consumption—Implemented Package (kWh)	113,199	133,540

predicted, with the original prediction of 69,455 kWh/year savings increasing slightly to 72,437 kWh/year. The increase in savings is driven by a combination of better than expected lighting savings (approximately 10% lower lighting peak power) and much longer measured operating hours for the lighting; approximately 30% more hours of operation result in higher gross savings. Occupancy is assumed to follow HVAC operation, however lighting exceeds the occupied period by several hours, possibly to accommodate cleaning.

Lighting

The lighting system operation suggests the occupancy sensors have a strong impact, with lighting power fluctuating throughout the day. The highest periods of lighting power usage fall after sunset, as would be expected. The current trending does not provide the resolution needed to verify the operation of the daylight harvesting system, but the reduced peak lighting power (0.6 W/SF versus the installed 0.7 W/SF) suggests that the combination of occupancy sensors and daylight dimming is functioning as predicted.

The lighting is left on significantly later than originally estimated, with the hours of full lighting use increased by over 30% from the pre-calibration model. The cause of this increase in lighting hours was investigated, since the lighting operation does not correlate with the HVAC operation (due to code requirements for ventilation of the interior spaces and lobby, it is assumed the HVAC operation is set to the occupied hours). NYSERDA verified the increased usage is tied to lights being on when the space is being cleaned, which takes several hours every night. NYSERDA is investigating ways to limit this after-hours usage.

- **High-Efficiency Lighting:** High-efficiency lighting leads to a significant reduction in the lighting installed power density. The maximum installed lighting power allowed was a design parameter set by the owner and design team that guided the lighting design, requiring the use of high-performance luminaries and limiting the use of decorative lighting to prudently deployed LED wall washers. Designing for even lower lighting power would result in additional savings.
- **Daylight Harvesting:** Photo sensors measure the strength of daylight coming in through the windows on each façade and dim the associated electric lights when they are not needed to maintain the desired design light levels in the space. To enhance the daylight harvesting procedures, NYSERDA could have also installed light shelves or light-redirecting film, which can throw natural light up onto the light-colored ceiling and deeper into the space. The deeper penetration allows for increased use of daylight and reduced use of electrical lighting.

HVAC

The mechanical system power consumption tracked closely with the modeled prediction. This supports that the mechanical system is operating to the expected efficiency and fan power. The system efficiency during the heating season and the peak cooling season should also be evaluated, but based upon this measurement period it appears to be performing per design intent.

The only significant adjustments to the model in the area of HVAC were the addition of a constant 0.3 kW load to account for a measured baseline load seen even at nights and on weekends. This additional energy consumption combined with a lower overall heating load from the as-measured lighting and plug loads significantly reduced the gross kWh/year saved, but had a smaller impact on the percentage energy savings.

- **Energy Recovery Ventilator:** A dedicated outside air exchange system (DOAS) is used to recover heat or cooling from the space ventilation air. The system uses a moisture-permeable flat plate heat exchanger that provides both latent and sensible heat recovery—so it both precools incoming air and dehumidifies it for negligible energy cost in the summer. All space exhaust air is returned to the DOAS unit via through-space transfer for heat recovery prior to exhaust.

- **Natural Ventilation:** Most of the open office space is perimeter space with operable windows. To take advantage of this layout, the HVAC system controls are designed to turn off mechanical cooling when outdoor air conditions are favorable for natural ventilation (between 55°F and 68°F). Indicator lights in the space illuminate during these favorable conditions and actively notify occupants that windows should be opened if fresh air or natural cooling is desired.
- **Variable Refrigerant Flow System:** The VRF system offered high cooling and heating efficiency, variable speed fan coil units, and heat recovery between spaces. Like a water source heat pump, if one zone is in cooling on the same circuit as a zone requires heating, the heat can be moved very efficiently between the zones with minimal energy cost and no compressor operation required.

Plug Loads/Equipment:

Plug load power was measured to peak at 0.88 W/SF, very close the original plug load power estimate of 0.83 W/SF. While peak lighting and plug load power was near the original model estimates, metering revealed significantly less nighttime reduction in plug load than expected. Night time plug loads reduce to only approximately half of daytime peak plug load.

An unusually high nighttime plug load suggests that there is opportunity to save additional energy by pursuing a more aggressive nighttime computer shutdown. Verification that the nighttime computer shutdown controls are properly configured and operating was recommended. Evaluation of server room equipment to identify any servers that could be hibernated during weekends is another possibility for reducing nighttime power consumption. A final item to verify is that the AV equipment serving the large conference room is being placed into its lowest possible power mode when the space is not in use. NYSERDA is evaluating the cost-effectiveness of options to reduce this nighttime load.

- **ENERGY STAR Equipment:** Plug loads are among the highest power consumers in an office space. Use of ENERGY STAR computers and other equipment significantly reduces the floor energy consumption. The observed plug load profile, which remains surprisingly high at night, suggests that the sleep and hibernate control functions common in ENERGY STAR equipment may be able to provide additional savings through a more optimized configuration.
- **Computer Shutoff Software:** Specialized software that ensures all computers in a space shutoff entirely at night (or go into a zero-energy hibernate mode) can significantly reduce the contribution of computer plug loads to off-hours power usage. In many cases, aggressive use of ENERGY STAR Basic Input Output System (BIOS) options can also result in significant savings. The project team recommended considering a simple plug control approach; the master shutoff switch allows for plugs in the open office area to be turned off entirely at the end of the work day. Not all outlets are expected to be connected to the switch, so while nighttime plug loads can be reduced significantly, they are not assumed to go to zero.

NYSERDA's Sustainability Initiatives

Based on the successes and lessons learned gathered from participating in the Tenant Energy Optimization Program, NYSERDA developed a program to incentivize the design of high-performance tenant spaces.

This new initiative, the Commercial Tenant Program, is structured to encourage building owners and tenants to work together to achieve greater energy efficiency in commercial buildings and stimulate investment in the development of high-performing office spaces. It also aims to demonstrate a cost-effective approach of doing so and engages tenants and building owners, as well as the design community, in the process.

The program offers a cost-share ranging from 50% to 100% of eligible expenses to buy down the cost of developing an energy model and energy efficiency package to inform the energy-efficient design elements of a tenant space.

Providing this type of targeted technical assistance at the onset of a project—during lease negotiations, lease renewal, or at the beginning of a major renovation—helps facilitate the conversation among tenants, landlords, architects, and engineers about building energy-efficient spaces that can provide energy and cost-savings benefits to tenants and landlords alike.

The program is open and accepting applications. (Program link: www.nyserda.ny.gov/All-Programs/Programs/Commercial-Tenant-Program.)

Further Recommendations

The project team determined that NYSERDA can reduce energy consumption even further during occupancy by implementing additional EPMs: occupancy sensor power strips and computer shutoff software. Plug load accounts for over 60% of the total estimated energy use, and controls that can be installed after construction can increase the total projected energy savings.

Ongoing energy management systems will help ensure energy use is well managed. Currently, end-use submetering (lighting, plug, IT room, and HVAC loads) and a tenant energy management platform provide feedback for ongoing commissioning and maintenance of the systems and assist in maintaining energy savings consistent over the life of the investment. An electricity submeter was installed as part of the Tenant Energy Optimization process and was used during the M&V period to verify energy consumption.

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

Original Model Results

		Tenant Space			Base Building		Total					
	Description	Electric (kwh)	Reduction from Existing Baseline	Electric (kw)	Electric (kwh)	Steam (Therms)	Electric (kWh)	Steam (Therms)	Lighting (kWh)	Equipment (kWh)	Fans (kWh)	HVAC (kWh)
	Code-Compliant Tenant Baseline/ASHRAE 90.1-2007 Baseline	202,995	0.0%	93	N/A	1,232	202,787	1,232	45,930	96,930	17,206	42,721
G-1	High-Efficiency Lighting (0.7/0.9 W/SF)	185,858	8.4%	86	N/A	1,365	185,648	1,365	31,924	96,930	16,306	40,488
G-2	Daylight Harvesting	175,675	13.5%	81	N/A	1,455	175,464	1,455	23,531	96,930	15,844	39,159
G-3	ENERGY STAR Equipment	160,533	20.9%	78	N/A	1,537	160,302	1,537	23,531	85,184	14,751	36,836
G-4	Computer Shutoff Software	151,138	25.5%	77	N/A	1,619	150,902	1,619	23,531	77,292	14,418	35,661
G-5	Demand-Controlled Ventilation	150,983	25.6%	76	N/A	1,501	150,749	1,501	23,531	77,292	14,415	35,511
G-6	Energy Recovery Ventilator (ERV)	151,637	25.3%	70	N/A	1,346	151,172	1,346	23,531	77,292	15,038	35,311
G-7	Natural Ventilation	149,414	26.4%	70	N/A	1,330	148,954	1,330	23,531	77,292	14,769	33,362
G-8	Variable Refrigerant Flow System (VRF)	133,540	34.2%	49	N/A	1,266	133,514	1,266	23,542	77,292	11,838	20,842
B-1	Master Shutoff Switch	129,332	36.3%	47	N/A	1,303	129,306	1,303	23,542	73,592	11,750	20,422
BB-1	High-Efficiency Lighting (to 0.5 W/SF)	121,517	40.1%	45	N/A	1,363	121,491	1,363	16,597	73,546	11,681	19,667
BB-2	Daylight Harvesting (Increased Depth)	120,736	40.5%	45	N/A	1,370	120,711	1,370	15,933	73,546	11,646	19,586
B-3	Occupancy Sensor Plug Strips	114,460	43.6%	43	N/A	1,428	114,434	1,428	15,933	68,004	11,520	18,977

Calibrated Model Results – Tenant Electricity

		Tenant Space			Base Building		Total					
	Description	Electric (kwh)	Reduction from Existing Baseline	Electric (kw)	Electric (kwh)	Steam (Therms)	Electric (kWh)	Steam (Therms)	Lighting (kWh)	Equipment (kWh)	Fans (kWh)	HVAC (kWh)
	Code-Compliant Tenant Baseline/ASHRAE 90.1-2007 Baseline	185,636	0.0%	79	NA	865	185,636	865	74,499	52,509	14,289	44,339
G-1	High-Efficiency Lighting (0.7/0.9 W/SF)	141,582	23.7%	70	NA	1,185	141,582	1,185	38,315	52,509	11,899	38,859
G-2	Daylight Harvesting	132,811	28.5%	66	NA	1,249	132,811	1,249	31,182	52,509	11,470	37,650
G-3	ENERGY STAR Equipment	124,685	32.8%	65	NA	1,324	124,685	1,324	31,182	45,816	11,051	36,636
G-4	Computer Shutoff Software	124,685	32.8%	65	NA	1,324	124,685	1,324	31,182	45,816	11,051	36,636
G-5	Demand-Controlled Ventilation	124,429	33.0%	64	NA	1,199	124,429	1,199	31,182	45,816	11,050	36,381
G-6	Energy Recovery Ventilator (ERV)	123,740	33.3%	61	NA	976	123,740	976	31,182	45,816	11,835	34,908
G-7	Natural Ventilation	122,448	34.0%	61	NA	957	122,448	957	31,182	45,816	11,694	33,755
G-8	Variable Refrigerant Flow System (VRF)	113,199	39.0%	41	NA	969	113,199	969	33,726	44,475	11,383	23,615
B-1	Master Shutoff Switch	113,199	39.0%	41	NA	969	113,199	969	33,726	44,475	11,383	23,615
BB-1	High-Efficiency Lighting (to 0.5 W/SF)	116,102	37.5%	42	NA	948	116,102	948	35,866	44,902	11,425	23,908
BB-2	Daylight Harvesting (Increased Depth)	116,102	37.5%	42	NA	948	116,102	948	35,866	44,902	11,425	23,908
B-3	Occupancy Sensor Plug Strips	105,602	43.1%	42	NA	1,041	105,602	1,041	35,866	35,478	11,284	22,973

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

Energy Model Output by Measure

EPM Description		Uncalibrated Results			Calibrated Model		
		Annual Electricity Savings (kWh)	Percent Savings	Annual Cost Savings	Annual Electricity Savings (kWh)	Percent Savings	Annual Cost Savings
BL	Code-Compliant Tenant Baseline/ ASHRAE 90.1-2007 Baseline	N/A	N/A	N/A	N/A	N/A	N/A
G-1	High-Efficiency Lighting (0.7 W/SF)	17,137	8.4%	$3,085	44,054	23.7%	$7,930
G-2	Daylight Harvesting	10,183	5.0%	$1,833	8,771	4.7%	$1,579
G-3	ENERGY STAR Equipment	15,142	7.5%	$2,726	8,126	4.4%	$1,463
G-4	Computer Shutoff Software	9,395	4.6%	$1,691	0	0.0%	N/A
G-5	Demand-Controlled Ventilation	155	0.1%	$28	256	0.1%	$46
G-6	Energy Recovery Ventilator (ERV)	-654	-0.3%	($118)	689	0.4%	$124
G-7	Natural Ventilation	2,223	1.1%	$400	1,292	0.7%	$233
G-8	Variable Refrigerant Flow System (VRF)	15,874	7.8%	$2,857	9,249	5.0%	$1,665
B-1	Master Shutoff Switch	4,208	2.1%	$757	0	0.0%	N/A
BB-1	High-Efficiency Lighting (to 0.5 W/SF)	7,815	3.8%	$1,407	-2,903	-1.6%	($523)
BB-2	Daylight Harvesting (Increased Depth)	781	0.4%	$141	0	0.0%	N/A
BB-3	Occupancy Sensor Plug Strips	6,276	3.1%	$1,130	10,500	5.7%	$1,890

Notes: Electric rate of $0.165/kWh assumed
All savings reported versus ASHRASE 90.1-2007 Baseline (BL)

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**.