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Siemens EngineeringAdvantage™

Newsletter

Issue 2—2018

Introduction

Lighting control systems generally serve two purposes: (1) Occupant needs – i.e., provide the right amount of light where and when it is needed, and (2) maximize energy savings to satisfy codes and conservation/sustainability programs. We will review some of the most common control strategies to achieve these goals, as well as touch on some of the evolving technologies for enhancing wellness and comfort by reinforcing the circadian rhythm of patients, students and other types of building occupants.

In This Issue:

Design Topic

Lighting Control Strategies

BACKGROUND

Electric lighting is included in virtually all commercial spaces. In the past, building occupants controlled the lights by operating switches that directly controlled power to the light fixtures. This gave occupants ultimate control over the light levels in their space. Building owners recognize that not all occupants can be relied upon to turn lights off when they are no longer needed.

To address this, building owners are now using lighting controls to reduce light levels or turn lights off when they are no longer needed. Automating the control of the lights can provide energy savings ranging from 10% to more than 60%, depending on the type of controls used.

In the past 10 years, energy codes such as ASHRAE 90.1, ASHRAE 189.1, International Green Construction Code (IGCC), and California Title 24, have been including requirements for automatic controls for building lights. Later editions of these codes require more sophisticated controls in more types of building spaces to provide additional energy savings.

Lighting Control Basics

When light levels are properly adjusted for the activities being performed in the controlled space, building occupants are happier, healthier and often more productive. In many cases, the light level that occurs with all lights at full brightness is greater than required for the activities being performed. Reducing light output to the proper level improves occupant comfort and results in energy and cost savings.

There are many different strategies for automatically setting and maintaining light levels appropriate for the activities being performed in the space. A few examples of these are daylight harvesting, lumen maintenance, task tuning, and control of color tunable fixtures. Another example of adjusting light levels to achieve a desired objective is demand response, which satisfies building energy limits rather than occupant requirements.

CONTROL STRATEGIES

Occupancy

This strategy turns lights on or off based on the presence of occupants. Occupancy can be determined based on time of day or actual occupancy sensing. Per the Average Energy Savings chart, this strategy can generate up to 24% energy savings.

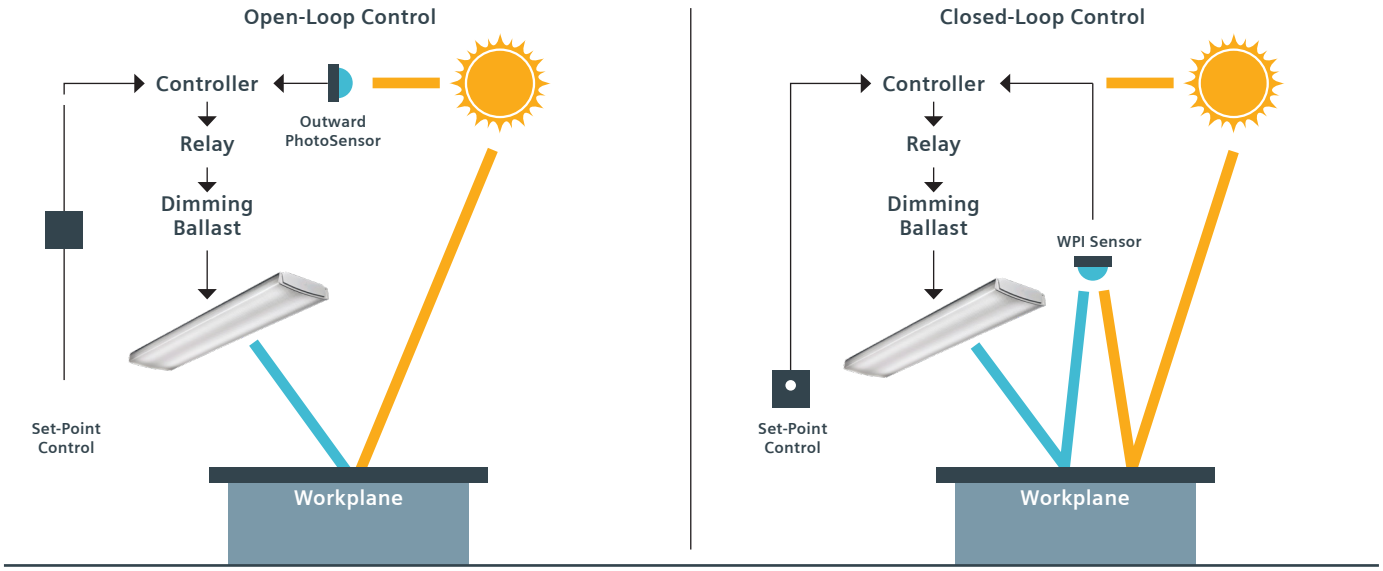
Time Based— At certain times, controlled lights will turn ON, OFF or dim to save energy or support changing space functions. Scheduling is highly suitable for larger, open spaces that are regularly occupied, as well as spaces that are intermittently occupied but where the lights must remain ON all day for safety or security reasons. Local override (time extension) wall controls are often used to allow for irregular use of the space.

Occupancy Sensing— Sensing controls turn off lighting or reduce it in response to occupancy in the space. The sensor may automatically turn on the lights to full output or a reduced light level, or require manual-on operation for vacancy sensing. This type of control is ideal for spaces that are intermittently occupied, such as private offices, classrooms, conference rooms, copy and break rooms, restrooms and other utility spaces. It also can be effective for lighting that must be on but can be dimmed while the area is unoccupied.

Average Energy Savings

The Lawrence Berkeley National Laboratory (LBNL) analyzed 240 energy savings estimates from 88 papers and case studies. After filtering for focus specifically on savings due to lighting control strategies only, the table below summarizes the findings.

Strategy	Description	Sample Input Sources	Average Energy Savings
Occupancy	Lights turn off when no activity	Occupancy sensors, time clocks, BAS	**24%**
Daylight harvesting	Lights turn down when outdoor light sufficient (dimming)	Photosensors	**28%**
Personal tuning	Lighting adjustment by occupants	Switches, dimmers, workstations, preset scenes	**31%**
Institutional tuning	Lighting adjusted by space/application needs, e.g. task tuning or lumen maintenance	Dimmable drivers, plus dimmers and switches used to control group lighting	**36%**
Combination	Two or more of the above	Any of the above	**38%**



Daylight Harvesting

In building areas where natural light is present for part of the day, electric light levels can be decreased. This strategy is called daylight harvesting or automatic daylight dimming. The general premise of this application is that a certain light level is required to perform the tasks in a space, and there is little benefit in providing more than the required light level.

Light level sensors detect the amount of natural light in a space. The electric light level is increased or decreased in response to changes in the natural light level to maintain the preferred light level. The electric lighting can either be controlled by turning lights on or off, or by increasing or dimming the light level.

Daylight harvesting offers numerous advantages: For building occupants, building spaces are not over-lit, thereby eliminating discomfort when viewing computer screens. For building owners, there can be a significant savings in electricity cost for building spaces, both in reduced lighting cost and in reduced cooling cost due to less heat being added to the space from the lights.

Daylight harvesting also allows building owners to comply with the "green" codes and energy-efficiency standards that are now being mandated in many jurisdictions. This strategy can generate up to 28% average energy savings.

Lumen Maintenance

The lumen output, or brightness, of a lamp decreases over time. Lamp specifications include data about initial lumens, mean lumens and the rated life of the lamp.

The mean lumens rating represents the lumen output of the lamp after it has operated for 40% of its rated life. For a fluorescent lamp, the mean lumens rating is typically 80%-95% of the initial lumens rating, meaning that at 40% of the rated life, the light output of the lamp is 5%-20% lower than when it was new. The light output of the lamp continues to fall until the lamp fails. The rated life of a lamp is the number of operational hours at which 50% of the lamps tested are still operating.

Designers who specify lighting for interior spaces will select the type, number and spacing of light fixtures and lamps to provide an appropriate light level for the type of activity that is expected to take place within the space. To ensure that the appropriate light level is still present years after installation, lighting is designed using the mean lumens rating of the lamps. While this approach is necessary to account for the reduction in light level over the life of the lamp, it means that the space will be overly lit when the lamps are new.

If all the lamps within a space are new—either because the building is new or because the facility periodically replaces all lamps at the same time rather than replacing them individually as they fail—it is possible to save energy by taking advantage of the fact that new lamps produce more light than indicated by their rated mean lumens. Because the lighting in the space was designed to work properly at the rated mean lumens, new lamps can be dimmed to the mean lumens level. This saves energy compared to operating the lamps at 100% output and over-lighting the space.

For example, if the mean lumens rating of a lamp is 20% less than the initial lumens rating, the maximum dimming value could be set to 80% when the lamps are new, resulting in a 20% energy reduction. Each year the lamps will have lost approximately 5% of their initial lumens, so dimming value would be reset upward, still yielding energy savings until reaching its full rating.

Task tuning

Task tuning is the process of controlling light levels as they correspond to a specific task or job responsibility (e.g., lighting conditions for an open office space with hundreds of computers requires different lighting levels than an electronics manufacturing bench where highly detailed work is completed).

When building spaces are designed to accommodate many types of activities, or when buildings are designed before a tenant is found, the lighting is generally designed for the type of activity with the greatest need for lighting that is likely to be performed in the space. Guidelines from the Illuminating Engineering Society (IES) are often used to determine appropriate light levels for different tasks.

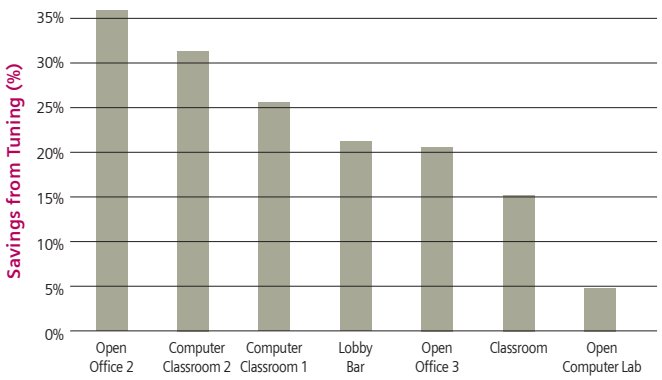
Task tuning takes place after installation, during the commissioning activities, to adjust light to the correct levels. This is similar to the process of air balancing to adjust proper airflows during commissioning of an HVAC system.

When a new tenant moves into a building that was not designed specifically for the tenant's tasks, it is likely that some areas of the building will be overly lit for the activities that will be performed in those areas. Oftentimes, the occupants will remove one or more lamps from the fixture over their work area to reduce the brightness to a more comfortable level.

A more appropriate solution would be to leave all lamps in the fixture and dim the fixture to produce the light level that is appropriate for the work being performed. This provides multiple benefits for the occupants, including greater comfort and less eye strain. Plus, it maintains the uniformity of lighting that was intended for the space. It also provides the building owner with financial benefits in terms of reduced energy use and greater longevity for the lamps.

Distribution of measured tuning savings (by %) for the sample of spaces.

In the task tuning study, there were four open office settings and three computer classroom settings.



Seventhwave; Facility Executive Magazine, April 4, 2017

Color and Correlated Color Temperature Control

Color tuning is the concept of changing the color of LED lighting for a variety of purposes such as presentations, comfort and well-being. Correlated color temperature (CCT) is the relative color appearance of a white light source ranging from cool and blue to warm and golden. Research shows how light can impact behavior, alertness and sleep patterns, as well as have psychological effects.

There are three basic categories of color-tunable products:

- **Dim to warm –** products that dim to a very warm white-like incandescent dimming. This is often used in settings such as restaurants, hotel lobbies and guestrooms, ballrooms, theaters and residential spaces.
- **Tunable-white –** products allow for changing the color of light from warm to neutral to cool in appearance, which may be desirable for a range of reasons, from aesthetic to medical. These are often used to support the human circadian system as light plays a key role in setting and regulating the body's biological clock.
- **Full-color-tunable –** products have separately dimmable red, green and blue LEDs, plus amber or white and potentially other colors. This is well-suited for theaters, theme parks and restaurants.

Tunable White Applications

Various research studies show how tunable white lighting fixtures create a positive environmental effect that can impact occupant behavior and wellness. For example, human circadian rhythm is hardwired with the light cycle of the solar day. By adjusting light intensity and color temperature using tunable-white luminaires, we can simulate natural daylight over the course of the day to avoid disrupting the cycle.

Some of the potential applications for this technology from the U.S. Department of Energy CALiPER Application Report "Understanding LED Color-Tunable Products" are:

- **Provide apparent cooling or warming to a room:** This can create psychological effects. For example, using cooler-colored light can make occupants feel cooler on a sweltering summer day.
- **Assist with behavior control:** Some classroom studies suggest that the color and intensity of light can be modified to calm or invigorate students, or to focus their attention.
- **Support the human circadian system:** Both the intensity and the spectral content of light can stimulate or suppress the secretion of melatonin and other hormones, which, in turn, affect our mood, alertness and health. Although the exact mechanisms and effects are not yet fully understood, this may be an important consideration for industrial and medical spaces, as well as senior living facilities, prisons, dormitories and high-density housing.
- **Correct circadian misalignment:** Varying the light color and intensity may be used by medical professionals to treat jet lag, sleep disorders and other conditions.

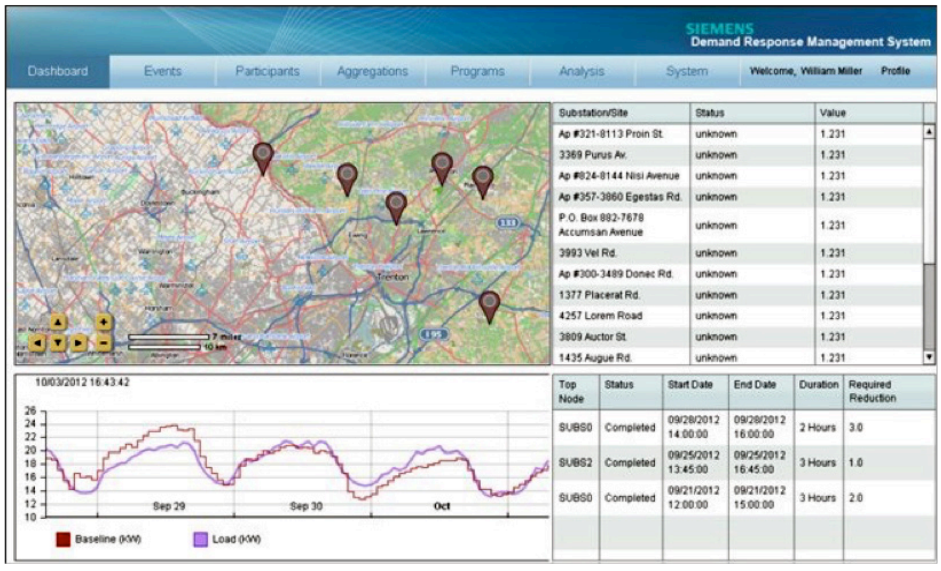
Demand Response

The previous sections described adjustments to light levels that are primarily intended to provide occupant comfort, with a secondary benefit of saving energy from lower electricity usage and reduced cooling loads. Demand response, on the other hand, is a strategy for controlling light levels solely for reducing energy usage in response to a signal from the electric utility directing customers to reduce electrical usage, or from onsite meters indicating that the facility is in danger of exceeding a specific peak threshold level of electricity usage. There may be only one signal requesting that a facility reduce demand, or there may be multiple signals representing different levels of severity.

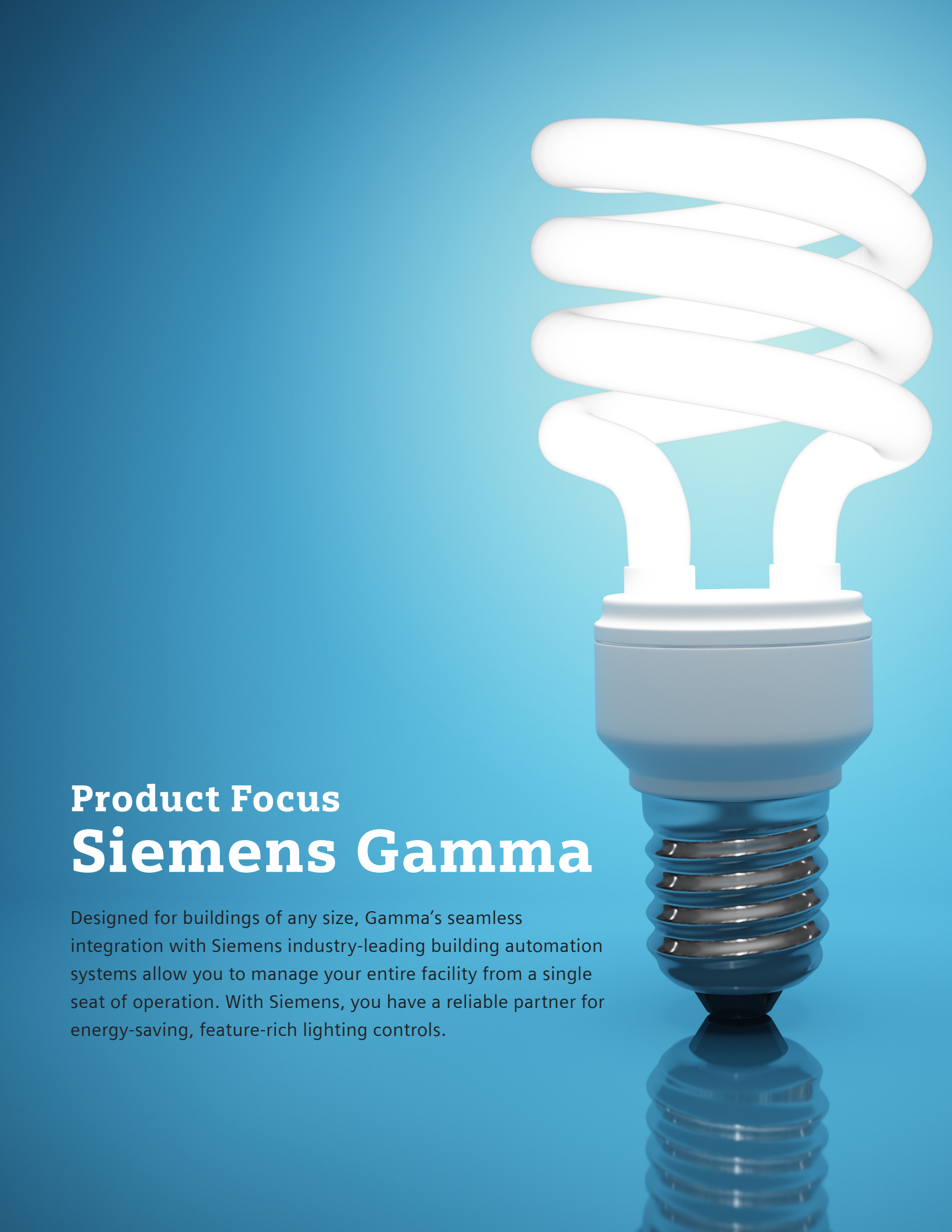
For Demand response strategies to be implemented by the lighting control system, it is necessary for the lighting designer to identify lights that should be turned off or dimmed when a signal to reduce electricity usage is received.

For example, if three levels of demand response requests will be received, lights that will participate in this strategy should be placed into three groups according to their importance. When the first level signal is received, the group containing the least critical lights will be turned off. If a second level request is received, the group containing more important, but not critical, lights will be turned off. A third level demand response request would result in the group containing all but the most critical lights being turned off.

If dimming drivers were installed, an alternate method of implementing demand response would be to place all lights that are part of the demand response in one group and dim the lights part way when the first level request was received, dim the lights to a minimum level when the second level request was received, and then turn them off if a third level request was received. The lighting control system can receive the demand response request signals either as a dry contact or from a building control system via a gateway.



Demand Response Management System



Product Focus

Siemens Gamma

Designed for buildings of any size, Gamma's seamless integration with Siemens industry-leading building automation systems allow you to manage your entire facility from a single seat of operation. With Siemens, you have a reliable partner for energy-saving, feature-rich lighting controls.

Energy-Saving Applications

Daylight harvesting – Responding to the available natural light in a room, brightness sensors reduce artificial lighting. This strategy retains the quality of the visual environment while reducing energy costs.

Occupancy control – To maximize energy savings when the space is not occupied, Gamma occupancy controls can dim, reduce or increase lighting, as well as adjust window shading and change temperature setpoints via your Siemens building automation system (BAS).

Task tuning – Preset the default light levels of a particular space based on the specific tasks associated with that space. You can control lighting levels of individual fixtures or areas throughout your facility, and provide just the right amount of light for the activities in each area. Giving occupants the ability to adjust the lighting to fit their own needs allows further comfort and energy savings.

Scheduling – Automate dimming and/or switching preferences and space use/occupancy through your Siemens BAS. You can pre-program lighting activity in various rooms all from your Siemens workstation.

Blind/shade control – Control blinds to meet the illumination and comfort needs of occupants, either manually or automatically. The Gamma Weather Station can calculate the position of the sun to control the blinds, so the glare of direct sunlight is never bothersome. When you can limit the amount of direct sunlight in a room, you also keep the room from getting uncomfortably warm. Savings are realized through lowered dependence on HVAC.

Driver-level control – Control lighting zones and groups, as well as individual lights. This level of granular control delivers the greatest savings and flexibility of use. Gamma supports On/Off control, analog dimming control and Digital Addressable Lighting Interface (DALI) control. Through individually addressable lighting, we flexibly meet your needs for functionality and comfort, as well as energy savings.

Gamma Grows With You

Benefit from distributed control

Gamma lighting controls can be installed in a traditional centralized panel configuration, but the greatest energy saving benefits come when Gamma is implemented as a fully distributed system. Gamma controls can be local to each lighting fixture, meaning there's no single point of failure.

The highest level of control distribution comes when you select the Gamma DALI interface. From On/Off control, dimming to scheduling, the Gamma DALI interface communicates to individual drivers or groups of drivers. It also provides controls for LED fixtures, allowing for diverse lighting controls and greater energy savings. This kind of granular control lets you deliver the right level of lighting to any space for any occupant's needs.

Gamma's components communicate with each other over a low-voltage network. This network can simplify the line voltage circuitry, making it easy and inexpensive to install and to introduce Gamma into any facility. Because the "control wiring" is independent of the "power wiring," you gain the flexibility to install devices where you need them.

Starting small in a single room, or expanding to a full building or multiple buildings as your organization grows, the distributed controls make it easy to add new functionalities as your needs evolve. Gamma can accommodate lighting functionality changes efficiently for new construction, expansions or retrofit projects. You can also adjust functionalities and applications easily through software, eliminating any need for costly rewiring.

Flexible Integration Options

Siemens provides various avenues for integrating Gamma into your BAS. Choose traditional integration methods, through our unique Total Room Automation approach, or a combination of both.

Traditional Integration

Gamma delivers single-seat control so you can better regulate your building's lighting. Integrated into your Siemens BAS, it improves how you control, monitor and coordinate lighting with other building systems. Along with HVAC and fire and life safety systems, Siemens BAS incorporates Gamma using BACnet, the industry standard protocol for interoperability among multiple building systems. You can easily manage lighting levels from the intuitive interface of your Siemens workstation or other BAS.

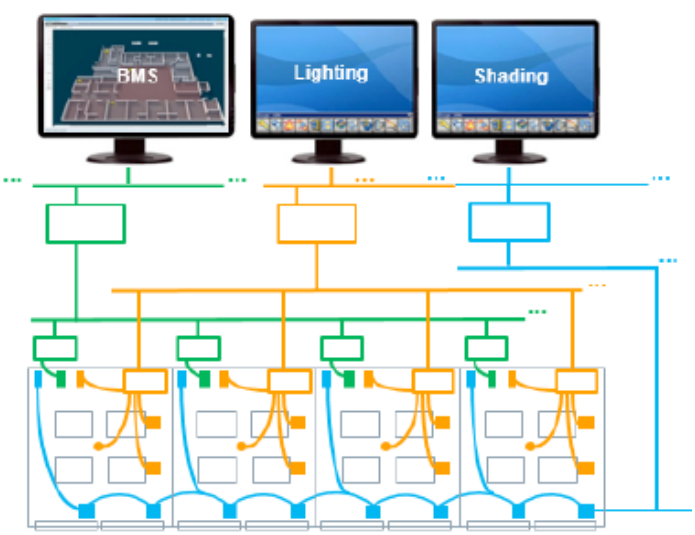
Through BAS integration, Gamma not only lets you operate lights precisely as needed, it also lets you better manage energy-reduction practices. Because Gamma can coordinate with other building systems, it simplifies load shedding for demand response needs. Now you can easily reduce power in less critical areas during peak demand times.

Lowest overall cost with Total Room Automation

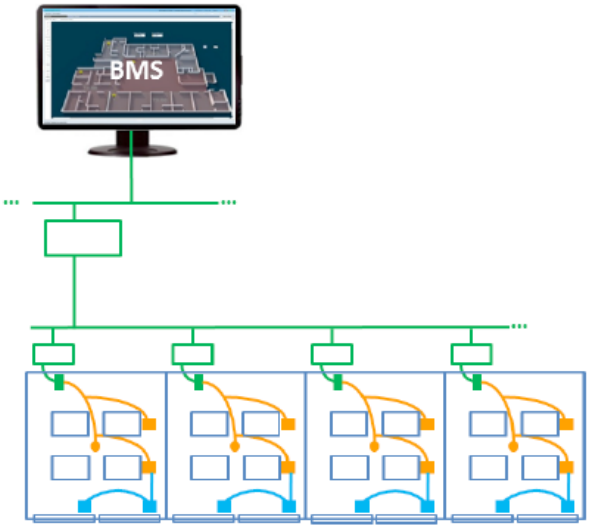
The Siemens Total Room Automation integral approach lowers installation cost by consolidating all lighting, HVAC, shading and plug load control into a single, unified controller, infrastructure and user interface. Contractor coordination is also simplified to a single vendor. These savings are hard cost savings on construction and can provide increased opportunities for customers. For example, on one project, a tenant fitting out space was able to expand the use of automatic shading due to savings from installing the unified system.

Traditional Integration Approach

3X Network Infrastructure; Integration Challenges; Complexity



Total Room Automation Integral Approach



HVAC Control **Lighting Control** **Shading Control**

Energy-Saving Applications

EngineeringAdvantage™
Designed for consultants, the site includes specs, product info and technical resources.

Gamma Lighting Control
Home page for Siemens Gamma Lighting Control System

Siemens Product Documentation
Search and download data sheets, manuals, brochures and more of Siemens Building Technology products.

SimpleSelect™ Valve Tool
Download Siemens valve sizing and selection tool.

SpecWriter
Link to Siemens online specification writing tool.

Total Room Automation
Learn more about Desigo Total Room Automation from Siemens, which offers a unified, intelligent HVAC, lighting and shade control strategy.

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