NAVIGANT
RESEARCH

WHITE PAPER

Wireless Lighting Controls

Assessment of Lighting Decision Makers and Influencers for College and University Facilities

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Section 1
EXECUTIVE SUMMARY

1.1 Overview

The lighting controls market is evolving, spurred by increased adoption of LED lighting products. Additionally, building codes and standards are helping drive increased adoption of lighting controls. Retrofitting or replacing a lighting system is often cheaper than doing so for other building systems, such as HVAC or IT. Lighting upgrades provide substantial energy savings, and when combined with lighting controls can also help future-proof a lighting system. Indeed, planning for and designing a lighting control system at the time of a lighting upgrade allows for reduced installation costs compared with doing these installations separately, making the ROI for lighting controls more attractive to a building owner, manager, or tenant.

Unfortunately, the conventional building design and construction process that predates the design and installation of networked lighting control systems makes it appear a complex landscape to navigate. Typically, the contractor that installs the controls is not the same party that specifies the controls—leaving design intent open to misinterpretation. This problem is exacerbated in higher education where numerous stakeholders need to support facilities improvements. Adding to the complexity, the process of investing in facilities upgrades varies from campus to campus. There is no consistent set of decision makers engaged in renovation and energy efficiency building projects in higher education. Despite this, higher education decision makers agree on the broad benefits of lighting controls: cost savings, energy savings, and sustainability. Beyond these immediate operational benefits, lighting controls also help colleges and universities meet the missions of their institutions.

Fundamentally, colleges and universities exist to serve the public through teaching and research. This service can be enabled or hindered by the physical and emotional experience students, teachers, and administrators have in their environment. Thus, the drive to create an optimal experience secures the investments institutions make. But, creating an optimal experience is difficult. The key ways that facility investments effect the experience are through efficiency, aesthetics, and usability of systems. These factors are depicted in Figure 1-1, with further discussion in Section 2.6.

Figure 1-1. Factors for an Optimal Experience for Stakeholders in Higher Education

(Source: Audacy Wireless)

When higher education institutions invest in new building systems, many struggle to fully realize the promise of an upgrade. Challenges with operations and maintenance, a lack of specialized expertise, the need for internal training, and staffing shortages create immediate headaches for administrators and facilities managers. Because of these challenges, the technical support provided to institutions after installation becomes a key factor, guiding decision makers in higher education when selecting lighting control suppliers.

Overall, the adoption of lighting controls is low in higher education. Lighting controls currently are perceived as nice to have and few institutions consider them a priority facility upgrade. However, lighting controls will increasingly be part of investment conversations. Long-term cost savings due to increased energy efficiency gained through a lighting controls deployment help the bottom line of a college or university and allows the decision makers to meet both budget-focused and sustainability goals. To Gary Weishaar, Energy Engineer and Manager of Energy and Controls at Kansas State University, “sustainability and social consciousness is second to cost savings,” as the most important factor for investing in lighting controls. Lighting controls provide students, faculty, and staff with customizable lighting solutions based on their individual needs, and work to increase the productivity of building occupants.

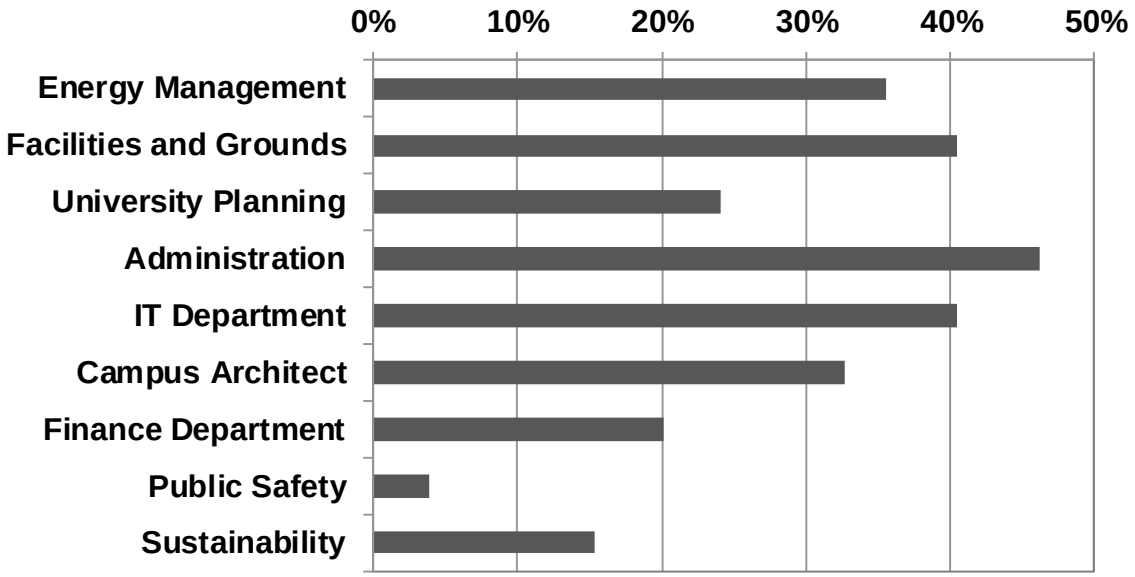
In addition to a better occupant experience, lighting controls can make management easier. A control system that allows for remote access can provide facility management the ability to make adjustments from various locations on campus and can provide the occupants greater control as well. Additionally, insights into lighting system failures provided through a control system can address concerns that universities and colleges face regarding staff shortages. Controls strategies that enhance the occupant and management experience by contributing to efficiency, aesthetics, and usability are poised for increased deployment.

Section 2
LIGHTING CONTROLS IN HIGHER EDUCATION

2.1 Multiple Decision Makers

In higher education, there is an inconsistent mix of decision makers engaged in renovation and energy efficiency building projects on campus. Responsibility is shared across multiple stakeholders and those stakeholders vary institution-by-institution, ranging from administration, to facilities and grounds, to energy management. In a survey Navigant Research administered to campus facility managers, lighting designers, architects, and engineers for this white paper, no single role was reported involved in lighting control decisions across a majority of respondent. As seen in Chart 2-1, while respondents were able to choose whichever and however many responses that were applicable, fewer than 50% of them selected any individual department.

Chart 2-1. Departments Involved in Lighting Control Decisions on Campuses



Note: n=104

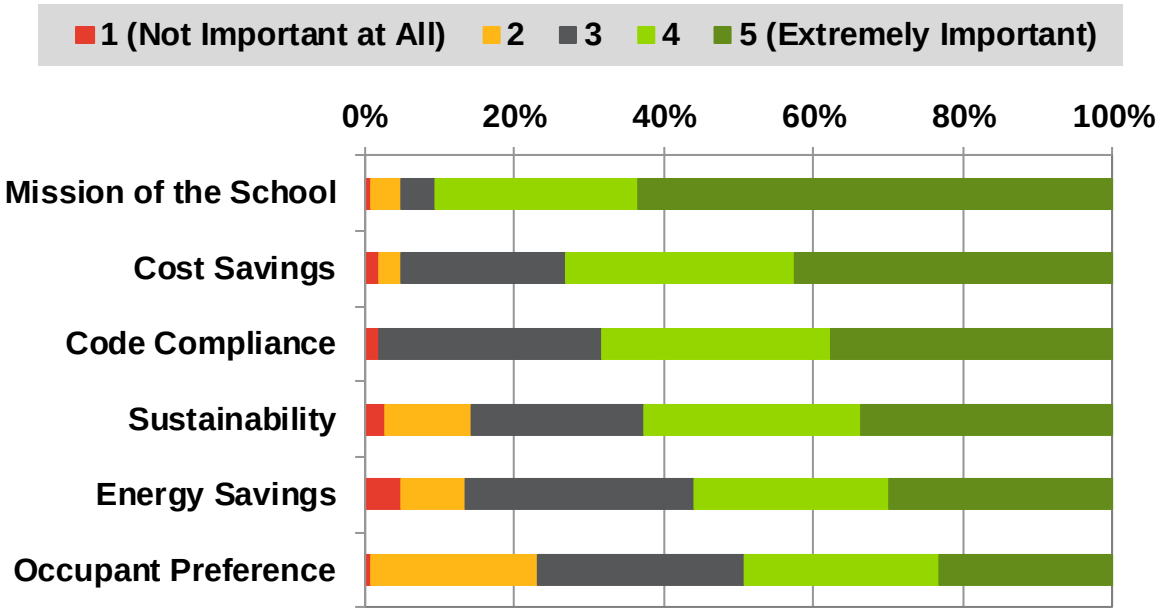
(Source: Navigant Research)

The benefits perceived from lighting controls are consistent, despite the lack of a regular set of decision makers. To the various decision makers for a campus energy efficiency upgrade project, wireless controls help meet the mission of a university or college.

2.2 Benefits to the Mission

A university's or college's mission allows it to set and communicate goals and helps create the foundation for its success. The mission of the school was ranked as the most important factor in the decision to invest in wireless lighting controls.

Chart 2-2. Ranking of Decision Factors When Investing in Lighting Controls



Note: n=104

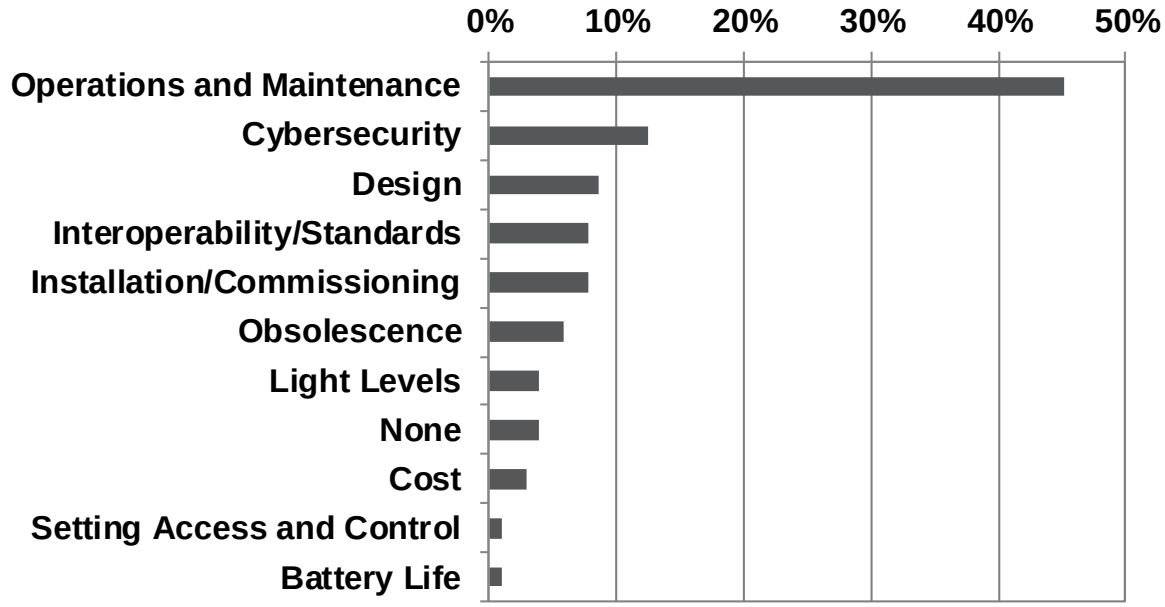
(Source: Navigant Research)

While the range of decision makers involved in energy efficient building projects varies by institution, the mission of the college or university emerged as a common theme. This underscores the role an institution's environment plays in fulfilling a mission, from sustainability to occupant experience.

2.3 Perceptions of Wireless Lighting Controls

Many colleges and universities face staff and budget shortages that result in strains on staffing to meet their operational and maintenance needs. New building systems can provide the additional burden of training and specialized expertise, adding challenges to already lean teams. Given these considerations, it is no surprise that operations and maintenance is perceived as the biggest barrier to wireless lighting control technologies. Chart 2-3 indicates that survey respondents indicated operations and maintenance significantly higher than any other category of barrier.

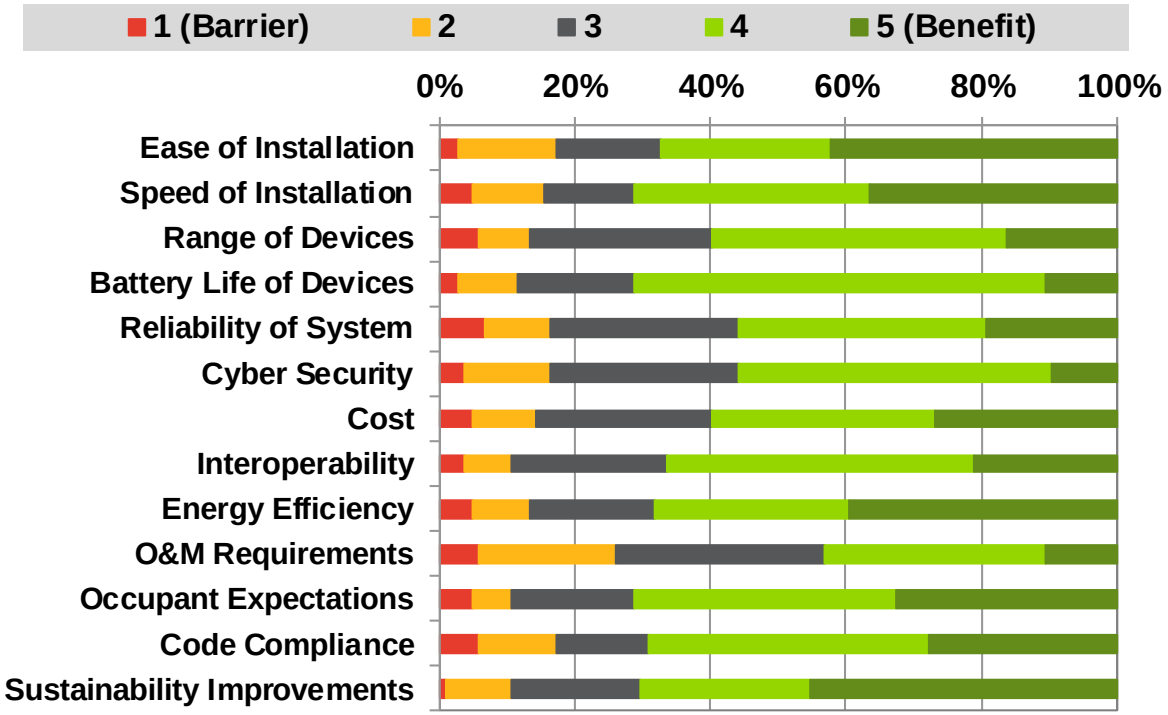
Chart 2-3. Barriers to Wireless Lighting Control Technologies



(Source: Navigant Research)

Although operations and maintenance is perceived as the largest barrier to the adoption of lighting controls, lighting controls also have many benefits that help alleviate this perceived barrier. Chart 2-4 shows the benefits of a wireless lighting control system. Both greens represents the percentage of each attribute that is perceived as a benefit of wireless lighting controls. For almost all attributes, over 60% of respondents ranked these as benefits to a wireless lighting control system.

Chart 2-4. Scale of Attributes of Wireless Lighting Controls



(Source: Navigant Research)

Lighting controls provide cost and energy savings while helping institutions meet sustainability targets and climate goals. Wireless lighting controls also provide additional unique benefits, especially relating to installation. One of the attributes most considered as a benefit is the ease and speed of installation. Mike Norris, Energy Resource Coordinator, Campus Facilities Management at the University of Missouri Kansas City understands this benefit, “Key benefits of wireless lighting controls are the energy savings and ease of installation. We have a lot of old buildings with hard ceilings. Running wires is sometimes very difficult. These are places where wireless makes sense.”

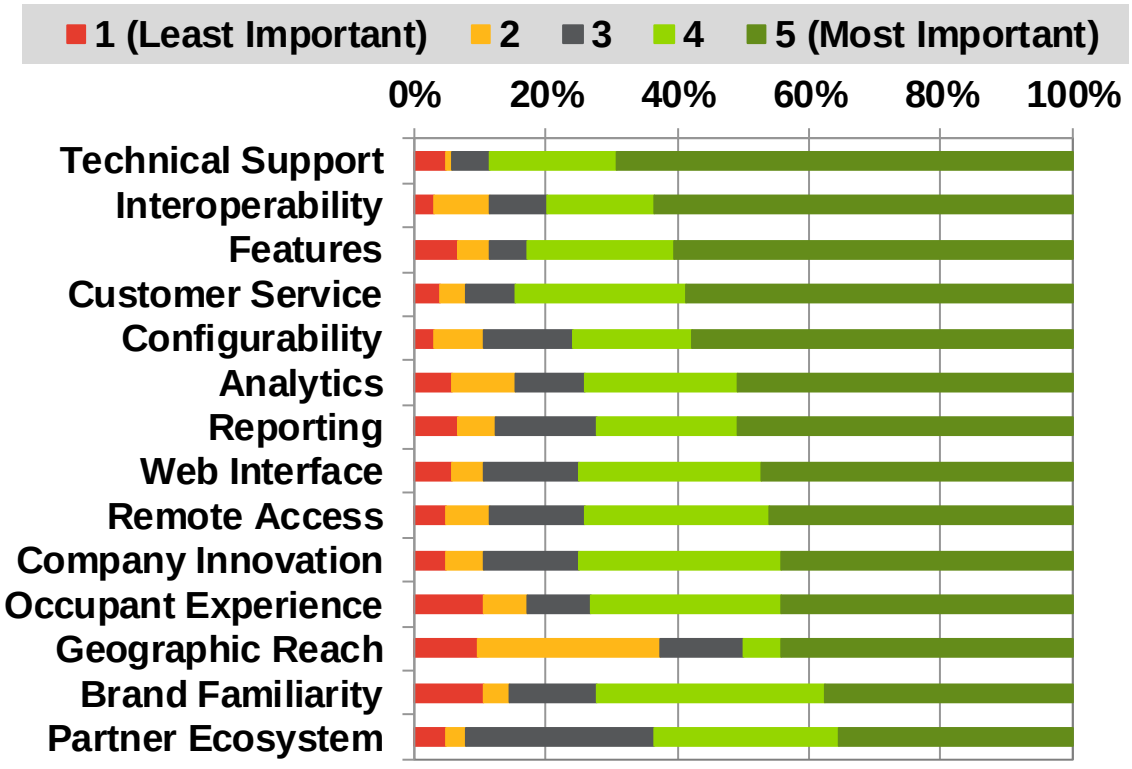
Many colleges and universities have older buildings where it might be difficult or labor intensive to run additional cabling in the ceilings. Wireless controls, therefore, are especially valuable in retrofit applications. Not only can wireless controls be installed more quickly than wired systems, in some cases they are also easier to deploy. Such benefits

are key drivers for a wireless solution. A project manager and electrical engineer at an engineering design and consulting services company highlighted the additional flexibility provided by wireless controls as a benefit, stating, “Wireless lighting controls are beneficial in renovations/retrofits where lighting control zones change in an existing space as it allows for the change to happen without needing to re-wire the lighting circuits.”

2.4 Technical Support

A higher education decision maker’s most important consideration is technical support when selecting a new lighting control system. Any upgrade can prompt concerns around adequate internal education and operation and maintenance of a new system. Technical support by a lighting controls vendor can help address and often mitigate concerns over the operations and maintenance of a new system. When looking at all aspects of the considerations for an energy efficiency upgrade project, technical support ranks as the most important consideration, as shown in Chart 2-5.

Chart 2-5. Importance of Characteristics for Energy Efficiency Upgrade Projects



(Source: Navigant Research)

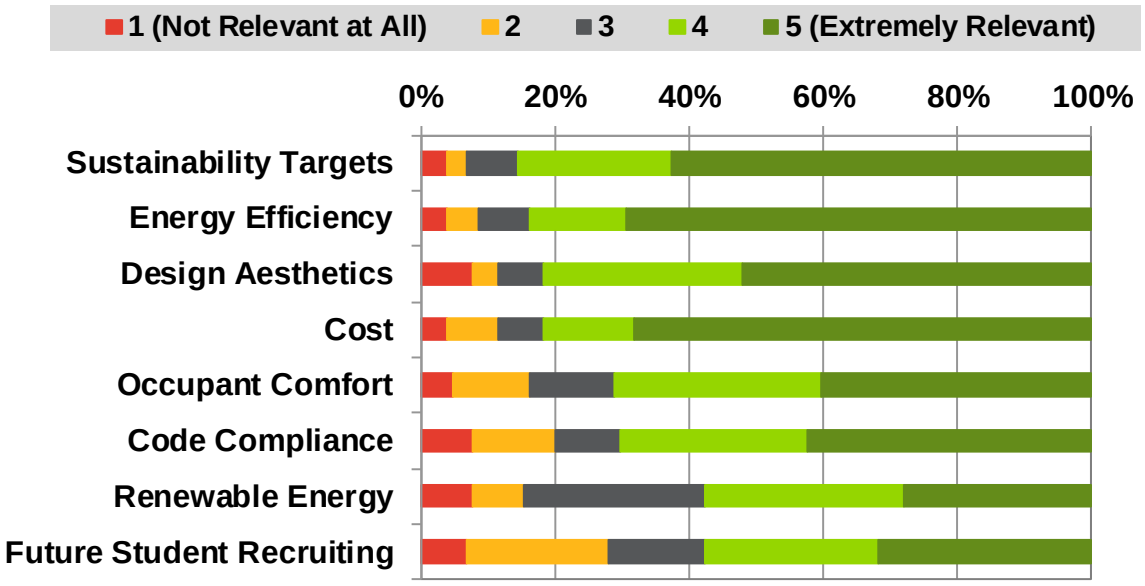
Lighting control vendors provide technical support and ongoing advisory services to help operate and ensure customer satisfaction and correct use of the systems. As Chart 2-5 shows, while technical support ranked as the most important factor for college and

university decision makers, overall satisfaction for technical support was ranked below 50%. Even with the overall general dissatisfaction of technical support provided by lighting control suppliers, there is still a variance in the type and range of support offered. It is critical for decision makers in higher education to understand how to best use technical support from lighting controls vendors and how these offerings can vary by vendor.

2.5 Optimal Experience

Efficiency, aesthetics, and usability are key factors (as shown in Figure 1-1) that contributed to decision-making in higher education for lighting control systems for building projects. Together, these factors come together to create the optimal experience for all stakeholders. Most of the key factors that contribute to an optimal experience ranked as extremely relevant in meeting the mission of the college or university, showing the importance of meeting the mission to the overall decision-making process for energy efficient building upgrades.

Chart 2-6. Ranking of Factors in Relevance to the Mission of the College or University



(Source: Navigant Research)

2.5.1 Efficiency

Decision makers must think about the upgrade's effects on their institution's bottom line, on the facilities department, and on the faculty and students that will inhabit the buildings. Any campus investment involves tradeoffs between the benefits provided and the costs required. This tension is underlined by the importance placed on efficiency. In the case of building systems, efficiency touches upon the investment cost, the impact on energy

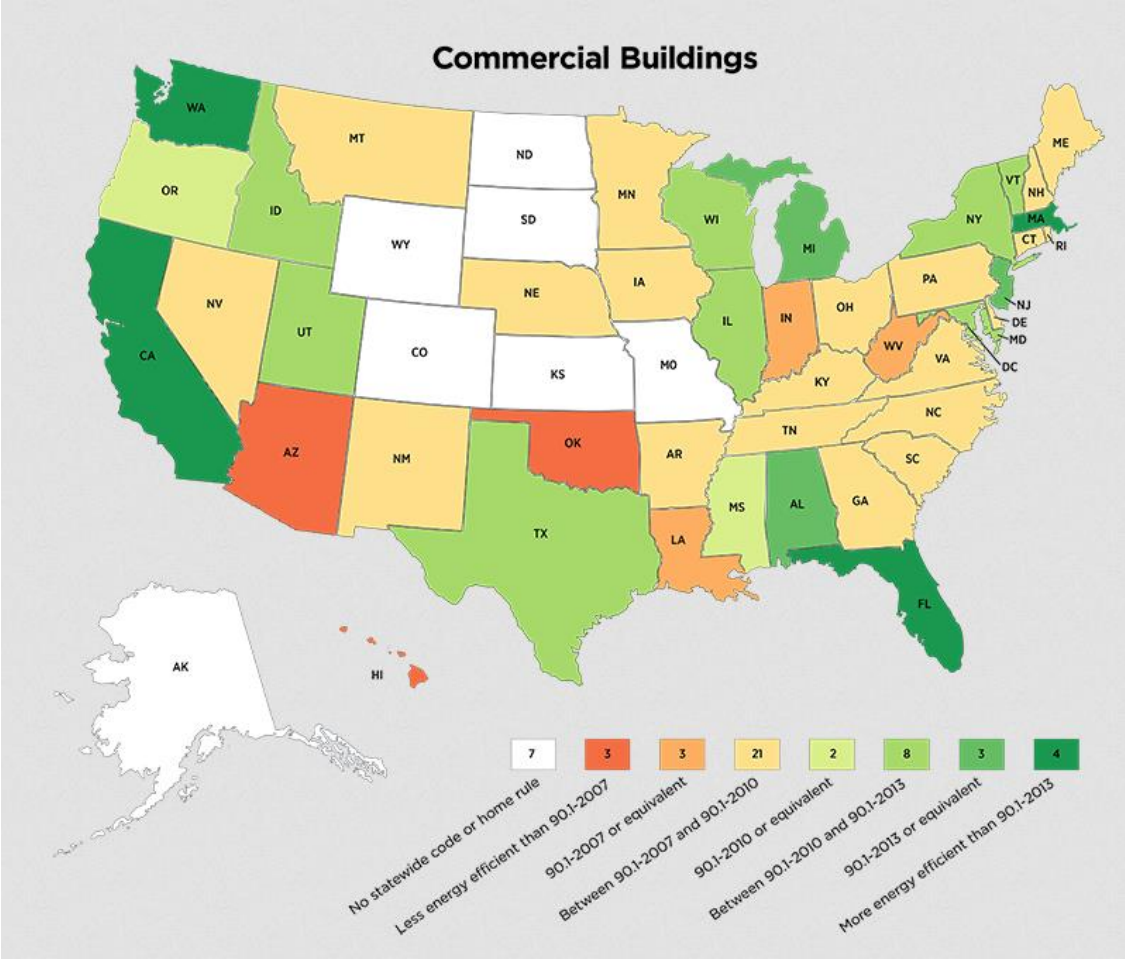
consumption and sustainability, and compliance with building codes—each of which are ranked as benefits of wireless lighting controls.

Reduced or restrictive budgets are common in many institutions, so the importance of a facility's renovation cost is of little surprise—and is often a primary hurdle. As lighting control technology has advanced the costs have decreased, and this will help increase adoption of lighting controls. A wireless lighting control system can often be more cost-effective than a wired solution, as it removes the need to open walls to run cabling. A director of lighting design at an electrical engineering design firm highlights these benefits; "cost is driving a lot of decisions. With digital controls, plug-n-play does help drive down the cost of installation. It offers flexibility to make changes in the future that regular hardwired systems don't offer." These features make a wireless lighting control system especially attractive in retrofit applications.

Meeting a state's building codes and standards often drives the decision to deploy lighting controls. Often state dependent, building codes can require occupancy sensors, dimming, or daylighting. California's Title 24, for example, is creating a growing market for lighting controls as the state works to reduce energy use and incorporate lighting-specific requirements into its Energy Efficiency Standards. While considered the most progressive in terms of energy efficiency requirements, California is not alone in requiring lighting control strategies at the state level. Many states have implemented components of the ASHRAE Standard 90.1, which provides a minimum benchmark for energy efficient design of buildings. The newest iteration of the ASHRAE Standard 90.1 passed in 2016 and was the first version to require controls for daylighting. While the ASHRAE Standard 90.1 is not required, many states use this as a benchmarking effort and aim to meet various versions. Lighting controls can help a university or college ensure code compliance through reduced energy use, even when it is not directly linked to lighting controls.

Figure 2-1 shows state energy code adoption as of June 2018.

Figure 2-1. Energy Code Adoption by State



(Source: US Department of Energy)

During the decision-making process, both short- and long-term energy savings often are part of the overall cost evaluation in terms of investment. For universities or colleges, this allows for an examination of the ROI of the project rather than just the upfront cost. When LED fixtures were introduced to the market at a higher cost than legacy fixtures, the justification for investment was that the new technology was the ROI delivered by increased energy savings. Wireless lighting controls can not only be less expensive than wired controls but they can also provide additional energy savings. These energy savings can even be provided to an LED lighting project—making the financial case for lighting controls more attractive. All of this now makes sustainability and optimal environments an affordable—even financially practical—option.

2.5.2 Aesthetics

The look and feel of a campus is a key pillar in building an optimal experience. Aesthetics undoubtedly influence the decision of prospective students and thus must play a role student recruiting strategy. Beyond enrollment management, aesthetics help create a sense of community in higher education. The connection to the built environment is fundamental to creating a space where students and faculty want to be.

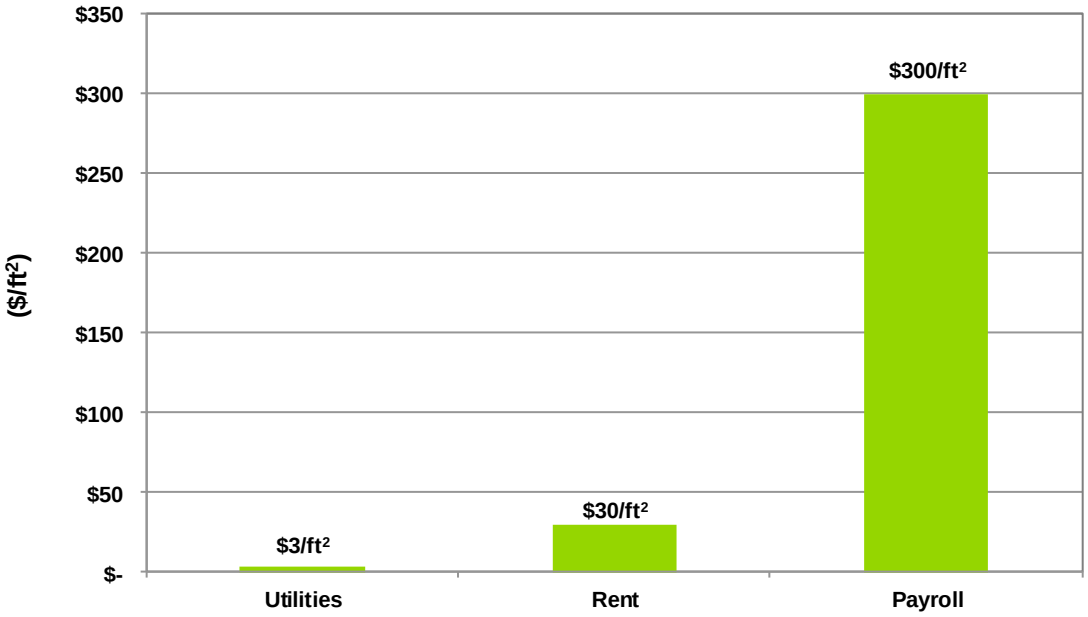
The design aesthetics of a lighting control system can enhance a building's appearance and highlight key attributes of the occupants' experience. Lighting controls allow for a customized solution for a building's interior and exterior design. A lighting control system allows a college or university to highlight the architecture or décor of its buildings and can provide a more welcoming environment due to a change in light levels.

2.5.3 Usability

The third component of an optimal experience is usability. Usability is reflected in the importance of occupant comfort. To Kimberly Smith, Lighting Designer at Jacobs, lighting controls are "great for faculty and the end user. They will have more freedom when they are in the classroom and will have flexibility. They will not be tied to a switch on the wall." Quantifying an occupant's well-being and productivity is more difficult than quantifying energy savings. Because of this, it is less likely to be the primary justification for a lighting controls retrofit. However, the impact is profound. The cost of real estate is typically an order of magnitude greater than the cost of energy. Moreover, the cost of payroll is typically an order magnitude greater than the cost of real estate.

Real estate investment management company JLL describes this as the 3-30-300 rule, with utilities costing on average $\$3/ft^2$, rent costing on average $\$30/ft^2$, and payroll costing on average $\$300/ft^2$. While these numbers are not set in stone, they help put an organization's occupancy cost distribution into perspective. This rule helps organizations see how cutting costs across these three areas can affect overall spending. For example, if a company can cut costs across each category by 10%, it will save $0.30 in utility costs, $3 in rent, and $30 in payroll per square foot. When viewing buildings costs in this manner, prioritizing occupant's health and productivity can become more important and more easily justified from a financial perspective for a company.

Chart 2-7. Occupancy Cost Distribution



(Source: Navigant Research, JLL)

While payroll is not viewed in higher education quite the same as it might be in a commercial office building, this concept can still apply where there is a range of businesses. The cost of attracting and keeping students, faculty, and staff is important to the success of a college or university. Looking at student performance and not just cost highlights the importance of focusing on the occupants' comfort, health, and productivity—and ultimately delivers on the institution's overall mission.

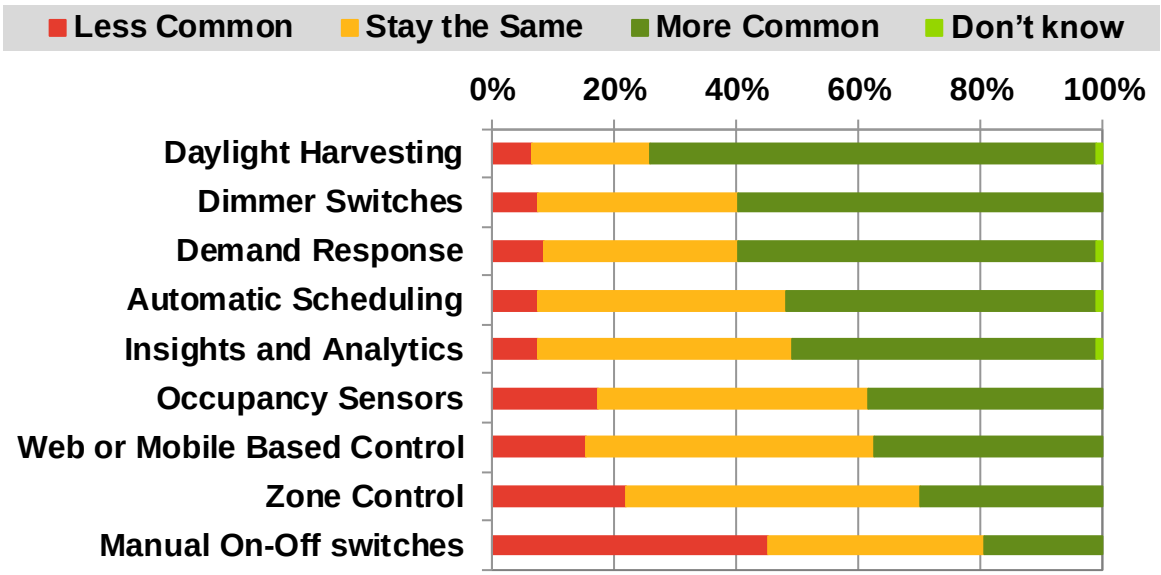
The effects could extend to a long-tail economic view as well. In a healthy and comfortable building, students perform better, which influences the success of their professional careers. This in turn can benefit the college or university by ultimately ramping up the bottom line through additional funding and more successful and engaged alumni, which then helps attract more students. To a project manager and electrical engineer at an engineering design and consulting services company, lighting controls are "a means of energy efficiency and personal comfort control when applied to tunable white or dimmable light fixtures." A lighting control system that provides occupants the correct lighting for a given task and is easy to use can help increase productivity and reduce frustration and time. When viewing building upgrade costs through this lens, prioritizing occupant well-being and productivity can be justified from a financial perspective for a higher education institution.

2.6 Future of Lighting Control Strategies

Lighting controls, though slower in adoption compared to LEDs, are expected to increase in proliferation due to several factors. The growth of LEDs—which provide more controllability than their legacy lighting counterparts—is expected to help drive adoption. This inherent controllability reduces the cost of adding controls. When coupled with the additional energy savings, lighting controls can provide an attractive ROI. Building codes and standards, sustainability goals, and increased occupant comfort and productivity are all drivers for increased adoption of lighting controls. Among decision makers for lighting controls, 62.5% of respondents believe lighting controls are a priority facility upgrade, demonstrating the growing awareness of the impacts of lighting controls.

In higher education deployments, not all lighting control strategies are expected to grow at the same rate. When asked about the growth potential of various lighting control technologies, survey respondents ranked daylight harvesting as the most likely to become more common, followed by dimmer switches and demand response control systems, as seen in Chart 2-8.

Chart 2-8. Growth Potential of Lighting Control Technologies



Note: n=100

(Source: Navigant Research)

A variety of lighting control strategies are available on the market. Some of the different lighting control approaches are described below.

- **Daylight harvesting** is a change in lighting in response to the amount of natural light. These systems offset the amount of electric lighting provided when natural light is already illuminating a space. A photosensor measures the amount of light in a space and a control module either dims or shuts off fixtures when the light they provide is not needed.
- **Dimmer switches** as part of an automated partial off for stairwells and corridors allow areas with lower traffic flow to be dimmed significantly when occupants are not present to help increase energy savings.
- **Demand response** control systems result in a change of lighting in response to a signal from a utility to reduce energy consumption during a particular period, often during peak demand.
- **Automatic scheduling** refers to a change in light levels delivered based on a set schedule. This more basic approach to lighting is already commonly used in many buildings but advances in lighting control systems can make automatic scheduling easier and applicable to a wider range of spaces. Even as lighting controls shift to more sophisticated strategies, automatic scheduling will continue to remain popular.
- **Insights and analytics** provide a facility manager data on how a system functions and can provide visualizations on improvements or opportunities for increased energy savings. Additionally, data from lighting control systems can be used to provide a picture of space utilization. The resulting information can be used to determine usage patterns and identify underutilized facilities.
- **Occupancy sensors** result in a change in lighting based on the presence (or lack) of people. This is one of the most popular lighting controls and has increased in use due in part to building energy codes and ease.

The lighting controls strategies expected to see increased deployment in the future enhance the experience by contributing to all key performance indicators for the institution: efficiency, aesthetics, and usability. Many of these are required by building codes, provide additional energy savings, and aid in occupant comfort and increased productivity.

2.7 Case Study

In 2014, the facilities department at UCLA Athletics was tasked with a request from the football team to control the lights in the athletic facilities for the film study rooms, auditorium, and computer classrooms. The stakeholders in the project were the end users of the systems, the coaches, staff, and students. Their objective was to save energy and have easier control to be able to customize their lighting for various needs. Kevin Borg, Assistant Athletic Director of Project Management at UCLA Athletics, worked with Audacy

to bring advanced wireless lighting controls into the university's athletic buildings through a pilot project. The project included the installation of 23 motion sensors, 22 switches, and two gateways.

For the UCLA athletic department, the advanced controls changed the way occupants interacted with the building, enabling a customizable experience while simultaneously saving energy. UCLA switched their lighting fixtures into smart fixtures with the wireless controls from Audacy, which allowed the system to be centrally located. Additionally, controls for the softball fields provided remote control of the lights and allowed the athletic department to save on staff hours at the end of events waiting to manually turn off the lighting.

The lighting control deployment allowed light levels to be pre-set for specific rooms. For example, when the football team enters the film rooms, the lights automatically come on to only 50% brightness. Depending on the needs of each room, from a movie event to speaking engagement, each luminaire can be controlled individually through a mobile device or tablet. For UCLA, the simplicity of the system to install, commission, and operate has allowed them to provide these improvements to the staff and students without additional operation and maintenance burdens on the facilities department. For Kevin Borg, the most important feature for lighting controls was a system that is "simple and easy to function at any level of experience" to assure no additional burden on training or staffing. The simplicity of the system has allowed for the administration, custodial team, and coaching staff to adjust the lighting to their specific needs without needing extensive training.

UCLA has seen a 35% savings in energy use and expects to see 45%-50% savings in the near term. The wireless configuration allowed each luminaire to be quickly retrofitted. An initial barrier faced by the athletic department was lack of knowledge of some of the stakeholders on different lighting systems. Due to the quick installation process, Kevin Borg was able to show the involved parties the benefits of the new system once in place, knowing that if they were not convinced of the benefits, removing the sensors would not be difficult. The long battery life, rated at 25 years, allowed for an easy, quick installation and system flexibility, while not creating extra work for the facilities department. Kevin Borg believes wireless lighting controls technologies will change "how [UCLA] will harvest and save energy in California."

2.8 Conclusion

The decision to invest in wireless lighting controls relies on multiple decision makers in higher education. Decision makers and those involved in the budget for energy efficient upgrades might vary from one institution to another, but all are committed to furthering the mission of their college or university. Lighting controls accomplish this by helping drive

sustainability goals, increase energy savings, comply with building codes, and increase occupant comfort and productivity for a college or university.

Despite the benefits, however, lighting control adoption has been limited. However, advancing controls technology and growing sophistication of controls strategies are expanding possibilities for higher education. In the future, lighting controls will increasingly become a priority for facilities upgrades. Strategies like daylight harvesting can help reduce the amount of electrical lighting needed, driving energy savings. Lighting control features that provide insights and analytics provide increased usability. Better lighting controls enable institutions to provide better light, improving campus aesthetics. Each of these connect in lighting control systems to help schools and universities create an optimal experience for students and faculty.

Section 3
ACRONYM AND ABBREVIATION LIST

ASHRAE.....American Society of Heating, Refrigerating and Air-Conditioning Engineers

ft .....Feet

HVAC ..... Heating, Ventilation, and Air Conditioning

IT ..... Information Technology

LED .....Light-Emitting Diode

O&M .....Operations and Maintenance

ROI .....Return on Investment

UCLA..... University of California, Los Angeles

Section 4

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Section 6
SCOPE OF STUDY

This white paper was commissioned by IDEAL INDUSTRIES, INC. and its subsidiary Audacy Wireless Lighting Control. Independent secondary research and interviews were conducted by Navigant Research. Additionally, Navigant Research administered a joint-developed survey about wireless lighting controls to architects, lighting and electrical engineers, facility managers, facility executives, lighting designers, and mechanical engineers as part of the work for this white paper. Navigant Research white papers are designed to be objective, third-party documents. As such, Navigant Research does not endorse any specific company or products. This white paper contains a case study highlighting Audacy Wireless Lighting Control's capabilities and success in higher education.

SOURCES AND METHODOLOGY

Navigant Research's industry analysts utilize a variety of research sources in preparing Research Reports. The key component of Navigant Research's analysis is primary research gained from phone and in-person interviews with industry leaders including executives, engineers, and marketing professionals. Analysts are diligent in ensuring that they speak with representatives from every part of the value chain, including but not limited to technology companies, utilities and other service providers, industry associations, government agencies, and the investment community.

Additional analysis includes secondary research conducted by Navigant Research's analysts and its staff of research assistants. Where applicable, all secondary research sources are appropriately cited within this report.

These primary and secondary research sources, combined with the analyst's industry expertise, are synthesized into the qualitative and quantitative analysis presented in Navigant Research's reports. Great care is taken in making sure that all analysis is well-supported by facts, but where the facts are unknown and assumptions must be made, analysts document their assumptions and are prepared to explain their methodology, both within the body of a report and in direct conversations with clients.

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