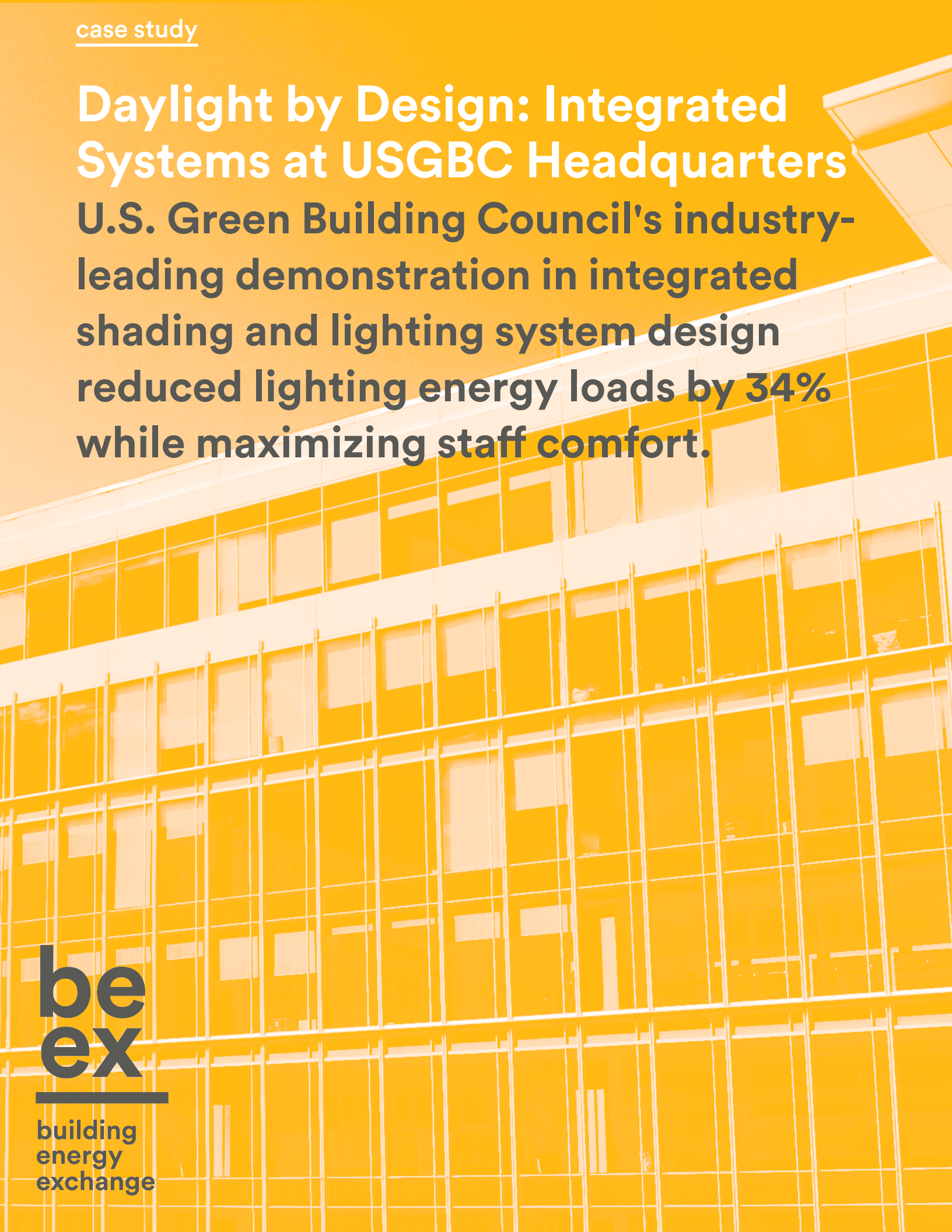
case study

# Daylight by Design: Integrated Systems at USGBC Headquarters

## U.S. Green Building Council's industry-leading demonstration in integrated shading and lighting system design reduced lighting energy loads by 34% while maximizing staff comfort.



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# USGBC HQ Lighting & Shading System Upgrades

A testament to their organizational mission, the U.S. Green Building Council's (USGBC) Washington, D.C. headquarters' integrated lighting and shading management systems are top-tier demonstrations in energy efficient design. By adopting a state-of-the-art shading system, integrated digital lighting system, and targeted LED upgrades, the Facilities team was able to provide adaptable and focused lighting to their staff—using 34% less electricity on average than their original systems. These harmonized measures delivered greater efficiency through the use of plug load management, occupancy sensors, photosensors and automatic shading. Focused, programmable system controls, in tandem with photosensors, catered to occupant preferences while minimizing lighting and HVAC loads.

### Lighting Control Upgrades

**Wattstopper ® Digital Lighting Management (DLM) System**

- Partition Interface
- Dimming Room Controllers
- Plug Load Controllers
- Photosensors
- Occupancy Sensors
- Dimming Wall Switches
- Network Bridges

### Shading Control Upgrades

**Mecho SolarTrac ® 3.0 Smart Shade System**

- PC-based SolarTrac Software
- Brightness & Shadow Management Software Options
- Brightness Sensors
- Roof-mounted Radiometer
- EcoVeil Shadecloth

### LED Lighting Upgrades

**Pinnacle Edge 2A Recessed Linear LED Fixtures**

**Fluxwerx VIEW 10 UP Suspended LED Fixtures**


*Image: smart shades shift along the south face of USGBC's Washington, D.C. headquarters. © Eric Laignel*

# Lighting & Shading — Background

**From late 2014 to early 2015, the USGBC D.C. headquarters' Facilities team installed a digital lighting management system to ensure energy efficient, responsive, and customizable lighting that complemented their smart shading system. Installed across 143 spaces in their fifth- and sixth-floor office space, the system was designed to respond to variable tenant preferences, site activities, seasonal changes, and time of day, while reducing electricity demands. Mecho's SolarTrac 3.0 smart shade system provided automatic shading and solar glare programs, while Legrand's Digital Lighting Management (DLM) system controlled lighting for exposure to natural light and occupancy, maximizing comfort while minimizing energy loads.**

## Background

In July of 2009, USGBC held the grand opening of their Washington, D.C. headquarters. The office, achieving LEED Platinum for Commercial Interiors designation, was an industry-leading demonstration in sustainable design, setting the stage for what is now a rapidly expanding US market for high performance buildings. Balancing energy efficiency, occupant comfort, and aesthetics, the USGBC headquarters set the tone for high performance buildings to come.

At the onset of the fit-out, Mecho's automatic SolarTrac 3.0 smart shade system was installed to provide maximum daylight to employees, while minimizing HVAC and lighting energy demand. By 2014, rapid advancements in lighting control systems made a digital lighting control system retrofit practical. In 2015, the USGBC Facilities team integrated Legrand's DLM system into their 5th and 6th floor office spaces, coupled with targeted LED fixture upgrades. These integrated systems promised greater adaptability given variable occupant preferences and external factors that impacted shading of the site.  Scheduling algorithms optimized lighting per the systems' shading and solar glare programs, maximizing comfort while minimizing lighting and HVAC energy loads. Centralized controls allowed the Facilities team to monitor and adjust lighting and shading programs to adapt to employee requests regarding glare or lack of daylight.

## System Details

Digital lighting and shading systems are complex, responsive technologies. With the use of room controllers, plug load controllers, load control devices, and daylight sensors, the USGBC Facilities team, in coordination with Legrand's technical advisors, were able  to optimize energy use for occupant comfort, daylight, and other environmental factors. Mecho's SolarTrac system uses a combination of predictive modeling, including a 3D model of the surrounding buildings to account for shadowing on its façade, and photosensors used to detect excess brightness and solar glare, to adjust the shades based on solar position and penetration.

Legrand's DLM responds in suite, dimming or increasing lighting in response to daylighting. This synergistic effect provides optimal sunlight at the lowest level of lighting energy demand.

In addition, advanced lighting controls provide a host of programmable energy-saving solutions. In the evening, when occupancy rates are low, occupancy sensors trigger lighting cut-offs faster than during the day; in the few spaces without occupancy sensors, programmed schedules shut off lights after-hours.

*Image: a radiometer on the USGBC D.C. HQ's rooftop monitors sky conditions to inform automatic shade movements. © USGBC*

## Lighting & Shading — Designing Eco-corridors

**Smartly designed perimeters, dubbed "eco-corridors," allowed Facilities to take full advantage of daylighting while minimizing space conditioning demands at the periphery of the building.**

*Image: the "eco-corridor" democratizes access to views, increases solar penetration, and lowers heating and cooling requirements around the building perimeter. © Eric Laignel*

### Design Details

The project team took the perimeter floor-to-ceiling glass into close consideration during design stages and optimization of the lighting and shading systems. Office desks were pushed six feet from the perimeter, democratizing access to views while lowering heating and cooling requirements around the perimeter. Lightly colored flooring options were specified to form light shelves, reflecting daylight deep into the office space. If sun caused too much glare, Mecho's SolarTrac shades automatically lowered to dampen exposure, given solar penetration allowances programmed into the algorithm. This perimeter design, dubbed the "eco-corridor," allowed Facilities to take full advantage of daylighting while minimizing conditioning demands at the periphery of the building.

The use of local zoning helped Facilities tailor lighting and shading programs to address employee comfort given exposure and shading conditions. One end of the office's south side faced significant glare, while the other received limited exposure due to neighboring buildings. Accordingly, shading programs were adjusted to limit exposure in areas prone to glare while increasing exposure to shaded areas. This programming lessened sensor-driven HVAC loads, ensuring that solar heat gain did not throw room conditioning off-balance.

### Results

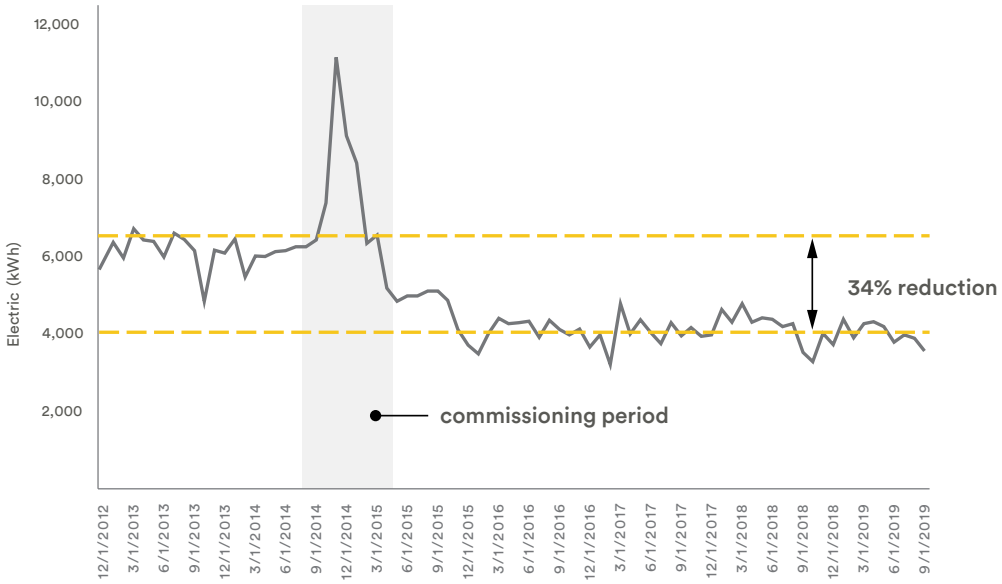
After a detailed commissioning period, given the complexity of installation and system program adjustments per employee feedback, USGBC realized significant, reliable reductions in lighting electric consumption—34% less on average relative to periods before the installation of Legrand's DLM system. These savings are attributable to daylighting, lighting and shading programs, occupancy sensors, and energy reductions vis-à-vis targeted LED replacements.

The figure on the following page shows the dramatic reduction in monthly lighting electricity use. Additional benefits, including reduction of HVAC loads due to solar heat gain management, while not captured in this figure, provide additional value to these systems.

# Lighting & Shading — Efficiency Gains

## After a detailed commissioning period from fall 2014 to spring 2015, USGBC realized consistent reductions in lighting electricity— 34% on average relative to pre-commissioning.

**DLM Impact on Monthly Lighting Electric Use**




*Seen here: lighting electricity use pre- and post-commissioning (fall 2014 - spring 2015). Increases during commissioning were associated with temporary lack of lighting controls.*

### How do lighting and shading management systems save energy?

#### Smart Time Scheduling

Scheduling controls save energy by turning lighting systems off during unoccupied periods, based on a set daily schedule. They are suitable for spaces with predictable occupancy patterns and should be supplemented with override switches or additional control schemes to accommodate activities outside of scheduled hours.

#### Daylighting

Daylighting controls use photosensors to monitor interior lighting levels and reduce electric lighting levels in proportion to available daylight. Installing both automatic lighting and shading systems allows for optimal daylighting and can significantly reduce energy use.

#### Occupancy & Vacancy Sensors

Occupancy sensors automatically turn lights off and are well suited for spaces with unpredictable occupancy patterns, like conference rooms. Vacancy sensors also turn lights off automatically, but require a manual control to turn lights on, thereby preventing unnecessary over-lighting. Occupancy sensors can also be linked to plug loads to further reduce energy use when rooms are unoccupied.

#### Personal Dimming & Tuning

Dimmable fixtures enable occupants to tune workspace lighting to meet specific needs. Office workers exhibit a wide range of light level preferences for different tasks. Allowing workers to adjust their own lighting increases satisfaction and productivity, while enabling a reduction in energy use.

#### Circadian Programming

Circadian programming is based on the premise that the human visual system needs and prefers less light at night than during the day. At night, facilities can reduce their interior illumination by as much as 50% without compromising usability or safety. As a result, spaces won't appear overly bright compared to their surroundings, and will provide an environment more in line with natural systems. Some controls also adjust the color of interior lighting to mimic the changes in natural lighting color that occur over the course of a day.

## Challenges and Lessons

**Post-occupancy optimization is a critical, iterative process. Integrated lighting and shading systems allow for the flexibility to regularly re-calibrate and optimize given new developments.**

### Modeling

At the time of this upgrade, integrated lighting and shading management systems had not been widely adopted. Due to the irregular building site and diagonal alleyways abutting the building, both systems required careful modeling to develop shading and lighting programs.

In addition to extensive modeling, organizational growth, employee feedback, and environmental changes informed the Facilities team's decision-making process. Given the flexibility of the systems, the Facilities team was able to take these factors into account to balance efficiency savings with occupant comfort.

For instance, employees seated along the 5th floor south curtain wall glass found themselves overexposed to sunlight during the afternoon. Some employees found reactive sensor-controlled shades in conference rooms to be disruptive. Over the years, neighboring high-rises expanded, impacting the shading system's predictive modeling.

### Flexible Systems

*"Flexibility is a central theme of the space's design,"* explains Ana Ka'ahanui, Marketing Project Coordinator, who highlights this point as the manager of the office's public tour program. *"From movable walls, to adaptable DLM control systems, flexible systems can accommodate shifting organizational needs and personal preferences while ensuring that our core energy efficiency goals are met."*

As with all advanced building technology systems, post-occupancy optimization is a critical, iterative process. Integrated lighting and shading systems allow for the flexibility to regularly re-calibrate and optimize given new developments and shifting preferences. *"There were growing pains—these solutions are very sophisticated and require significant oversight and collaboration between project team members and manufacturers,"* said Ana. *"Pushing through these, listening to employee concerns, and integrating cutting-edge technology [like LED lighting] as it entered the market, were key to implementing the systems."*

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- Ana Ka'ahanui, Marketing Project Coordinator, USGBC

### Fine-tuning

*"The most difficult piece of the integrated lighting and shading [commissioning] is the initial fine-tuning to occupant activity and function,"* said Linda Sorrento, design industry strategist and one of the original USGBC project team members. *"Staff engagement is critical to getting this right. Moreover, the Facility team is key to the process by listening and taking action on their feedback."*

By updating lighting and shading programs by zones and floor, with the help of Mecho and Legrand's technical teams, Facilities optimized lighting electricity use for tenant comfort through careful consideration of shading programs. Seasonal shading scheduling was used to mitigate solar gain and eye-level light disruptive to employees. Additional adjustments were also made in low-light zones to increase exposure to light.

*"The USGBC space is a living laboratory where we test out new technology, benchmark our data and always look for ways to improve so that we provide the most healthy and efficient space possible,"* explains Melanie Mayo-Rodgers, Director, Facility Management. *"The Facility Management team's role is to ensure that the technology performs to specifications and meets the needs of our staff. The integrated lighting and shading systems have provided the flexibility we required. Solar Trac has enabled us to adapt with special programming and set schedules to resolve issues with solar gain, glare, and low light levels to stay efficient while still maintaining as much of the natural daylight and outdoor views as possible."*

# Conclusion

**Reactive, programmable lighting and shading systems, combined with smartly designed perimeter spaces and open offices, have reduced lighting electricity consumption by one-third.**

## Comfort & Efficiency

USGBC's lighting and shading systems paved the way for industry adoption across a wide variety of building projects. Reactive, programmable lighting and shading systems, in combination with smartly designed perimeter spaces and open offices, have reduced lighting electricity consumption by 34%.

Given the complexity of these projects, careful coordination between MEP, architects, facilities teams, occupants, and manufacturers is required during the install. A carefully organized commissioning period is recommended to effectively optimize the system to tenant preferences and other evolving factors. To ensure long-term success, a well-trained and responsive facilities team is a critical asset.

The resulting benefits—tenant comfort, system flexibility, and reliable energy efficiency gains, are well worth the effort.

## Learn More

**For more information on lighting system upgrades:**

- **Lighting the Way: Upgrading Lighting Systems for Commercial Offices (2017)**

**For information on energy savings via daylighting:**

- **Queens College: Daylight Hour Strategies & Outcomes (2016)**
- **Daylighting at Genzyme (2015)**
- **Let There Be Daylight (2012)**

**To learn about Daylight Hour, Building Energy Exchange's annual social media campaign encouraging the use of daylighting in lieu of electric lighting:**

- **www.daylighthour.org**

**To learn about the impact of participation in Daylight Hour:**

- **NYPA: Daylight Hour Strategies & Outcomes (2016)**
- **Infosys: Daylight Hour in Daylit Buildings (2015)**

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## Disclaimer

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